Energy Community

Renewable Energy

Modalities to foster use of renewable energy sources in the transport sector by the Energy Community Contracting Parties

LBST, E4tech, S.E.E.C.

December 2020

This report was financed by the Energy Community.

MODALITIES TO FOSTER USE OF RENEWABLE ENERGY SOURCES IN THE TRANSPORT SECTOR BY THE ENERGY COMMUNITY CONTRACTING PARTIES

AN EXPERTISE FOR THE ENERGY COMMUNITY

FINAL REPORT

Ludwig-Bölkow-Systemtechnik GmbH (LBST)
Daimlerstr. 15
85521 Ottobrunn (Munich)
Germany

E4tech UK Ltd.
83 Victoria Street
London SW1H 0HW
United Kingdom

South East Europe Consultants Ltd. (S.E.E.C.)
Makenzijeva 53/I
Belgrade, 11000
Serbia

Title:	Modalities to foster use of renewable energy sources in the transport sector by the Energy Community Contracting Parties
Client:	Energy Community
Document version:	Final Report V5.7
Date:	30. November 2020
Authors:	Matthias Altmann (Ludwig-Bölkow-Systemtechnik) Patrick Schmidt (Ludwig-Bölkow-Systemtechnik) Tetyana Raksha (Ludwig-Bölkow-Systemtechnik) Jan Albrecht (Ludwig-Bölkow-Systemtechnik) Ausilio Bauen (E4tech) Jo Howes (E4tech) Lizzie German (E4tech) Lee Roberts (E4tech) Pedja Bulic (South East Europe Consultants) Pavle Vulić, Ivan Vulić, Milena Tomić (South East Europe Consultants)
Contact:	Matthias Altmann, Senior Consultant Ludwig-Bölkow-Systemtechnik GmbH Ottobrunn/München, Germany e: matthias.altmann@lbst.de p: +49 89 60 81 10 38

REPORT

Disclaimer

CONTENTS

TABLES

FIGURES

ACRONYMS AND ABBREVIATIONS

1G	1st generation
ABE	Acetone-Butanol-Ethanol
AD	Anaerobic digestion
AEL	Alkaline electrolyser
BEV	Battery-electric vehicle
CAPEX	Capital Expenses
CCS	Carbon Capture and Storage
CNG	Compressed natural gas
CO2	Carbon dioxide
CP	Contracting Parties
DME	Dimethyl ether
DMU	Diesel Multiple Unit
E10	Gasoline with 10%vol ethanol
E5	Gasoline blended with 5%vol ethanol
ECS	Energy Community Secretariat
EMU	Electric Multiple Unit
ETBE	Ethyl Tert-Butyl Ether
ETJ	Ethanol to Jet
ETS	Emissions trading system
EU	European Union
EV	Electric vehicle
FAME	Fatty Acid Methyl Ester
FAO	Food and Agriculture Organisation
FCEV	Fuel cell-electric vehicle
FCH JU	Fuel Cells and Hydrogen Joint Undertaking
FEC	Final Energy Consumption
FT	Fischer-Tropsch
FT-SPK	Fischer-Tropsch Synthetic Paraffinic Kerosene
GDP	Gross Domestic Product
GHG	Greenhouse Gas
H2	Hydrogen
HEFA	Hydroprocessed Esters and Fatty Acids
HVO	Hydrotreated Vegetable Oil
ICE	Internal Combustion Engine
iLUC	Indirect land use change
LBST	Ludwig-Bölkow-Systemtechnik
LCA	Life Cycle Analysis
LNG	Liquefied Natural Gas
MSW	Municipal solid waste
MTBE	Methyl-tert-butyl-ether
MTG	Methanol-to-gasoline
NECP	National Energy and Climate Plan

NG	Natural Gas
NEEAP	National Energy Efficiency Action Plan
NEURC	National Energy and Utilities Regulatory Commission of Ukraine
NREAP	National Renewable Energy Action Plan
PEM	Proton Exchange Membrane
PEV	Plug-in electric vehicles
PHEV	Plug-in hybrid electric vehicle
PtG	Power-to-Gas
PtL	Power-to-Liquids
RE	Renewable Energy
RED	Renewable Energy Directive (Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources)
RED II	Renewable Energy Directive recast (DIRECTIVE (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources)
RES	Renewable Energy Sources
RES-T	Renewable Energy Sources in the Transport sector
RFNBO	Renewable Fuels of Non-Biological Origin
RME	Rapeseed methyl ester
SEEC	South East Europe Consultants
SOE	Solid oxide electrolyser
TRL	Technology Readiness Level
TSOI	Technical Specifications of Interoperability
UK	United Kingdom
USA/US	United States of America
UCOME	Used cooking oil methyl ester
WEG	World Energy Group
ZEV	Zero Emission Vehicle
Contracting Party Codes	
AL	Albania
BA	Bosnia and Herzegovina
GE	Georgia
XK	Kosovo*[1]
MD	Moldova
ME	Montenegro
MK	North Macedonia
RS	Serbia
UA	Ukraine

[1] *This designation is without prejudice to positions on status and is in line with UNSCR 1244/99 and the ICJ Opinion on the Kosovo* declaration of independence

Executive Summary

The Energy Community Contracting Parties (CPs) have the obligation to reach binding targets for the renewable energy share in gross final energy consumption by 2020 on the basis of the Renewable Energy Directive (RED). For the transport sector, the binding target is a minimum 10% of renewable energy in transport (RES-T) by 2020. None of the CPs will achieve this target.

The Energy Community has started considering the implementation of the revised Renewable Energy Directive (EU) 2018/2001 (RED II) on the promotion of the use of energy from renewable sources. Currently, RED II is not a part of the Energy Community acquis, but the adaptation and transposition by the Contracting Parties is, however, envisaged. Assuming for this study that the provisions of RED II are transposed into the laws of the CPs without changes, we develop roadmaps for each CP towards achieving the 2030 target for renewables in transport in accordance with RED II.

Energy consumption in transport is anticipated to grow in the CPs; in many, anticipated growth is stronger by 2030 than RES-T consumption for target compliance. This would result in a net increase in fossil fuel imports making even higher ambitions for RES-T potentially beneficial economically by reducing fossil fuel imports, and in environmental terms.

The level of renewable energy consumption in transport in 2018[2] varies between the CPs from 0 to 1.6%[3]. Biofuels consumption that does not comply with the provisions, notably on sustainability, of RED, is not included in these figures. The regulatory basis for RES-T development also varies between the CPs, from being at an early stage of consideration to having regulatory frameworks with recently added major elements of RED. Provisions of RED II, which in some elements are different from RED or are new, and in other elements are more ambitious, notably on sustainability requirements, have not yet been taken up in any CP. In most CPs, no target for renewable energies in transport has been defined yet.

In all CPs, sufficient options are available to achieve RES-T targets compliant with RED II.

Policies for RES-T should be based on three pillars: biofuels, electricity and hydrogen.

For biofuels, RED II shifts the focus away from crop-based biofuels towards advanced biofuels: those made from a defined list of waste or residue-based or cellulosic feedstocks.

Electricity can be readily used in incumbent electric applications including rail, trolleybuses, tramways and metros, or in battery-electric vehicles from passenger cars to delivery vehicles to buses. The latter require the roll-out of a recharging infrastructure, and the introduction of battery-electric vehicles into the fleet. Electricity consumption in transport is taken to be renewable by RED and RED II to the extent that the national electricity mix is renewable. This provides for major synergies between policies aiming at increasing renewables in the electricity mix and in transport. Also, there are synergies between general transport policies

[2] latest available data for all CPs.

[3] Based on the calculation methodology of RED including multipliers for certain fuels and applications.

and RES-T policies, e.g. through promoting public transport and rail, including for freight transport.

Hydrogen in transport using fuel cell-electric vehicles is in early phases of commercialization world-wide, and shows major potential for decarbonizing transport in a complementary fashion to battery-electric vehicles. A small contribution by 2030 and dynamic growth thereafter is anticipated for hydrogen in road transport with a focus on road vehicles for longer driving distances including passenger cars, and for heavy duty purposes such as trucks, buses and coaches, and on non-electrified rail lines. Renewable hydrogen can also be used to produce sustainable liquid fuels for aviation, shipping, etc.

Key policy elements to be implemented and enforced by the CPs include:

- blending obligation on fuel suppliers for renewable fuels,
- sustainability framework for renewable fuels,
- sustainability certification for renewable fuels,
- promotion of electric charging and hydrogen refuelling infrastructures and incentives for battery-electric and fuel cell-electric vehicle purchase.

All elements of the regulatory framework should be in place by the end of 2022.

Complementary policies are recommended to be established in order to ensure target achievement and maximum benefits to the CP economies. These may include:

- adjusting taxation and customs duty systems to provide incentives for renewable fuels as well as electric and hydrogen vehicles, and disincentives for fossil fuels,
- financial incentives through grants, subsidies and loans,
- clear permitting rules for electric charging and hydrogen refuelling infrastructure,
- communication and information campaigns on renewable fuels and vehicles,
- lighthouse projects at local/ municipal level, the establishment of zero or low emission zones in urban areas for reduced air pollution,
- professional and academic training,
- technical inspections of vehicles (both electric and conventional), etc.

Policies should be revised and possibly adjusted around 2025 based on a policy evaluation. The regular revisions of the National Energy and Climate Plans are the appropriate instrument for monitoring success and ensuring 2030 target achievement.

Additional benefits of achieving 2030 RES-T targets include the reduction of fossil energy import dependence, additional national value creation, new or enhanced national value chains with related economic benefits and job creation, and additional contributions to the national climate targets.

At Energy Community level, we recommend

- including RED II into the Energy Community acquis,
- encouraging CPs to implement all provisions of RED II into national law by the end of 2022, and defining a RES-T target for 2030 on this basis,
- facilitating the exploitation of synergies between the CPs in introducing RES-T,
- promoting good practices from other CPs and globally for the benefit of the CPs.

1 INTRODUCTION

The Energy Community, established on 1 July 2006 by the European Union (EU) on the one side and Albania, Bosnia and Herzegovina, Georgia, Kosovo*[4], North Macedonia, Moldova, Montenegro, Serbia and Ukraine (the "Contracting Parties" – CPs) on the other side, extends the European Union internal energy market to the Contracting Parties.

The mission of the Energy Community is to create an integrated and sustainable pan-European energy market providing a framework that is capable of attracting investments for stable and continuous energy supply. Furthermore, the Energy Community strives to improve the environmental situation in relation with energy supply in the region and foster the use of renewable energy and energy efficiency.

The Contracting Parties of the Energy Community have committed to meet the targets and obligations arising from the Energy Community acquis comprising the EU legislation in network energy (electricity, gas, oil), environment, climate, competition, renewable energy, energy efficiency and statistics.

In addition to a general obligation of the Contracting Parties to achieve targets for renewable energy by 2020[5], there is a specific target for renewable energy in transport (RES-T) of 10% by 2020 based on the Renewable Energy Directive (RED) of 2009. None of the CPs will achieve this target.

The Energy Community has started considering the implementation of the Renewable Energy Directive recast (EU) 2018/2001 of 21 December 2018 on the promotion of the use of energy from renewable sources (RED II), together with the Clean Energy Package, including the Governance Regulation[6]. The governance mechanism of the regulation is based on integrated National Energy and Climate Plans (NECPs) covering ten-year periods starting from 2021 to 2030. The CPs are currently drafting the first NECPs, following the Recommendation of the Ministerial Council of the Energy Community 2018/1/MC-EnC on preparing for the development of integrated national energy and climate plans by the Contracting Parties of the Energy Community

RED II has revised the sustainability criteria for biofuels, and has significantly enhanced the options for renewable electricity and renewable fuels of non-biological origin[7] (RFNBO) including hydrogen to contribute to the RES-T targets. It has set an overall target of 14%

4 *This designation is without prejudice to positions on status and is in line with UNSCR 1244/99 and the ICJ Opinion on the Kosovo* declaration of independence

5 Decision D/2012/04/MC-EnC of the Energy Community' Ministerial Council on the implementation of Directive 2009/28/EC and amending Article 20 of the Energy Community Treaty

6 Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action

7 RED II Art. 2 defines: "'renewable liquid and gaseous transport fuels of non-biological origin' means liquid or gaseous fuels which are used in the transport sector other than biofuels or biogas, the energy content of which is derived from renewable sources other than biomass".

renewable energies in transport by 2030, albeit with options for Member States to adjust that target. A number of options and limitations are defined in RED II to achieve this target, including most notably limitations for biofuels from food and feed crops. For biofuels, RED II shifts the focus away from crop-based biofuels towards advanced biofuels: those made from a defined list of waste or residue-based or cellulosic feedstocks.

The European Union is currently developing the details of the European Green Deal, which aims to make the European Union climate neutral by 2050 by turning climate and environmental challenges into opportunities, and making the transition just and inclusive for all. Based on a set of policy initiatives by the European Commission, climate ambitions by 2030 are anticipated to be increased, which includes adjustments to RED II.

As an early response to the European Green Deal, and more generally significant transformation of approaches to energy development around the globe, Ukraine has adopted the "Ukraine 2050 – Green Energy Transition Concept – Ukraine Green Deal". The document sees this transition as "both a challenge and an opportunity for Ukraine".[8]

This study has the overall objective of reviewing the current status of RES-T in the Contracting Parties and of developing a roadmap for each CP for increasing the renewable share in transport to a level compliant with RED II by 2030. It is assumed for the analyses of this study that the provisions of RED II are transposed into CP laws without changes.

This report provides information and results covering all CPs in the first 5 chapters:

- A review of the current status of RES-T in the CPs, and development of projections of RES-T share development by 2030 (chapter 2);
- A description the main characteristics of different types of renewable fuels, and identification of the RES potentials in each CP for use in transport (chapter 3);
- A review of good practices in increasing RES-T shares in Europe and globally (chapter 4);
- An overview of the options combining renewable fuels and transport (sub-)sectors (chapter 5).

Each of the subsequent chapters provides specific information and results for one CP, including:

- current status and 2030 projections of RES-T (chapters x.3);
- potential of national renewable energy sources to meet the 2030 RES-T target, and status of fuel pathway deployment (chapters x.4);
- regulatory status quo assessment and roadmap up to 2030 for achieving the RES-T target according to RED II on the three pillars of biofuels, electricity and hydrogen covering all transport sectors (chapters x.5);

8 Ukraine 2050 – Green Energy Transition Concept – Ukraine Green Deal (2020), p. 1.

- conclusions and recommendations (chapters x.6).

This study was carried out during the COVID-19 pandemic, which has significantly affected all CPs. However, it was unfortunately not possible to take consequences and effects of COVID-19 into account in the analyses and assessments, which are based on statistical data until 2018, on the regulatory status quo in each CP, and on a large number of available publications, which in general do not include COVID-19 effects.

2 STATUS OF RENEWABLE ENERGIES IN TRANSPORT

2.1 Status quo

Transport energy consumption is dominated by oil and petroleum products in all CPs.[9] Ukraine has a significant share of electricity consumption in transport. Georgia has a significant consumption of natural gas in transport.

Renewable energy consumption in transport is generally low in the Energy Community Contracting Parties (CP) except in Albania, which has a high share of biofuels. However, these do not fulfil sustainability requirements, and are thus not compliant with RED. Transport in Ukraine also consumes biofuels, which are not compliant with RED. The quantities here are lower than in Albania, both in absolute and in per-capita terms.

Bosnia and Herzegovina, Georgia, Montenegro, North Macedonia, Serbia and Ukraine have renewable electricity consumption in rail. This is based on significant shares of rail in transport in Ukraine (7.5% of final energy consumption in transport, of which 5.8% electricity), Georgia (3.4%, of which 2.5% electricity), and Serbia (2.0%, of which 1.5% electricity). Rail has smaller shares in the other CPs, with zero electricity consumption in rail in Albania and Kosovo*. Electricity is consumed in public transport by trolleybuses operated in Moldova, Serbia and Ukraine, tramways operated in Bosnia and Herzegovina, Serbia and Ukraine, and by a metro operated in Ukraine[10].

The renewable share of electricity depends on the renewable share in the electricity mix in each CP.[11]

This chapter gives an overview of the energy consumption in transport in the Contracting Parties. Data for the following figures in this section are based on CP statistical offices, Eurostat Energy Balances, Eurostat SHARES and Progress Reports by the CPs relating to the Renewable Energy Directive 2009/28/EC. More details are provided in the relevant sections X.3.1 of each CP's chapter below.

Latest available data are for 2018 with very few exceptions, where 2017 values are shown in the following graphs as an overview of the CPs. Both absolute consumption data and per capita consumption data are shown.

Ukraine has the largest energy consumption being the Contracting Party with the largest population. In all countries oil and petroleum products are the dominant type of fuel. Significant shares of other types of fuel are electricity in Ukraine, natural gas in Georgia, and biofuels in Albania and Ukraine. Biofuels consumed in Albania and in Ukraine are not

9 Ukraine has a significant consumption of LPG, which is covered by oil and petroleum products.

10 A metro system for Belgrade, Serbia, is in planning.

11 The provisions of RED allow for using either the national electricity mix or the European electricity mix. This choice is no longer possible under RED II.

compliant with the requirements of the Renewable Energy Directive. Most notably, they do not fulfil sustainability requirements as defined in RED (see section 3.1.1).

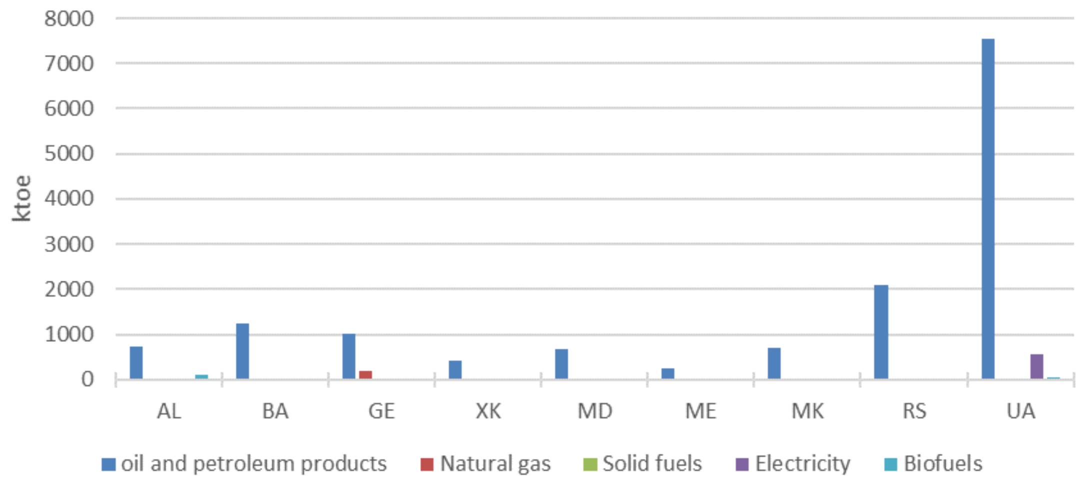

Figure 1: Absolute energy consumption in transport by type of fuel in 2018[12]

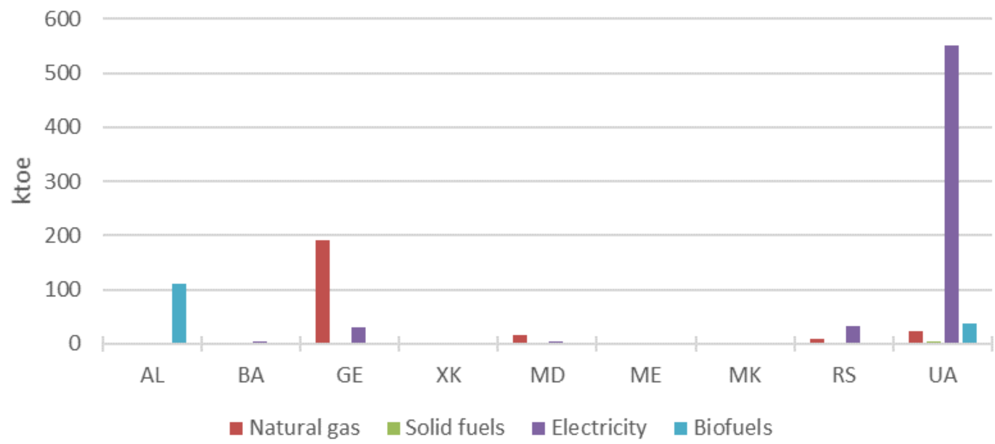

Figure 2: Absolute energy consumption in transport by type of fuel in 2018 without petroleum products (showing details of previous figure)[13]

[12] CP statistical offices, CP Progress Reports related to the Renewable Energy Directive 2009/28/EC, Eurostat Energy Balances, Eurostat SHARES (see CP chapters below for details)); solid fuels include all types of solid fossil fuels as used in statistics by Eurostat, including hard coal, brown coal and coal products; see https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Fossil_fuel

[13] Biofuels are non-compliant with RED; Sources: CP statistical offices, CP Progress Reports related to the Renewable Energy Directive 2009/28/EC, Eurostat Energy Balances, Eurostat SHARES (see CP chapters below for details)

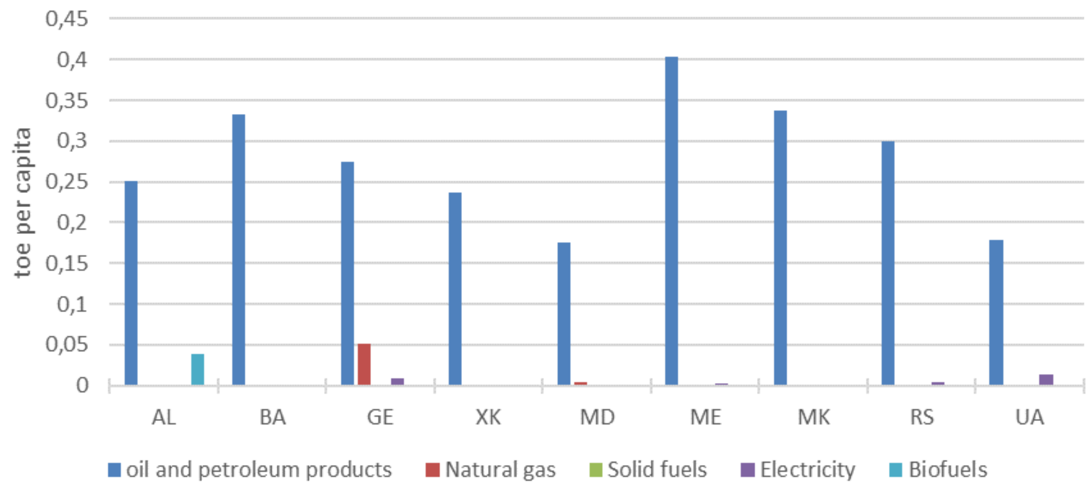

Figure 3: Energy consumption in transport per capita by type of fuel in 2018[14]

For better comparison of the structure of energy consumption in transport in the CPs, energy consumption per capita is shown below in order to eliminate the effect of CP size.

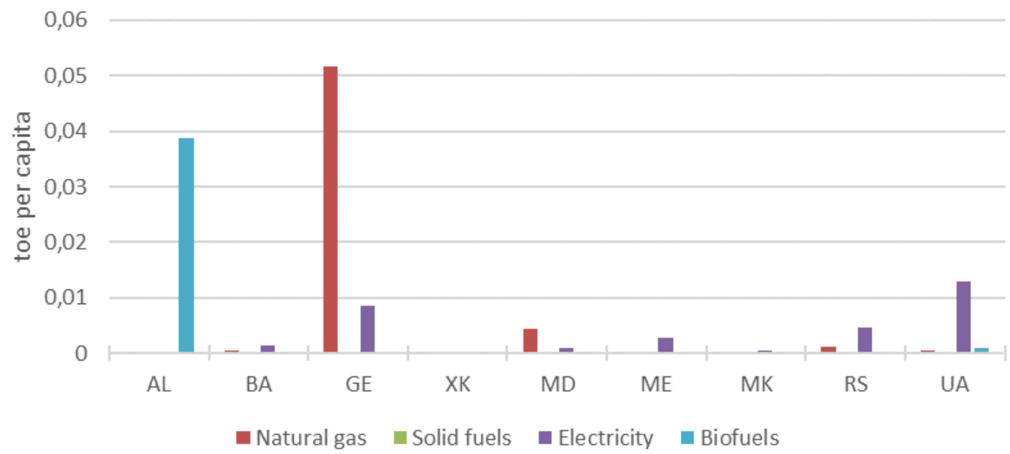

Figure 4: Energy consumption in transport per capita by type of fuel in 2018 without petroleum products (showing details of previous figure)[15]

[14] Biofuels are non-compliant with RED; Sources: CP statistical offices, CP Progress Reports related to the Renewable Energy Directive 2009/28/EC, Eurostat Energy Balances, Eurostat SHARES (see CP chapters below for details)); population data for Moldova are from 2017

[15] Biofuels are non-compliant with RED; Sources: CP statistical offices, CP Progress Reports related to the Renewable Energy Directive 2009/28/EC, Eurostat Energy Balances, Eurostat SHARES (see CP chapters below for details) ; population data for Moldova are from 2017

Montenegro has the highest per capita consumption of oil and petroleum products in transport of all CPs. Moldova and Ukraine have the lowest. Natural gas consumption in Georgia is the most significant per capita consumption of non-oil-based transportation fuels. Natural gas consumption per capita is much lower in Bosnia and Herzegovina, Moldova, North Macedonia, Serbia and Ukraine, and zero in the other CPs.

Ukraine has the highest per capita consumption of electricity in transport.

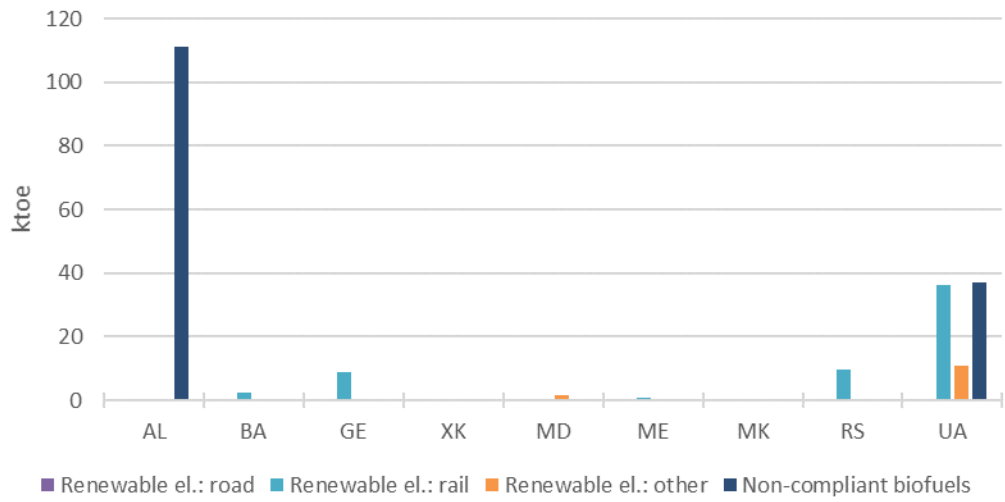

Figure 5: Renewable energy consumption in transport by type of fuel in 2018[16]

Where biofuels are consumed in transport in the CPs, these are not compliant with requirements of the Renewable Energy Directive so far, notably with the sustainability requirements.

Albania has a significant consumption of biofuels of above 10%, which are not compliant with the Renewable Energy Directive. Due to its large amount of non-compliant biofuels, Albania has an absolute consumption of renewable energy in transport that is almost as high as the consumption of renewable electricity in transport in Ukraine, which has a far larger population. Georgia and Serbia have a sizeable consumption of electricity from renewable sources in transport. All consumptions in other CPs are small in comparison.

The large absolute consumption of non-compliant biofuels yields a per capita consumption for Albania which is more than 20 times higher than in any of the other CPs. Leaving Albania aside, Ukraine has the highest combined consumption of renewable energy in transport; however, biofuels are not RED compliant. Half of all renewable energy consumed in Ukraine is provided by (non-compliant) bioethanol while the other half is provided by electricity. In all other CPs, use of electricity from renewable sources is the only renewable energy in

16 CP statistical offices, CP Progress Reports related to the Renewable Energy Directive 2009/28/EC, Eurostat Energy Balances, Eurostat SHARES (see CP chapters below for details)); data for Bosnia and Herzegovina are from 2017; assignment of renewable electricity consumption to “road”, “rail” and “other” as defined by the CPs.

transport except for Kosovo*, which does not use renewable energy in transport at all. Georgia has the highest per capita renewable electricity consumption in rail.

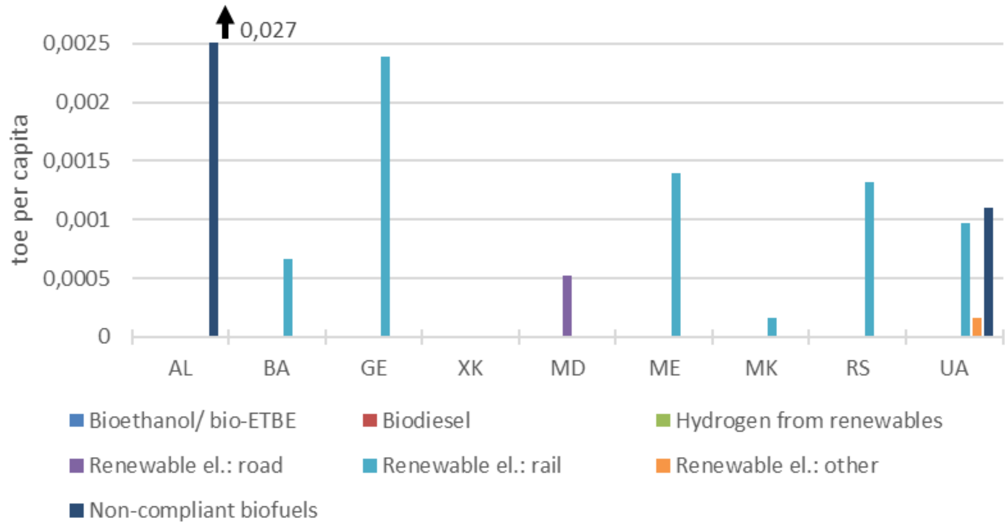

Figure 6: Renewable energy consumption per capita by type of fuel in 2017[17]

2.2 2030 projections

For each Contracting Party, 2030 projections of fuel consumption in transport have been made, which are presented in the respective sections X.3.2 of the CP chapters below.

Depending on available publications, the basis for the projections varies by CP. For 3 CPs (XK, ME, RS) government documents are taken as the basis, for 1 CP (UA) a scientific study is used, for 1 CP (MK) a strategy study is used, and for 4 CPs (AL, BA, GE, MD), extrapolations of past energy consumption data in transport have been made based on a correlation of final energy consumption in transport with GDP and assuming an overall efficiency gain of 10% by 2030. As the bases for the projections and the underlying methodologies are different in each CP, the projections cannot be compared with each other. However, we provide an overview of the projections for all CPs here in order to allow for an appreciation of the similarities and differences in the nine CPs for the coming decade.

We provide here two 2030 projections: a business as usual scenario, and a scenario for compliance with the 2030 target for renewable energies in transport according to RED II. The business as usual scenario assumes no policy changes related to energy in transport until 2030. The compliance scenario assumes that all necessary policies are put in place to achieve the 2030 RES-T target based on RED II.

[17] CP statistical offices, CP Progress Reports related to the Renewable Energy Directive 2009/28/EC, Eurostat Energy Balances, Eurostat SHARES (see CP chapters below for details)

2.2.1 Absolute energy consumption

Final energy consumption in transport increases more or less strongly in the CPs by 2030 in the business as usual scenario. Figure 7shows the business as usual development assumed here in all CPs. Please note that this shows physical energies; multipliers according to RED II are not taken into account here.

Non-compliant biofuels consumption increases somewhat based on existing policies in Albania and Ukraine, while compliant biofuels consumption remains at zero in all CPs. Renewable electricity consumption, notably in rail, increases following the anticipated increases of renewable electricity in the national power mix.

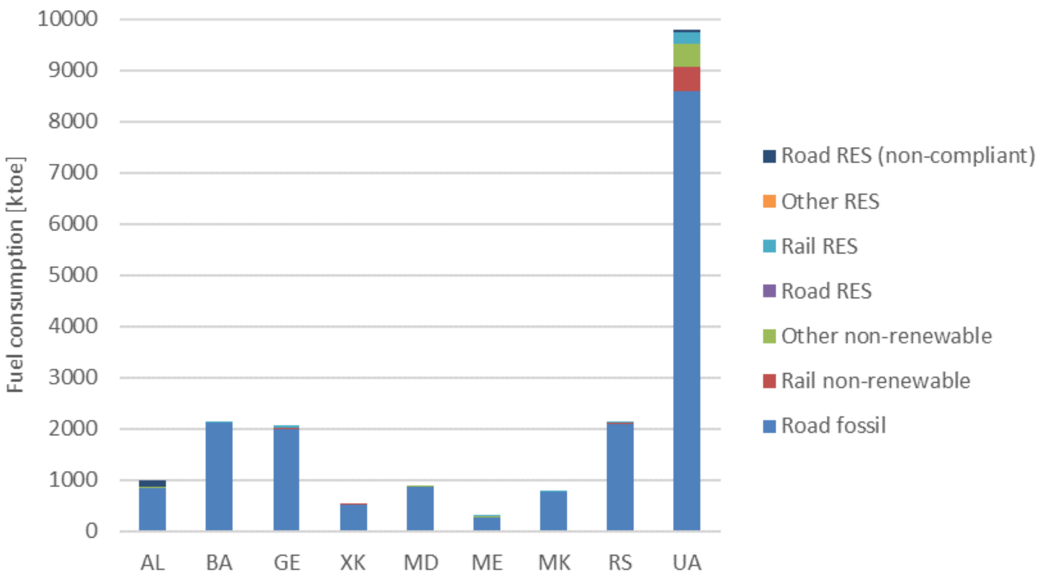

Figure 7: Final energy consumption in transport in 2030 in the business as usual scenario

For the target compliance scenario, the overall energy consumption of the business as usual scenario is assumed as a starting point. However, direct electricity use in battery-electric vehicles and hydrogen consumption in fuel cell-electric vehicles is more efficient than fuel consumption in conventional internal combustion engine vehicles. Therefore, the overall energy consumption in transport goes down as battery or fuel cell vehicles are introduced into the vehicle fleet.

Figure 8 shows the transport energy consumption in 2030 in the target compliance scenario in absolute terms.

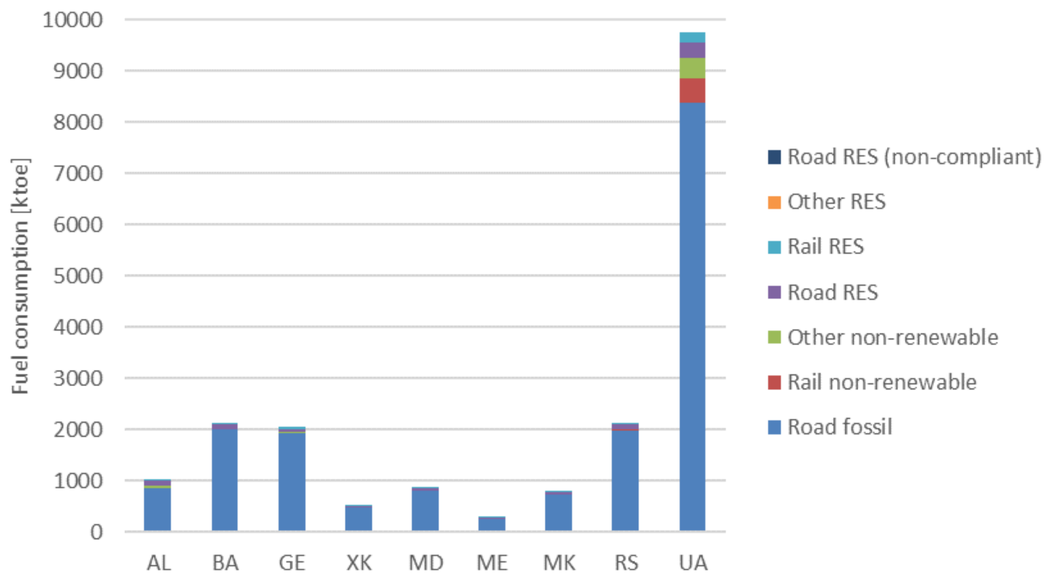

Figure 8: **Final energy consumption in transport in 2030 in the target compliance scenario**

2.2.2 Per-capita energy consumption

Figure 9 shows the business as usual scenario in terms of per capita values allowing for a better appreciation of structural similarities and differences between CPs. Renewable consumption in transport per capita remains at low levels in this scenario in all CPs excluding non-compliant biofuels.

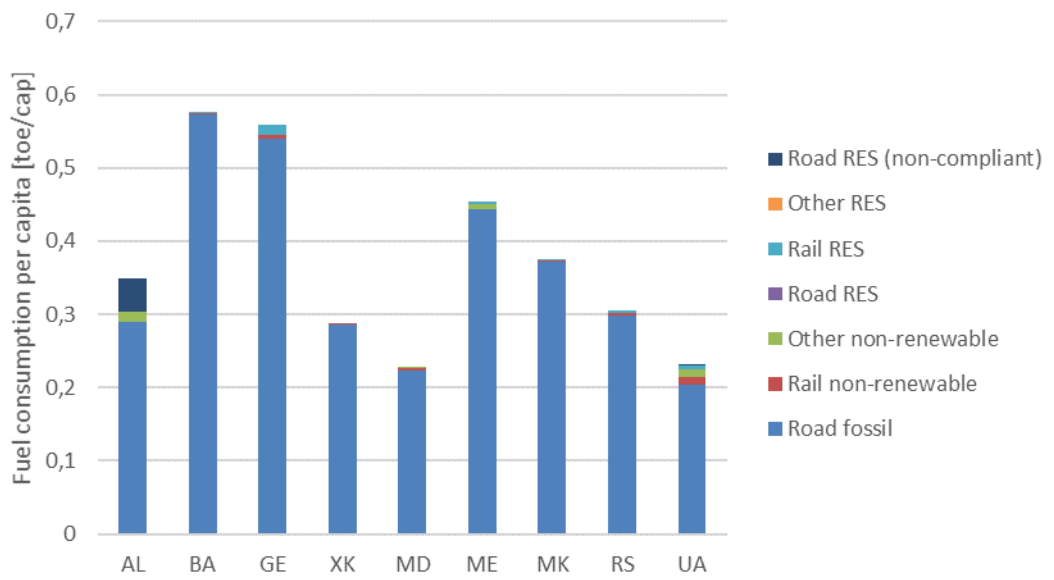

Figure 9: **Per capita final energy consumption in transport in 2030 in the business as usual scenario**

Figure 10 shows the per-capita values in the target compliance scenario for a better appreciation of structural similarities and differences between CPs.

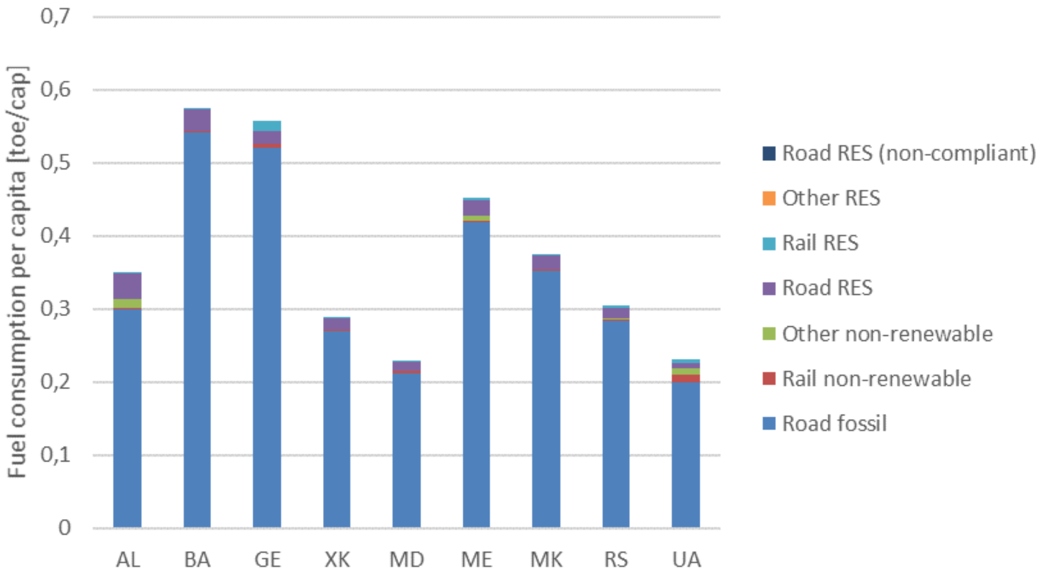

Figure 10: **Per capita final energy consumption in transport in 2030 in the target compliance scenario**

2.2.3 Target compliance scenario by option

Figure 11 and Figure 12 show the renewable energies in transport in 2030 broken down by option as defined in chapter 0 in absolute terms, and as per-capita values, respectively.

The figures show that biofuels make significant contributions to target compliance in all CPs. The high quantities of (non-compliant) crop-based biofuels consumed in Albania today are assumed in the target compliance scenario to be RED II compliant. Because of the current consumption level, the overall RES-T target for Albania is assumed to be 14%, while the target is assumed to be 9% for all other CPs, based on RED II provisions (see section 3.1.1 for more details).

Renewable methane in transport is relevant where methane (CNG vehicles and refuelling stations) is established today; this is notably the case in Georgia, and to a limited extent in Bosnia and Herzegovina, Moldova, North Macedonia, Serbia and Ukraine.

Renewable electricity in rail makes major contributions where electrified rail is available in 2030, and where the national electricity mix has a relevant share of renewable energies. This is notably the case in Georgia, Serbia and Ukraine; on a per capita basis this is also relevant in Bosnia and Herzegovina, Montenegro and North Macedonia. This is not assumed to be the case in the other CPs, but opportunities are available. Renewable electricity in public transport based on trolleybuses, tramways and metros makes a significant contribution in Ukraine.

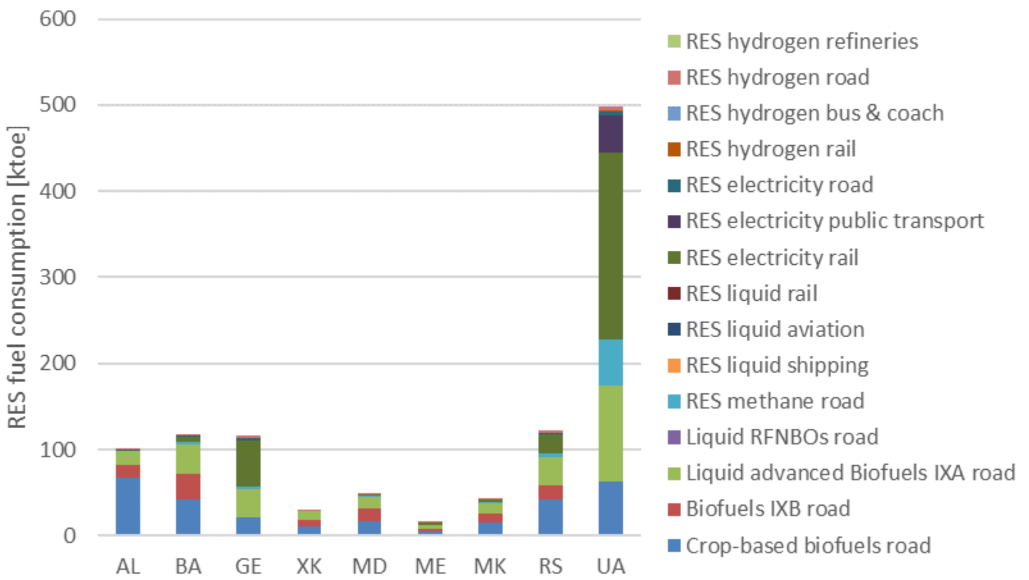

Figure 11: **Renewable energy consumption by option in transport in 2030 in the target compliance scenario**

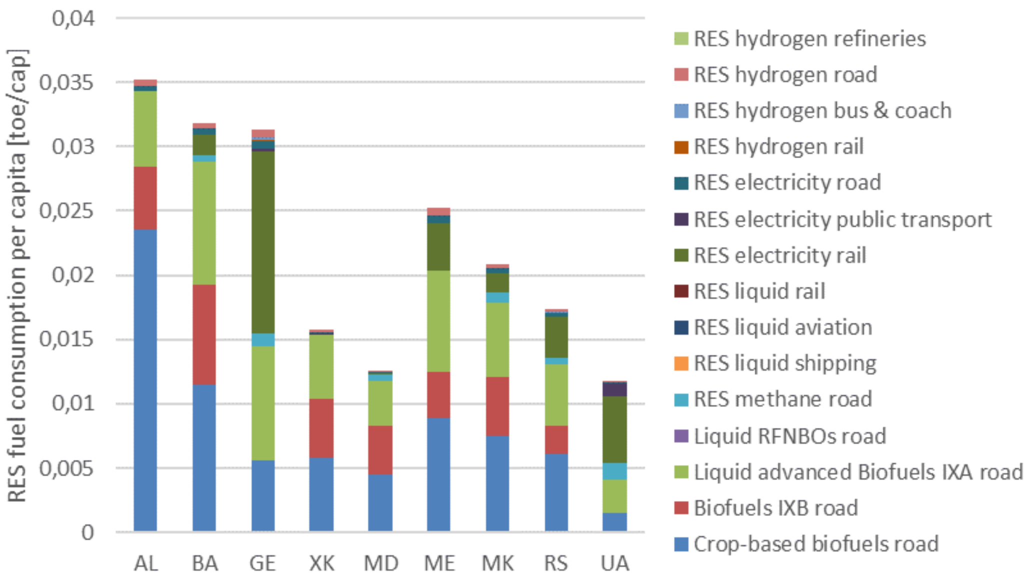

Figure 12: **Per capital renewable energy consumption by option in transport in 2030 in the target compliance scenario**

Renewable electricity in road transport (cars and delivery vehicles) makes limited contributions by 2030. This is due to the fact that battery-electric vehicles need to find their way into the vehicle fleet, which takes many years given the average age and fleet renewal periods in the CPs. However, rather conservative assumptions have been made here, and additional opportunities are available.

Renewable hydrogen makes minor contributions by 2030 based on its earlier stage in commercialization today compared to battery-electric vehicles, but a strong development dynamic. Hydrogen and battery-electric vehicles are complementary where hydrogen enables long driving distances, and is suitable for cars and heavy-duty transport alike.

3 MAIN CHARACTERISTICS OF DIFFERENT TYPES OF RENEWABLE TRANSPORTATION FUELS

The aim of this task is to describe the main characteristics of the different types of fuels which could be used to meet the renewable energy in transport targets in Directive (EU) 2018/2001, and the potential of renewable energy sources to be used by each Contracting Party to meet the 2030 target laid out in this directive. This has been split into three sub-tasks, which together will provide policy-makers within the Contracting Parties with a comprehensive overview of each option.

Sub-task 3.1 will describe a range of biofuels, renewable fuels of non-biological origin, recycled carbon fuels and electricity used directly in the transport sector, all of which are at an advanced enough stage of commercialisation or show sufficient promise to achieve such status in order to contribute commercial volumes of fuel to the transport sector in 2030. This will include an overview of production routes, technology maturity, and fuel production costs or end user price where appropriate.

Sub-task 3.2 will outline the potential for the production of renewable energy/fuels for use in transport in each Contracting Party, based on resources (biomass, wastes, and renewable energy) within that territory. In addition, an overview of the potential for importing both feedstocks and final fuels across all of the Contracting Parties will be provided.

Under sub-task 3.3 the current production and commercialisation of each fuel pathway within each Contracting Party will be reviewed. Existing production plants will be noted, along with planned plants where these are known.

3.1 Characteristics of fuels

In this section a range of fuel production pathways are discussed, where each pathway refers to a production technology and the feedstocks that the technology can be applied to. In order to compare the maturity of each pathway, technology readiness level (TRL) definitions are used as defined by the European Commission. These TRL definitions are shown in Table 1, while the pathways are summarised in Table 2.

Different feedstocks require different treatments, due to differences in chemical composition and physical characteristics. For the purposes of the pathways selected for discussion, feedstocks have been grouped as follows:

- Lignocellulosic material/non-biogenic wastes (inc. MSW): Lignocellulosic material refers to all fibrous matter originating from plants, consisting of carbohydrates (cellulose and hemicellulose) and lignin. This includes non-edible biomass such as energy crops, forestry, agricultural waste (such as corn stover and straw). Non-biogenic waste includes plastics, metals, rubber and other inorganic material.
- Sugar/starch crops: Sugar/starch crops contain carbohydrates in the form of long chains of complex sugars: these types of carbohydrates are easily converted into simple sugars that can be fermented. These crops are typically from edible parts of the plant, including grains such as wheat and corn or tubers such as potatoes.

- Oils (crops and waste): Vegetable oils extracted from plants (flowers, fruits, nuts, seeds and oil crops) and waste oils such as used cooking oil (UCU) and tallow.
- Wet wastes and agricultural residues: Waste biomass material and residues from agriculture with a high moisture content, including food waste and manure.
- Alcohols: Alcohols such as ethanol, butanol and methanol can be upgraded to produce more complex long chain fuels such as gasoline, diesel or jet fuel.

Table 1: TRL Definitions used in this study[18]

TRL Number	Definition
TRL 9	Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies)
TRL 8	System complete and qualified
TRL 7	System prototype demonstration in operational environment (industrially relevant environment in the case of key enabling technologies)
TRL 6	Technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
TRL 5	Technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
TRL 4	Technology validated in lab
TRL 3	Experimental proof of concept
TRL 2	Technology concept formulated
TRL 1	Basic principles observed

There are different terms that are often used to describe biofuels, depending upon the feedstock used in its production process. Food and feed crop-based biofuels use feedstocks that are edible, and therefore have a competing use as food or feed, and also require arable land. Crop-based feedstocks are easier to process: as such, most biofuels in use today are crop-based ethanol or FAME. Annex IXB biofuels are produced from used cooking oil (UCO) and animal fats: as a result, feedstock potential is limited. Advanced biofuels are produced from wastes or lignocellulosic material, such as the inedible part of food crops and plants: eligible feedstocks are defined in Annex IX part A of the Renewable Energy Directive (Section 3.1.1). The total potential for these feedstocks is large compared with demand in most CPs

[18] European Commission (2015) Technology Readiness Levels (TRL), Available from: https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf

– however, there may be competition with other sectors, and the technology is at an early stage of commercialization, with high costs today.

Many of the fuel routes in Table 2 are below TRL 9, and as such are not yet commercially available on wide scales. As a result, these fuels are not yet traded as commodities, and pricing information is not readily available. Instead, the levelized cost of production is provided based on available data: where possible, cost information based upon different feedstocks is shown for comparison, although this level of detail is not available for all routes. Where market prices are available, these are included.

Renewable electricity: Although not a biomass feedstock, renewable electricity can be used as an energy source for producing a range of renewable fuels, and has been considered a feedstock here for simplicity and consistency.

Table 2: Fuel pathways described in Section 3.1

Fuel chain number	Feedstock	Conversion technology	Fuel(s) produced
1	Sugar/starch crops	Fermentation	Alcohols
2	Oils (crops and waste)	Esterification	FAME
3	Oils (crops and waste)	Hydro-treatment	HVO/HEFA
4	Lignocellulosic material/non-biogenic wastes (incl. MSW)	Gasification + FT	Diesel/kerosene/gasoline
5	Lignocellulosic material/non-biogenic wastes (incl. MSW)	Gasification + synthesis	Methanol
6	Lignocellulosic material/non-biogenic wastes (incl. MSW)	Pyrolysis	Diesel/kerosene/gasoline
7	Lignocellulosic material/non-biogenic wastes (incl. MSW)	Hydrolysis fermentation	Alcohols
8	Wet wastes and agricultural residues	Anaerobic digestion	Methane
9	Alcohols	Alcohol catalysis	Kerosene/diesel
10	Renewable electricity		Electricity
11	Renewable electricity	Electrolysis	Hydrogen
12	Renewable electricity	Electrolysis + methanation	Methane
13	Renewable electricity	Electrolysis + synthesis	Standard liquid transport fuel products via power-to-liquids (PtL), notably alcohol/ gasoline/ kerosene/ diesel

3.1.1 Renewable Energy Directive recast

The Renewable Energy Directive, first implemented in 2009 (RED) and recast in 2018 (RED II), sets renewable energy targets, with an overarching goal of 32% of final energy consumption coming from renewable energy by 2030. In the transport sector 9-14% of all energy used in transport must be renewable, calculated according to Equation 1. Resting on three pillars, this transport target of RED II can be met through the use of biofuels, renewable electricity, and renewable hydrogen (or more generally: renewable fuels of non-biological origin – RFNBO). Member States can also choose to include recycled carbon fuels.

Equation 1 Calculation to determine share of renewable energy used in transport

$$\%\ RE\ in\ transport = \frac{RE\ used\ in\ all\ transport, incl. renewable\ electricity\ *}{Energy\ from\ fuels\ used\ in\ road\ and\ rail\ transport\ **}$$

** "the energy content of all types of energy from renewable sources supplied to all transport sectors, including renewable electricity supplied to the road and rail transport sectors, shall be taken into account" (RED II Art. 27(1b))*

*** This includes petrol, diesel, natural gas, biofuels, biogas, renewable liquid and gaseous transport fuels of non-biological origin, recycled carbon fuels and electricity supplied to the road and rail sectors. This does not include fuels, even renewable fuels, supplied to the aviation and marine sectors, despite being included in the numerator.*

Articles 25-27 of the RED II further set several sub-targets and caps related to the transport target (Figure 13):

- At least 3.5% of transport energy must come from advanced biofuels in 2030. These are defined in Annex IX Part A of RED II (Figure 13).
- A maximum of 1.7% of transport energy can come from fuels produced from waste oils and fats, as defined in Annex IX Part B.
- A maximum of 7% of transport energy can come from fuels produced from feed and food crops (e.g. sugarcane, wheat, maize). This cap varies by Member State. It is determined by the percentage of transport energy coming from food and feed crops in 2020 in that Member State and adding an extra one percent, up to a maximum of 7%; however, Member States are free to set a lower target. If in 2020, the share of transport energy from these feedstocks is less than 1% in a Member State, the cap is 2%.
- By 2030, all fuels produced from high indirect land-use change (iLUC) feedstocks must be phased out. This was introduced in order to reduce the amount of indirect land use change caused by use of land for biofuels feedstocks, which can lead to greenhouse gas emissions (e.g. through conversion of high carbon stock land) and other environmental

impacts such as biodiversity loss. Currently this applies to palm oil, with the European Commission setting rules on which feedstocks qualify through a delegated regulation[19].

The overall target for RES-T of 14% can be reduced as far as the cap on crop-based biofuels is lower than 7%. Where the cap on crop-based biofuels is 2%, the overall target can thus be reduced to 9%.

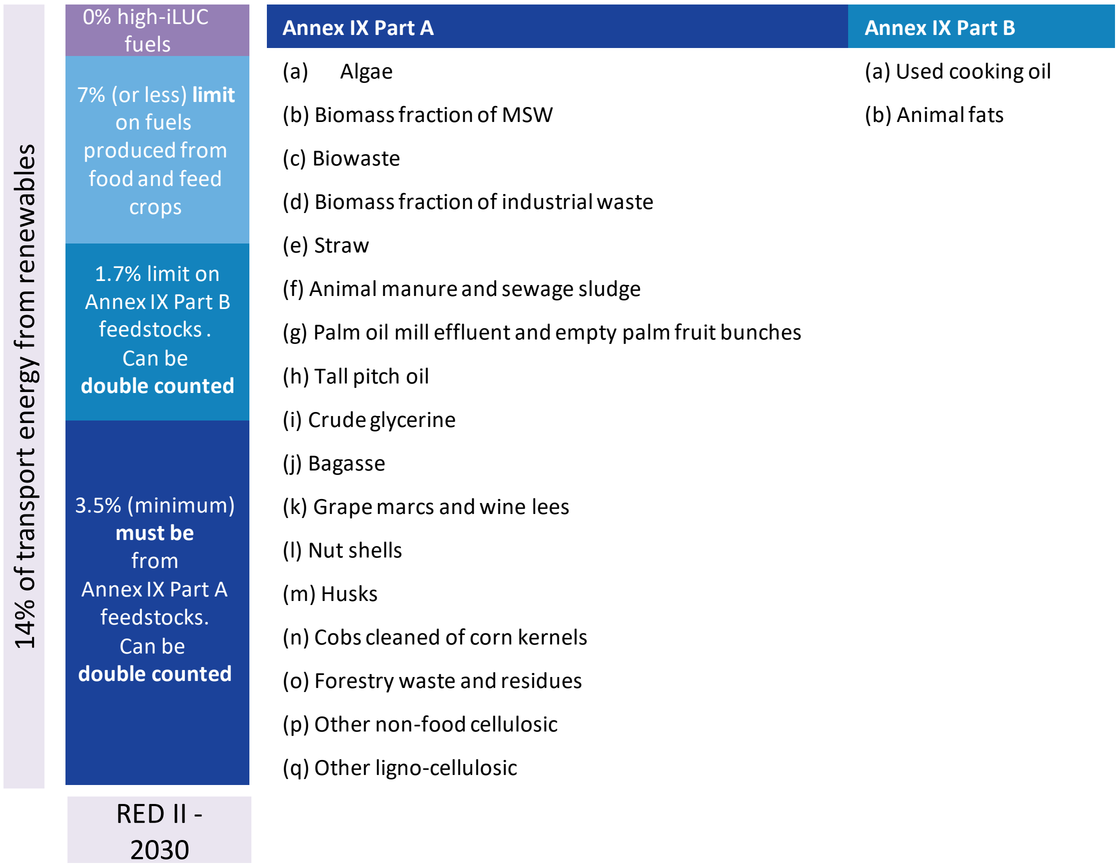

Figure 13: Renewable Energy Directive Recast (RED II) targets, caps and advanced feedstocks

To further incentivise the uptake of less commercialised fuels, RED II allows for multiple counting of a fuel's energy content towards the overall 14% target and the sub-targets, based on their feedstock or end-use application. Multiple counting (or double-counting, when the multiple is two) refers to the practice whereby the use of one unit of renewable energy counts as more than one for the purposes of demonstrating compliance with a particular target. This is intended to provide a higher incentive for these types of renewable fuels and is allowed under the legislation. It is therefore different to the use of the term 'double-counting' to refer to the practice of counting one unit of renewable energy towards two

[19] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/2099-High-and-low-Indirect-Land-Use-Change-ILUC-risks-biofuels-bioliquids-and-biomass-fuels

separate targets, for example in different sectors, which is generally not desirable. Under the RED II the following fuel types can be multiple-counted towards the overall RES-T target and towards all relevant sub-targets to which they contribute:

- Biofuels and biogas produced from feedstocks listed in Annex IX can be double counted.
- The share of renewable electricity can be considered as 4 times its energy content if used in road vehicles or 1.5 times if used in rail.
- The share of renewable fuels supplied to the aviation and maritime sector can be considered as 1.2 times their energy content, as long as they are not produced from food and feed crops.

As fuels derived from feedstocks listed in Annex IX Part A can be double counted, the 3.5% advanced biofuel sub-target, mentioned above, corresponds to an actual requirement of 1.75% of transport energy coming from advanced biofuels. Further, fuels produced from Annex IX Part B feedstocks can also be double counted towards targets, whilst the 1.7% cap refers to the actual amount of fuel supplied. Therefore, fuels derived from these waste oil and animal fat feedstocks can contribute up to 3.4% towards the renewable energy in transport target.

Article 29 sets out sustainability criteria that biofuels, bioliquids and biomass fuels must meet to be considered renewable and count towards the targets mentioned above. It specifies minimum emissions savings biofuels must achieve compared to the fossil fuel comparator, as well as setting requirements around the type of land use for the biomass production (see Box 1). However, biofuels, bioliquids and biomass fuels produced from waste and residues, other than agricultural, aquaculture, fisheries and forestry residues, are required to fulfil only the greenhouse gas emissions saving criteria and not the land requirements.

Box 1 **Key sustainability criteria from Article 29 of the Renewable Energy Directive applicable to transport biofuels.**

Greenhouse gas savings thresholds:

Biofuels must achieve a minimum lifecycle greenhouse gas savings compared to the fossil fuel comparator (94 gCO_2e/MJ).

The minimum savings threshold is based on when the installation started operation for biofuel production:

- >50% if producing before 5 Oct. 2015
- >60% if producing between 6 Oct. 2015 and 31 Dec. 2020
- >65% if producing after 1 Jan. 2021

Land requirements:

Biofuels should not be produced from feedstocks cultivated on:

- Land with high biodiversity value
- Land with a high carbon stock
- Peatland

Monitoring/enforcement system in place to minimise unsustainable forestry production.

For electricity and RFNBOs (incl. hydrogen), the renewable share needs to be identified. RED II allows for two ways of doing that in Art. 27:

1. The renewable content of the electricity is taken to be the share of renewable electricity in the national electricity mix two years before the year in question (e.g. for target compliance in 2030, the electricity mix in the year 2028 is used);
2. In the case of electricity obtained from a direct connection to an installation generating renewable electricity and supplied to road vehicles, that electricity shall be fully counted as renewable.

For hydrogen, and more generally RFNBOs, used in transport, the logic is the same; however, different conditions apply in detail as defined in Art. 27.

1. Where electricity is used for the production of RFNBOs, the average share of electricity from renewable sources in the country of production, as measured two years before the year in question, shall be used to determine the share of renewable energy.
2. Electricity obtained from direct connection to an installation generating renewable electricity may be fully counted as renewable electricity where it is used for the production of RFNBOs, provided that the installation: (a) comes into operation after, or at the same time as, the installation producing the RFNBO; and (b) is not connected to the grid or is connected to the grid but evidence can be provided that the electricity concerned has been supplied without taking electricity from the grid.
3. Electricity that has been taken from the grid may be counted as fully renewable provided that it is produced exclusively from renewable sources and the renewable properties and other appropriate criteria have been demonstrated, ensuring that the renewable properties of that electricity are claimed only once and only in one end-use sector.

Several decisions or issues were not resolved in RED II, but will be addressed through delegated acts over the coming years. Certification criteria to define feedstocks with a low or high iLUC risk were published in a delegated act and annex in March 2019. Other delegated acts are listed in Table 3, with the date where a decision is expected. The conclusions and changes as a result of these delegated acts could change how some fuels are accounted for under RED II.

Table 3: **List of delegated acts required under RED II and approximate dates of publication**

Delegated Act	Approximate Date
Determine the criteria for certification of high and low iLUC risk feedstocks and biofuels. (Article 26).	21 May 2019
Based on the delegated act above, review and amend the criteria to determine the iLUC risk of a feedstock and biofuel.	Sep. 2023
Adapt energy content of fuels in line with technological changes.	
Establish an EU methodology to account for renewable electricity for the production of renewable liquid and gaseous transport fuel of non-biological origin.	Dec. 2021
Establish a methodology to determine the share of biofuel in a co-processed fuel, where both biomass and fossil fuels are processed together Establish a methodology for assessing the GHG savings of RFNBO and recycled carbon transport fuels	Dec. 2021
Amend the list of feedstocks in Annex IX Part A and Part B to reflect technological changes. Feedstocks can be added but not removed.	Every 2 years
Establish the Union Renewable Development Platform and set the conditions of finalising transactions.	~2021
Establish a minimum GHG savings threshold of recycled carbon fuels through an LCA approach	Jan. 2021

3.1.2 Sugar/starch crops to alcohols via fermentation

3.1.2.1 Fuel chain structure and fuel use in vehicle

The vast majority of ethanol used in the road transport sector today is produced from food crop feedstocks such as corn, wheat and sugarcane. The biomass is pre-treated to produce simple sugars, which are then biologically fermented using yeast or bacteria. Such ethanol plants are also capable of converting non-food waste parts of the plant, such as corn kernel fibre, to ethanol through minor modifications. Although this utilises a lignocellulosic feedstock (see Section 3.1.8), this often only accounts for a small amount of the total feedstock, and there is debate as to whether the corn kernel should be considered as a food-based biofuel and hence would be capped in its use, since it derives from the edible part of the feedstock. As such, the conversion of corn kernel is typically accounted for alongside crop-based ethanol production figures.

Butanol production through the Acetone-Butanol-Ethanol (ABE) fermentation process requires strictly anaerobic conditions, however ethanol fermentation is possible under aerobic conditions. The alcohols are then typically extracted using distillation and/or molecular sieves.

While butanol can be blended with gasoline at high rates (up to 85%) with minimal modification to vehicles and infrastructure, ethanol blends are much more limited. Gasoline blended with $5\%_{vol}$ ethanol (E5) is suitable for all vehicles on the road today; and gasoline with $10\%_{vol}$ ethanol (E10) can be used with all modern vehicles, but is not compatible with older vehicles without significant modifications to the engine and fuel lines. Whether an older vehicle is compatible with E10 depends upon the model and manufacturer, and can vary significantly even between models from the same manufacturer. The European Automobile Manufacturers Association (ACEA) provides a list of ACEA member company petrol vehicle compatibility with E10[20].

Flex-fuel vehicles are required for use with high ethanol blends, up to E85. E95 blends exist in Brazil; however widespread use is limited by cold weather properties. Butanol blends of up to 16% were approved for use in the USA in 2018, with this blending limit designed to stay within fuel specification oxygen limits.

3.1.2.2 Commercial and market status of fuel

Bioethanol production through ethanol fermentation is well established, with hundreds of full-scale operational refineries in existence across the globe (TRL 9[21]). Global fuel ethanol production was estimated to be 85.7 million tonnes in 2018, with 71.6 million tonnes of ethanol consumed as biofuels (Figure 14) [22].

Of global fuel ethanol production, 99.9% is produced using sugar/starch crops and 1.5G feedstocks, with just an estimated 0.09% of ethanol produced using exclusively 2G lignocellulosic feedstocks[23]. The United States and Brazil account for over 80% of both global production and consumption.

The EU is a net importer of fuel ethanol, producing 4.3 million tonnes (2.76 mtoe) and consuming 5.6 million tonnes (3.59 mtoe) in 2018. This compares to a total EU energy consumption by fuel of approximately 1,000 mtoe in 2017, with 300 mtoe energy

[20] ACEA, 2018: List of ACEA member company petrol vehicles compatible with using ‘E10’ petrol. Accessed November 2020: https://www.acea.be/uploads/publications/ACEA_E10_compatibility.pdf

[21] Please see Annex A for TRL definitions.

[22] Sydney et al, Current analysis and future perspective of reduction in worldwide greenhouse gases emissions by using first and second generation bioethanol in the transportation sector. Bioresource Technology Reports, 2019.

[23] Padella, M., O` Connell, A. and Prussi, M., What is still limiting the deployment of cellulosic ethanol? Analysis of the current status of the sector, APPLIED SCIENCES-BASEL, ISSN 2076-3417 (online), 9 (21), 2019, p. 4523, JRC117955.

consumption in transport[24]. There were 58 crop-based ethanol refineries in operation in the EU in 2018, with a total capacity of 6.8 million tonnes per annum[25].

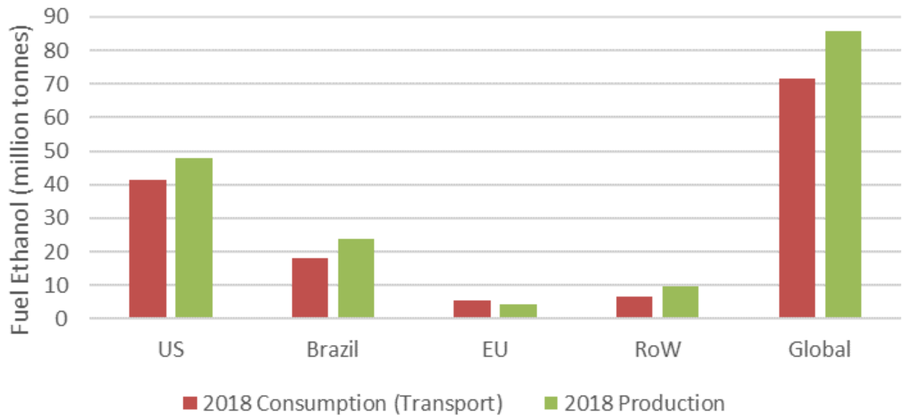

Figure 14: Fuel ethanol production and consumption by region, 2018

Significant expansion of food/feed crop-based ethanol facilities is not expected in the EU, due to the limit on food/feed crop-based biofuels imposed under the RED II and blending limits in the gasoline pool. In addition, ethanol blend walls will limit market size.

Historically, ABE fermentation of butanol has been used to produce solvents from petrochemicals. Numerous large-scale ABE fermentation plants exist in China, with the largest operating in Saudi Arabia at SABUCO, producing 330,000 t/a n-butanol. However, ABE fermentation using biomass feedstocks is at a lower level of readiness (TRL 5-6), with current demonstration activities remaining at a small scale, and improvements in the fermentation processes and resulting butanol yields are required before ABE fermentation becomes commercially viable. Currently, butanol yields are limited by the toxicity of the alcohols to the bacteria used in the process, and so genetic engineering of the bacteria is a crucial area of development.

3.1.2.3 Commodity price

The price of feedstock is the most significant contributor to the production cost of ethanol from sugar / starch fermentation, which can account for over 80% of the cost[26]. The type of feedstock used varies significantly depending upon region, due to differences in availability

24 EUROSTAT 2019, Energy, transport and Environment statistics. Accessed November 2020: https://ec.europa.eu/eurostat/documents/3217494/10165279/KS-DK-19-001-EN-N.pdf/76651a29-b817-eed4-f9f2-92bf692e1ed9

25 USDA EU Biofuels Annual 2019, GAIN Report Number: NL9022

26 Joelsson, E., Erdei, B., Galbe, M. et al. Techno-economic evaluation of integrated first- and second-generation ethanol production from grain and straw. Biotechnol Biofuels 9, 1 (2016). https://doi.org/10.1186/s13068-015-0423-8

and cost. The US almost exclusively uses corn starch, while EU feedstocks mostly use a mix of corn, wheat and sugar beet, as shown in Figure 15[27,28].

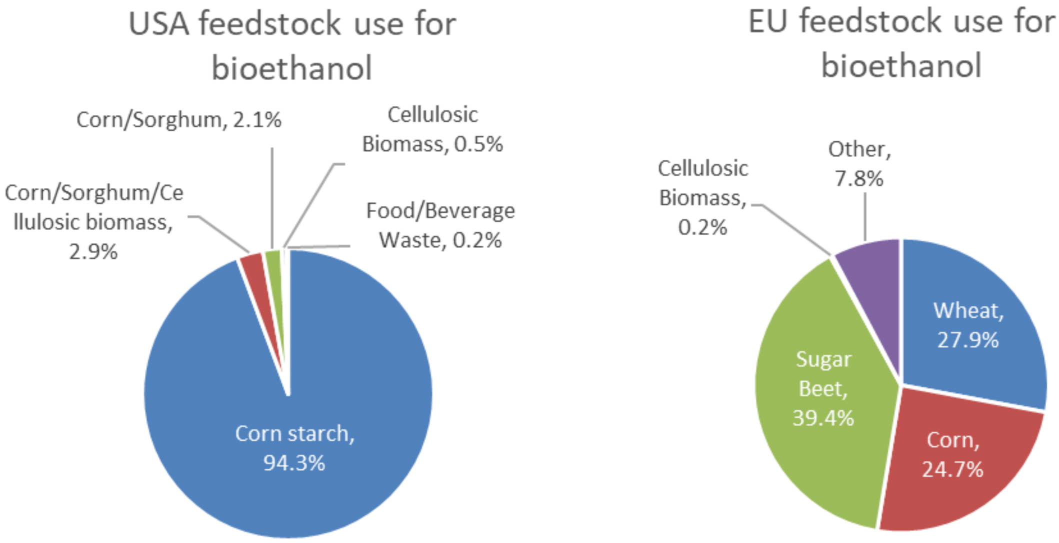

Figure 15: Differences in feedstock use between USA (left) and EU (right) in 2018

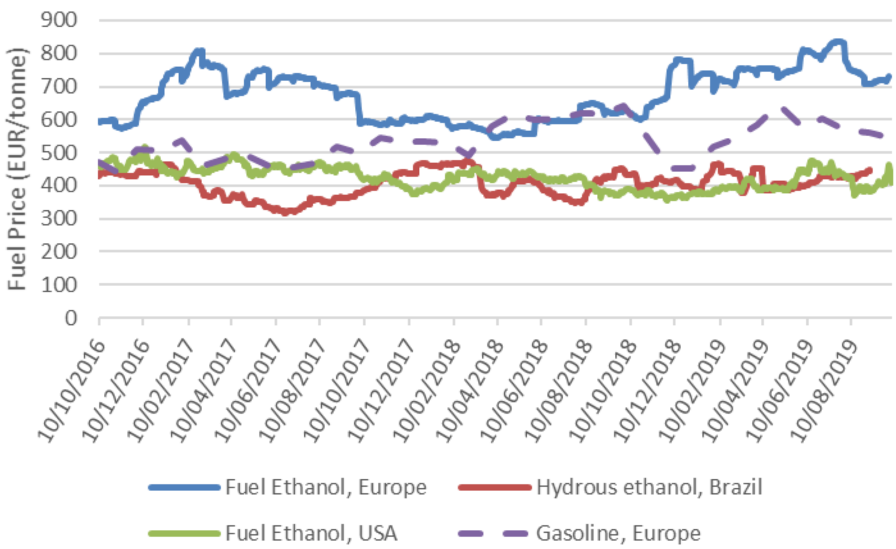

Figure 16: Ethanol commodity trading price comparison between different regions (Europe = Platts T2 futures, Brazil = BM&F prices, USA = CBOT prices)

---

27 RFA 2019 Ethanol Industry Outlook: https://ethanolrfa.org/wp-content/uploads/2019/02/RFA2019Outlook.pdf

28 USDA EU Biofuels Annual 2019, GAIN Report Number: NL9022

The price of fuel ethanol in EU markets, where demand outstrips supply, is notably higher than in the US and Brazil, where there is abundant supply (Figure 16). T2 ethanol includes both domestically-produced ethanol and imported ethanol where the foreign duty has been paid.

3.1.2.4 Policy treatment under RED II

The treatment of transport alcohols, namely ethanol, under RED II is dependent on the feedstock used to produce them. If they are produced from food and feed crops, the alcohols are capped (see 3.1.1). Further, if the feedstock is deemed to pose a high iLUC risk, it will be phased out completely by 2030. Conversely, if the alcohol is produced from an advanced feedstock (Annex IX Part A feedstocks), its energy content can be double counted towards the overall 14% renewable energy in transport target.

3.1.3 Oils to FAME via esterification

3.1.3.1 Fuel chain structure and fuel use in vehicle

Fatty acid methyl ester (FAME) is produced from either from vegetable oils (including rapeseed, sunflower, soybean and palm), or Annex IXB feedstocks such as animal fats and used cooking oils (UCO) via a transesterification chemical process. It is sometimes referred to by its feedstock specific name, e.g. rapeseed methyl ester (RME), used cooking oil methyl ester (UCOME). While the physical characteristics of FAME are similar to those of conventional diesel, it can only be blended at 5-10% (vol) in road diesel: B7 is the standard blend across Europe. Higher blends are limited by compatibility with exhaust treatment in cars, cold weather properties, lower energy content of FAME compared to diesel and poor storage stability. FAME can in principle also be used in shipping and rail, but this is very uncommon today.

3.1.3.2 Commercial and market status of fuel

FAME production from oil crops via transesterification is a mature and commercial biofuel production route, with a TRL of 9.

In 2018, global FAME production was nearly 30 million tonnes with consumption at 28 million tonnes (Figure 17). Ultimately, blend walls will limit total FAME market size. FAME feedstocks can also be used to produce Hydrotreated Vegetable Oil (HVO) or Hydroprocessed Esters and Fatty Acids (HEFA) fuels, increasing competition for the feedstocks. Further, increased competition for vegetable oils, related to an increasing population and diet changes, will affect the availability of the feedstock.

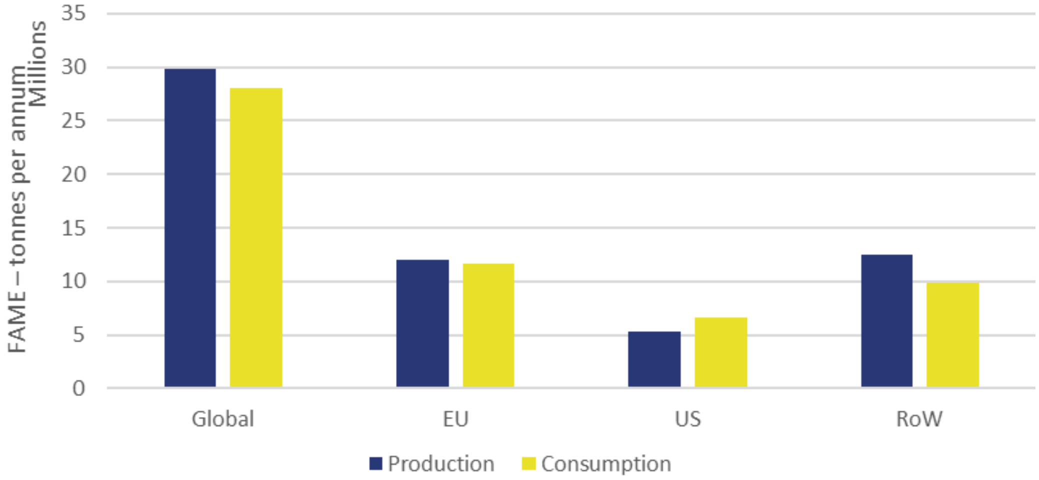

Figure 17: FAME production and consumption by region in 2018 (source F.O. Licht, 2018)

The EU is the largest producer and consumer of biodiesel, where the biodiesel accounts for 80% of its biofuel market. FAME is produced in almost all EU countries, except for Finland, Luxembourg and Malta. Biodiesel plant sizes range from 2.3 million litres per annum to over 600 million litres.

3.1.3.3 Commodity Price

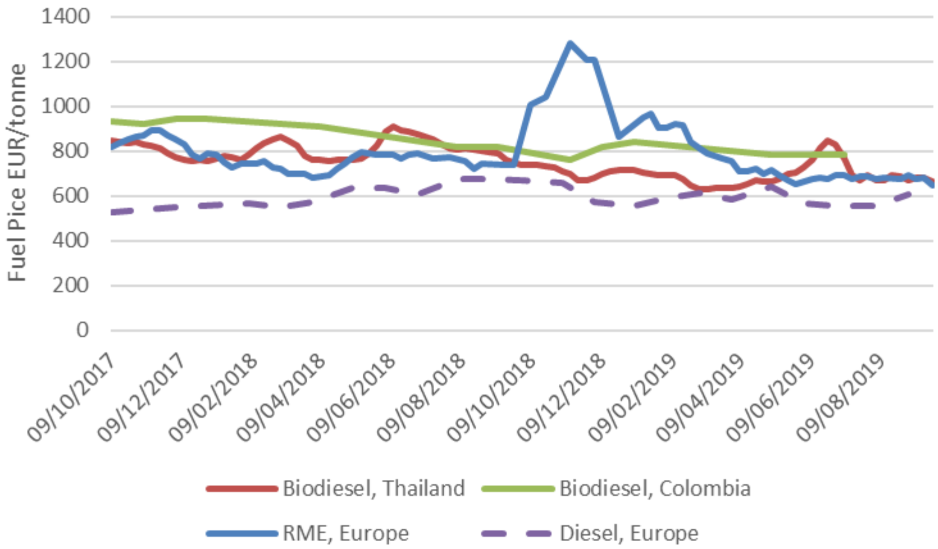

Figure 18: FAME commodity trading price comparison between different regions

Production cost varies depending on the feedstock, largely due to the variable price of the different oil crops and waste oils, as conversion cost is similar for all feedstocks[29]. CAPEX/OPEX contribute a relatively small amount to overall production cost. Vegetable oils and UCO are globally traded commodities where the price (Figure 18) is influenced by policy as well as production cost and blending limits. As FAME is a mature technology there is limited scope for reductions in production cost.

3.1.3.4 Policy treatment under RED II

The treatment of FAME under RED II is dependent on the feedstock used to produce the fuel. If it is produced from food and feed crops, it is capped (see 3.1.1). Further, if the feedstock is deemed to pose a high iLUC risk, it will be phased out completely by 2030. Conversely, if the HVO/HEFA is produced from an advanced feedstock (Annex IX Part A/Part B feedstocks), its energy content can be double counted towards the overall 14% renewable energy in transport target. HVO and HEFA fuels produced from Annex IX Part B feedstocks (UCO or tallow) are capped at 1.7% of transport energy.

3.1.4 Oils (crops and waste) to HVO/HEFA via Hydro-treatment

3.1.4.1 Fuel chain structure and fuel use in vehicle

Hydrotreatment is used to convert vegetable oils and Annex IXB waste oils into hydrocarbons, typically producing a mixture of diesel (known as hydrotreated vegetable oil, or HVO), jet fuel (known as hydroprocessed esters and fatty acids, or HEFA), naphtha and other lighter hydrocarbons such as propane. Hydrotreatment involves the use of hydrogen at high temperatures to saturate the double bonds of the unsaturated vegetable fats (triglycerides). This is followed by an isomerisation/cracking stage, which brings the biofuel to the desired quality. The production method for HVO and HEFA is identical, save for an additional isomerisation step required to produce HEFA.

HVO is generally considered to be a drop-in fuel which can be used in diesel engines without modification or blend walls. However, in practice HVO blends are limited by existing European and US fuel standards, which set limits for the density of diesel fuels. The use of 100% HVO must be approved by the vehicle manufacturer as a result.

HEFA is currently certified by the voluntary standards developing organization ASTM as HEFA-SPK, and can be blended into kerosene at a blend of up to $50\%_{vol}$[30].

3.1.4.2 Commercial and market status of fuel

The production of HVO via hydroprocessing is at a commercially operational stage (TRL 9), with numerous companies operating plants in the US, Europe and Asia. There are 14

[29] European Commission, 2016. Improving the sustainability of fatty acid methyl esters (FAME – Biodiesel), Tender No. ENER/C2/2013/628: https://ec.europa.eu/energy/sites/ener/files/documents/Technical report.pdf

[30] CAAFI, 2020: http://www.caafi.org/focus_areas/fuel_qualification.html (accessed April 2020)

dedicated HVO biorefineries operating in the EU as of 2019, with plants operating at an estimated 82% of total nameplate capacity of 3.4 billion litres in 2018[31].

Total EU production of HVO in 2018 was 2.8 billion litres, and was almost exclusively produced in five countries: Netherlands, Finland, Spain, Italy and Sweden. EU HVO production accounts for approximately 40% of global HVO production, with 7 billion litres of HVO produced in 2018 globally[32].

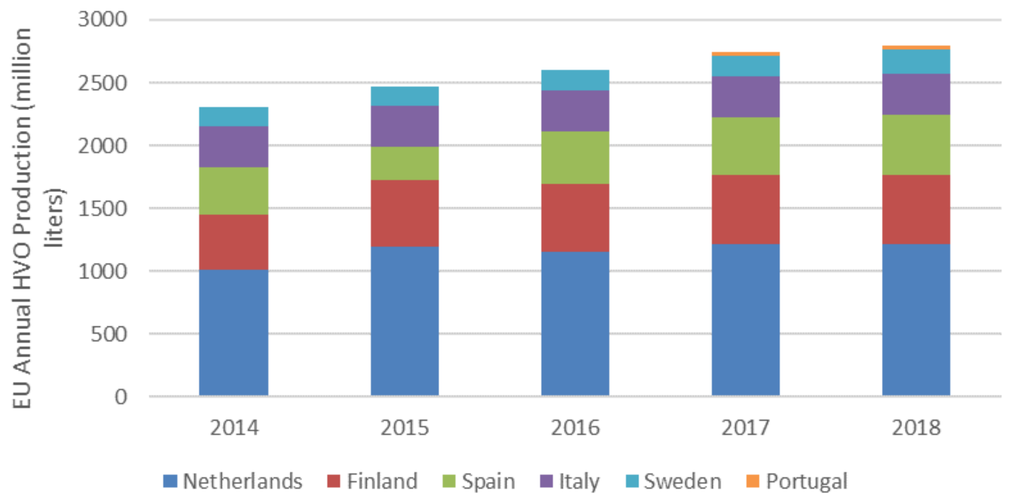

Figure 19: Annual total HVO production figures in the EU (USDA, 2019)

Hydroprocessing of HEFA is the most mature alternative fuel pathway for jet fuels, and is the only alternative aviation fuel currently in widespread commercial use. Although few modifications are required to HVO plants in order to produce HEFA, only one plant worldwide is currently operating the primary aim of producing HEFA.

The main limitation facing this production route is feedstock availability: vegetable oil use is limited by land availability and sustainability issues, while used cooking oil and tallow are a relatively limited resource. Other crop sources, such as algae oil and camelina, are currently being researched.

3.1.4.3 Production cost

Figure 20[33] shows indicative production costs for HVO production for a range of plant set-ups. The low estimate reflects upgrading an existing refinery to allow for co-processing, the medium estimate reflects a full refinery conversion to HVO production, and the high estimate

[31] USDA EU Biofuels Annual 2019, GAIN Report Number: NL9022

[32] Ren21 (2019), "Renewables 2019 Global Status Report" https://www.ren21.net/wp-content/uploads/2019/05/gsr_2019_full_report_en.pdf

[33] IEA (2020), "Advanced Biofuels – Potential for Cost Reduction", IEA Bioenergy Task 41: https://www.ieabioenergy.com/wp-content/uploads/2020/02/T41_CostReductionBiofuels-11_02_19-final.pdf

reflects a standalone self-supporting facility. Production cost of both HVO and HEFA (Figure 21)[34] is dominated by the cost of feedstock, with the production cost of HEFA typically only slightly higher than that of HVO under the same conditions, due to the additional isomerisation step. The limited availability of sustainable feedstocks is likely to cause volatility and only further increase prices in future.

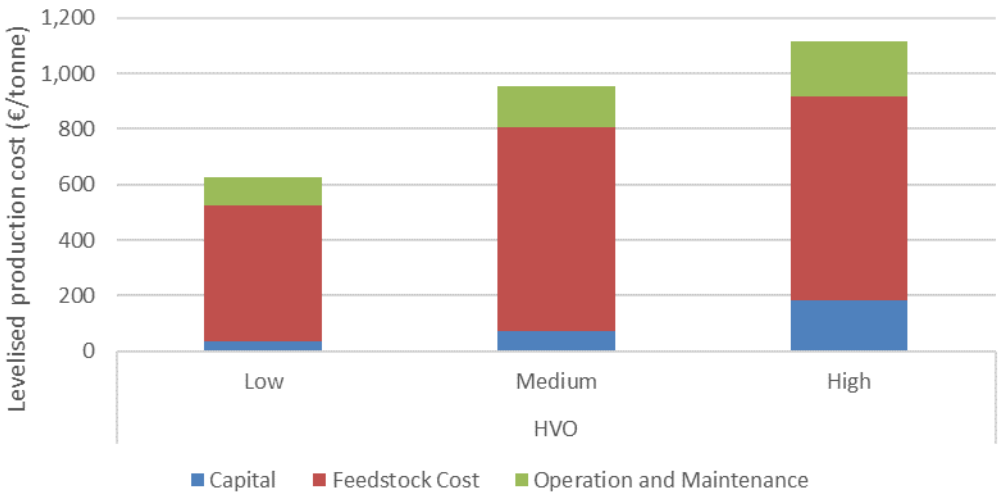

Figure 20: **Estimated production cost ranges of HVO (IEA, 2020)**

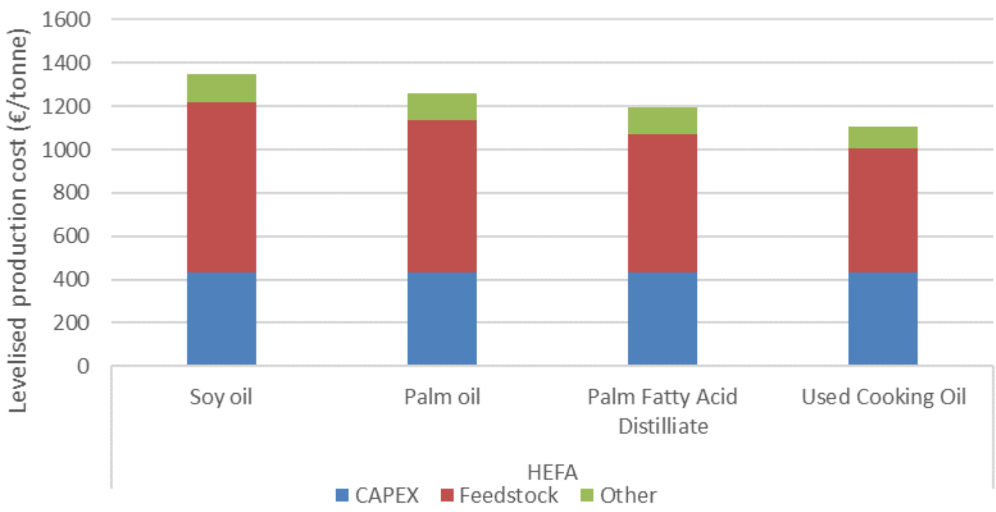

Figure 21: **Levelised production costs for production of HEFA from different feedstocks**

34 ICCT, 2019 "The cost of supporting alternative jet fuels in the European Union": https://theicct.org/sites/default/files/publications/Alternative_jet_fuels_cost_EU_20190320.pdf

The traded price of HVO is currently substantially higher than the production cost of FAME, as it is driven by policy demand for HVO produced from double-counted waste fats and oils, which can continue to be supplied into the diesel pool even once the B7 FAME blend wall has been hit. Currently traded prices of HVO range from around €1150/tonne for food and feed-based HVO, to €1500/tonne for UCO-based HVO. HEFA currently trades at €1800/tonne. For reference, IATA jet fuel prices as of the 30th October 2020 were €280/tonne, although this price is currently depressed due to the effects of COVID: between 2017 and 2019, the average jet fuel price was approximately €550/tonne[35].

3.1.4.4 Policy treatment under RED II

The treatment of HVO and HEFA transport fuels under RED II is dependent on the feedstock used to produce them. If they are produced from food and feed crops, they are capped (see 3.1.1). Further, if the feedstock is deemed to pose a high iLUC risk, it will be phased out completely by 2030. Conversely, if the HVO/HEFA is produced from an advanced feedstock (Annex IX Part A/Part B feedstocks), its energy content can be double counted towards the overall 14% renewable energy in transport target. HVO and HEFA fuels produced from Annex IX Part B feedstocks (UCO or tallow) are capped at 1.7% of transport energy.

3.1.5 Lignocellulosic material/non-biogenic waste (inc. MSW) to diesel/kerosene/gasoline via gasification + FT

3.1.5.1 Fuel chain structure and fuel use in vehicle

The gasification with Fischer-Tropsch process (Gas+FT) can be used to convert advanced biofuel feedstocks such as lignocellulosic biomass and solid waste into various fuels, such as gasoline, diesel and jet fuel, as well as other co-products such as naphtha. Before processing, biomass feedstocks are usually pre-treated by drying and sizing or sorting if required. The treated biomass is then subjected to high temperatures, a limited oxygen environment, and sometimes high pressures as part of the gasification process. This produces syngas, a combination of hydrogen and carbon monoxide, which is then conditioned, to remove CO_2 and compressed.

Fischer-Tropsch (FT) synthesis reacts this conditioned syngas over catalysts, creating a mixture of long-chain hydrocarbons, which can then be upgraded to fuel quality through typical routes such as hydrocracking and distillation.

Kerosene produced through FT synthesis is known as Fischer-Tropsch Synthetic Paraffinic Kerosene (FT-SPK). FT-SPK is certified by ASTM for use in blends of up to 50% with kerosene. [36] Typically, FT-SPK does not contain aromatic compounds that are found in petroleum-based jet fuel. These aromatics are required to prevent fuel leaks in certain aircraft components, and can be added later to FT-SPK.

---

35 https://www.iata.org/en/publications/economics/fuel-monitor/. Accessed November 2020.

36 CAAFI, 2020: http://www.caafi.org/focus_areas/fuel_qualification.html (accessed April 2020)

3.1.5.2 Commercial and market status of fuel

Although FT routes are mature for coal and natural gas-to-liquid routes, the application to biomass is only at TRL 7-8. The technology and components required for biomass gasification plus FT have been commercially demonstrated in other applications, such as biomass gasification for heat and power and FT use in coal-to-liquid plants, but this process has yet to reach demonstration scale as a fully integrated biomass gasification to FT fuel production process. The largest plant globally is currently under construction in the USA, which will process 175,000 tonnes / year of waste into approximately 29,000 tonnes / year of fuel.

3.1.5.3 Production cost

Gasification-FT is a particularly capital-intensive fuel route (Figure 22 and Figure 23), and even though the technology costs are expected to reduce over time, this high capital cost is predicted to remain a significant factor in near term production plants[37]. Feedstock costs can vary significantly depending upon whether waste feedstocks can be sourced, which can potentially generate gate fees as shown in Figure 23[38]. Tail gases can also be re-processed or re-used to produce renewable electricity, generating a credit in larger plants. Operating costs are generally low, due to low facility overheads and operating expenses.

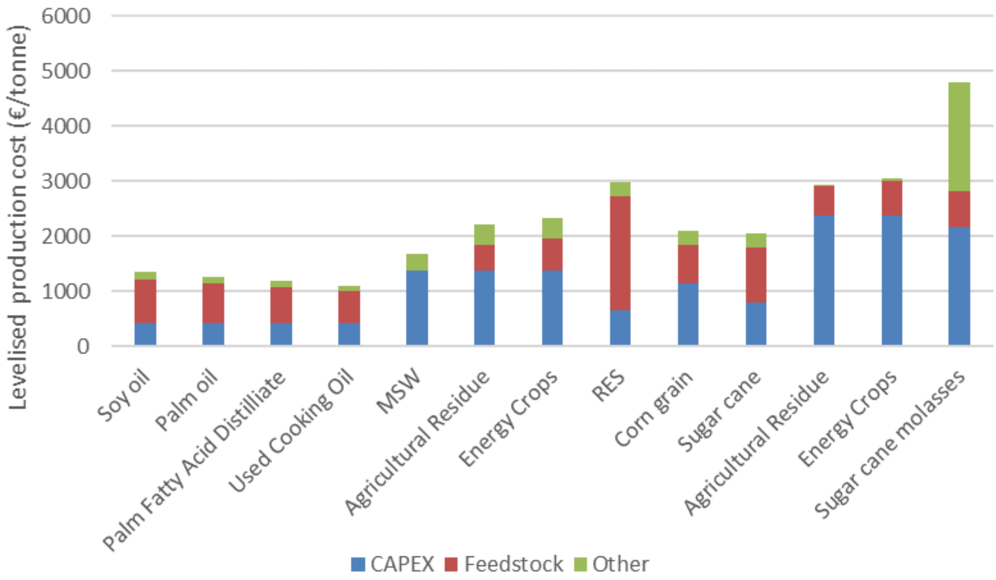

Figure 22: **Levelised production costs for production of jet fuel through gasification + FT for different feedstocks**

[37] ICCT, 2019 "The cost of supporting alternative jet fuels in the European Union": https://theicct.org/sites/default/files/publications/Alternative_jet_fuels_cost_EU_20190320.pdf

[38] IEA (2020), "Advanced Biofuels – Potential for Cost Reduction", IEA Bioenergy Task 41: https://www.ieabioenergy.com/wp-content/uploads/2020/02/T41_CostReductionBiofuels-11_02_19-final.pdf

Figure 23: Estimated production cost ranges for gasification and Fischer-Tropsch to produce gasoline from biomass and waste feedstocks

3.1.5.4 Policy treatment under RED II

The treatment of fuels produced via gasification + FT under RED II is dependent on the feedstock used for their production. Fuels produced from lignocellulosic or the biogenic fraction of municipal solid waste (MSW) can be double counted on an energy basis towards the renewable energy in transport target, as they are listed as advanced feedstocks under Annex IX Part A. If the fuel is produced from the non-biogenic fraction of MSW, it currently cannot be considered a renewable fuel and therefore cannot contribute to the transport target. The treatment of “recycled carbon fuels”, including those produced from the non-biogenic fraction of MSW, under RED II will be reviewed and decided in a delegated act (see Table 3).

3.1.6 Lignocellulosic material/ non-biogenic waste (incl. MSW) to alcohols/ diesel/ kerosene/ gasoline via synthesis to methanol

3.1.6.1 Fuel chain structure and fuel use in vehicle

Syngas can also be converted into alcohols by reacting the gas over metallic catalysts, typically to produce methanol, ethanol (either directly or via methanol), or dimethyl-ether (DME, either directly or via methanol). The gasification process remains the same as described for gasification +FT (Section 3.1.5), with feedstocks such as forest residues, energy crops and MSW being pre-treated and converted to syngas under a high temperature, low oxygen environment.

Methanol can be used directly as a fuel (blended with gasoline) or it can be converted to dimethyl ether (DME) for combustion in diesel engines or to gasoline via the ExxonMobil methanol-to-gasoline (MTG) process, or to methyl-tert-butyl-ether (MTBE) for combustion in gasoline engines. Methanol blends in gasoline in the EU are limited by the oxygenate limits to 3%(vol).

3.1.6.2 Commercial and market status of fuel

Although gasification + methanol catalysis plants have been commercially available for fossil feedstocks such as coal for several decades, this route has only recently been applied for the conversion of MSW at a commercial scale (TRL 8). Enerkem operate several plants at commercial-scale for methanol production from gasification, and in their Edmonton plant further produce ethanol from the methanol. However, the production of DME is currently at TRL 5, as past pilot activities are no longer operational.

3.1.6.3 Production cost

As with gasification + FT, production costs for gasification to methanol can be significantly decreased with the use of waste feedstocks, which can potentially generate gate fees. Estimated capital costs do not vary substantially between different feedstocks (Figure 24)[39]. Although operation costs when using waste feedstocks would be expected to be generally be higher due to the requirement for additional treatment, this would be offset by the initial zero or negative feedstock costs.

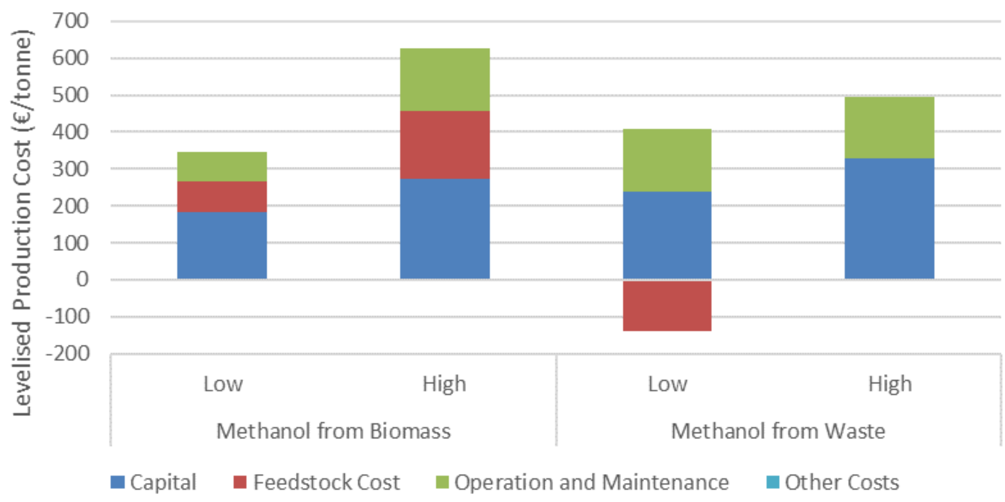

Figure 24: Levelised production costs for methanol produced from biomass (left) and waste (right) feedstocks

3.1.6.4 Policy treatment under RED II

The treatment of fuels produced via gasification and synthesis under RED II is dependent on the feedstock used for their production. Fuels produced from lignocellulosic or the biogenic fraction of MSW can be double counted on an energy basis towards the renewable energy in transport target, as they are listed as advanced feedstocks under Annex IX Part A. If the fuel is produced from the non-biogenic fraction of MSW, it currently cannot be considered a renewable fuel and therefore cannot contribute to the transport target. The treatment of

[39] IEA (2020), “Advanced Biofuels – Potential for Cost Reduction”, IEA Bioenergy Task 41: https://www.ieabioenergy.com/wp-content/uploads/2020/02/T41_CostReductionBiofuels-11_02_19-final.pdf

"recycled carbon fuels", including those produced from the non-biogenic fraction of MSW, under RED II will be reviewed and decided in a delegated act (Table 3:).

3.1.7 Lignocellulosic material/non-biogenic waste (incl. MSW) to diesel/kerosene/gasoline via pyrolysis

3.1.7.1 Fuel chain structure and fuel use in vehicle

Pyrolysis is the thermal decomposition of a material in the absence of oxygen. This can be used to transform advanced feedstocks such as lignocellulosic biomass and waste into a liquid bio-crude oil, gases and charcoal (bio-char). Fast pyrolysis using catalysts can be used to maximise the production of pyrolysis oil, which can be upgraded to diesel/kerosene/gasoline. A range of pyrolysis-type technologies can be used to process a wide range of feedstocks (including low-quality wet feedstocks), increasing feedstock flexibility. In addition, the bio-crude oil can be transported separately to dedicated refinery facilities, removing the need for on-site conversion, although this may require some pre-processing and infrastructure modifications.

Jet fuel produced via pyrolysis is not currently certified for any blend level in kerosene.

3.1.7.2 Commercial and market status of fuel

Fast pyrolysis to bio-crude oil is currently at TRL 8, with a number of first commercial facilities selling the pyrolysis oil for heating applications. However, refining of the pyrolysis oil is only at the demonstration stage, with limited trial runs taking place (TRL 6). Currently, there is no commercial process for upgrading pyrolysis oil to finished fuel in dedicated plants. There is also significant interest from industry in the potential to co-process pyrolysis in refineries, although current this is only at trial stage.

3.1.7.3 Production cost

Figure 25 shows the estimated production cost ranges for the production and refining of pyrolysis oil, which can be upgraded on site in a standalone facility, or upgraded off-site by co-processing at a fossil fuel refinery[40]. Although capital costs are lower generally for the co-processing option, there are a number of limitations that result in the similar production costs estimated by IEA Bioenergy. The blend-in rate into fossil streams in suitable refineries is limited to between 2-10%, while the conversion efficiency is lower than in a standalone plant. However, it should be noted that there is considerable uncertainty about the costs of producing and upgrading bio-oil and the relative benefits of stand-alone or coprocessing.

[40] IEA (2020), "Advanced Biofuels – Potential for Cost Reduction", IEA Bioenergy Task 41: https://www.ieabioenergy.com/wp-content/uploads/2020/02/T41_CostReductionBiofuels-11_02_19-final.pdf

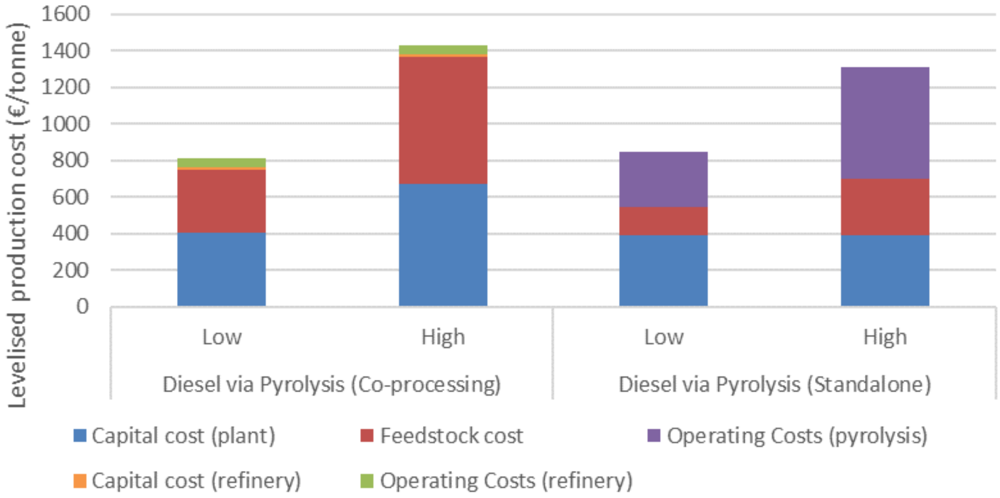

Figure 25: **Estimated production cost ranges for production of pyrolysis oil and upgrading on site (standalone) or upgrading off-site by co-processing at fossil fuel refinery (co-processing)**

3.1.7.4 Policy treatment under RED II

The treatment of fuels produced via pyrolysis under RED II is dependent on the feedstock used for their production. Fuels produced from lignocellulosic or the biogenic fraction of MSW can be double counted on an energy basis towards the renewable energy in transport target, as they are listed as advanced feedstocks under Annex IX Part A. If the fuel is produced from the non-biogenic fraction of MSW, it currently cannot be considered a renewable fuel and therefore cannot contribute to the transport target. The treatment of "recycled carbon fuels", including those produced from the non-biogenic fraction of MSW, under RED II will be reviewed and decided in a delegated act (Table 3:).

3.1.8 Lignocellulosic material/non-biogenic wastes (incl. MSW) to alcohols via hydrolysis fermentation

3.1.8.1 Fuel chain structure and fuel use in vehicle

Ethanol produced from advanced lignocellulosic feedstocks, such as corn stover and energy crops, is much more difficult to produce compared to sugar/starch crops, as the glucose must be extracted from the cellulose before it can be fermented. As in Section 3.1.2, the feedstock is pre-treated via thermal or chemical means. Further pre-treatment is required to separate the lignin fraction. A more intensive hydrolysis treatment is then required to break down the cellulose and hemicellulose within the biomass to sugars. The sugar molecules are then fermented using yeast or bacteria in the same manner as described in Section 3.1.2. The alcohols produced are the same those produced from sugar/starch crops, as are the fuel properties and uses.

3.1.8.2 Commercial and market status of fuel

Ethanol production using waste products from more established feedstocks, such as corn stover and sugarcane bagasse, are at early commercial phase (TRL 8). Demonstration plants exist for woody biomass, such as forestry residues and short rotation coppice (TRL 7). Ethanol fermentation of MSW as a feedstock is at a lower level of readiness (TRL 5), as the processes to refine the sugars from MSW are at a pilot stage. Butanol production from lignocellulosic feedstocks is at TRL 5-6, based on pilot scale and small-scale demonstration projects.

Lignocellulosic ethanol is estimated to account for 0.09% of the global fuel ethanol market, with many existing plants operating far below capacity or idle. Much of the currently existing production is found in the US, accounting for over 40% (Figure 26)[41]. Existing plant capacities range from 16 ktons per year to 90 ktons per year (Fujiang Bioproject, China). However, Fujiang Bioproject is currently on hold: the largest operational plant is Project Liberty in the US, with an output capacity of 75 ktons per year.[42]

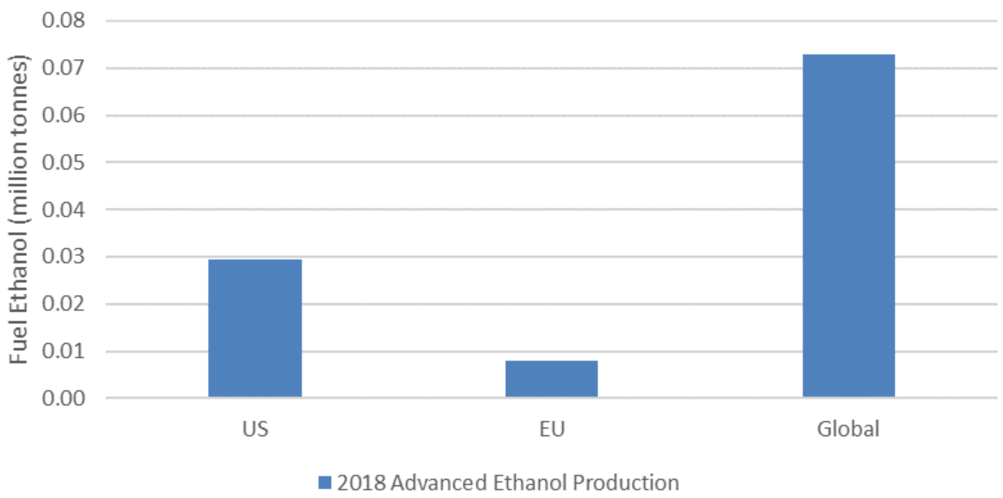

Figure 26: Production of advanced ethanol by region in 2018

Numerous barriers must be overcome before lignocellulosic biofuels can be competitive with existing starch-based ethanol fuels or fossil fuels. These include pre-treatment difficulties, feedstock supply chains, and technical challenges related to the fermentation process, alcohol separation process, and the fate of lignin and hemicelluloses after pre-treatment. Butanol faces the additional challenges that already exist for the ABE fermentation process.

41 Padella, M., O` Connell, A. and Prussi, M., What is still limiting the deployment of cellulosic ethanol? Analysis of the current status of the sector, APPLIED SCIENCES-BASEL, ISSN 2076-3417 (online), 9 (21), 2019, p. 4523, JRC117955.

42 Ibid.

3.1.8.3 Production cost

Capital costs are a significant factor in cellulosic ethanol production, and vary based upon a number of factors, including plant size, location and the complexity of the process itself: Brown et al estimate a range of between 2,570 EUR/kW and 3,650 EUR/kW of ethanol production based upon plant size, location and the complexity of the process itself. Feedstock costs are significantly reduced for ethanol plants where the material is already on site (for instance, if nearby a sugar refinery where sugarcane bagasse is readily available). Another factor unique to advanced ethanol production costs is the cost of the enzymes used: however recent improvements in enzyme efficiency and knowledge have reduced costs substantially. The low scenario in Figure 27 is based upon an idealised plant using the cheapest available feedstock, and was included by the authors to demonstrate the importance of capital and feedstock costs[43]. The medium and high scenarios are more representative of typical plant production cost ranges.

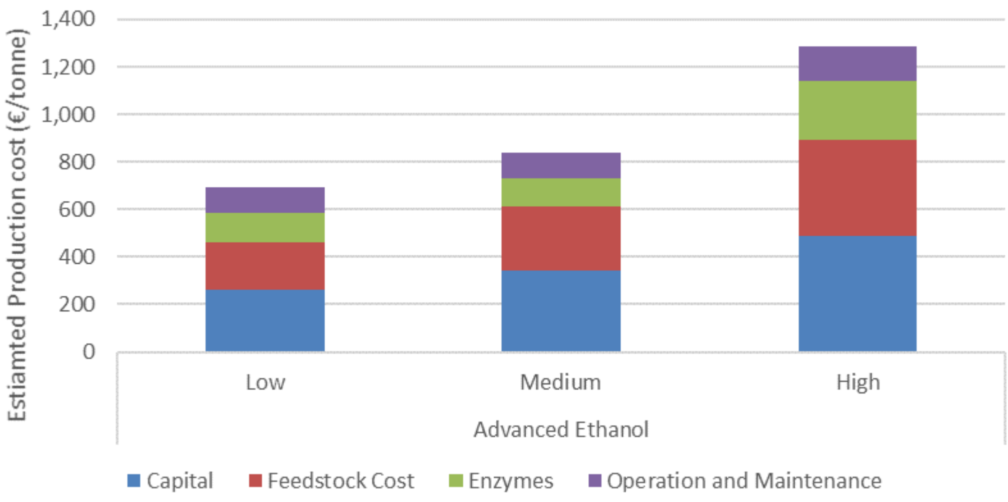

Figure 27: Estimated production cost ranges of advanced ethanol production

3.1.8.4 Policy treatment under RED II

The treatment of fuels produced via hydrolysis and fermentation under RED II is dependent on the feedstock used for their production. Fuels produced from lignocellulosic or the biogenic fraction of MSW can be double counted on an energy basis towards the renewable energy in transport target, as they are listed as advanced feedstocks under Annex IX Part A. If the fuel is produced from the non-biogenic fraction of MSW, it currently cannot be considered a renewable fuel and therefore cannot contribute to the transport target. The treatment of “recycled carbon fuels”, including those produced from the non-biogenic fraction of MSW, under RED II will be reviewed and decided in a delegated act (Table 3:).

---

43 IEA (2020), “Advanced Biofuels – Potential for Cost Reduction”, IEA Bioenergy Task 41: https://www.ieabioenergy.com/wp-content/uploads/2020/02/T41_CostReductionBiofuels-11_02_19-final.pdf

3.1.9 Wet wastes and agricultural residues to methane via anaerobic digestion

3.1.9.1 Fuel chain structure and fuel use in vehicle

Anaerobic digestion (AD) involves the use of bacteria to break down organic material into fatty acids and alcohols, which are in turn converted into methane and CO_2, water, and a solid residue (digestate). The methane/CO_2 mix (commonly referred to as biogas) can either be used directly by burning for heat and power production, or the biogas can be upgraded, through CO_2 separation and removal of other impurities, to biomethane which can be used as transport fuel.

Typically, wet wastes, such as manures, food waste or MSW (all considered advanced feedstocks) are used in AD plants, as the carbohydrate structures within the material are more easily accessible to the digesting enzymes, but agricultural residues and some crops can also be used. The lignocellulosic structure of grassy and woody energy crops makes them unsuitable without thermal and/or chemical pre-treatment, increasing the cost and energy requirements.

Existing gasoline vehicles can be modified to run on biomethane in the form of compressed biomethane (bio-CNG) or liquefied biomethane (bio-LNG), either as a bi-fuel vehicle (running on either gasoline or CNG/LNG) or as a dedicated CNG/LNG vehicle. The most significant and costly modification is a specialised fuel tank in both cases, while a fuel regulator and additional injectors are also required. Both CNG and LNG can be used in passenger and heavy-duty vehicles, but the vehicle fleet and refuelling infrastructure in Europe today for CNG is much more established than for LNG. LNG is nevertheless seen as a promising fuel for the decarbonisation of the long-haul heavy-duty road sector due to its greater volumetric energy density compared to CNG. LNG also sees use in other transport sectors, in particular for maritime applications. As an example, the Port of Rotterdam has a dedicated LNG terminal with facilities to refuel ships. LNG has also been demonstrated for rail applications in Florida, USA.

3.1.9.2 Commercial and market status of fuel

Biomethane from the AD of most wet wastes and agricultural residues is at TRL 9, with hundreds of plants operating globally: the conversion of MSW into biomethane is at TRL 8, with the first commercial plants only recently coming online.[44]

The European Union is currently the main producer of biomethane worldwide, with 515 plants online accounting for approximately one third of global production in 2018.[45] However, much of current biomethane demand is in the heat and power sector, with transport

[44] Brémond, U., de Buyer, R., Steyer, J.-P., Bernet, N., & Carrere, H. (2018). Biological pre-treatments of biomass for improving biogas production: an overview from lab scale to full-scale. Renewable and Sustainable Energy Reviews, 90, 583–604. doi:10.1016/j.rser.2018.03.103

[45] GIE/EBA European Biomethane Map 2018

accounting for approximately 1% of biogas demand in final energy consumption globally as of 2016.[46]

3.1.9.3 Production cost

Due to limitations on feedstock availability and the cost of transporting wet wastes, anaerobic digestion is typically conducted in smaller capacity plants (between 1-20MW), meaning that economies of scale are limited, and operating and maintenance costs are a higher proportion of the overall production cost than for other fuels. Staffing requirements are independent of the capacity, and as such become a dominant cost in smaller facilities. In addition, many biomethane production plants operate well below full capacity, with nameplate capacity in Europe being three times larger than production in 2017.

A wide variety of substrates can be used in the production of biomethane from AD, including mixtures of energy crops and straw with other waste feedstocks. As a result, the feedstock cost can range from a negative cost up to €100/tonne for feedstocks such as straw, which has a significant impact on production costs as shown in Figure 28[47]. In this case, the high scenario represents a small plant using straw as a feedstock, and the low scenario represents the use of waste feedstocks in a larger plant.

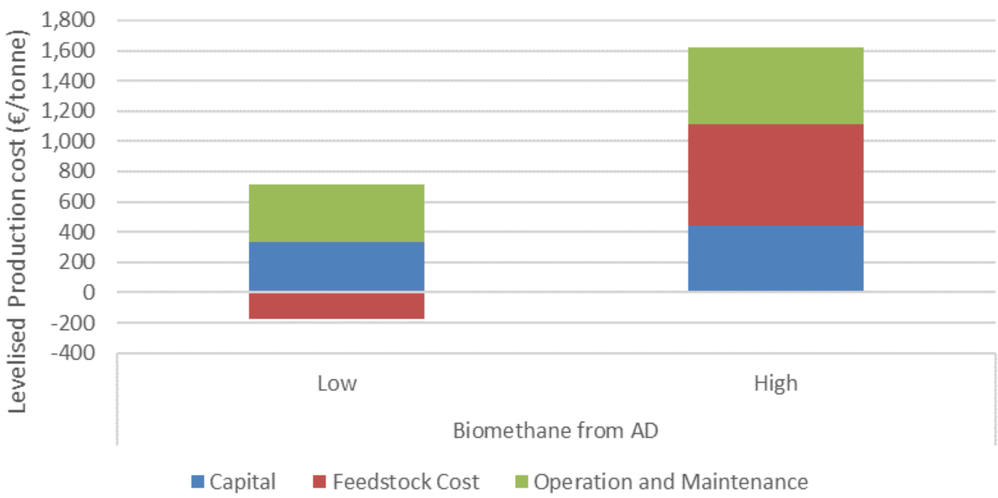

Figure 28: Estimated production cost range for the production of biomethane (including upgrading of syngas) from anaerobic digestion (AD) (IEA, 2020)

[46] https://webstore.iea.org/download/direct/2322?fileName=Market_Report_Series_Renewables_2018.pdf

[47] IEA (2020), "Advanced Biofuels – Potential for Cost Reduction", IEA Bioenergy Task 41: https://www.ieabioenergy.com/wp-content/uploads/2020/02/T41_CostReductionBiofuels-11_02_19-final.pdf

3.1.9.4 Policy treatment under RED II

The treatment of fuels produced via AD under RED II is dependent on the feedstock used for their production. Fuels produced from lignocellulosic or the biogenic fraction of MSW can be double counted on an energy basis towards the renewable energy in transport target, as they are listed as advanced feedstocks under Annex IX Part A. If the fuel is produced from the non-biogenic fraction of MSW, it currently cannot be considered a renewable fuel and therefore cannot contribute to the transport target. The treatment of "recycled carbon fuels", including those produced from the non-biogenic fraction of MSW, under RED II will be reviewed and decided in a delegated act (Table 3:).

3.1.10 Alcohols to kerosene/diesel via alcohol catalysis

3.1.10.1 Fuel chain structure and fuel use in vehicle

Short chain alcohols, such as methanol, ethanol, and butanol isomers, can be converted to more complex long chain fuels such as gasoline, diesel or jet fuel. The source of the alcohol has no impact upon the process, which can be created from both food/feed crop-based and advanced biomass feedstocks. In addition, the alcohols can be sourced via other routes, such as the microbial fermentation of flue gases. The alcohol is dehydrated to produce alkenes, which are then combined using oligomerisation reactions, before being rehydrated and isomerised to meet fuel specifications. Finally, the desired fuel (gasoline, diesel or jet) is produced through distillation.

3.1.10.2 Commercial and market status of fuel

Alcohol to jet (ATJ) fuels are certified for use in aviation fuel at up to 50% blend in kerosene[48]; however, the technology is currently at TRL 6-7. The majority of existing and planned plants focus on ethanol as a feedstock, but technology is also being developed which can use isobutanol.[49]

3.1.10.3 Production cost

The production of jet fuels produced through the ethanol to jet (ETJ) route could be 20-40% higher than the ethanol feedstock on an energy basis, depending upon ethanol input prices. Since the alcohols can be produced via a number of routes, the feedstock costs for alcohol catalysis plants will potentially vary significantly.

However, the single largest factor in plant cost is whether the plant is designed to deal with crop-based or advanced feedstocks: the additional technical challenges posed by the

48 CAAFI, 2020: http://www.caafi.org/focus_areas/fuel_qualification.html (accessed April 2020)

49 https://gevo.com/products/sustainable-aviation-fuel/

production of alcohols for advanced feedstocks such as agricultural residues and energy crops have a significant impact upon plant CAPEX (Figure 29)[50].

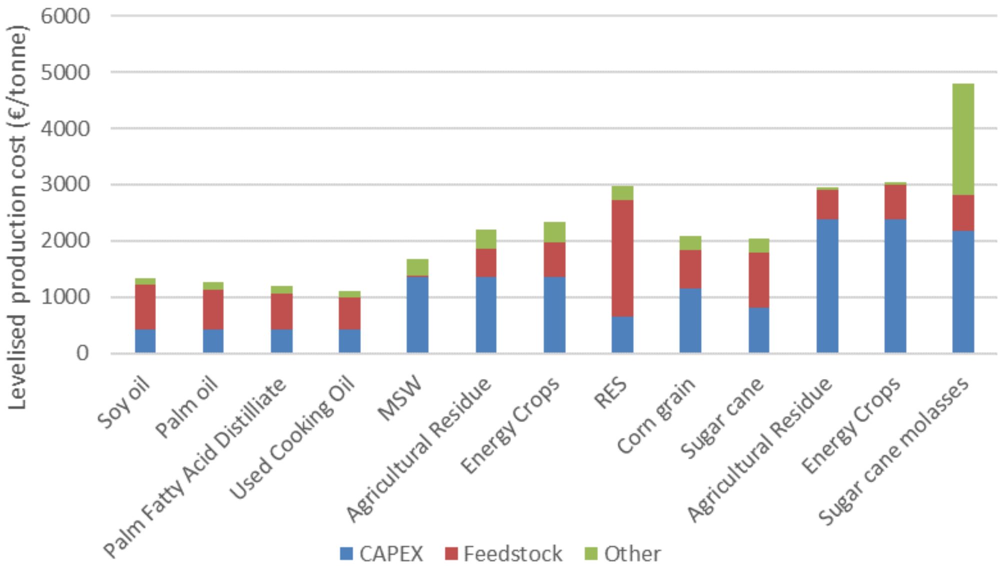

Figure 29: **Comparison of levelized production costs of kerosene via alcohol catalysis using different feedstocks**

3.1.10.4 Policy treatment under RED II

The treatment of fuels produced via alcohol catalysis under RED II is dependent on the feedstock used for the production of the alcohol. If the alcohol was produced from food and feed crops, the contribution of the fuel is to RED II targets is capped (see 3.1.1). Further, if the feedstock is deemed to pose a high iLUC risk, it will be phased out completely by 2030. Conversely, if the alcohol is produced from an advanced feedstock (Annex IX Part A feedstocks), the energy content of the resulting fuel can be double counted towards the overall 14% renewable energy in transport target.

3.1.11 Renewable electricity as an energy source

3.1.11.1 Fuel chain structure and fuel use in vehicle

Electricity can be used in a wide range of vehicles, but is only in widespread commercial use today in light and medium-duty road transport, and in rail. For road transport, plug-in electric vehicles (PEVs) can be recharged using grid electricity as an energy source, storing the energy in rechargeable battery packs. The vehicle can either by wholly reliant upon battery storage (battery electric vehicles, BEVs) or it can have a combination of a combustion engine with an electric motor, alongside a rechargeable battery pack enabling fully electric operation (plug-

[50] ICCT, 2019 “The cost of supporting alternative jet fuels in the European Union”: https://theicct.org/sites/default/files/publications/Alternative_jet_fuels_cost_EU_20190320.pdf

in hybrid, PHEV). The same principle can be followed for shipping, with hybrid and all-electric ships currently available with ships recharged at each end of its journey at set charging stations. In addition, some ships take advantage of solar PV installed on deck to partially generate power.

Electric rail transport relies upon a direct connection to electrified railway lines, rather than batteries. The extent of rail electrification varies significantly between Energy Community Contracting Parties: as of 2018, approximately 34% of Serbia's total railway lines were electrified[51], while Eurostat indicates that, of North Macedonia's 683 km railways lines, 234 km were electrified as of 2017[52]. However, none of the Republic of Moldova's railways were electrified as of 2018[53]. Electrification of the aviation industry is highly unlikely for medium or long-haul flights in the next few decades, due to battery limitations. Electrification of short-haul aircraft is developing, and in 2019 the first small-scale, short distance commercial all-electric flights began[54].

The potential for use of renewable energy in transport is dependent upon the energy mix of the electricity grid from where the electricity is sourced: an energy mix with a greater proportion of electricity from fossil fuels will produce electricity with a greater average emission coefficient (gCO_2e/kWh), and will therefore have higher emissions from use in vehicles. Figure 30 shows that electricity generation from renewable sources currently varies significantly between Energy Community Contracting Parties, from approximately 3% in Kosovo* to 100% in Albania[55]. However, it should be noted that these statistics do not account for sources such as small diesel generators, and electricity consumption figures can differ significantly; for instance, Albania imported 39% of its total consumed electricity in 2016[56].

Many of the Energy Community Contracting Parties are part of the European Continental Synchronous Area, with varying degrees of interconnectivity, and as such their proportion of total electricity generation from renewable energy will depend somewhat on other European countries. A small part of Ukraine is currently synchronised with the grid of Continental Europe; however, the rest of the territory is connected to the IPS/UPS grid, alongside

[51] https://www.unece.org/fileadmin/DAM/trans/doc/2018/wp5/6_Mr._Marko_Jeremic_Serbia_Rail_Connectivity_Workshop_29Nov18.pdf

[52] Eurostat https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=rail_if_electri&lang=en

[53] https://unfccc.int/sites/default/files/resource/Moldova_BUR2_EN_web_19.04.2019.pdf (Page 64)

[54] https://www.harbourair.com/harbour-air-and-magnix-announce-successful-flight-of-worlds-first-commercial-electric-airplane/# (Accessed April 2020)

[55] IEA.org Data and Statistics https://www.iea.org/data-and-statistics/?country=WORLD&fuel=Electricity%20and%20heat&indicator=CO2%20emissions%20from%20electricity%20generation%20factors (Accessed March 2020)

[56] https://www.cia.gov/library/publications/the-world-factbook/geos/al.html

Moldova and Georgia, and electricity sourced from the IPS/UPS grid will be dependent upon the energy mix of countries such as Russia.

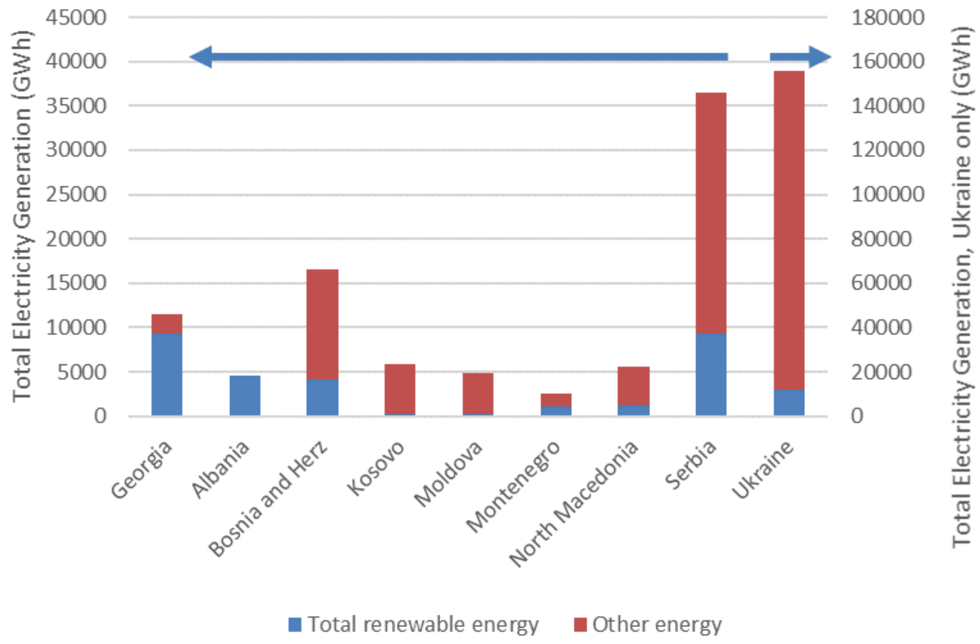

Figure 30: Proportion of electricity from renewable energy sources in Energy Community Contracting Parties, 2017 (Ukraine on separate axis to avoid scale issues) (IEA, 2020)

3.1.11.2 Commercial and market status of fuel

Unlike other fuel routes, the commercial status of electric vehicles is mostly determined by infrastructure rather than the fuel route itself. The penetration of PEVs into current markets is limited in most countries. For instance, there were an estimated 12,330 BEVs in Ukraine in 2018, accounting for less than 0.1% of the total fleet, although EV sales accounted for 3% of total sales in 2018[57]. Various barriers exist to widespread EV use, including battery costs, range anxiety and dependence upon battery recharging networks, all of which currently cause uncertainty and prevent investment[58]. As such, government policy will play a crucial role in the uptake of EVs in the coming decades.

Fully electric ships are in operation in Europe, but are currently restricted to ferries covering distances of up to 95km per journey[59]. However, advances in battery technologies are

57 Eastern Partnership 14th Panel on Transport: Electric Vehicles in Ukraine Transport Infrastructure Business Climate, EV's and Infrastructure Perspectives in Ukraine

58 Statharas et al. (2019) "Factors Influencing Electric Vehicle Penetration in the EU by 2030: A Model-Based Policy Assessment", Energies 2019, 12(14), 2739; https://doi.org/10.3390/en12142739

59 https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Sep/IRENA_Renewable_Shipping_Sep_2019.pdf

expected to make full-scale electric propulsion an economically attractive option for large scale vessels by 2030. Railway electrification projects, such as the electrification of the Orient/East Med corridor in Serbia, are currently ongoing[60].

3.1.11.3 Electricity prices

Although current electricity prices are not specific to renewables[61], the grid electricity price is a reflection of the cost to the consumer of refuelling their electric vehicle, and as such is an important indicator. Electricity prices in Energy Community Contracting Parties are significantly lower than those in the European Union and Euro area (Figure 31)[62]. Currently, EU electricity prices account for a carbon pricing mechanism through the emissions trading system (ETS), while prices in Energy Community Contracting Parties do not: this is due to change in future[63], which will likely lead to a convergence in price to some degree. It should be noted that the electricity price is likely to vary between charging at home (where the price will fluctuate depending upon demand) and at refuelling stations, where a premium may be added to account for CAPEX costs.

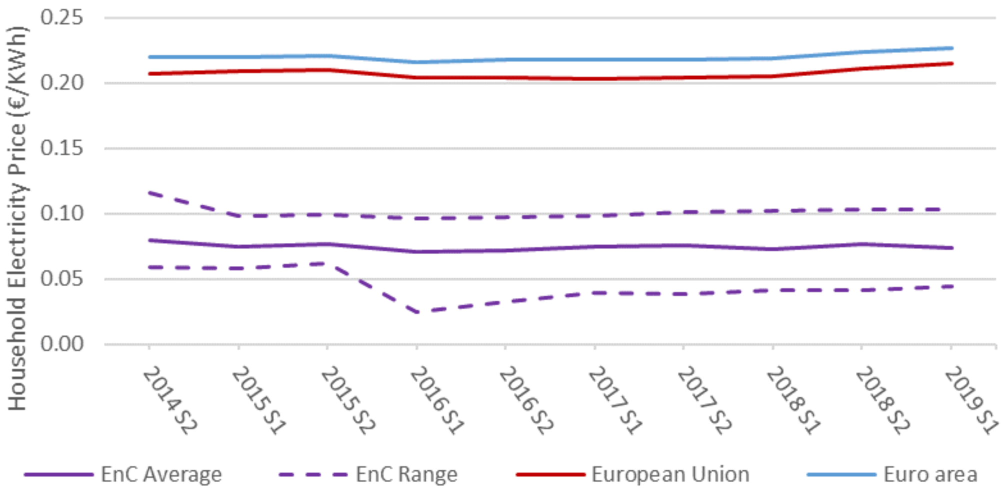

Figure 31: **Household electricity price comparison between EnC contracting parties and Europe regions (all taxes and levies included) Policy treatment under RED II (Eurostat: accessed March 2020)**

A large part of the reason for the comparably low electricity prices is that there are significant subsidies for coal use in many Contracting Parties (with the exception of Albania, Moldova

60 https://ec.europa.eu/neighbourhood-enlargement/sites/near/files/connectivity_agenda_2017_trieste_summit.pdf

61 Serbia is the first CP to have introduced Guarantees of Origin for renewable electricity.

62 Eurostat - Electricity prices components for household consumers - annual data (from 2007 onwards) (Accessed March 2020)

63 https://energy-community.org/news/Energy-Community-News/2020/02/03.html

and Georgia, who lack coal fired generation capacity). In a study by the Energy Communities64, if subsidies for coal-fired electricity generation were removed, the price of electricity for households would have to be increased by some 29% in North Macedonia, 23% in Kosovo*, 31% in Bosnia and Herzegovina, 37% in Montenegro and 49% in Serbia. Prices for industrial consumers would have to be increased by 34% in North Macedonia, 30% in Bosnia and Herzegovina, 18% in Serbia and 36% in Montenegro, while in Kosovo* it would be decreased by 9%.

Renewable electricity used directly in road transport counts 4 times its energy content towards the renewable energy transport target, and renewable electricity used in rail can count 1.5 times its energy content towards the target. Under the RED II, if the vehicle uses electricity from the grid, the share of renewable electricity use in transport is calculated by taking the average share of renewables supplied to the grid in the Member State where the transport occurs, two-years prior to the year of consumption. It is possible that electricity from the grid is 100% renewable, in which case the vehicle can be considered to run on 100% renewable electricity, so long as the renewable property of the electricity is only claimed once (i.e. the renewable attribute is not sold to another user). If the vehicle is supplied electricity solely from a direct connection to a renewable electricity installation, it can be considered to be powered by 100% renewable electricity.

3.1.12 **Renewable electricity to produce hydrogen via electrolysis**

3.1.12.1 Fuel chain structure and fuel use in vehicle

The production of hydrogen from water through electrolysis has been used industrially for more than a century. Electrolysis involves passing a direct current through an ionic substance (in this case water) using two electrodes, creating an electric potential. Renewable electricity can be used to power the process, producing a carbon-neutral fuel. With the help of the so-called Power-to-Gas technology, electricity is converted into the gaseous energy carrier hydrogen, or where appropriate and including an additional process step into methane (see 3.1.13). By applying suitable synthesis processes liquid fuels can also be produced from hydrogen (Power-to-Liquids, see 3.1.14). When using renewable electricity, the resulting chemical energy carriers are virtually emission-free.

There are three main types of electrolyser in use today: alkaline (AEL), proton exchange membrane (PEM)[65] and solid oxide electrolysers (SOE). Alkaline electrolysers are the most established technology, and comprise the majority of installed electrolyser capacity globally today. PEM and solid oxide electrolysers are at an earlier stage of commercialisation but could offer advantages such as higher efficiency of more flexible operation.

64 Miljevic 2019, Analysis of Direct and Selected Indirect Subsidies to Coal Electricity Production in the Energy Community Contracting Parties

65 Or “polymer electrolyte membrane”

Hydrogen is used to power fuel cell electric vehicles (FCEVs). Fuel cells consist of three components: an anode, an electrolyte, and a cathode. A catalyst at the anode oxidises the hydrogen, producing a positively charged ion and a negatively charged electron. The electrolyte allows the ions to pass through, but prevents electrons from doing so: instead, these electrons pass through a wire, producing the electric current which powers the vehicle. The hydrogen ions are transferred to the cathode, where they react with oxygen and the electrons to produce water.

Fuel cells are not restricted to road transport: fuel cell and fuel-cell hybrid technologies can be used in trains and in smaller ships, with larger projects in development for both transport modes.

3.1.12.2 Commercial and market status of fuel

Global dedicated hydrogen production was approximately 70Mt in 2019: however, hydrogen from electrolysis accounted for only 2%, with the significant majority produced from natural gas and coal[66]. However, electrolyser capacity has been increasing in recent years (Figure 32), and is expected to increase significantly in coming years.

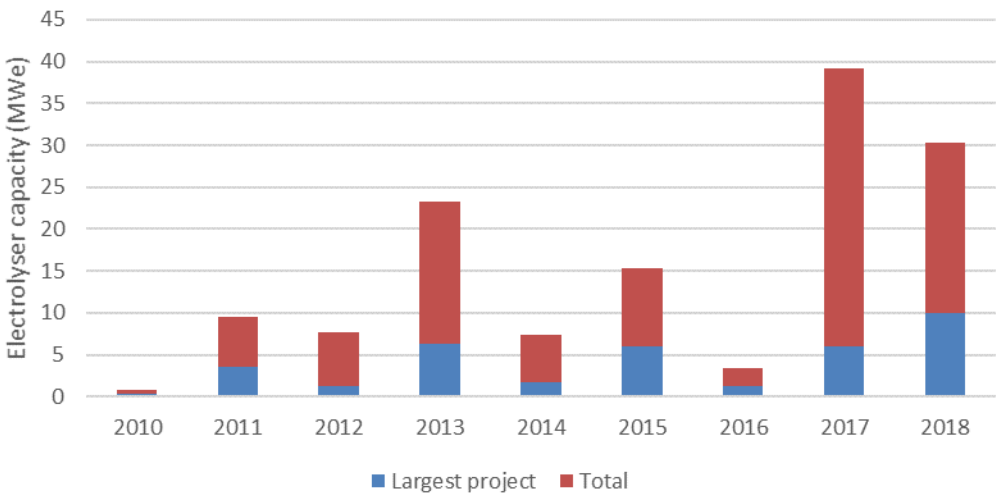

Figure 32: Global electrolyser capacity installed per year (IEA, 2019)

Whereas initially only smaller systems with electrolysis capacities in the kilowatt (kW) range for research purposes had been in operation, projects with several megawatts (MW) of electrical input power capacity are being implemented today, even larger projects are in the planning stage. During the last 6 months (2019), more construction capacity has been announced than in the last 6 years altogether, while in July 2020 the European Commission released its Hydrogen Strategy, which aims to support the installation of at least 6 GW of

[66] IEA (2019), "The Future of Hydrogen", IEA, Paris https://webstore.iea.org/download/direct/2803

renewable hydrogen electrolysers in the EU by 2024[67]. Several electrolyser plants with an electrical capacity of significantly more than 100 MW will be built worldwide in the next few years (announced: GW range). The number of projects has strongly increased, and by 2025, about 60 plants (over 420 MW electrolysis power) are expected to be in operation or under construction in Germany alone (see Figure 33).

Figure 33: Hydrogen production capacity in Germany[68]

The global stock of FCEVs was 11,200 units as of the end of 2018: 4,000 of those were sold in the previous 12 months, representing an 80% increase in sales on the previous year[69]. Fuel cell hybrid trains are already seeing extended use in Germany, with two trains in use since 2018 achieving more than 130,000km in revenue service, with 14 additional units to be delivered in 2021. Europe, particularly Germany, France, UK and Romania, has shown significant interest in the use of hydrogen for trains, with a Fuel Cells and Hydrogen Joint Undertaking (FCH JU) and Shift2Rail Joint Undertaking (JU) study suggesting that 20% of newly purchased trains could be hydrogen-fuelled by 2030. In shipping, smaller hydrogen-powered vessels have been proven, and hybrid ferry projects are in development in Scotland and Norway. Several recently announced projects funded by the European Commission are

67 EC, 2020. A hydrogen strategy for a climate-neutral Europe. Accessed November 2020. Available at: https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf

68 LBST (own analysis)

69 IEA (2019), "Tracking Energy Integration", IEA, Paris https://www.iea.org/reports/tracking-energy-integration

aiming to further develop hydrogen infrastructure across the continent, including across Central, Eastern and South-Eastern Europe.[70]

3.1.12.3 Production cost

The production cost of hydrogen from electrolysis comes with a high degree of uncertainty. Brynolf et al state that the main factors affecting the production cost are the capital cost of the electrolyser and the electricity price: the feedstock is less important[71]. With technological improvements, costs are expected to decrease significantly over time (Figure 34).

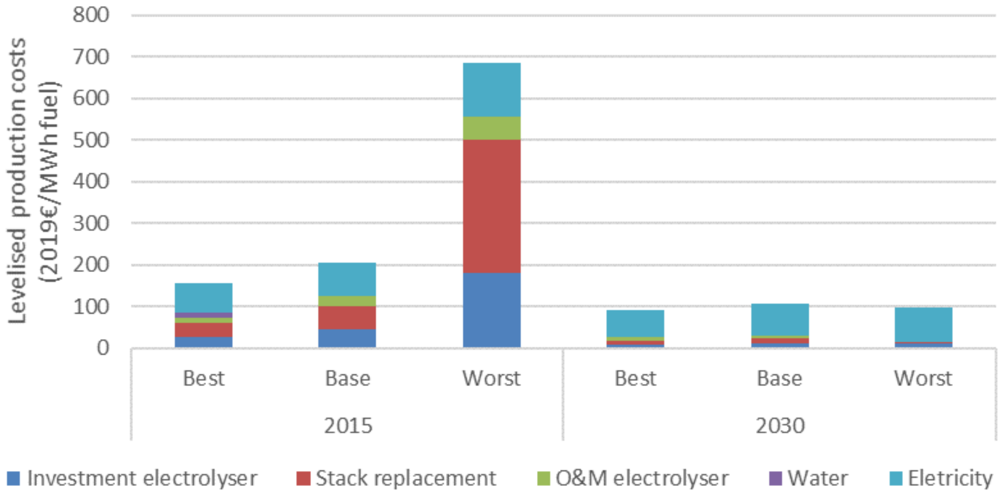

Figure 34: Estimated production cost breakdown of hydrogen production via electrolysis using a PEM electrolyser (assuming a fixed electricity cost of €52/MWh (2019 prices)) (Brynolf et al, 2018)

3.1.12.4 Policy treatment under RED II

Hydrogen produced from renewable electricity cannot have its energy content counted multiple times towards the renewable energy in transport target, even if the hydrogen is produced from renewable electricity. However, Member States can decide that RFNBOs can count towards their advanced biofuels target, in turn incentivising their use. Although, the RFNBO cannot be double counted towards the target, as other advanced biofuels (produced from Annex IX feedstocks) would.

If the hydrogen is produced from grid electricity, the renewability of the hydrogen is based on the renewable mix of the grid it is produced from, two years prior to its production. However, the hydrogen can be considered completely renewable if the RFNBO plant has a

[70] Hydrogen for Climate Action, Available from: https://www.hydrogen4climateaction.eu/projects

[71] Brynolf, S., Taljegard, M., Grahn, M., & Hansson, J. (2018). Electrofuels for the transport sector: A review of production costs. Renewable and Sustainable Energy Reviews, 81, 1887–1905. doi:10.1016/j.rser.2017.05.288

direct connection to a renewable electricity generator/installation, which meets the following conditions:

- It became operational after (or at the same time) as the hydrogen producing plant;
- It is not grid connected or if it is grid connected, it can evidence that the electricity used by the hydrogen plant has not been supplied from grid electricity

A delegated act is expected by the end of 2021, which would set out a Union methodology detailing rules the operators will need follow to prove the renewability of produced hydrogen for use in transport.

3.1.13 Renewable electricity to produce methane via electrolysis + methanation

3.1.13.1 Fuel chain structure and fuel use in vehicle

The hydrogen generated via electrolysis can alternatively be stored in either natural gas pipelines or storage sites, for use as a feedstock to combine with CO_2 in either a thermochemical (catalytic) or biological methanation reactor. The hydrogen stream can be combined with biogas plants, enabling the direct use of the waste CO_2 from the biogas process for conversion to methane. If the electrolysis uses renewable electricity and the process is combined with CCS, negative emissions are possible[72].

As described in 3.1.9, the methane can be used in transport either as CNG or LNG, if existing gasoline vehicles are modified appropriately. While CNG has a more established vehicle fleet and infrastructure in Europe, LNG is used in maritime applications.

3.1.13.2 Commercial and market status of fuel

The TRL of methanation via electrolysis is currently at TRL 5 for biological reactors, and TRL 7 for catalytic methanation[73], and further work is needed to improve systems to be capable of working with intermittent energy supplies, which is particularly relevant for the electrolysis process. Existing Power-to-Methane projects are mostly at pilot scale, and a lot of these are located in Germany where Power-to-Gas is considered a crucial part of Germany's transition strategy (Energiewende[74]).

3.1.13.3 Production cost

The estimated production cost of power-to-methane plants varies significantly due to the different methods available for achieving methanation (i.e. biological or thermochemical

---

[72] Brandon,2017: Clean energy and the hydrogen economy, Philos Trans A Math Phys Eng Sci.; 375(2098): 20160400. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5468720/

[73] VGB PowerTech 2018, Transformation of the German energy system: https://www.vgb.org/vgbmultimedia/PT201908PIEPER-p-15598-pk_campaign-vgb_newsletter.pdf

[74] Bundesministerium für Wirtschaft und Technologie and Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (2010), Energiekonzept, https://www.bmwi.de/Redaktion/DE/Downloads/E/energiekonzept-2010.pdf?__blob=publicationFile&v=5

routes) and the differences in technological maturity. Capital costs in particular are estimated by Grond et al.[75] to be significant for small-scale methanation (<10 MW) at 1000 EUR/kW_{fuel} as of 2015; however, this would be expected to drop to 300-500 EUR/kW_{fuel} with advances in the process. Best case scenarios (Figure 35) assume pre-existing electrolysis facilities that require minimal modification, where the main cost arises from the methanation process.

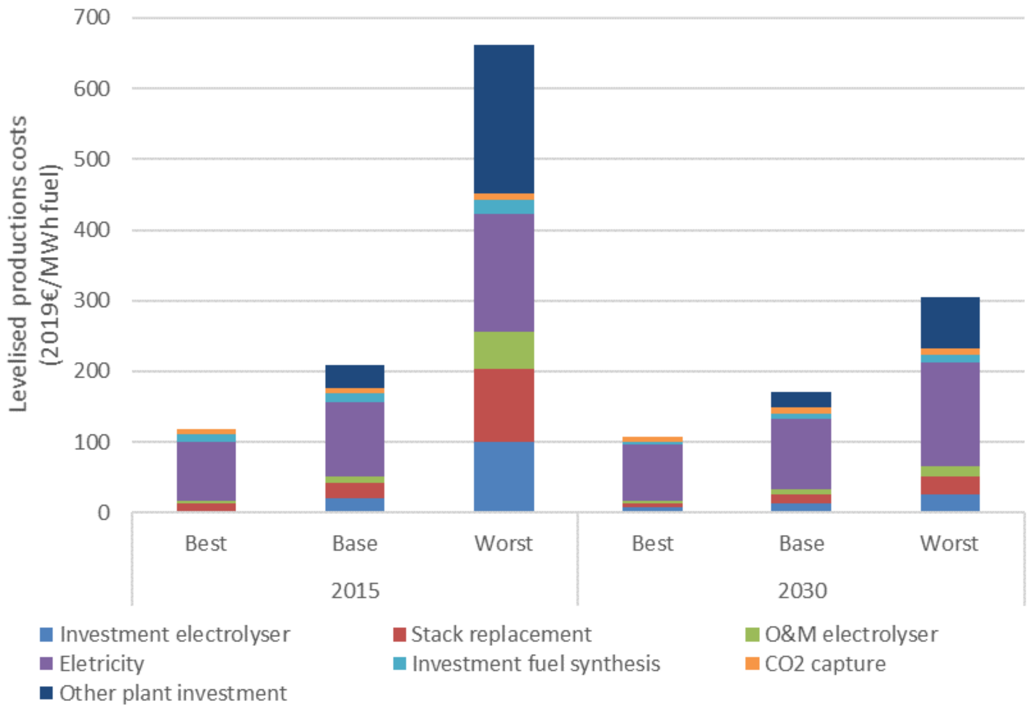

Figure 35: Production cost of methane through power-to-gas routes[76]

3.1.13.4 Policy treatment under RED II

Methane produced from renewable electricity and methanation is not counted multiple times towards the renewable energy in transport target, even if it is produced from renewable electricity. Each Member State can decide whether RFNBOs count towards their advanced biofuels target. Even if RFNBOs are allowed to count towards this target, they cannot be double counted towards the target, as advanced biofuels (produced from Annex IX feedstocks) would.

If the hydrogen, an intermediary product, is produced from grid electricity, the renewability of the hydrogen is based on the renewable mix of the grid it is produced from, two years prior to its production. However, the hydrogen can be considered completely renewable if

[75] Grond, Lukas, Paula Schulze, and Johan Holstein. "Systems analyses Power to Gas: A technology review." DNV KEMA Energy & Sustainability, Groningen (2013).

[76] Brynolf, Selma, et al. "Electrofuels for the transport sector: A review of production costs." Renewable and Sustainable Energy Reviews 81 (2018): 1887-1905.

the RFNBO plant has a direct connection to a renewable electricity generator/installation, which meets the following conditions:

- It became operational after (or at the same time) as the RFNBO producing plant;
- It is not grid connected or if it is grid connected, it can evidence that the electricity used by the hydrogen plant has not been supplied from grid electricity

A delegate act is expected by the end of 2021, which would set out a Union methodology detailing rules the operators will need follow to prove the renewability of produced hydrogen and fuels derived from hydrogen for use in transport.

3.1.14 **Renewable electricity to produce PtL and methanol via electrolysis + synthesis**

3.1.14.1 Fuel chain structure and fuel use in vehicle

Liquid fuels can be produced using electricity, water, and a source of CO_2. Either methanol or hydrocarbon fuels can be produced via this route. Fischer-Tropsch synthesis is used to produce a range of hydrocarbon fuels including diesel, jet and naphtha. As with other Fischer-Tropsch routes, the hydrocarbons produced can be upgraded to the desired fuel quality, to produce diesel, kerosene or gasoline. Methanol can also be produced from electricity, water and CO_2, and can be blended with gasoline or further converted to DME or gasoline.

3.1.14.2 Commercial and market status of fuel

The PtL-FT route is not yet established; however, it is attracting significant interest due to its potential to produce fuels with extremely low GHG emissions, with less feedstock constraints and fewer sustainability issues than other biofuels. Some PtL-FT systems have been demonstrated at small scale (TRL 5-6), but the maturity differs between the components and configuration of the system (e.g. solid oxide electrolysers (SOE) are more efficient but less mature than alkaline electrolysers)[77].

CO_2 production is commercially available from sources such as biogas upgrading or flue gases from industrial processes, although sources such as direct air capture are at TRL 6-7. FT synthesis is an established process at large scales for converting coal and natural gas to liquid fuels, however sizing-down of plants to a size appropriate for biomass supply chains are at a demonstration scale (TRL 6-7).

Producing a fuel with a low GHG intensity relies on the use of renewable electricity. Whilst renewable power production is at TRL 9, production is low in some countries, which can limit deployment of renewable e-fuels.

[77] O. Schmidt et al 2017, Future cost and performance of water electrolysis: An expert elicitation study, International Journal of Hydrogen Energy, Volume 42, Issue 52, https://doi.org/10.1016/j.ijhydene.2017.10.045.5

3.1.14.3 Production cost

The economic viability of PtL routes depends primarily upon the efficiency of the electrolysis process and the cost of the electricity. Figure 36 shows estimated production costs for PtL through FT synthesis using polymer electrolyte membrane (PEM) electrolysers: although PEM is more expensive than alkaline electrolysis, it is potentially better suited for use with renewable electricity, which may be intermittent. The production of methanol is cheaper than PtL (Figure 37), although the process remains sensitive to electrolyser and electricity costs. Production costs are expected to reduce significantly as process efficiency and renewable electricity costs decrease over time.

Another consideration is the opportunity cost of using hydrogen as a feedstock: if the hydrogen itself can be sold into a high value market as a transport fuel, this route may be unattractive from an economic perspective.

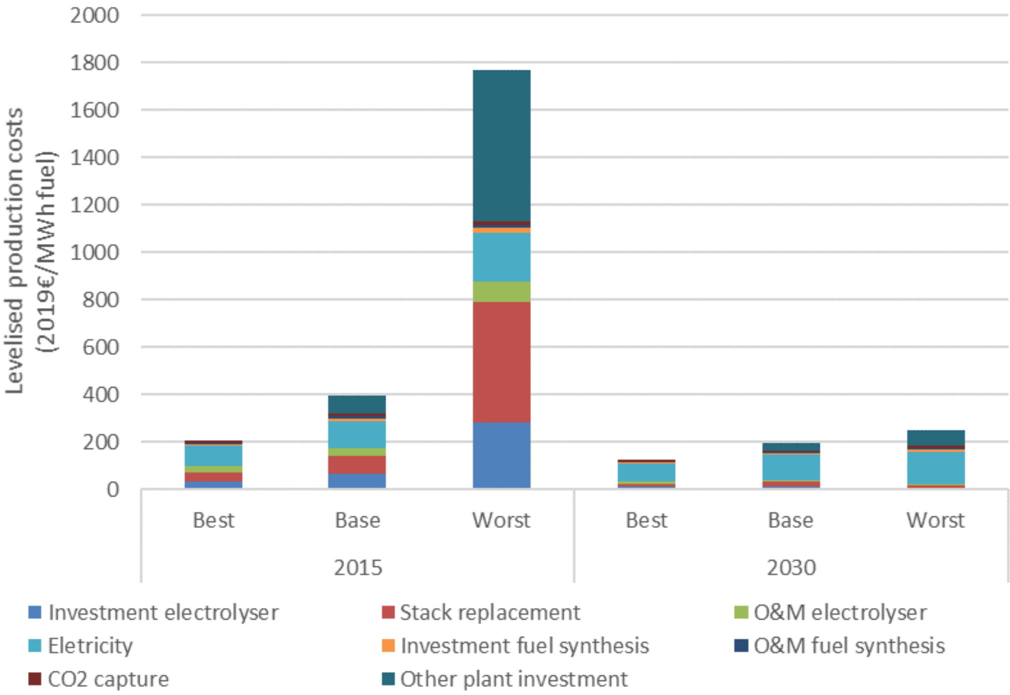

Figure 36: Estimated production cost breakdown of PTL through Fischer-Tropsch synthesis with hydrogen produced using a PEM electrolyser (assuming a fixed electricity cost of €52/MWh (2019 prices))[78]

[78] Brynolf, S., Taljegard, M., Grahn, M., & Hansson, J. (2018). Electrofuels for the transport sector: A review of production costs. Renewable and Sustainable Energy Reviews, 81, 1887–1905. doi:10.1016/j.rser.2017.05.288

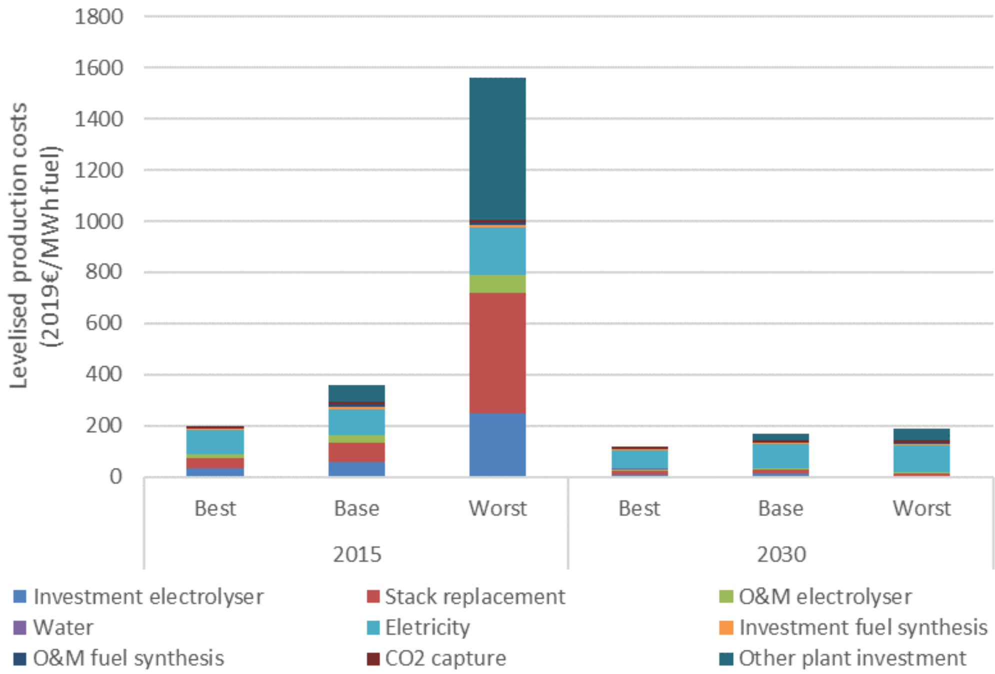

Figure 37: **Estimated production cost breakdown of methanol synthesis with hydrogen produced using a PEM electrolyser (assuming a fixed electricity cost of €52/MWh (2019 prices))**[79]

3.1.14.4 Policy treatment under RED II

PtL and methanol produced from renewable electricity and methanation is not counted multiple times towards the renewable energy in transport target, even if it is produced from renewable electricity. Each Member State can decide whether RFNBOs count towards their advanced biofuels target. Even if RFNBOs are allowed to count towards this target, they cannot be double counted towards the target, as advanced biofuels (produced from Annex IX feedstocks) would.

If the hydrogen, an intermediary product, is produced from grid electricity, the renewability of the hydrogen is based on the renewable mix of the grid it is produced from, two years prior to its production. However, the hydrogen can be considered completely renewable if the RFNBO plant has a direct connection to a renewable electricity generator/installation, which meets the following conditions:

- It became operational after (or at the same time) as the RFNBO producing plant;
- It is not grid connected or if it is grid connected, it can evidence that the electricity used by the hydrogen plant has not been supplied from grid electricity

[79] Brynolf, S., Taljegard, M., Grahn, M., & Hansson, J. (2018). Electrofuels for the transport sector: A review of production costs. Renewable and Sustainable Energy Reviews, 81, 1887–1905. doi:10.1016/j.rser.2017.05.288

A delegated act is expected by the end of 2021, which would set out a Union methodology detailing rules the operators will need follow to prove the renewability of produced hydrogen and fuels derived from hydrogen for use in transport.

3.1.15 Characteristics of fuels – summary

Table 4: Summary of characteristics of fuels

Feedstock	Conversion technology	Fuel(s) produced	TRL	Current production cost range	Typical blend limits in EU road transport
Sugar/starch crops	Fermentation	Alcohols	9	300-830 EUR/tonne (Commodity price)	Ethanol: 5% or 10% Butanol: 16%
Oils (crops and waste)	Esterification	FAME	9	600-1300 EUR/tonne (commodity price)	FAME: 7%
Oils (crops and waste)	Hydro-treatment	HVO/HEFA	9	610-1110 EUR/tonne	HVO: 100%(if meets specification)*
Lignocellulosic material/non-biogenic wastes (incl. MSW)	Gasification + FT	Diesel/ kerosene/ gasoline	7-8	1100-4800 EUR/tonne	100% (if meets specification)*
Lignocellulosic material/non-biogenic wastes (incl. MSW)	Gasification + synthesis	Methanol	8	270-620 EUR/tonne	Methanol: 3%
Lignocellulosic material/non-biogenic wastes (incl. MSW)	Pyrolysis	Diesel/ kerosene/ gasoline	8	800-1410 EUR/tonne	100% (if meets specification)*
Lignocellulosic material/non-biogenic wastes (incl. MSW)	Hydrolysis fermentation	Alcohols	5-8	700-1270 EUR/tonne	Ethanol: 5% or 10% Butanol: 16%
Wet wastes and agricultural residues	Anaerobic digestion	Methane	9	500-1600 EUR/tonne	100% (in NG vehicles)
Alcohols	Alcohol catalysis	Kerosene/diesel	6-7	1100-4800 EUR/tonne	100% (if meets specification)
Renewable electricity		Electricity	9	EnC Price: 0.025-0.115 EUR/kWh EU Price: 0.20-0.225 EUR/kWh	100% (in BEVs)
Renewable electricity	Electrolysis	Hydrogen	9	2015: 150-690 EUR/MWh 2030: 95-105 EUR/MWh	100% (in FCEVs)
Renewable electricity	Electrolysis + methanation	Methane	5-7	2015: 110-660 EUR/MWh 2030: 105-300 EUR/MWh	100% (in NG vehicles)
Renewable electricity	Electrolysis + synthesis (PtL)	Standard liquid transport fuel, e.g. alcohol/ gasoline/ kerosene/ diesel	5-7	2015: 200-1780 EUR/MWh 2030: 100-220 EUR/MWh	100% (if meets specification)*

*These routes produce paraffinic fuels that are less dense than required by the current diesel specification EN590, and for which a new standard EN15940 has been made. Many, but not all, vehicle manufacturers have approved use of EN15940 fuels in their vehicles with no modifications.

3.2 Potential of renewable energy sources in each Contracting Party

3.2.1 Overview of sources

A number of different sources were used to assess the resource potential in each Contracting Party. These are summarised in Table 5. In this section the sources used are described. In the relevant sections X.4.1. in each Contracting Party chapter, the results for each Contracting Party are presented. For all feedstocks we aim to show the total resource that could realistically be available to be used, without taking into account competing uses of that resource. However, there are differences in the methods used between sources, hence in this section a detailed description of each source used is provided, along with information on the underlying method and assumptions.

Table 5: Summary of sources used to assess renewable resources in each CP

	AL	BA	GE	XK	MK	MD	ME	RS	UA
Sugar and starch crops	FAO-stat	FAO-stat	FAO-stat	**N/A**	FAO-stat	FAO-stat	FAO-stat	FAO-stat	FAO-stat
Oil crops	FAO-stat	FAO-stat	FAO-stat	**N/A**	FAO-stat	FAO-stat	FAO-stat	FAO-stat	FAO-stat
Waste fats and oils	World Bank	World Bank	World Bank	World Bank	World Bank	World Bank	World Bank	World Bank	World Bank
Municipal waste (bio fraction)	World Bank	World Bank	World Bank	World Bank	World Bank	World Bank	World Bank	World Bank	World Bank
Wet wastes	Scarlat et al (2018)	Scarlat et al (2018)	**N/A**	Scarlat et al (2018)	Scarlat et al (2018)	Scarlat et al (2018)	Scarlat et al (2018)	Scarlat et al (2018)	Scarlat et al (2018)
Agricultural residues	S2Biom (2017)	S2Biom (2017)	WEG (2014)	S2Biom (2017)	S2Biom (2017)	S2Biom (2017)	S2Biom (2017)	S2Biom (2017)	S2Biom (2017)
Forestry residues	S2Biom (2017)	S2Biom (2017)	WEG (2014)	S2Biom (2017)	S2Biom (2017)	S2Biom (2017)	S2Biom (2017)	S2Biom (2017)	S2Biom (2017)
Energy crops	S2Biom (2017)	S2Biom (2017)	**N/A**	S2Biom (2017)	S2Biom (2017)	S2Biom (2017)	S2Biom (2017)	S2Biom (2017)	S2Biom (2017)
Renewable electricity	Shell	Shell	Shell	IRENA	Shell	Shell	Shell	Shell	Shell

3.2.1.1 FAO-stat: Sugar, starch and oil crops

The Food and Agriculture Organisation (FAO) of the United Nations collects data on crop production in the majority of countries/territories globally, however Kosovo* is not included.[80] The data is collected via data requests to individual countries/territories from the FAO. The FAO aim to achieve high reliability and consistency of data, but are reliant on a

[80] FAO, Available from: http://www.fao.org/faostat/en/#data/QC

consistent and robust national response to data requests in order to achieve this.[81] To make the coverage of data as complete as possible, official data have sometimes been supplemented with data from unofficial sources or other national or international agencies.[82] In as far as possible, this data-set is therefore consistent in methodology and scope across all CPs (apart from Kosovo*).

This source has been used to obtain data on total production of sugar, starch and oil crops in each CP. This does not show how much of the crop would be available for fuel production, but gives an indication of whether the CP is a large producer of the crop type, and so the likelihood of making some of the production available for fuel, or increasing yield or area to produce more crops for fuel.

Production of a wide range of crops is reported by the FAO. The crops included under "sugar and starch crops" and "oil-crops" are described in Table 6. The FAO note that production data on cereals relate to crops harvested for dry grain only, so cereal crops harvested for hay or harvested green for food, feed or silage or used for grazing are excluded. The crops considered under 'oil crops' are also described in Table 6. For those crops reported as seeds a conversion factor of 0.38 $tonnes_{oil}/tonnes_{seed}$ is used to convert tonnes of seeds into tonnes of oil.

Table 6: Aggregation of data on individual crops into categories of crops

Sugar and starch crops	Oil crops
• Barley	• Castor oil seed
• Buckwheat	• Oil, palm
• Cereals, nes	• Oilseeds, nes
• Flax fibre and tow	• Rapeseed
• Grain, mixed	• Sunflower seed
• Maize	• Sesame seed
• Maize, green	
• Millet	
• Rye	
• Sugar beet	
• Sugar cane	
• Triticale	
• Wheat	

81 FAO (2016) Revision of the agriculture production data domain in FAOSTAT, Available from: http://fenixservices.fao.org/faostat/static/documents/Q/Q_Revision_Note_e.pdf

82 FAO (n.d.) Agricultural production – Crops primary, Available from: http://fenixservices.fao.org/faostat/static/documents/QC/QC_methodology_e.pdf

3.2.1.2 World Bank: MSW, UCO, tallow

Historical information on MSW generation was extracted from the What a Waste Global Database,[83] a project run by the WORLD Bank to aggregate data on solid waste management from around the world. The information is based on a study of current literature and conversations with waste agencies and authorities. Historical data on UCO was taken from Ecofys[84], and on tallow from Ricardo (2017).[85] For countries which were not covered by these sources, an estimation was made based on per-capita UCO / tallow resource in regions with a similar economic situation. For MSW, where available, the biogenic portion of the collected waste is used (Bosnia and Herzegovina, North Macedonia, Serbia, and Montenegro), whilst for other CPs, the biogenic portion of total waste is used. For UCO and tallow the volumes refer to the collectable amount of that waste generated. Within a given territory, the amount of waste generated is strongly dependent on population. Therefore, population statistics from the World Bank[86] were used to extrapolate the historical waste volumes as provided in these sources to estimate a 2030 potential of each feedstock in each CP. UCO and tallow potential was summed together to give total waste fats and oils potential.

For MSW, only the biogenic waste volumes are used in this study, as use of fossil wastes does not produce a renewable fuel. The World Bank data reports the total amount of MSW broken down by material (e.g. rubber, glass, plastic etc.). Based on the composition of the waste in each territory, the mass of biogenic waste can be calculated. The fraction of total waste that is biogenic varies between territory, but for the CPs considered in this study the figure lies between 50% (Montenegro) and 73% (Georgia).

3.2.1.3 Scarlat et al (2018): Biomethane, sludge biomass

Scarlat et al. (2018)[87] estimate the potential for biomethane production from manure, covering all of the Contracting Parties apart from Georgia. The study was a spatially explicit assessment at 1km resolution, in order to assess the local feasibility of biogas plants. The manure potential was calculated using spatial data on livestock and poultry, and biogas yields from each type of manure. Scarlet et al. present both a 'theoretical' biomethane production potential, based on the total available manure resource, and a 'realistic' biomethane production potential based on the manure resource that is considered collectible depending

83 World Bank, What A Waste Global Database, Last updated September 20th 2018, Available from: https://datacatalog.worldbank.org/dataset/what-waste-global-database

84 Ecofys (2013) Trends in the UCO market, Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/266089/ecofys-trends-in-the-uco-market-v1.2.pdf

85 Ricardo (2017) UK and Global Bioenergy Resource Model, Available from: https://www.gov.uk/government/publications/uk-and-global-bioenergy-resource-model

86 World Bank, Population Estimates and Projections, Last updated September 19 2019, Available from: https://datacatalog.worldbank.org/dataset/population-estimates-and-projections

87 Scarlat, N., Fahl, F., Dallemand, J-F., Monforti, F., Motola, V. (2018) A spatial analysis of biogas potential from manure in Europe, *Renewable and Sustainable Energy Reviews,* https://doi.org/10.1016/j.rser.2018.06.035

on livestock, farming system and technical limitations for collection. The 'realistic' figure was used in this study.

Estimates of sludge biomass potential were provided by the JRC (2015)[88] for Albania, Bosnia and Herzegovina, North Macedonia, Montenegro and Serbia, but was assessed to be zero. As a result, no potential from sludge was included in this study.

3.2.1.4 S2Biom: Lignocellulosic biomass (residues and energy crops)

S2Biom was a project supported by the European Commission which ran from 2013 to 2016. One of the three key themes of the project focussed on estimating current and future sustainable lignocellulosic biomass supply using the CAPRI model and COCO database, covering all of the CPs apart from Georgia.[89] All data is freely available from the S2Biom website.[90]

The data is provided in dry tonnes, disaggregated into 47 different feedstocks. For each feedstock, the information provided in the S2Biom study on the typical moisture content and energy content of each feedstock was used to convert values in dry tonnes into PJ. If these values were missing, then a typical value for that biomass type was used. The individual feedstocks were then aggregated together into the macro-categories used in this study as shown in Table 7.

In the S2Biom project biomass potentials under a number of different scenarios are calculated: a technical potential and a 'base scenario', representing a sustainable technical potential in both 2020 and 2030. The base scenario imposes more stringent sustainability criteria and is therefore used in this study. Under the base scenario, a limit is imposed on the amount of agricultural residues that can be removed from the field in order to maintain soil organic carbon; dedicated biomass crops are assumed to be cultivated on all good and low productive agricultural land released from other forms of cultivation and fallow land, with protected areas excluded, and a minimum percentage of fallow land maintained.

88 JRC (2015) Bioenergy potentials for EU and Neighbouring countries, Available from: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC98626/biomass%20potentials%20in%20europe_web%20rev.pdf

89 S2Biom, About S2Biom project, Available from: https://www.s2biom.eu/en/about-s2biom.html

90 S2 Biom, Available from: https://s2biom.wenr.wur.nl/web/guest/data-downloads

Table 7: Aggregation of data on individual feedstocks into categories of feedstocks

Agricultural residues	Forestry residues	Energy crops
Secondary residues of industry utilising agricultural products: • Olive-stones • Rice husk • Pressed grapes dregs • Cereal bran Agricultural residues: • Rice straw • Cereals straw • Oil seed rape straw • Maize stover • Sugarbeet leaves • Sunflower straw • Residues from vineyards • Residues from fruit tree plantations • Residues from olives tree plantations • Residues from citrus tree plantations	Waste from wood: • Hazardous post consumer wood • Non hazardous post consumer wood Secondary residues from wood industries: • Sawdust (conifers) • Sawdust (nonconifers) • Other residues (conifers) • Other residues (nonconifers) • Residues from industries producing semi finished wood based panels • Residues from further woodprocessing • Bark • Black liquor Primary residues from forests: • Logging residues from final fellings from nonconifer trees • Logging residues from final fellings from conifer trees • Logging residues from thinnings from nonconifer trees • Logging residues from thinnings from conifer trees • Stumps from final fellings from nonconifer trees • Stumps from final fellings from conifer trees	Primary production of ligno-cellulosic biomass crops: • Miscanthus • Switchgrass • Giant reed • Cardoon • Reed Canary Grass • SRC Willow • SRC Poplar • Other SRC

3.2.1.5 Shell GER Database: Renewable electricity

Information on the renewable energy potential in each Contracting Party was taken from the Shell Global Energy Resources (GER) Database.[91] The data was compiled by Shell in autumn 2016. The renewable energy resources represent the long-term (2070) potential final electrical energy available per year. Wind and solar potentials are based on Deng et al. (2015)[92] and reflect a realistic potential supply of wind and solar electricity, taking into account limitations such as land-use competition and acceptance, resource quality and remoteness.

These estimates showed reasonably good agreement with the resource potentials provided in IRENA (2017)[93]. The IRENA study calculates the wind and solar power potential in each territory based on resource intensity, distance to power grid, population density, land cover, topography and altitude, and protected areas. For the other renewable technologies, information on potentials was taken from national energy strategies (or NREAPs) or other studies. The figures shown in Figure 38 are based on the technical potential for each renewable energy generation source in each CP. It should be noted that IRENA have since published a new study on this topic in October 2020[94], which was not available at the time of this analysis.

This was further compared with information from Jacobson.[95] The potentials provided by Jacobson were substantially higher, as the paper aimed to demonstrate that all countries/territories could supply their energy demand from 100% wind, water and solar power.

A comparison between these three sources is provided in Figure 38. The Shell data was used for all Contracting Parties except Kosovo*, which was not included by Shell, in which case IRENA data was used. The information from Jacobson demonstrates that there is a wide

---

91 Shell, Global Energy Resources Database, Available from: https://www.shell.com/energy-and-innovation/the-energy-future/scenarios/shell-scenarios-energy-models/energy-resource-database.html#iframe=L3dlYmFwcHMvRW5lcmd5UmVzb3VyY2VEYXRhYmFzZS8jb3Blbk1vZGFs

92 Deng, Y.Y., Haigh, M., Pouwels, W., Ramaekers, L., Brandsma, R., Schimschar, S., Grozinger, J., de Jager, D. (2015) Quantifying a realistic, worldwide wind and solar electricity supply, Global Environmental Change, (31) P239-242, Available from: https://www.sciencedirect.com/science/article/pii/S0959378015000072, https://doi.org/10.1016/j.gloenvcha.2015.01.005

93 IRENA, Joanneum Research and University of Ljubljana (2017), *Cost-Competitive Renewable Power Generation: Potential across South East Europe*, International Renewable Energy Agency (IRENA), Abu Dhabi.

94 IRENA (2020), Renewable Energy Prospects for Central and South-Eastern Europe Energy Connectivity (CESEC). Available at: https://www.irena.org/publications/2020/Oct/Renewable-Energy-Prospects-for-Central-and-South-Eastern-Europe-Energy-Connectivity-CESEC

95 Data used was the supplementary information (available from: https://web.stanford.edu/group/efmh/jacobson/Articles/I/WWS-50-USState-plans.html) for the following paper: Jacobson, M.Z., Delucchi, M.A., Cameron, M.A., Coughlin, S.J., Hay, C.A., Manogaran, I.P., Shu, Y., von Krauland, A-K, Impacts of Green New Deal Energy Plans on Grid Stability, Costs, Jobs, Health, and Climate in 143 Countries (2019) One Earth, Available from: http://web.stanford.edu/group/efmh/jacobson/Articles/I/143WWSCountries.pdf

range of estimates of renewable energy potential depending on the constraints applied, and technical potential in each Contracting Party is likely to be substantially higher than the estimates provided by Shell and IRENA.

mtoe	Total RES potential		
Contracting Party	**Shell**	**IRENA**	**Jacobson**
Albania	4.49	2.84	56.17
Bosnia and Herzegovina	3.89	4.73	91.65
Georgia	5.18	N/A	48.89
Kosovo*	N/A	0.53	11.08
North Macedonia	2.22	1.19	45.12
Moldova	2.20	5.14	100.70
Montenegro	2.10	1.07	15.58
Serbia	8.00	6.85	267.67
Ukraine	41.63	83.26	388.22

Figure 38: Comparison of estimates of renewable power in each CP from the Shell GER database, IRENA and Jacobson et al.

3.2.1.6 WEG (2014): wood and agricultural biomass in Georgia

In 2014 World Energy Group (WEG) did a detailed desk-based study on wood and agricultural biomass energy potential in Georgia.[96] This information was subsequently validated with surveys[97] and appears to have been used in subsequent UNDP information campaigns.[98]

Information on the availability of agricultural residues and wood residues was taken from WEG (2014). The figures for agricultural residues include agricultural residues from perennial crops (vine, fruit, hazelnut, apple, bay leaf, peach and pear residues) and annual crops (wheat, barley, corn, kidney bean, oat and sunflower residues). Figures for wood residue refer to the total wood residue from timber harvesting and from primary wood processing.

No information on the potential for energy crops production in Georgia was found, but it was noted in their 2017 National Renewable Energy Action Plan that no measures were at that time planned for encouraging the use of unused or degraded land for energy purposes.[99]

---

96 WEG (2014) Assessment Of Wood And Agricultural Residue Biomass Energy Potential In Georgia, Available from: biomass.ge/sites/default/files/biomass_potential_study_1.pdf

97 WEG (2014) Assessment Of Wood And Agricultural Residue Biomass Energy Potential In Georgia, Field Study, Available from: http://biomass.ge/sites/default/files/final_report-weg_0_1.pdf

98 UNDP (2017) All About Biomass and its use in Georgia, Available from: https://www.ge.undp.org/content/georgia/en/home/library/environment_energy/all-about-biomass-and-its-use-in-georgia.html

99 Georgia National Renewable Energy Action Plan (NREAP) (2017) unofficial English translation, Available from: http://www.economy.ge/uploads/files/2017/energy/samoqmedo_gegma/nreap_v_3_eng_21022020.pdf

3.2.1.7 Conversion of feedstock estimates into fuel estimates

The sources described in sections 3.2.1.1 to 3.2.1.6 were used to estimate the total feedstock available in each CP. This was then converted into a fuel potential for each Contracting Party, using the conversion efficiencies given in Table 8.

Table 8: Energy-based conversion efficiency of feedstock into fuel

Feedstock type	Conversion efficiency ($MJ_{fuel}/MJ_{feedstock}$)	Reference and notes
Sugar and starch crops	0.53	Biograce V4d
Oil crops (as oils)	0.97	Biograce V4d
Waste fats and oils	0.97	Biograce V4d
Municipal waste (bio fraction)	0.66	Pressley et al., 2014, "Municipal solid waste conversion to transportation fuels: a life-cycle estimation of global warming potential and energy consumption", https://www.sciencedirect.com/science/article/pii/S0959652614001875
Wet wastes (as CH4)	1.00	Feedstock data is given as PJ of methane anyway
Agricultural residues	0.66	Pressley et al (2014)
Forestry residues	0.66	Pressley et al (2014)
Energy crops	0.66	Pressley et al (2014)
Renewable electricity	1	Assume electricity used directly in vehicle

3.2.2 Imported fuels and feedstocks

It would also be possible for the CPs to import either feedstocks or renewable fuel. In general, it is only practical to import feedstocks which have a high energy density. Of the feedstocks considered above, sugar and starch crops, oil crops, and waste fats and oils are commonly traded. Forestry residues and energy crops may also be traded, but typically over shorter due to their lower energy density, and there are not well-established trading markets in these products. For all other feedstocks, it is likely that they would be converted into fuel near to their point of production, so CPs would need to import the final fuel.

The global, or even European, potential of renewable feedstocks far exceeds what would be required in the CPs to meet their 2030 RES-T target. However, each CP will need to compete for renewable fuels and feedstocks with other countries which are also trying to increase their use of renewable energy. A detailed analysis of traded renewable feedstock and fuel prices is outside of the scope of this study, but it is likely that with an increasing drive globally to increase the use of renewable energy in all sectors of the economy, the price of renewable feedstocks and fuels is unlikely to drop significantly in the future. Nevertheless, with strong policies in place, it would be possible for CPs to compete for imports of renewable feedstocks and fuels.

3.3 Existing production of renewable fuel in each Contracting Party - overview

This section provides an overview of the renewable fuel production across all Contracting Parties. More information is given for each Contracting Party in section 5 to 14.

Of the renewable fuel production routes described in Sub-task 2.1 (section 3.1), only two types of plants exist today in the Contracting Parties:

- Fermentation to ethanol
- Esterification to FAME

It is likely that there are also small-scale AD plants on farms, but these were not captured in any statistics available to the consulting team. Moreover, it is unlikely that they are upgrading the biogas to biomethane, which would be required in order to use this fuel in the transport sector.

Table 9: Summary of known renewable fuel production in CPs with production today

Route	Number of plants	Total capacity	Unit	Comment
Albania				
Esterification to FAME	1	100	kt/yr	
Bosnia and Herzegovina				
Fermentation to ethanol				One planned facility producing lignocellulosic ethanol
Esterification to FAME	1	155	kt/yr	
Georgia				
Esterification to FAME	1	1	kt/yr	
North Macedonia				
Esterification to FAME	4	31	kt/yr	Two additional FAME plants planned by Blagoj-Gorev with a combined 13kt/yr capacity.
Moldova				
Fermentation to ethanol	1	12	kt/yr	A FAME plant has closed (capacity 50t/day)
Ukraine				
Fermentation to ethanol	8	110	kt/yr	Four additional planned ethanol plants, with total planned capacity 280 kt/yr. Eight closed plants (total capacity: 154kt/yr) could start up again if economical.
Esterification to FAME	4	25	kt/yr	One closed plant with 180 kt/yr capacity.

4 GOOD PRACTICES OF POLICY OPTIONS FOR INCREASING THE SHARE OF RENEWABLE ENERGY IN TRANSPORT

The majority of renewable fuels have higher production costs than conventional transport fuels, hence require policy support in order to stimulate their uptake in the market. In addition, many of the routes for producing alternative fuels are not currently commercialised, and even for those that are, a substantial scale-up in production will be required in order to meet RED II targets. For fuels which do not meet existing gasoline or diesel specifications, or electricity used directly in vehicles, there may be insufficient refuelling infrastructure or suitable vehicles to use that fuel. Policy measures can address these barriers.

Broadly, the key barriers which must be addressed by policy in order to scale-up the use of renewable fuel in transport are:

1. High cost of alternative compared to fossil fuel
2. Insufficient supply of alternative fuel
3. Production of alternative fuel is currently at early stage of commercialisation (this can contribute to both #1 and #2)
4. Insufficient refuelling infrastructure for non-drop-in renewable fuel
5. Insufficient number of vehicles in the market which can use non-drop-in renewable fuel
6. Lack of standards or certification for non-drop-in renewable fuel

To increase the uptake of renewable fuel across the transport sector, an entire renewable fuel value chain must be mobilised, covering fuel production, fuel supply, fuel retail, and fuel use in vehicles. At each stage of the supply chain there are different stakeholders, and policy may be required at a number of different points in the supply chain, for example to ensure that there is both a sufficient supply of renewable fuel and a sufficient number of vehicles that can use that fuel. For each stakeholder along the value chain, governments can either impose obligations or can provide incentives. In order to review best practice in promoting renewable fuel use in transport, policies across all of these stakeholders and points in the value chain must be considered. Therefore, this section is structured as follows:

4.1 Obligation on fuel suppliers

4.2 Incentive for fuel suppliers

4.3 Obligations on fuel retailers

4.4 Incentives for fuel retailers

4.5 Obligations on vehicle manufacturers

4.6 Incentives for vehicle manufacturers

4.7 Obligations on transport end-user

4.8 Incentives for transport end-user

4.9 Case studies

4.10 Summary of policy mechanisms

In some cases, the same companies may occupy different places in the supply chain, for example suppliers of fossil fuel may also be fuel retailers. The term fuel suppliers (as addressed in section 4.1 and 4.2) includes suppliers of both renewable and fossil fuel, and fuel blenders.

In addition, an alternative or complementary way to address the competitiveness of renewable options is to remove any policies such as fossil fuel subsidies which depress the price of fossil fuel options, and introduce policies to price in their externalities such as a carbon tax. These measures are not specific to the transport sector so are not discussed further here.

4.1 Obligation on fuel suppliers

4.1.1 Blending obligation

4.1.1.1 Policy description and key options for implementation

Blending obligations (also known as blending mandates) are typically placed on fuel suppliers, and require a certain percentage of renewable fuel to be blended into the fuel supplied to the market. Blending obligations can be on an energy or a volume basis, and typically a minimum greenhouse gas saving is required. Other sustainability requirements may also be imposed. If a blending obligation is imposed on fuel suppliers, costs are typically passed on to fuel consumers. Costs of compliance are determined by the fuel production cost, the level of the obligation and the level of buy-out. Therefore, a key decision when implementing a blending mandate is what level of renewable fuel should be mandated. Having a "buy-out" option, which allows suppliers to pay a fee rather than supplying the required amount of renewable fuel, caps the total cost to the consumer, but can result in less renewable fuel being supplied than anticipated. Guaranteeing that an obligation will be maintained over a minimum number of years is important to provide certainty to investors in low-carbon fuel production plants.

A range of measures can be used to ensure compliance, with fines and legal penalties both used in European Member States today. Under a blending mandate it is possible to preferentially incentivise certain fuels. This is typically done because they are produced from feedstocks which are considered more sustainable; because the production of that fuel is at an earlier level of commercialisation and so more support is considered necessary, or because they are strategically important for hard-to-decarbonise sectors such as heavy-duty road or aviation. Such preferential incentivisation can be done through either a sub-target for particular types of fuels, or multiple-counting of certain fuels towards the target.

Whilst the cost of compliance with an obligation is typically passed on to the consumer, other policies can be put in place to mitigate these costs, such as grants for plants. However it should be noted that European State Aid rules prohibit support for low-carbon fuels which are subject to blending obligation unless: a) the production cost of fuels from the plant is so high that it would not be competitive under the obligation, compared with either the price of fuels that would be supplied, or with a penalty price and b) that the aid would not give rise to significant undue adverse effects on the competition by outcompeting fuels that had not received the support. This could be demonstrated by showing that the plant's production capacity was small compared with the market demand, and/or that the level of support had been set to avoid such effects.[100]

Many countries are beginning to make electricity and electricity-derived fuels eligible under their renewable fuel blending obligations, but there are some specific aspects of including these that should be considered, including: measuring and verifying the amount of renewable power being supplied into the transport sector; guaranteeing the renewability of the power used; and interaction with other incentives which already exist for the promotion of renewable electricity generation.

4.1.1.2 Advantages and disadvantages

Table 10: Advantages and disadvantages of a blending mandate

Advantages	Disadvantages
• Provides a high level of assurance that a minimum level of renewable fuel in the transport sector will be achieved. • Clear bankable signal of a future market to all industry players, but level of certainty for investors depends on timescale over which obligation is guaranteed. • Provides a stable market signal to producers despite changing fossil fuel prices	• Costs are passed on to consumers, which may impact ability of some consumers to pay for transport. • Under EU State Aid rules cannot preferentially support low-carbon fuel production in a particular Member State, so does not necessarily build up domestic low-carbon fuel production.

4.1.1.3 Examples

All EU countries apart from Germany and Sweden impose a blending obligation on fuel suppliers to supply a minimum percentage of renewable fuel and meet their targets under the Renewable Energy Directive.[101] The USA Renewable Fuel Standard (RFS) which covers the whole USA is also a key example of this type of policy. Typically, the policies in EU Member States impose a percentage blending obligation which is set for a number of years, whilst the volumes of renewable fuel required in the USA are set annually by the US government, which provides less certainty for suppliers under the RFS compared with most of the EU blending obligations.[102]

[100] E4tech and Studio GearUp (2019) https://www.rijksoverheid.nl/documenten/rapporten/2020/03/03/bijlage-1-onderzoek-e4tech-sgu-obligation-for-aviation-in-the-netherlands-final-v3

[101] E4tech for the European Commission Joint Research Centre (2019), Available from: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC118309/jrc118309_1.pdf

[102] Congressional Research Service (2019) The Renewable Fuel Standard (RFS):An Overview, Available from: https://fas.org/sgp/crs/misc/R43325.pdf

4.1.2 Low carbon fuel standard

4.1.2.1 Policy description and key options for implementation

A low carbon fuel standard is a general term for an obligation on fuel suppliers to reduce the GHG emissions of the fuel that they supply into the market.

The key options for implementation are similar to the volume or energy-based blending obligation discussed in section 4.1.1, and include:

- Level of GHG reduction required over time compared with a defined base year
- Number of years over which GHG reduction obligation is guaranteed
- Whether to have a buy-out price, and if so at what level to set it
- Penalty for non-compliance
- Complementary measures to reduce the cost burden on the consumer (note that these are subject to the same EU State Aid rules as discussed in section 4.1.1.1).

4.1.2.2 Advantages and disadvantages

Table 11: Advantages and disadvantages of a low carbon fuel standard

Advantages	Disadvantages
• Provides a higher incentive to fuels with high GHG savings, and an incentive for continuous improvement in supply chains in order to reduce these over time. • Provides assurance that a certain level of renewable fuel in the transport sector will be achieved, although meeting the 14% RES-T target will rely on policy-makers estimating the GHG intensity of fuels likely to be supplied into each territory and setting the GHG target accordingly. • Clear bankable signal of a future market to all industry players, but level of certainty for investors depends on timescale over which policy is guaranteed. • Provides a stable market signal to producers despite changing fossil fuel prices	• Typically, does not allow sub-targets or multiple-counting for fuels which are strategically important or at earlier stage of commercialisation. • Because value of incentive is directly linked to GHG saving of fuel, strong verification of supplier's claimed GHG savings is required in order to reduce risk of fraud. • Costs are passed on to consumers, which may impact ability of some consumers to pay for transport. • Under EU State Aid rules cannot preferentially support low-carbon fuel production in a particular territory, so does not build up domestic low-carbon fuel production.

4.1.2.3 Examples

Amongst the EU Member States, Germany is the only Member State which has a GHG-based low-carbon fuel standard,[103] although alongside this Germany is still obliged to meet the 14%

[103] Bundesministerium der Justiz und für Verbraucherschutz, Gesetz zum Schutz vor schädlichen Umwelteinwirkungen durch Luftverunreinigungen, Geräusche, Erschütterungen und ähnliche Vorgänge, Available from: https://www.gesetze-im-internet.de/bimschg/

RES-T target in RED II. The California Low Carbon Fuel Standard is also a key example of this policy.[104]

4.2 Incentive for fuel suppliers

4.2.1 Grants, loans and financing guarantees for low carbon fuel production plants

Low cost loans or grants can help to finance plants which are considered risky by other investors. Even if the grant / loan is a small percentage of the total project finance it can demonstrate government support and therefore help developers to secure other investment. Government loan guarantees can also enable plant developers to access finance from conventional lenders which would otherwise consider the project too risky.

Typically, these measures are used to support low-carbon fuel production technologies which are not yet at commercial stage and which would therefore struggle to access finance for plant construction. It is common that grants, loans and/or financing guarantees are implemented alongside obligations on fuel suppliers in order to support the scale-up and cost reduction of low-carbon fuel production technologies which are not yet commercial. Grants and loans can also be used to support the establishment of biomass feedstocks, such as energy crops.

The main options for the design of grant, loans or financing schemes for suppliers of alternative fuel are around eligibility criteria and selection criteria. Eligibility criteria may include: scale of plant; limitations on eligibility according to conversion technology type, conversion technology TRL, feedstock, or fuel; requirement for production plant to be located in a particular country or region, etc.

4.2.1.1 Advantages and disadvantages

Table 12: Advantages and disadvantages of grants, loans and financing guarantees for low carbon fuel producers

Advantages	Disadvantages
• Effective means of support for pre-commercial technologies • Can be targeted towards domestic production • Can be targeted towards specific areas of the supply chain which are inhibiting the scale-up of the supply-chain as a whole.	• Government partly takes on risk of technologies failing or plants being unprofitable • When used alone are not sufficient to underpin a business case for technology and plant developers: a market-based policy mechanism to support multiple plants is also needed

[104] California Air Resources Board, Low Carbon Fuel Standard, Available from: https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard

4.2.1.2 Examples

Examples of grants or loan schemes include the UK Future Fuels for Flight and Freight (F4C) competition[105]; the EU NER300 Program[106], the USA Defense Production Act (DPA) Title III Advanced Drop-in Biofuels Production Project (ADBPP) Biofuels 2[107], USA state level programs such as the Minnesota Biofuel Production Grant Program[108], and Brazil's PAISS Program (Support Program for Industrial Technology Innovation in the Sugarcane and Sucrochemistry Sectors)[109].

Plant financing guarantees are less common, but the USDA Biorefinery, Renewable Chemical, and Biobased Product Manufacturing Assistance Program[110] provides an example.

4.2.2 Payment for fuel supplied

4.2.2.1 Policy description and key options for implementation

The term 'payment for fuel supplied' refers generally to a government payment or subsidy for every unit of renewable fuel supplied or consumed. There are a range of options for how this policy could be designed[111]:

- Funding of the scheme:
  - An industrial levy - can be targeted so that only the sector receiving the low-carbon fuel is paying for it. Examples include a fuel tax for road transport fuel, a tax on aviation passengers, or higher landing charges for aircraft.
  - General taxation - can relieve the financial pressure on the transport sector, and ultimately on transport consumers, by funding the payment through a tax on the whole population. This could mitigate the impact of the measure on the

---

105 Ricardo Energy and Environment, Future Fuels for Flight and Freight Competition (F4C), Available from: https://ee.ricardo.com/transport/case-studies/f4c

106 European Commission, NER300 Programme, Available from: https://ec.europa.eu/clima/policies/innovation-fund/ner300_en

107 US Government, View Grant Opportunity, Available from: https://www.grants.gov/web/grants/view-opportunity.html?oppId=291334

108 Minnesota Department of Agriculture (2019) Available from: https://www.mda.state.mn.us/mda-biofuels-grants-expand-access-production

109 Cirani, C.B.S., Kono, C.M., dos Santos, A.M., Cassia, A.R. (2016) The Role of Public Institutions for Innovation Support in Brazil, BBR, Braz. Bus. Rev. vol.13 no.6 Vitória Nov./Dec. 2016 ; https://doi.org/10.15728/bbr.2016.13.6.3, Available from: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1808-23862016000600210

110 US Department of Agriculture (2020) Available from: https://www.rd.usda.gov/programs-services/biorefinery-renewable-chemical-and-biobased-product-manufacturing-assistance

111 E4tech and Studio GearUp (2019) Study on the potential effectiveness of a renewable energy obligation for aviation in the Netherlands, Available from: https://www.rijksoverheid.nl/documenten/rapporten/2020/03/03/bijlage-1-onderzoek-e4tech-sgu-obligation-for-aviation-in-the-netherlands-final-v3

competitiveness of the CP's transport sector, or on users of the transport sector who cannot afford to pay higher costs.

- Distribution of funds:
  - A payment is provided for every unit of renewable fuel used.
  - A pre-agreed arrangement with the government determines the price and volume of fuel to be supplied.
- Setting the basis of the payment:
  - Fixed payment per unit of fuel supplied
  - Fixed payment per unit of fuel supplied, differentiated according to fuel types or production process
  - Payment is given based on the differential between a wholesale fuel price and a 'strike price'. The strike price could be set in a number of different ways, e.g. set by the government, agreed bilaterally between government and producers, or agreed competitively through a reverse auction.

The strength of the signal provided to the market, and hence level of certainty provided to investors, is largely determined by the scheme design. Continuity over a long time period, for example through multiple rounds of payment allocation, and commitment to continue paying for a fixed number of years, is important to ensure investor confidence.

Such a measure has to-date typically been used to support renewable electricity generation more than renewable fuels, likely because the power sector is more homogeneous with the generation asset the only major differentiator between different projects. Such policies supporting renewable power production generally do not specify whether the renewable electricity must be used in the heat, power or transport sector. If a country operates this support scheme for renewable electricity, it must be considered whether a producer can continue to claim this subsidy if they are also claiming support for electricity used in the transport sector under a renewable fuel blending obligation.

It should be noted that under rules of RED II, direct support may not be given to food-based biofuels, but any other fuel types can be supported in the absence of a blending obligation. As noted in section 4.1.1, if policy providing payment for renewable fuel is implemented alongside a blending obligation, EU State Aid rules restrict the types of fuels to which the payment can be provided.

4.2.2.2 Advantages and disadvantages

Table 13: Advantages and disadvantages of payment for fuel supplied

Advantages	Disadvantages
• Costs can be spread over both industrial consumer and government, depending on how much of the funding comes from general taxation and how much from an industry levy. • Provides moderate level of assurance to the supplier that renewable fuel can be sold at a profitable price and therefore will be supplied into the market. However, may not be sufficient for making production of alternative fuels profitable, if oil prices fall.	• Commitment to fixed payment over time is important for investor confidence in order to build new plants, but government takes on risk of over-paying for renewable fuel as production costs decrease with maturing technology and production processes. Some aspects of the policy design can mitigate this risk. • Does not provide a high level of certainty on reaching the RED II 14% RES-T target, as supply of renewable fuel is not obligatory.

4.2.2.3 Examples

Typically, this policy has been used in the electricity sector, for example the UK Contracts for Difference scheme[112]; the Netherlands' SDE+ scheme[113]; renewable energy auctions have taken place in Albania[114]; and Ukraine has recently launched a new auction-based support mechanism for renewable power[115].

4.3 Obligations on fuel retailers

4.3.1 Mandatory availability of certain fuels

4.3.1.1 Policy description and key options for implementation

Uptake of new fuel blends or new types of fuels can be limited if there is insufficient refuelling infrastructure available. However, construction of retail stations of e.g. CNG or LNG can be expensive, and the economics particularly challenging when demand for these fuels is still low. To break this deadlock, policy could oblige fuel retailers to make refuelling infrastructure available at their stations.

[112] UK Department for Business, Energy and industrial Strategy (2020) Contracts for Difference, Available from: https://www.gov.uk/government/publications/contracts-for-difference/contract-for-difference

[113] Netherlands Enterprise Agency (2020) Stimulation of Sustainable Energy Production - SDE+, Available from: https://english.rvo.nl/subsidies-programmes/sde

[114] Energy Community, Albania, Available from: https://www.energy-community.org/implementation/Albania.html

[115] Balkan Green Energy News (2019) Ukraine launches renewable auction system, Available from: https://balkangreenenergynews.com/ukraine-launches-renewable-auction-system/

Examples of fuels to which this may be relevant include:

- E10
- Higher-blends of ethanol or biodiesel e.g. E85
- Methane (CNG or LNG)
- Electricity
- Hydrogen

The options for implementation of this policy are relatively limited, but include: the timescale over which new fuel blends become mandatory; whether measures must be taken to inform the public of which vehicles can use the new fuel blend; whether exemptions should be allowed for retailers that do not have sufficient space; whether there should be exemptions for small retailers for whom the cost of installation may be challenging; whether the obligation should target particular locations first, for example to build up refuelling corridors.

4.3.1.2 Advantages and disadvantages

Table 14: Advantages and disadvantages of mandating availability of certain fuels

Advantages	Disadvantages
• Effective in ensuring that certain fuel grades or types are available to consumers at retail stations	• Does not guarantee use of particular fuels – requires other policy measures to ensure that there is sufficient demand for these alternative fuel blends

4.3.1.3 Examples

Transitions to alternative liquid fuel blends have typically been driven by blending mandates imposed on fuel suppliers rather than by obligations on fuel retailers – who are in many cases the same as the fuel suppliers. Where blends such as E10 have been introduced to replace existing petrol grades, this has generally been done in a coordinated manner across all fuel suppliers, but not necessarily through a mandate.

In the US, voluntary building standards have recently been amended so that new homes should be built 'EV-ready'.[116] The UK is currently consulting on proposals on minimum EV charging infrastructure that is required at residential and non-residential buildings.[117] The EU Energy Performance of Buildings Directive sets minimum requirements for charging

[116] Coren, M.J. for Quartz (2020) New US building codes will make every home ready for electric cars, Available from: https://qz.com/1781774/new-us-building-codes-require-plugs-for-electric-cars/

[117] UK Government (2019) Electric Vehicle Charging in Residential and Non-Residential Buildings, Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/818810/electric-vehicle-charging-in-residential-and-non-residential-buildings.pdf

infrastructure in new and renovated buildings.[118] This Directive will be introduced in the Energy Community in 2021, therefore Contracting Parties will have to comply with its requirements. The EU Alternative Fuel Infrastructure Directive, whilst not a mandate, requires Member States to develop national policy frameworks for the market development of alternative fuels and their infrastructure, and foresees the use of common technical specifications for recharging and refuelling stations.[119]

4.4 Incentives for fuel retailers

4.4.1 Grants, loans and financing guarantees for construction of refuelling stations

4.4.1.1 Policy description and key options for implementation

As described in section 4.2.1, grants loans and financing guarantees can support the business case for the construction of new refuelling stations before sufficient demand is in place to make these viable.

Conditions to the award of the grant could be imposed in order to ensure that refuelling stations are placed in the most strategically advantageous locations.

4.4.1.2 Advantages and disadvantages

Table 15: Advantages and disadvantages of grants, loans and financing guarantees for the construction of refuelling stations

Advantages	Disadvantages
• Retailers still need to make a business case for the refuelling infrastructure, so unlikely to get construction of refuelling facilities in places where these are unviable. • Can be used to support the installation of charge-points at both commercial and residential locations.	• Does not guarantee that refuelling infrastructure will get built, and does not guarantee that it will get built in the most strategically important location.

4.4.1.3 Examples

The UK government Hydrogen for Transport Advancement Programme (HyTAP) run by the Office for Low Emissions Vehicles (OLEV) has provided funding in three rounds: £11 million in 2014, £9 million in 2017 and £14 million in 2019, which has gone towards infrastructure

118 IEA (2019) Global EV Outlook 2019, Available from: https://www.iea.org/reports/global-ev-outlook-2019

119 IEA (2019) EU Directive 2014/94/EU on Alternative Fuels Infrastructure, Available from: https://www.iea.org/policies/8829-eu-directive-201494eu-on-alternative-fuels-infrastructure?country=European%20Union&sector=Non-residential%2CRoad%20transport

developments and to support the purchase of hydrogen fuel cell vehicles. Both domestic and non-domestic charge-points can receive funding.[120]

In other cases, retailers may be able to access funds under broader research or energy funding schemes which are not necessarily dedicated to the construction of alternative fuel refuelling facilities. For example, under the European Commission's Connection Europe Facility (CEF) funding programme, grants have been awarded for the construction of LNG refuelling stations[121] and hydrogen refuelling stations[122]. Under Horizon 2020 and FP7 funding grants have also been awarded for the construction of refuelling stations, for example through the Blue Corridors project for LNG.[123]

4.5 Obligations on vehicle manufacturers

4.5.1 Vehicle CO_2 standards or production mandates

4.5.1.1 Policy description and key options for implementation

Vehicle CO_2 standards can require manufacturers of vehicles to reduce the CO_2 intensity of the vehicles they supply into a given market. This improves the efficiency of ICE vehicles, but can also push the development of electric and hydrogen vehicles, if these are counted towards manufacturers' compliance with the CO_2 targets. For example, if the target covers all vehicles that a manufacturer sells, the production of zero emission vehicles (ZEVs) can lower the average CO_2 intensity of a manufacturer's products, helping them to achieve compliance with the target overall.

Production mandates, which mandate production of specific vehicle types, would be politically challenging in the European CPs, but have been introduced in China, alongside a restriction on investment in new ICE vehicle manufacturing plants.[124]

---

120 Society of Motor Manufacturers and Traders (SMMT) (2019) Hydrogen Fuel Cell Electric Vehicles, Available from: https://www.smmt.co.uk/wp-content/uploads/sites/2/2019.03.11-SMMT-FCEV-guide-FINAL.pdf

121 LNG World News (2018) EU funds German LNG fuelling project, Available from: https://www.lngworldnews.com/eu-funds-german-lng-fueling-project/

122 European Commission (2018) Connecting Europe Facility (CEF) 2017 Transport Blending Call, Second cut-off, Proposal for the Selection of Projects, Available from: https://ec.europa.eu/inea/sites/inea/files/2017_cef_blending_call_brochure_20180926_last.pdf

123 LNG Blue Corridors, Available from: http://lngbc.eu/

124 IEA (2019) Global EV Outlook 2019, Available from: https://www.iea.org/reports/global-ev-outlook-2019

4.5.1.2 Advantages and disadvantages

Table 16: Advantages and disadvantages of vehicle CO_2 standards

Advantages	Disadvantages
• Costs are born by vehicle manufacturers • Can stimulate innovation • Can also promote vehicle efficiency	• Does not necessarily ensure these vehicles are purchased and used by consumers, for example if vehicles are too expensive or insufficient refuelling infrastructure is in place. Therefore, may require other complementary policies in order to be effective • Complementary policy focussed on fuels and related infrastructure is also required, to ensure that vehicles sold are actually used with renewable fuel.

4.5.1.3 Examples

The EU vehicle tailpipe CO_2 standards are the key example of this scheme. Other similar schemes are in place in China and the USA. In China proposal to tighten average fuel economy for the passenger light-duty vehicle (PLDV) fleet in 2025 (updating the 2015 limits).[125]

4.6 Incentives for vehicle manufacturers

4.6.1 Grants, loans and financing guarantees for the construction of ZEV manufacturing facilities

4.6.1.1 Policy description and key options for implementation

As described in section 4.2.1, grants loans and financing guarantees can support the business case for the construction of new ZEV manufacturing facilities. Typically, a strong driver for these policies are the economic benefits which can be realised from domestic vehicle manufacture.

4.6.1.2 Advantages and disadvantages

Advantages	Disadvantages
• Can be used to support domestic vehicle manufacturing industry	• Governments take on risk of companies' manufacturing and sales strategies

[125] IEA (2019) Global EV Outlook 2019, Available from: https://www.iea.org/reports/global-ev-outlook-2019

4.6.1.3 Examples

The EU is currently strongly supporting companies which wish to build battery manufacturing facilities in the region,[126] for example through a €350M loan from the European Investment Bank to support a factory for lithium-ion battery cells in Sweden.[127] Individual Member States are also strongly supporting battery production, for example with billions of euros in funding for companies involved in electric battery production[128,129]. South Korea also supports the vehicle manufacturing industry with liquidity support and loan guarantees.[130]

4.7 Obligations on transport end-user

4.7.1 Sales bans or ZEV targets

4.7.1.1 Policy description and key options for implementation

Countries, regions and cities may choose to reduce the number of ICE vehicles on the road by directly placing bans on ICE vehicles. This type of policy can send strong signals to not only manufacturers but also to consumers. Generally, the bans/targets have been placed on the sale of new vehicles, focussed primarily on the passenger vehicle segment. If the ban was also placed on the import or sale of used vehicles, this would strongly discourage people from buying new ICEs long before this date, as they would not then be able to sell them on.

Some countries have chosen to implement less ambitious ZEV targets (e.g. <100% new sales). A target can be set mandating the percentage of newly sold vehicles that must be ZEVs, e.g. 30% of new vehicles must be ZEVs. Or a country could set a deployment target, whereby it targets an absolute number of vehicles in the fleet e.g. 10,000 ZEVs by 2020. These targets will also send signals to manufacturers of a strong developing market in a certain region.

Key to the efficacy of these bans and targets is the enforcement mechanisms which underpin them.

---

126 Financial Times (2018) https://www.ft.com/content/097ff758-cec3-11e8-a9f2-7574db66bcd5

127 European Commission (2019) European backing for Northvolt's battery gigafactory in Sweden Available from: https://ec.europa.eu/commission/news/european-backing-northvolts-battery-gigafactory-sweden-2019-may-15_en

128 European Commission (2019) State aid: Commission approves €3.2 billion public support by seven Member States for a pan-European research and innovation project in all segments of the battery value chain, Available from: https://ec.europa.eu/commission/presscorner/detail/en/ip_19_6705

129 DW news (2019) EU greenlights mega subsidies for electric batteries, Available from: https://www.dw.com/en/eu-greenlights-mega-subsidies-for-electric-batteries/a-51588076

130 Electrive (2018) South Korea to boost electric vehicle industry, https://www.electrive.com/2018/12/18/south-korea-to-boost-electric-vehicle-industry/

4.7.1.2 Advantages and disadvantages

Advantages	Disadvantages
• Does not require government funds • Sends signals to manufacturers to increase supply in a country • Encourage consumers to purchase ZEVs, especially if they cannot resell an ICE vehicle later on	• Generally, requires parallel financial support measures to achieve the target, • Complementary policies should be put in place to mitigate unintended consequences on poor or vulnerable members of society, and those in rural areas

4.7.1.3 Examples

To date, 13 countries have announced 100% ZEV sales targets or banned ICE sales altogether (Table 17).

Table 17 Countries that have announced a 100% ZEV sales target, ICE ban or target for ICE free fleet

Country	Target year – 100% ZEV sales target or ICE sales ban	Target year – ICE free fleet
Costa Rica	2050	
Denmark	2030	
France	2040	
Iceland	2030	
Ireland	2030	
Israel	2030	2045
Netherlands	2030	2045
Norway	2025	
Portugal	2040	
Slovenia	2030	
Spain	2040	2050
Sri Lanka		2040
United Kingdom	2040	

Some countries are even targeting ICE-free fleets before or by 2050, such as Sri Lanka and Spain. However, whilst many countries have announced targets or bans, many of them have not legislated for them, which can prove to be challenging. For example, France's Senate have opposed a proposal which includes among other measures banning the sale of new and second-hand fossil fuel vehicles. Other targets include the EV30@30 campaign, which targets 30% of vehicles (bus, trucks and cars) sales being EVs by 2030. Countries that have signed up to this campaign include: Canada, China, Finland, France, India, Japan, Mexico, Netherlands, Sweden and the United Kingdom[131].

4.7.2 Public procurement obligations

4.7.2.1 Policy description and key options for implementation

Governments – including local authorities – generally procure a substantial number of vehicles for public services, such as police vehicles, ambulances, fire engines, and refuse collection vehicles. Governments have a significant purchasing power and it can be used to promote the uptake of cleaner and more efficient vehicles and fuels. Procurement obligations can also be applied to public transport such as buses and trains, depending on whether public transport is run by the government or a private company.

There are different ways that public procurement obligations can be introduced. Governments can include environmental criteria in their procurement specifications – e.g. vehicle emissions, fuel renewability. These criteria can be used as differentiators between bids and a greater weighting can be placed on these criteria over others. Another option would be to set procurement targets, where, for example, a certain percentage of newly purchased vehicles must be zero-emissions.

The overall aim of introducing a public procurement obligation would be to help stimulate the market for cleaner, more efficient vehicles and fuels. It would also help drive development and investment in the automotive industry, as well as increasing related infrastructure such as charging and refuelling networks.

4.7.2.2 Advantages and disadvantages

Advantages	Disadvantages
• Provides some certainty of future market for vehicle manufacturers, fuel producers and installers of refuelling stations • Increases related infrastructure, which is beneficial for private uptake of alternative vehicles • Group purchasing, for example from several local authorities, can enable them to purchase ZEVs at lower cost[132] • Stimulates innovation • Can scale-up supply chains therefore reduce costs for consumers and commercial vehicle purchasers.	• Development can be localised and fragmented • Can increase costs to public bodies

131 IEA (2019) Global EV Outlook 2019: Scaling-up the transition to electric mobility. Available at: https://webstore.iea.org/download/direct/2807?fileName=Global_EV_Outlook_2019.pdf

132 For example in the cases of hydrogen buses: Fuel Cell Electric Buses knowledge base (2016) Strategies for joint procurement of Fuel Cell Electric Buses, Available from: https://www.fuelcellbuses.eu/public-transport-hydrogen/strategies-joint-procurement-fuel-cell-electric-buses-0

4.7.2.3 Examples

The EU Clean Vehicles Directive[133] sets national targets for public procurement of clean vehicles, with differentiated targets and definitions of a 'clean' vehicle for heavy-duty and light-duty vehicles. Other public bodies that have set obligations on their procured vehicles include:

- C40 cities, as part of the Fossil Fuel Free Streets Declaration[134]
- California Air Resources Board[135]
- North-Brabant Region in the Netherlands[136]
- Costa Rica – Law 9518[137]
- Chile's Electric Mobility Strategy[138]
- New Zealand emission free government fleet by 2025/6[139]

4.8 Incentives for transport end-user

4.8.1 Grants, loans or other financial incentives for the purchase of ZEVs

4.8.1.1 Policy description and key options for implementation

Currently, ZEVs have a higher purchase price compared to traditional ICE vehicles. Financial incentives can be used to reduce the up-front cost of ZEVs (and in some instances low-emission vehicles). These incentives are usually one-time financial benefits earned when

[133] European Commission, Mobility and Transport, Available from: https://ec.europa.eu/transport/themes/urban/clean-vehicles-directive_en

[134] C40 (n.d.) *Fossil Fuel Free Streets Declaration*. Available at: https://www.c40.org/other/green-and-healthy-streets

[135] California Air Resources Board (2018) *California transitioning to all-electric public bus fleet by 2040* https://ww2.arb.ca.gov/news/california-transitioning-all-electric-public-bus-fleet-2040

[136] European Platform on Sustainable Urban Mobility Plans (2019) *Topic Guide: Public Procurement of Sustainable Urban Mobility Measures.* Available at: https://www.eltis.org/sites/default/files/public_procurement_of_sump_v2.pdf

[137] IEA (2019) *Global EV Outlook 2019: Scaling-up the transition to electric mobility*. Available at: https://webstore.iea.org/download/direct/2807?fileName=Global_EV_Outlook_2019.pdf

[138] IEA (2019) *Global EV Outlook 2019: Scaling-up the transition to electric mobility*. Available at: https://webstore.iea.org/download/direct/2807?fileName=Global_EV_Outlook_2019.pdf

[139] IEA (2019) *Global EV Outlook 2019: Scaling-up the transition to electric mobility*. Available at: https://webstore.iea.org/download/direct/2807?fileName=Global_EV_Outlook_2019.pdf

purchasing a ZEV. Broadly speaking, financial incentives focused on decreasing the upfront costs of ZEVs can fit into the following categories[140]:

- *Rebates/vehicle purchase price subsidy:* financial benefit received when purchasing a qualifying vehicle. It is usually applied when the vehicle is purchased and reduces the purchase price of the vehicle. In some instances, the rebate can be given to the retailer, allowing them to pass on the benefit to the customer (by decreasing the purchase price of the vehicle).
- *Feebate:* financial measure where a qualifying vehicle receives a purchase rebate, while a surcharge or fee is placed on certain vehicle types. This is generally linked to the CO2 emissions of vehicles, where purchasers of low or zero emission vehicles receive the rebate, whereas purchase of vehicles with high CO2 emissions incurs a fee. The fee and rebate amounts can vary based on the reported CO_2 emissions of the vehicle.
- *Scrappage scheme:* measure which promotes the replacement of older vehicles with newer, less polluting models. It provides a financial return for scrapping an older vehicle, which can then be applied to the purchase of a new vehicle. This can help stimulate the automotive industry while also removing inefficient vehicles. The financial benefit will vary based on the CO2 emissions of the scrapped vehicle and new vehicle, with the greatest benefit occurring when the most polluting vehicle is scrapped and exchanged for a zero-emission vehicle.
- *Tax exemptions, breaks and deductions:* financial measure which reduces the amount of tax paid either directly associated with the vehicle (e.g. vehicle import, purchase or registration tax) or removed from a personal or company's yearly tax bill. The policy may be a straightforward tax exemption for certain types of vehicles, or taxes can be applied on a sliding scale according to the environmental impact of the vehicle.

These types of fiscal policies have been used extensively to incentivise the uptake in ZEVs (and in some cases natural gas and other less polluting vehicles). These have been implemented in a number of geographies including Member States of the European Union, the United States, Japan etc.

When developing these types of financial policies, key options for policy implementation include:

- Total value of the financial incentive
- Number of vehicles that claim benefit (e.g. per year, over the whole programme)
- Whether certain criteria must be met before the subsidy is given (e.g. minimum mileage achieved)

[140] Committee on Overcoming Barriers to Electric-Vehicle Deployment et al. (2015) *Chapter 7: Incentives for the Deployment of Plug-In Electric Vehicles* in Overcoming Barriers to Deployment of Plug-In Electric Vehicles. Available at: https://www.nap.edu/read/21725/chapter/9

- Funding of the financial incentive (e.g. general taxation, industry levy)

While tax exemptions, breaks and reductions can be useful incentives to promote the uptake of ZEVs, it also reduces government tax income. When ZEV penetration is still low, the relative impact on total income may be minimal. However, as penetration continues to increase, it is likely that the impact will no longer be nominal.

As mentioned, these financial incentives are put in place to overcome the barrier associated with the higher upfront cost of ZEVs. However, as the penetration of ZEVs increase across many geographies, it is likely that economies of scale will reduce the cost of ZEVs. Therefore, as ZEVs and ICE vehicles approach cost parity, the need for financial measures may decrease. This is starting to occur in some key markets, such as Norway, which has begun to phase out or reduce some of the subsidies. However, it is important, to ensure market maturity occurs, that the phasing out of these subsidies do not occur too soon. Further, perceived stability and reliability of the support scheme is essential to ensure the local market develops.[141]

4.8.1.2 Advantages and disadvantages

Advantages	Disadvantages
• Proven to be effective in increasing uptake of ZEVs • Generally, provides an immediate (or semi-immediate) incentive to the purchaser	• If subsidy is not set high enough it may not be taken up by vehicle purchasers • Even if vehicle is purchased, it may not be extensively used • Can be challenging to set value of incentive at a level that provides sufficient incentive whilst still being value for money for the government

4.8.1.3 Examples

A number of governments are implementing financial incentives to reduce the upfront cost associated with purchasing a ZEV compared to an ICE vehicle. Most implemented policies focus on encouraging the ZEV transition for the passenger car segment. However, some policies do exist that either explicitly or implicitly encourage the transition in other vehicle segments, including buses and trucks. Table 18 highlights some policies that have been implemented in certain countries. It is not an exhaustive list but rather provides an overview of where and how different financial measures have been implemented.

141 ICCT (2019) *Funding the transition to all zero-emission vehicles*. Available at: https://theicct.org/sites/default/files/publications/Funding_transition_ZEV_20191014.pdf

Table 18: Selected financial measures implemented to reduce the upfront cost of ZEVs

Type	Country	Details	Other countries/regions who have implemented a similar scheme
Rebate	India	Purchase price rebates, as a function of the battery size – at 10,000 rupees (€121) per kW across all segments except buses. For buses 20,000 rupees (€242) per kW. [142]	Canada, Germany, a number of US states, UK, Austria, among others
Feebate	Sweden	Bonus-malus system for new passenger cars (incl. motorhomes), light buses and light trucks. The maximum bonus (or rebate) that can be received is SEK 60,000 (€5,419) and applies only to vehicles with zero-emissions. The bonus decreases by SEK 714-833 (€64-75) for every additional gram of CO_2/km emitted. The malus (or fee) is an increased vehicle tax for the first three years of the vehicle for petrol and diesel vehicles.[143]	France, Austria
Scrappage scheme	France	Value of the measure depends on the type of vehicle purchased, the purchase price, and personal reference revenue of the purchaser. Maximum benefit of €5,000.[144]	Germany, Romania and UK, among many others.
Tax exemption	Norway	Exempts EVs from the weight tax and VAT (as well as CO_2 tax and NOx tax).[145]	Netherlands, Spain, Korea, Japan, Flanders (Belgium), Denmark
	France	Regions can decide whether alternative fuelled vehicles (including electric, hybrid, CNG, LPG and E85) are fully or partially excluded from registration tax.[146]	
Tax reduction	Finland	Vehicle registration tax is based on a vehicle's value and CO_2 emissions. .[147]	Wallonia and Brussels (Belgium), UK
Tax deduction	USA (federal + some states)	For qualifying plug-in electric vehicles including passenger and light trucks, between $2,500 and $7,500, given to the tax payer purchasing the vehicle. Begins to be phased out once a manufacturer has sold over 200,000 qualifying vehicles. [148]	Belgium, Israel, Australia, Austria

[142] Ministry of Heavy Industries and Public Enterprises (2019) *S.O. 1300 € - Scheme for Faster Adoption and Manufacturing of Electric Vehicles in India Phase II (FAME India Phase II)*. Available at: https://fame2.heavyindustry.gov.in/content/english/11_1_PolicyDocument.aspx

[143] Transport Styrelsen (2020) *Bonus malus systems for passenger cars, light trucks and light buses* (translated from Swedish). Available at: https://www.transportstyrelsen.se/sv/vagtrafik/Fordon/bonus-malus/

[144] LegisPermis (2020) *Comment bénéficier de la prime à la conversion 2020 ?* Available at: https://www.legipermis.com/estimation-cote-voiture/prime-a-la-conversion.html

[145] Norsk elbilforening (n.d.) *Norwegian EV policy.* Available at: https://elbil.no/english/norwegian-ev-policy/

[146] European Automobile Manufacturers Association (2018) *Overview on tax incentives for electric vehicles in the EU.* Available at: https://www.acea.be/uploads/publications/EV_incentives_overview_2018_v2.pdf

[147] Autoalan Tiedotuskeskus (n.d) *Motoring Taxation.* Available at: http://www.aut.fi/en/road_transport/motoring_taxation

[148] IRS (2019) *Plug-in electric drive vehicle credit (IRC 30D).* Available at: https://www.irs.gov/businesses/plug-in-electric-vehicle-credit-irc-30-and-irc-30d

4.8.2 Financial incentives to reduce relative cost of owning a vehicle using renewable energy

4.8.2.1 Policy description and key options for implementation

There are a wide range of policy measures which governments can put in place to make the lifetime ownership costs of low-carbon or zero emission vehicles more attractive. These can broadly be categorised by incentives which are accrued regardless of use (ownership-based incentives) and by those which are accrued as a result of use (use based incentives).

Examples of ownership-based incentives in use today include:

- Exemption from or reduction of annual vehicle taxes
- Exemption from vehicle inspections

Examples of use-based incentives in use today include:

- Exemption from or reduction of motor fuel taxes
- Reduced roadway taxes or fees
- Discounted or free charging
- Discounted or free parking
- Preferential electricity rates
- Free access to low emission vehicle/restricted use zones

For all ZEVs there are co-benefits for air quality. Given the localised nature of air quality impacts, it is likely that ZEV incentives will align with air quality legislation. For example, discounted or free parking, and low emission zones may be focused on cities, where air quality limits are most likely to be breached.

Given the impact of many of these measures on government budgets, it is likely that as ZEVs become cost-competitive with ICEs, many of these incentive measures that are not budget neutral or positive will eventually be phased out to ensure that services related to vehicle use can still be provided (e.g. road maintenance).

4.8.2.2 Advantages and disadvantages

Advantages	Disadvantages
• Provides continual support towards ZEV ownership • Encourages the use of ZEVs • Decreases the total cost of ownership of ZEVs compared to ICE vehicles • Can promote use of ZEVs in cities to maximise their beneficial air quality impacts.	• If there are a number of small financial incentives for ZEVs it may be challenging for a consumer to decide whether these stack up to make an economic case for purchasing a ZEV. • Generally, benefits take time to accrue, i.e. not immediate incentives • Tax reductions or exemptions cause an increasingly large loss in government revenue as the use of RE in transport increases.

4.8.2.3 Examples

As with the financial incentives put in place to reduce the upfront cost of ZEVs, many governments have introduced incentives which focus on reducing ownership and use costs compared to ICE vehicles once the vehicle has been purchased. Some of these measures may extend to more than just ZEVs. For example, if a motor fuel tax is based on the CO_2 intensity of a fuel, then it could incentivise biofuels and natural gas as well as electricity and hydrogen. Table 19 provides examples of measures that have been implemented across various geographies.

Table 19: Ownership and use-based incentives adopted in different countries

	Type	Country	Details	Other countries/regions which have implemented a similar scheme
Ownership-based incentives	Exemption from or reduction in annual vehicle taxes	Czech Republic	Alternative fuel vehicles, including electric and hybrids, are exempt from road tax.[149]	Greece, Ireland, Latvia, Romania, Bulgaria, Hungary, and Slovakia, among others
	Exemption from/reduction in vehicle inspection fees	Latvia	EVs have the lowest fee for annual technical inspections. [150]	Various US states e.g. Illinois[151]
Use-based incentives	Exemption from motor fuel taxes	France	Introduced a tax on polluting activities resulting in higher costs for fuels with higher fossil content and lower costs for fuels with higher biofuel blends. [152]	UK, Netherlands, Norway, Japan, various US States
	Reduced roadway taxes or fees	Ireland	Owners of ZEVs can receive refunds between 25-75% on tolls, up to €5,000 per vehicle per year[153].	Germany, Netherlands, Norway, UK, Japan, various US states

149 European Automobile Manufacturers Association (2018) *Overview on tax incentives for electric vehicles in the EU.* Available at: https://www.acea.be/uploads/publications/EV_incentives_overview_2018_v2.pdf

150 European Automobile Manufacturers Association (2018) *Overview on tax incentives for electric vehicles in the EU.* Available at: https://www.acea.be/uploads/publications/EV_incentives_overview_2018_v2.pdf

151 E.g. U.S. Department of Energy (n.d.) *All-Electric Vehicle (EV) Emissions Inspections Exemption.* Available at: https://afdc.energy.gov/laws/11584

152 Douanes et droits indirects (2019) *Établir votre déclaration annuelle de la taxe incitative relative à l'incorporation de biocarburants (TIRIB).* Available at: https://www.douane.gouv.fr/demarche/etablir-votre-declaration-annuelle-de-la-taxe-incitative-relative-lincorporation-de

153 ICCT (2019) *Funding the transition to all zero-emission vehicles.* Available at: https://theicct.org/sites/default/files/publications/Funding_transition_ZEV_20191014.pdf

Discounted or free charging	Reykjavik, Iceland	Public charging stations can be used freely in the city of Reykjavik.[154]	Japan, Norway, various US states
Discounted or free parking	Norway	Parking fees for EVs have been devolved to the local municipalities. They must provide a discount to EVs of at least 50% compared to the price paid by fossil fuel cars.[155]	Hawaii, Nevada, Inner Mongolia, Shanxi Province, Tokyo, Reykjavik
Preferential electricity rates	France	EDF offer a reduced tariff for vehicle charging at night[156].	California, Connecticut, Maryland, New York, UK
Free access to low emission vehicle/restricted access zones	London, United Kingdom	Vehicles that emit less than 75gCO_2/km and have a minimum 20 mile zero-emission range can receive a 100% discount on London's congestion charge.[157]	Cities in Bulgaria, Czech Republic, Greece, Hungary, Latvia, Poland, Romania, and Slovenia, among many others.[158]

4.8.3 Non-financial incentives to increase attractiveness of vehicles using renewable energy

4.8.3.1 Policy description and key options for implementation

As well as policies which make alternatively fuelled vehicles financially attractive over their lifetime, policies can also promote the use of AFVs through non-financial means. Non-financial incentives that apply to owners of ZEVs and other low-carbon vehicles can include:

- Access to bus lanes and other restricted use lanes (e.g. carpool lanes in the US)
- Preferential parking arrangements

In some cases, non-financial (for the consumer) incentives can help overcome consumer awareness barriers. They can help consumers understand the benefits of these vehicles over traditional vehicles, as well as disseminate information on available incentives. Some measures that have been implemented include:

- Education and information campaigns
- Demonstration and pilot projects

[154] Reykjavik (2018) *Electric car charging stations in parking garages* (translated from Icelandic). Available at: https://reykjavik.is/frettir/hledslustodvar-fyrir-rafbila-i-bilastaedahusum

[155] Norsk elbilforening (n.d.) *Norwegian EV policy.* Available at: https://elbil.no/english/norwegian-ev-policy/

[156] ICCT (2019) *Funding the transition to all zero-emission vehicles.* Available at: https://theicct.org/sites/default/files/publications/Funding_transition_ZEV_20191014.pdf

[157] TfL (2020) *Congestion Charge*. Available at: https://tfl.gov.uk/modes/driving/congestion-charge

[158] Urban Access Regulations in Europe (n.d.) *Schemes by Country.* Available at: https://urbanaccessregulations.eu/countries-mainmenu-147

4.8.3.2 Advantages and disadvantages

Advantages	Disadvantages
• Improves the ZEV proposition, if paired with other incentives • Can provide important information to consumers	• Alone, will not overcome barriers to deploy ZEVs • Preparing and disseminating information could be administratively burdensome

4.8.3.3 Examples

A number of countries have implemented non-financial measures to make the ZEV offer more attractive. For example, the state of California allows vehicles that meet specified emission standards to use high occupancy vehicle lanes (i.e. carpool lanes), which are normally reserved for vehicles with two or more passengers[159]. This is an attractive benefit to many commuters, as California highways and freeways are renowned for extreme congestion at peak times. In Norway, EVs are allowed to use bus lanes[160]. To improve consumer awareness, New Zealand introduced an EV public information campaign, which aimed to provide information to consumers to dispel myths around EVs. The overall objective was to encourage consumers to switch to EV vehicles[161].

4.9 Case studies

Five case studies are outlined below. These were chosen to provide examples from across the transport sector of good practice, with a focus on policies which may be suitable for the CPs to emulate.

159 State of California, Department of Motor Vehicles (n.d.) *Clean Air Vehicle Decals – High Occupancy Vehicle Lane Usage.* Available at: https://www.dmv.ca.gov/portal/dmv/?1dmy&urile=wcm:path:/dmv_content_en/dmv/vr/decal

160 Norsk elbilforening (n.d.) *Norwegian EV policy.* Available at: https://elbil.no/english/norwegian-ev-policy/

161 IEA (2019) *Global EV Outlook 2019: Scaling-up the transition to electric mobility*. Available at: https://webstore.iea.org/download/direct/2807?fileName=Global_EV_Outlook_2019.pdf

CASE STUDY 1: UKRAINE PACKAGE OF MEASURES TO INCREASE UPTAKE OF PASSENGER CAR BATTERY-ELECTRIC VEHICLES (BEVS)

Background: Ukraine's National Transport Strategy sets out a target for 75% of domestic transport to be from electric vehicles by 2030[162]. EVs have a higher upfront cost than ICE vehicles, and uptake relies on development of charging infrastructure.

Description of measures: Ukraine has mainly focussed their policy measures on reducing the upfront cost of EVs. The 10% import tax, 20% VAT and excise tax have been scrapped for EVs in Ukraine.[163,164] This has more recently been supplemented with ownership incentives, including a 10% discount on insurance tariffs. On the 1 January 2020, additional measures were implemented, which would bring Ukraine closer to aligning with international standards on EV infrastructure. These new measures include special lanes and designated parking spaces for EVs, as well as fines for non-EVs using or blocking EV-specific infrastructure.[165,166]

Analysis of success of these measures: In 2019, Ukraine was one of the top 5 fastest growing EV markets in Europe. Over 7,500 EVs were sold in 2019, compared to 5,300 the year before[167]. By fall 2019, there were approximately 15,500 EVs on the roads in Ukraine[168]. While there has been strong growth in recent years, some suggest this will not last if infrastructure developments do not keep up. While there are over 600 charging stations in Ukraine, few of these are fast charging stations. This has contributed to the preference for smaller EVs, generally imported as used vehicles from the USA and EU, as the newer, higher capacity batteries cannot be reliably and quickly charged on the current infrastructure.[169]

---

162 MTU (2018) *National Transport Strategy of Ukraine 2030.* Available at: https://mtu.gov.ua/files/for_investors/230118/National%20Transport%20Strategy%20of%20Ukraine.pdf

163 Kiev Check-in (2018) *Is Ukraine entering the era of the electric car? Here's everything you need to know…* Available at: https://www.kievcheckin.com/discover-kiev/are-we-entering-the-era-of-the-electric-car-heres-everything-you-need-to-know

164 Electrive (2018) *Ukraine exempts electric vehicles from taxes.* Available at: https://www.electrive.com/2018/11/26/ukraine-exempts-electric-vehicles-from-taxes/

165 CMS Law (2019) *Ukraine takes another step in its support of electric cars.* Available at: https://www.cms-lawnow.com/ealerts/2019/08/ukraine-takes-another-step-in-its-support-of-electric-cars?cc_lang=en

166 Medium (2019) *Green light and green license plates to electric cars.* Available at: https://medium.com/@UNDPUkraine/green-light-and-green-license-plates-to-electric-cars-7895e2af88f8

167 Ukrinform (2020) *Ukrainians purchase over 7,500 electric vehicles in 2019.* Available at: https://www.ukrinform.net/rubric-economy/2852902-ukrainians-purchase-over-7500-electric-vehicles-in-2019.html

168 Electrive (2020) *The small e-car boom in Ukraine.* Available at: https://www.electrive.net/2020/03/10/der-kleine-e-autoboom-in-der-ukraine/

169 Kiev Post (2019) *Ukraine showing electric growth in this car market.* Available at: https://www.kyivpost.com/business/ukraine-showing-electric-growth-in-this-car-market.html?cn-reloaded=1

CASE STUDY 2: PROMOTION OF RENEWABLE FUEL USE IN THE NETHERLANDS THROUGH BLENDING OBLIGATION

Background: The first renewable fuel blending mandate was introduced in 2007 in the Netherlands. Fuel suppliers were obligated to supply at least 4% of their fuel, on an energy basis, from biomass by 2010. The blending mandate has increased over time and has included a greater scope of renewable fuels. [170]

Description of measures: For 2020, the blending mandate is set for 16.4% of transport energy use from renewable fuels, including double counting. The delivery of renewable fuels to the Dutch transport market generates tradable renewable fuel units, HBEs (Hernieuwbare Brandstof Eenheden), which allow suppliers to demonstrate that they have met their renewable fuel obligations. There are three types of HBE assigned to a fuel, depending on the feedstock used to produce the fuel – one for advanced biofuels produced from feedstocks of Annex IX Part A of RED and fuels produced from renewable energy of non-biological origin, one for biofuels produced from feedstocks of Annex IX Part B and one for conventional biofuels produced from agricultural and energy crops. Conventional biofuels from food and feed crops are capped at 5% of transport energy for 2020. A sub-target is applied to advanced renewable fuels starting at 0.6% in 2018 rising to 0.8% in 2019 and 1% in 2020 (including double counting). From January 2018 onwards, the obligated parties need to demonstrate that the feedstock used for obtaining double counting status has not been intentionally modified so as to become eligible for double counting, to counter fraudulent claims. [171,172]

Analysis of success of these measures: In 2018, biofuels accounted for 8% of total energy used in transport, including double counting. Over 70% of supplied biofuels, on an energy basis, are from Annex IX feedstocks (both Part A and B).[173]

170 Nederlands Emissieautoriteit (n.d.) *Energy for Transport.* Available at : https://www.emissionsauthority.nl/topics/themes/energy-for-transport

171 Nederlands Emissieautoriteit (n.d.) *Annual obligation.* Available at: https://www.emissionsauthority.nl/topics/obligations---energy-for-transport/annual-obligation

172 Nederlands Emissieautoriteit (n.d.) *Renewable fuel units.* Available at : https://www.emissieautoriteit.nl/onderwerpen/algemeen-ev-2018/hernieuwbare-brandstofeenheden

173 Eurostat (2019) *SHARES detailed results 2018.* Available at: https://ec.europa.eu/eurostat/web/energy/data/shares

CASE STUDY 3: RAILWAY ELECTRIFICATION IN INDIA

Background: Main-line railway operations are handled by Indian Railways, a state-owned organisation, run by the Ministry of Railways[174]. In 1979, the Central Organization for Railway Electrification was set up to organise the electrification of Indian Railways[175].

Description of measures: In February 2020, the Union Ministry of Finance stated that Indian Railways will be fully electrified by 2023. According to the Railway Minister, by 2030, Indian Railways will become the first 'net-zero' carbon emitter. This is because it is envisaged that solar energy will be produced alongside the railways to provide power requirements for traction. A few measures have been implemented to accelerate the electrification of the remaining railway lines, including awarding Engineering Procurement and Construction contracts and introducing better project monitoring mechanisms.[176,177]

Analysis of success of these measures: Nearly 40,000 kms of railway lines in India are electrified, accounting for 63% of all railway lines. Further, these electrified lines account for 57% of passenger rail traffic and 65% of freight rail traffic. Between 2015 and 2020, railway electrification increased by 345% or 16,889 kms compared to the previous 5-year period (2010-2015). In the 2019-2020 period, 2,606 kms were electrified. An additional 560 kms have been built, but commissioning has been delayed due to COVID-19 restrictions.[178,179]

174 Indian Railways (n.d.) *Home Page.* Available at: http://www.indianrailways.gov.in/

175 Central Organization for Railway Electrification (2020) *Home page.* Available at: https://core.indianrailways.gov.in/

176 Livemint (2020) *Government plans to electrify all railway tracks in next three years.* Available at: https://www.livemint.com/news/india/government-plans-to-electrify-all-indian-railway-tracks-in-next-three-years-11580657367536.html

177 Livemint (2019) *Indian Railways to be fully electrified in next 3-4 years.* Available at: https://www.livemint.com/news/india/indian-railways-to-be-fully-electrified-in-next-3-4-years-11574622192167.html

178 Central Organization for Railway Electrification (2020) *Home page.* Available at: https://core.indianrailways.gov.in/

179 Central Organization for Railway Electrification (2020) *Home page.* Available at: https://core.indianrailways.gov.in/

CASE STUDY 4: HYDROGEN BUS FLEET DEMONSTRATION PROJECT – H2BUS

Background: Hydrogen deployment in transport in Europe has predominantly been incentivised with capex support to demonstration projects, as the technology and supporting infrastructure continues to develop. Projects supporting hydrogen deployment in transport in Europe tend to cover multiple markets. Some of the key ongoing demonstration projects for buses include JIVE[180], Liverpool Bus Project[181] and H2Bus[182]. Key ongoing demonstration projects for trucks and light commercial vehicles include H2ME[183], REVIVE[184], H2Haul[185], H2Share[186] and HECTOR[187]. In the maritime sector, the ongoing FlagShips[188] demonstration project is most relevant.

Description of measures: Whilst there are numerous ongoing demonstration projects, H2Bus is described here in more detail as an example of the type of aims and targets of demonstration projects. The H2Bus demonstration project aims to deploy 1,000 hydrogen fuel cell electric buses and the required supporting infrastructure in several European cities. It also aims to achieve these goals in a cost-competitive manner, with a single-decker bus priced below €375,000, hydrogen price between €5 and €7 per kg, and a service cost of €0.30 per km. The price decrease for buses is expected to occur as the suppliers of the project – Wrightbus, Ballard and Hexagon – join together to reduce the cost of various components, possible due to the scale of the project.[189] The first phase of the project focusses on deploying 600 buses, and the required infrastructure, in three markets – the UK, Denmark, Latvia – by 2023. This first phase is supported by €40 million from the EU's Connecting Europe Facility.[190]

Analysis of success of these measures: Work is currently still on-going for the H2Bus demonstration project. The H2Bus single-decker bus is expected to be ready for delivery in 2020, and an articulated bus will be ready from 2021.[191]

180 https://hydrogeneurope.eu/project/jive

181 www.liverpoolcityregion-ca.gov.uk/liverpool-city-region-launches-6-4m-hydrogen-bus-project

182 www.h2bus.eu

183 https://h2me.eu

184 https://h2revive.eu

185 www.h2haul.eu

186 www.waterstofnet.eu/en/projects-roadmaps/h2-share

187 www.nweurope.eu/projects/project-search/hector-hydrogen-waste-collection-vehicles-in-north-west-europe

188 https://flagships.eu/

189 H2Bus *Accelerating Hydrogen Mobility.* https://indd.adobe.com/view/c28d7bdf-5a6b-420b-bc7d-bea06b10e1e0

190 H2Bus (2019) *Leading players enabling true zero-emission hydrogen solution for public transport.* Available at: https://h2bus.eu/onewebmedia/H2Bus.pdf

191 H2Bus *Offering.* Available at: https://h2bus.eu/offering.html

CASE STUDY 5: ELECTRIC BUS FLEET IN LONDON

Background: The London bus network transports over 2 billion passengers a year, which is more than the rest of England combined[192]. London's public bus fleet is managed by Transport for London (TfL), through their subsidiary London Bus Services Ltd. The fleet size is around 9,300 busses operating on 675 routes. Most bus services are run by private companies, who are awarded service contracts by TfL. [193] The Mayor of London has made improving air quality a top priority for London, and buses have a key role to play in this.[194]

Description of measures: Transport for London has introduced a procurement strategy for buses, which aims for all buses operating as part of the TfL network to be zero-emissions by 2037[195]. To achieve this, starting from autumn 2020, any new bus entering the fleet will need to be zero-emissions at tailpipe[196]. Over £300 million has been set aside to transform the London bus fleet, with money used to retrofit buses as well as committing to phase out pure diesel buses and replace them with cleaner buses, among other actions. Further, 12 Low Emission Bus Zones have been introduced in London, aiming to put the cleanest buses on the most polluted London streets.[197] Once the bus retrofit programme is complete, all buses in London will meet Euro VI emission standards, and therefore the whole of London will be a Low Emission Bus Zone[198]. The majority of the buses operate 'back to base' charging at the operator's depot, but there is also an ongoing trial of wireless charging at route ends.

Analysis of success of these measures: London has the largest electric bus fleet in Europe[199], with 280 electric buses in the transport fleet[200]. Three bus routes in London are fully-electric, with an additional 12 routes expected to become fully-electric by the end of 2020. The 12 Low Emission Bus Zones were delivered ahead of schedule.

---

[192] Transport for London (n.d) *Improving buses.* Available at: https://tfl.gov.uk/modes/buses/improving-buses

[193] Transport for London (n.d.) *What we do*. Available at: https://tfl.gov.uk/corporate/about-tfl/what-we-do?intcmp=2582#on-this-page-0

[194] Mayor for London (2018) *Manifesto pledge on clean air.* Available at: https://www.london.gov.uk/questions/2018/0090

[195] Mayor of London (n.d.) *Cleaner buses.* Available at: https://www.london.gov.uk/what-we-do/environment/pollution-and-air-quality/cleaner-buses

[196] Transport for London (n.d.) *Improving buses.* Available at: https://tfl.gov.uk/modes/buses/improving-buses

[197] Mayor of London (n.d.) *Cleaner buses.* Available at: https://www.london.gov.uk/what-we-do/environment/pollution-and-air-quality/cleaner-buses

[198] Transport for London (n.d.) *Improving buses.* Available at: https://tfl.gov.uk/modes/buses/improving-buses

[199] Mayor of London (2019) *London's electric bus fleet becomes the largest in Europe.* Available at: https://www.london.gov.uk/press-releases/mayoral/london-has-europes-largest-electric-bus-fleet

[200] Intelligent Transport (2020) *Three London bus routes now fully electric.* Available at: https://www.intelligenttransport.com/transport-news/95979/three-london-double-deck-bus-route-now-fully-electric/

4.10 Summary of policy mechanisms

Table 20: Summary of policy options

Stake-holder	Policy mechanism	Advantages	Disadvantages
Fuel suppliers	Blending obligation	• Provides a high level of assurance that a minimum level of renewable fuel in the transport sector will be achieved. • Clear bankable signal of a future market to all industry players, but level of certainty for investors depends on timescale over which obligation is guaranteed. • Provides a stable market signal to producers despite changing fossil fuel prices	• Costs are passed on to consumers, which may impact ability of some consumers to pay for transport. • Under EU State Aid rules cannot preferentially support low-carbon fuel production in a particular Member State, so does not necessarily build up domestic low-carbon fuel production.
	Low carbon fuel standard	• Provides a higher incentive to fuels with high GHG savings, and an incentive for continuous improvement in supply chains in order to reduce these over time. • Provides assurance that a certain level of renewable fuel in the transport sector will be achieved, although meeting the 14% RES-T target will rely on policy-makers estimating the GHG intensity of fuels likely to be supplied into each territory and setting the GHG target accordingly. • Clear bankable signal of a future market to all industry players, but level of certainty for investors depends on timescale over which policy is guaranteed. • Provides a stable market signal to producers despite changing fossil fuel prices	• Typically, does not allow sub-targets or multiple-counting for fuels which are strategically important or at earlier stage of commercialisation. • Because value of incentive is directly linked to GHG saving of fuel, strong verification of supplier's claimed GHG savings is required in order to reduce risk of fraud. • Costs are passed on to consumers, which may impact ability of some consumers to pay for transport. • Under EU State Aid rules cannot preferentially support low-carbon fuel production in a particular territory, so does not build up domestic low-carbon fuel production.
	Grants, loans and financing guarantees for low carbon fuel production plants	• Effective means of support for pre-commercial technologies • Can be targeted towards domestic production • Can be targeted towards specific areas of the supply chain which are inhibiting the scale-up of the supply-chain as a whole.	• Government partly takes on risk of technologies failing or plants being unprofitable • When used alone are not sufficient to underpin a business case for technology and plant developers: a market-based policy mechanism to support multiple plants is also needed
	Payment for fuel supplied	• Costs can be spread over both industrial consumer and government, depending on how much of the funding comes from general taxation and how much from an industry levy. • Provides moderate level of assurance to the supplier that renewable fuel can be sold at a profitable price and therefore	• Commitment to fixed payment over time is important for investor confidence in order to build new plants, but government takes on risk of over-paying for renewable fuel as production costs decrease with maturing technology and production processes. Some aspects of the policy design can mitigate this risk.

Stake-holder	Policy mechanism	Advantages	Disadvantages
		will be supplied into the market. However may not be sufficient for making production of alternative fuels profitable, if oil prices fall.	• Does not provide a high level of certainty on reaching the RED II 14% RES-T target, as supply of renewable fuel is not obligatory.
Fuel retailers	Mandatory availability of certain fuels	• Effective in ensuring that certain fuel grades or types are available to consumers at retail stations	• Does not guarantee use of particular fuels – requires other policy measures to ensure that there is sufficient demand for these alternative fuel blends
	Grants, loans and financing guarantees for construction of refueling stations	• Retailers still need to make a business case for the refuelling infrastructure, so unlikely to get construction of refuelling facilities in places where these are unviable. • Can be used to support the installation of charge-points at both commercial and residential locations.	• Does not guarantee that refuelling infrastructure will get built, and does not guarantee that it will get built in the most strategically important location.
Vehicle manufacturers	Vehicle CO2 standards or production mandates	• Costs are born by vehicle manufacturers • Can stimulate innovation • Can also promote vehicle efficiency	• Does not necessarily ensure these vehicles are purchased and used by consumers, for example if vehicles are too expensive or insufficient refuelling infrastructure is in place. Therefore, may require other complementary policies in order to be effective • Complementary policy focussed on fuels and related infrastructure is also required, to ensure that vehicles sold are actually used with renewable fuel.
	Grants, loans and financing guarantees for construction of manufacturing facilities	• Can be used to support domestic vehicle manufacturing industry	• Governments take on risk of companies' manufacturing and sales strategies
Transport end user	Sales bans or zero-emission vehicle (ZEV) targets	• Does not require government funds • Sends signals to manufacturers to increase supply in a country • Encourage consumers to purchase ZEVs, especially if they cannot resell an ICE vehicle later on	• Generally, requires parallel financial support measures to achieve the target, • Complementary policies should be put in place to mitigate unintended consequences on poor or vulnerable members of society, and those in rural areas
	Public procurement obligations	• Provides some certainty of future market for vehicle manufacturers, fuel producers and installers of refuelling stations • Increases related infrastructure, which is beneficial for private uptake of alternative vehicles	• Development can be localised and fragmented • Can increase costs to public bodies

Stake-holder	Policy mechanism	Advantages	Disadvantages
		• Group purchasing, for example from several local authorities, can enable them to purchase ZEVs at lower cost[201] • Stimulates innovation • Can scale-up supply chains therefore reduce costs for consumers and commercial vehicle purchasers.	
	Grants, loans or other financial incentives for the purchase of vehicles	• Proven to be effective in increasing uptake of ZEVs • Generally, provides an immediate (or semi-immediate) incentive to the purchaser	• If subsidy is not set high enough it may not be taken up by vehicle purchasers • Even if vehicle is purchased, it may not be extensively used • Can be challenging to set value of incentive at a level that provides sufficient incentive whilst still being value for money for the government
	Financial incentives to reduce relative cost of owning a vehicle using renewable energy	• Provides continual support towards ZEV ownership • Encourages the use of ZEVs • Decreases the total cost of ownership of ZEVs compared to ICE vehicles • Can promote use of ZEVs in cities to maximise their beneficial air quality impacts.	• If there are a number of small financial incentives for ZEVs it may be challenging for a consumer to decide whether these stack up to make an economic case for purchasing a ZEV. • Generally, benefits take time to accrue, i.e. not immediate incentives • Tax reductions or exemptions cause an increasingly large loss in government revenue as the use of RE in transport increases.
	Non-financial incentives to increase attractiveness of owning a vehicle using renewable energy	• Improves the ZEV proposition, if paired with other incentives • Can provide important information to consumers	• Alone, will not overcome barriers to deploy ZEVs • Preparing and disseminating information could be administratively burdensome

[201] For example in the cases of hydrogen buses: Fuel Cell Electric Buses knowledge base (2016) Strategies for joint procurement of Fuel Cell Electric Buses, Available from: https://www.fuelcellbuses.eu/public-transport-hydrogen/strategies-joint-procurement-fuel-cell-electric-buses-0

5 ROADMAPS FOR ACHIEVING THE RENEWABLE ENERGY IN TRANSPORT TARGET FOR 2030

The methodology adopted for the development of roadmaps is common to all Contracting Parties and is therefore explained upfront in this report in the next section.

The second section of this chapter describes the options in principle available to all CPs for achieving the transport target for 2030.

The detail particular to each CP is then discussed in the subsequent chapters.

5.1 Overview of methodology

Roadmaps for all CPs have been derived by assessing all options, and combining the most promising options to a roadmap.

An option is understood in this study as one renewable fuel or one group of renewable fuels introduced into one or more transport (sub-)sectors. As an example, liquid crop-based biofuels in road transport are one option.

The possible contributions of each option have been estimated based on the individual circumstances in each CP, and based on international developments as described in chapter 3. Where the sum of these contributions exceeds the 2030 target, the contributions of the most challenging or expensive[202] options have been reduced accordingly in order to fulfil the minimum requirements as defined in RED II. However, over-achievement of the targets is possible. The combined options and their target contributions have been the basis for the development of each CP's roadmap.

A roadmap, as understood in this study, is a set of actions (related to legal framework, incentives, strategy, policies in different sectors, certification schemes for renewable fuels) on a timeline to 2030 required to implement the options.

Each roadmap includes key policies fundamental to target compliance, as well as complementary policies ensuring or enhancing the success. The existing regulatory status quo already achieved is taken into account for each CP.

Figure 39 shows the steps taken to develop the sets of options as basis for the roadmaps.

[202] Detailed cost assessments have not been carried out in this study. Rough cost judgements are made here based on information on costs and prices provided in chapter 3.

A. Lay out options for achieving RED II, including caps and targets where relevant

B. Review regulatory status quo (Task 4.1) and existing use of renewable energy in transport in each CP

C. Estimate contribution which could be made by each option, independently of other options

D. Reduce contribution from most challenging or expensive options in order to assess how RED II target could most feasibly be achieved

Figure 39: Summary of steps taken for Task 4.2

Under step B the same principles were followed for all CPs to estimate the approach which could be made by each option. These are summarised in Table 21 below.

Table 21: Options and the estimation of their contributions to the 2030 targets

Option		Approach adopted to estimate contribution from that option
Biofuels and liquid RFNBOs	1. Liquid crop-based biofuels in road transport	Equal to the crop cap
	2. Liquid fuels produced from Annex IX B feedstocks in road transport	Equal to the Annex IXB fuel cap
	3. Advanced liquid biofuels (based on Annex IX A feedstocks) in road transport	Equal to the Annex IXA target
	4. Liquid RFNBOs in road transport	Equal to one demonstration-scale plant of 10ML/year, with the renewability of the resulting fuel determined by the renewable energy percentage in the 2030 grid mix.

Option		Approach adopted to estimate contribution from that option
	5. Renewable methane in road transport	Varied according to each CP (see CP specific chapters below)
	6. Renewable liquid fuels in shipping	No renewable fuel in shipping, aviation or rail is assumed for all CPs, as they can all meet targets with renewable fuel for the road transport sector.
	7. Renewable liquid fuels in aviation	
	8. Renewable liquid fuels in rail	
Electricity	9. Rail electrification	Depending on electrified rail in the CP and assuming that the electric rail share in total transport energy consumption remains constant if no other detailed forecasts per CP exist
	10. Electric public transport (bus, trolleybus, tram, metro)	This is estimated based on the development of electric transport over the past years in EU countries as a share of total energy consumption in this sector, applied to the energy consumption in this sector in the CP; electricity use in this sector as in the BAU scenario is added
	11. Electric road vehicles (passenger cars and trucks)	This is estimated based on the development of electric transport over the past years in EU countries as a share of total energy consumption in this sector, applied to the energy consumption in this sector in the CP; electricity use in this sector as in the BAU scenario is added
Hydrogen	12. Hydrogen in rail	This is estimated based on the diesel consumption in rail in the CP and assuming a certain share for hydrogen by 2030 based on experience and studies in Europe
	13. Hydrogen bus and coach (urban bus, long distance coaches)	This is estimated based on the fuel consumption in buses and coaches in the BAU scenario in the CP and assuming a certain share for hydrogen by 2030 based on experience in Europe

Option		Approach adopted to estimate contribution from that option
	14. Hydrogen road vehicles (passenger cars and trucks)	This is estimated based on the fuel consumption of road vehicles in the CP and assuming a certain share for hydrogen by 2030 based on experience and studies in Europe
	15. Hydrogen in refineries	This is assumed to be zero for this study; however, CPs having a refinery sector should assess this in detail to identify short-term opportunities

The reduction in contribution from the most challenging or expensive options (step D) was done using the same approach across all CPs. The contributions from the following options were removed or reduced, in this order, until the RED II target was met:

1. Liquid RFNBOs in road transport
2. Liquid fuels produced from Annex IX B feedstocks in road transport
3. Crop-based biofuels in road transport

This merit order was adopted because RFNBOs are still expensive, therefore unlikely to be a cost-effective way for CPs to meet RED II targets. The availability of Annex IXB feedstocks is likely to be constrained, therefore the contribution of Annex IXB feedstock was reduced next. Finally, for a few CPs, crop-based biofuel use was decreased below the maximum allowed under the crop cap in order for them to meet RED II targets.

5.2 Options for compliance with RED II targets

5.2.1 Option 1: Liquid crop-based biofuels in road transport

Drivers for growth	Crop-based biofuels are currently the most widely available and generally the cheapest alternative fuel in the EU and globally. Nevertheless they are still generally more expensive than fossil diesel and gasoline so policy is required to support their use. The majority of crop-based biofuels used globally today are ethanol and FAME biodiesel.
Policy framework	**Central key policies:** • Blending mandate / GHG reduction obligation – Requires legislation defining all aspects of the mandate / obligation including who is obligated, penalty for non-compliance, where is the duty point, what is the target obligation / GHG reduction, buy-out price, caps or sub-targets for particular fuels or feedstocks etc. • Sustainability framework – this should be implemented alongside the blend mandate, to ensure that biofuels make high GHG savings and do not cause other environmental impacts such as on biodiversity. The sustainability requirements in the RED II should act as the framework for biofuel sustainability legislation, including provision to limit the supply of crop-based biofuels and phase out high-ILUC biofuels by 2030. Certification (national or voluntary schemes) must be established. **Complementary policies:** • Grants / subsidies to fuel producers to build up domestic biofuel production in each CP • Information to retailers and consumers on switching and vehicle compatibility • A unit within the relevant government ministry must be designated responsible for: implementing, reviewing and updating policy; ensuring sustainability certification of fuels; administration of the scheme; data collection and reporting
Dedicated vehicles	Ethanol can be blended up to $5\%_{vol}$ in gasoline (E5) and fatty acid methyl ester (FAME) can be blended up to $7\%_{vol}$ in diesel (B7) with no modifications required to vehicles. Given the 2% cap, use of crop-based biofuels will not exceed these blend walls.
Dedicated infrastructure	E5 and B7 blends do not require dedicated infrastructure. Check materials for compatibility; follow protocols for first filling of storage tanks; additional blending facilities and tanks may be required.
Contribution 2030 (CP-specific)	Up to 2% for all CPs apart from Albania which can use up to 7%
Co-benefits	▪ Domestic fuel production could support fuel producers and agricultural sector in each CP

Figure 40: Option 1: Liquid crop-based biofuels in road transport

The central policy mechanism for crop-based biofuels (and all other biofuels and liquid RFNBOs) is an obligation on fuel suppliers to drive their uptake in transport to supply a minimum proportion of these fuels, or achieve a defined GHG saving through use of these fuels. The key features of this type of policy that need to be defined in legislation, and importantly aligned with the RED II requirements, are the definition of which economic operators are obligated, the level and timing of the targets (including caps and sub-targets), and the penalty for non-compliance or a buy-out price. Alongside this central policy mechanism, a sustainability certification framework is essential, to ensure that the fuels supplied are sustainable, and so qualify towards RED II targets. Biofuels supplied that do not meet this framework will not be considered as eligible to meet targets. This framework needs to match the requirements in RED II including on sustainability criteria, GHG calculation methodologies, certification and reporting.

A unit within the relevant government ministry must be designated responsible for implementing, reviewing and updating the policy as a whole, ensuring sustainability certification of fuels, administering the scheme, data collection and reporting. It is essential to ensure that this unit has the correct power to be able to introduce and enforce the policy such that targets are met. It should also establish sufficient knowledge of the area to manage the scheme on an ongoing basis, given that sustainability requirements and fuel production pathways change regularly.

For crop-based biofuels, particular attention needs to be paid to the crop cap, which must be set at the higher of: the percentage of transport energy coming from food and feed crops in 2019 in that Member State plus one percentage point, up to a maximum of 7%; and 2%. This results in a cap of 2% for all CPs except Albania, which can use up to 7%. In addition, the restriction on use of high ILUC biofuels, which currently applies only to palm oil derived biofuels, must be implemented (see section 3.1.1).

Several other measures that are complementary to this demand-side policy have also been important in other countries, namely support for domestic fuel production, such as capital grants for plants and information provision for consumers on fuel switching and vehicle compatibility. Supporting domestic fuel production can increase the value to the CP, through providing jobs and value to the domestic agriculture, forestry, waste and construction sectors. Nevertheless, within the EU there are State Aid restrictions on financial support for crop-based biofuels (see 4.1.1.1), and so this would need careful consideration in CPs. The blending levels used in the roadmaps here do not in general entail biofuel blending above E5 and B7, meaning very limited requirements for information provision for consumers.

5.2.2 Option 2: Liquid fuels produced from Annex IX B feedstocks in road transport

Drivers for growth	Contribution from Annex IXB biofuel towards RES-T target is capped at 3.4% ($1.7\%_{energy}$ due to 2X multiplier). Annex IXB feedstocks (UCO and category 1 & 2 animal fats) are commonly used to produce FAME and HVO.
Policy framework	**Central key policies:** • Blending mandate / GHG reduction obligation – Requires legislation defining all aspects of the mandate / obligation including who is obligated, penalty for non-compliance, where is the duty point, what is the target obligation / GHG reduction, buy-out price, caps or sub-targets for particular fuels or feedstocks etc. • Sustainability framework – this should be implemented alongside the blend mandate, to ensure that biofuels make high GHG savings and do not cause other environmental impacts such as on biodiversity. The sustainability requirements in the RED II should act as the framework for biofuel sustainability legislation, including provision to limit the supply of Annex IXB biofuels to 1.7% of total transport fuel. Certification (national or voluntary schemes) must be established. **Complementary policies:** • Grants / subsidies to fuel producers to build up domestic biofuel production in each CP • Information to retailers and consumers on switching and vehicle compatibility • A unit within the relevant government ministry must be designated responsible for: implementing, reviewing and updating policy; ensuring sustainability certification of fuels; administration of the scheme; data collection and reporting
Dedicated vehicles	Fatty acid methyl ester (FAME) can be blended up to $7\%_{vol}$ in diesel (B7) with no modifications required to vehicles. HVO can be used up to 100% in diesel engines with no modification to engines.
Dedicated infrastructure	Diesel containing up to $7_{\%vol}$ FAME and higher percentages of HVO does not require dedicated infrastructure. Check materials for compatibility; follow protocols for first filling of storage tanks; additional blending facilities and tanks may be required.
Contribution 2030 (CP-specific)	Up to level of cap, 3.4%
Co-benefits	▪ Domestic fuel production could support fuel producers and waste collectors in each CP

Figure 41: Option 2: Liquid fuels produced from Annex IX B feedstocks in road transport

The policies needed to achieve this option are the same as those for all biofuels (see Option 1), with the following differences:

A cap on the contribution of feedstocks from Annex IXB must be set and implemented. RED II defines this as 1.7%, but “Member States may, where justified, modify that limit, taking into account the availability of feedstock”. As a result, CPs may wish to justify a different cap level. In addition, some CPs already export Annex IXB feedstocks to EU Member States: an analysis may be necessary of the relative value to the CP of exports compared with the added value of domestic fuel production, and policy such as taxation levels then be set to ensure that use of these feedstocks gives the maximum economic and/or GHG benefit.

Complementary policy to support waste oil collection could enable a higher resource base, and policy to support domestic conversion to fuel would support the supply chain.

5.2.3 Option 3: Liquid advanced biofuels (Annex IX A) in road transport

Drivers for growth	There is a sub-target in RED II for Annex IXA fuels of 3.5% contribution to RES-T target (1.75%$_{energy}$ due to 2X multiplier). Limited production today of fuels from Annex IXA feedstocks and typically more expensive than fuels from crops or Annex IXB feedstocks. Annex IXA feedstocks may be used to produce a wide range of fuels, including ethanol or drop-in diesel, gasoline or kerosene.
Policy framework	**Central key policies:** • Blending mandate / GHG reduction obligation – As described for previous options. This should contain a sub-target for Annex IXA biofuels. Suppliers supplying fuel in the form of electricity or RFNBOs may be exempted from the requirement to comply with this sub-target, but the CP as a whole must still comply with the Annex IXA biofuel sub-target. • Sustainability framework – this should be implemented alongside the blend mandate, to ensure that biofuels make high GHG savings and do not cause other environmental impacts such as on biodiversity. The sustainability requirements in the RED II should act as the framework for biofuel sustainability legislation. Certification (national or voluntary schemes) must be established. **Complementary policies:** • Grants / subsidies to fuel producers to build up domestic biofuel production in each CP – these are particularly important if domestic production is to be achieved given the limited commercialization of Annex IXA fuels today • Information to retailers and consumers on switching and vehicle compatibility • A unit within the relevant government ministry must be designated responsible for: implementing, reviewing and updating policy; ensuring sustainability certification of fuels; administration of the scheme; data collection and reporting
Dedicated vehicles	Ethanol blends up to E5 and drop-in diesel/gasoline do not require dedicated vehicles.
Dedicated infrastructure	B7 diesel and E5 gasoline, and higher percentages of drop-in diesel and gasoline do not require dedicated infrastructure. Check materials for compatibility; follow protocols for first filling of storage tanks; additional blending facilities and tanks may be required.
Contribution 2030 (CP-specific)	3.5% for all CPs in order to meet Annex IXA target in the RED II.
Co-benefits	▪ Domestic fuel production could support fuel producers, waste collectors and producers of agricultural, forestry or other waste in each CP

Figure 42: Option 3: Liquid advanced biofuels (Annex IX A) in road transport

The policies needed to achieve this option are the same as those for all biofuels (see Option 1), with the following differences: A sub-target must be set and enforced for Annex IXA biofuels, defined in RED II as least 0.2% in 2022, at least 1% in 2025 and at least 3.5% in 2030. Options for enforcement of the sub-target may be different from those for the target as a whole, for example a higher buy-out price will be needed in order to reflect the higher production costs of these fuels. For these fuels, supply side support, such as support for domestic production plants, and feedstock supply chains is more important than for crop-based and Annex IXB biofuels, due to their earlier stage of development and higher production costs. Supporting domestic production could also create jobs and bring value to the CP in the conversion plant and supply chain, and in some CPs there is feedstock resource that could also support fuel production for export. It is important to note that the minimum contributions from liquid advanced biofuels in most CPs amount to less than the equivalent of the output of one advanced ethanol plant at average scale.

5.2.4 Option 4: Liquid RFNBOs in road transport

Drivers for growth	Liquid RFNBO fuels (e.g. methanol, diesel, jet fuel or gasoline) could be more easily or cheaply used within existing infrastructure than hydrogen or electricity, and address the challenge of sourcing sufficient amounts of sustainable biomass feedstock. However most RFNBO fuels are at low TRL and typically have higher production costs than Annex IXA biofuels.
Policy framework	**Central key policies:** • Blending mandate / GHG reduction obligation – As described for previous options. Suppliers supplying fuel in the form of electricity or RFNBOs may be exempted from the requirement to comply with an Annex IXA sub-target, but the CP as a whole must still comply with the Annex IXA biofuel sub-target. May require separate sub-target for RFNBOs given high production cost • Sustainability framework –The sustainability requirements in the RED II should act as the framework for RFNBO sustainability legislation, including upcoming Delegated Act detailing EU sustainability criteria for RFNBO fuels, expected at the end of 2021. • Establish dedicated RES electricity capacity which could be used to produce RFNBOs for transport **Complementary policies:** • Grants / subsidies to fuel producers to build up domestic fuel production in each CP – these are particularly important if domestic production of RFNBOs is to be achieved given the limited commercialization of liquid RFNBO production today. • Information to retailers and consumers on switching and vehicle compatibility • A unit within the relevant government ministry must be designated responsible for: implementing, reviewing and updating policy; ensuring sustainability certification of fuels; administration of the scheme; data collection and reporting
Dedicated vehicles	Methanol can be blended up to ~3%$_{vol}$ in gasoline ; RFNBO diesel, jet and gasoline can be used with no engine modifications. As noted above, these are the key RFNBO fuels considered under this option
Dedicated infrastructure	No dedicated infrastructure required for methanol blended up to ~3%$_{vol}$ in gasoline; and for RFNBO diesel, jet and gasoline. Check materials for compatibility; follow protocols for first filling of storage tanks; additional blending facilities and tanks may be required.
Contribution 2030 (CP-specific)	Contribution from the construction of one demo-scale (10ML/year) RFNBO plant in each CP ranges from 0.03% to 2.3% contribution to RES-T target. However, liquid RFNBOs are not required in any CPs in order to meet RES-T targets.
Co-benefits	▪ Domestic fuel production would support the domestic renewable power generation industry, and could support PtL technology development, although currently there are no known PtL technology developers in any of the CPs.

Figure 43: Option 4: Liquid RFNBOs in road transport

The policies that would be needed to achieve this option are the same as those for biofuels (see Option 1), with the following differences. Note that liquid RFNBOs are not included in any CP roadmaps developed in this study as they are higher cost than other options.

Liquid RFNBOs have even higher production costs today than advanced biofuels, but do not count towards Annex IXa targets or double count towards RED II targets. This makes their economics very challenging, meaning that a separate sub-target, or supply side support would be needed for a CP wishing to incentivise these routes.

Ensuring the sustainability of RFNBOs means including rules around additionality of the renewable electricity used, and lifecycle GHG methodology in sustainability frameworks and certification, which may entail changes where these have been in development for biofuels only. These need to be aligned between liquid RFNBOs, hydrogen and electricity.

5.2.5 Option 5: Renewable methane in road transport

Drivers for growth	This option is focused on switching from existing fossil methane use to biomethane. Animal manure, sewage sludge and a number of other biomass wastes are on the Annex IXA list of feedstocks, therefore would contribute towards the CP Annex IXA sub-target. Biomethane is more expensive to produce than fossil methane, therefore policy support will be required.
Policy framework	**Central key policies:** • Blending mandate / GHG reduction obligation, including sub-target for Annex IXA biofuels as described above. The level of policy support to biomethane used in transport should be sufficient to overcome the cost of upgrading biogas to biomethane and (potentially) connecting to and injecting into the gas grid, given that it is generally less capex-intensive to produce heat and power directly from biogas, and policy may already exist to support heat/power production from biogas. Sustainability framework should include green gas certification to allow mass balance of biomethane across gas networks **Complementary policies:** • Grants / subsidies to fuel producers to build up domestic biofuel production in each CP • A unit within the relevant government ministry must be designated responsible for: implementing, reviewing and updating policy; ensuring sustainability certification of fuels; administration of the scheme; data collection and reporting **Not recommended**: • Grants / subsidies to purchasers of vehicles or installers of NG refuelling stations to scale-up use of methane in transport
Dedicated vehicles	Dedicated vehicles required to use natural gas (NG) but increasing the overall number of NGVs is not within scope of this option. No changes to vehicles required if switching from NG to biomethane
Dedicated infrastructure	Dedicated refuelling infrastructure is required for methanol / biomethane. No changes required if switching from natural gas to biomethane.
Contribution 2030 (CP-specific)	Ranges from 0% in CPs which do not have any existing methane use in transport, to 1.1%
Co-benefits	▪ There are air quality (AQ) benefits from using natural gas instead of gasoline or diesel, but no additional AQ benefits from switching from NG to biomethane. ▪ Domestic fuel production could support fuel producers and agricultural sector in each CP

Figure 44: Option 5: Renewable methane in road transport

The policies needed to achieve this option are the same as those for liquid advanced biofuels (see Option 3), with the following differences:

Policy design needs to consider interaction with other biomethane markets, such as power production and grid injection for a range of applications. The level of support given in each sector will affect where biomethane is used, and there is a need to consider alignment of sustainability rules so that producers can supply into multiple markets. The sustainability framework should also allow for green gas certification so that biomethane injected in one place can be claimed against transport use in another.

For this option, policy is also needed to support biomethane producers, including enabling grid injection.

5.2.6 Option 6: Renewable liquid fuels in shipping

Drivers for growth	Renewable fuels are several times more expensive than fossil marine fuel, therefore policy will be required which bridges the price gap between bio and fossil marine fuel. Only low blends of biofuel which do not require engine modifications are anticipated, so policy driver should focus on fuel suppliers.
Policy framework	**Central key policies:** • Blending mandate / GHG reduction obligation for the marine sector – As described above for other options. Blending mandate / obligation for marine sector should be separate to that imposed on road transport sector. • Sustainability framework – this should be implemented alongside the blend mandate, to ensure that biofuels make high GHG savings and do not cause other environmental impacts such as on biodiversity. The sustainability requirements in the RED II should act as the framework. **Complementary policies:** • Grants / subsidies to fuel producers to build up domestic biofuel production in each CP • Information campaign for ship operators on any required changes to storage or operational protocols • Grants / subsidies for alternative engine types for non-drop-in fuels (longer-term option, not included in roadmap to 2030) • A unit within the relevant government ministry must be designated responsible for: implementing, reviewing and updating policy; ensuring sustainability certification of fuels; administration of the scheme; data collection and reporting
Dedicated vehicles	Varies depending on fuel type. Biodiesel (FAME or HVO) can be used at low blend in existing engines with no modification. Other fuels (e.g. methanol, ammonia, hydrogen) would require dedicated ships with different engines and fuel storage infrastructure. This option focuses on low-blends in existing ships, given the 2030 timeframe.
Dedicated infrastructure	Varies depending on fuel type and blending share. At the low blends considered here, minor modifications may be required e.g. for blending or storage, but dedicated infrastructure is not required.
Contribution 2030 (CP-specific)	Only non-zero for Albania as Albania has a higher target, and a high proportion of total fuel use in domestic shipping
Co-benefits	▪ Compliance with international targets such as the International Maritime Organisation GHG reduction targets and air quality legislation requiring the reduction of NOx and SOx. ▪ Domestic fuel production could support fuel producers and agricultural sector.

Figure 45: Option 6: Renewable liquid fuels in shipping

As for biofuels in road transport, the primary policy needed to enable liquid biofuels use in shipping is an obligation to supply renewable fuels or achieve GHG reductions in fuels. This can be separate to that introduced in the road transport sector, to enable different obligated parties, and a different level and timing of support. However, aligned sustainability frameworks with the road transport sector are needed to enable producers to supply multiple markets.

In shipping, complementary policies may also be needed to enable non drop-in fuel use in shipping, such as support for port infrastructure, and information and financial support for switching by ship owners. In this study, only low blends (drop-in) are used in one CP (Albania).

5.2.7 Option 7: Renewable liquid fuels in aviation

Drivers for growth	There are several alternative aviation fuels certified for use today. HEFA, typically produced either from crops or from Annex IXB feedstocks, is the most readily available and cheapest option, but is still several times more expensive than kerosene. Renewable aviation fuel can also be produced from Annex IXA feedstocks but supply is much more limited and production cost typically higher.
Policy framework	**Central key policies:** • Blending mandate / GHG reduction obligation for the aviation sector – As described above for other options, taking into account Annex IXA fuel sub-target, and limits on crop-based, Annex IXB and high- ILUC biofuels. Blending mandate / obligation for aviation sector should be separate to that imposed on road transport sector. • Sustainability framework – as outlined above for the road transport sector. • If any renewable aviation fuel apart from HEFA is to be supplied, a separate sub-target for 'non-HEFA' renewable aviation fuels would be required. However this is not a priority to 2030. **Complementary policies:** • Grants / subsidies to fuel producers to build up domestic biofuel production in each CP • Administration of mechanism should tie-in with the monitoring and reporting airlines are required to do under CORSIA • A unit within the relevant government ministry must be designated responsible for: implementing, reviewing and updating policy; ensuring sustainability certification of fuels; administration of the scheme; data collection and reporting
Dedicated vehicles	No – all fuels certified for commercial aviation use meet existing fuel specifications and can be used without modifying planes
Dedicated infrastructure	No - all fuels certified for commercial aviation use meet existing fuel specifications and can be used without modifying infrastructure. Minor modifications may be required e.g. to blending facilities and protocols and storage tanks.
Contribution 2030 (CP-specific)	0% in all CPs
Co-benefits	▪ There could be benefits from using renewable aviation fuel in terms of air quality and non-CO2 global warming impacts but these are generally not well characterized. ▪ Domestic fuel production could support fuel producers and agricultural sector.

Figure 46: Option 7: Renewable liquid fuels in aviation

As for biofuels in road transport, the primary policy needed to enable liquid biofuels use in aviation is an obligation to supply renewable fuels or achieve GHG reductions in fuels. This can be separate to that introduced in the road transport sector, to enable different obligated parties, and a different level and timing of support. However, aligned sustainability frameworks with the road transport sector are needed to enable producers to supply multiple markets. However, due to high costs compared with other options, this option is not suggested in any CPs in this study.

5.2.8 Option 8: Renewable liquid fuels in rail

Drivers for growth	Rail is an efficient mode of transporting passengers and freight. FAME biodiesel can be blended into rail diesel, but there are few examples of commercial trains today using biodiesel or other renewable fuels. Policy support would be required as FAME is more expensive than diesel. Long-term investment cycles in rail.
Policy framework	**Central key policies:** • Blending mandate / GHG reduction obligation for the rail sector – As described above for other options, taking into account Annex IXA fuel sub-target, and limits on crop-based, Annex IXB and high- ILUC biofuels. Blending mandate / obligation for rail sector should be separate to that imposed on road transport sector. **Complementary policies:** • Grants / subsidies to fuel producers to build up domestic biofuel production in each CP • Information campaign, and potentially additional support, to railway operators to support transition to biodiesel use in rail • A unit within the relevant government ministry must be designated responsible for: implementing, reviewing and updating policy; ensuring sustainability certification of fuels; administration of the scheme; data collection and reporting
Dedicated vehicles	No – At low blends biofuels can be used in existing diesel locomotives. This study does not recommend going to higher biofuel blends which would require modified engines..
Dedicated infrastructure	At low blends existing infrastructure can be used; minor modifications may be required e.g. for blending or storage
Contribution 2030 (CP-specific)	0% in all CPs
Co-benefits	▪ Domestic fuel production could support fuel producers and agricultural sector in each CP

Figure 47: Option 8: Renewable liquid fuels in rail

As for biofuels in road transport, the primary policy needed to enable liquid biofuels use in rail is an obligation to supply renewable fuels or achieve GHG reductions in fuels. This can be separate to that introduced in the road transport sector, to enable different obligated parties, and a different level and timing of support. However, aligned sustainability frameworks with the road transport sector are needed to enable producers to supply multiple markets. However, due to high costs compared with other options, this option is not suggested in any CPs in this study.

5.2.9 Option 9: Rail electrification

Drivers for growth	Increased renewable electricity share in national electricity mix and dedicated renewable capacities for rail contribute to the RES-T target. Electrifying existing rail lines where catenaries are not yet available allows using (renewable) electricity in rail. Expanding rail lines allows shifting transport from road to rail. Long-term investment cycles in rail.
Policy framework	**Central key policies: Develop dedicated Rail Strategy** • Increase targets for the RES share in electricity in general in existing policy instruments; • Amend existing policies to incentivise development of dedicated RES electricity capacities for rail • Close gaps in the electrification of the rail network (electrify non-electrified rail lines, close non-electrified gaps) • Shorten planning and approval processes for rail infrastructure, notably electrification of rail lines • Maintain and expand existing rail infrastructure and rolling stock through strategies and dedicated policies **Complementary policies:** • Inter-ministerial co-operation in the development and implementation of the transport/rail strategy; • Ensure long-term financial viability of rail, e.g. through financial support programmes to electric rail operators (public transport, freight) incl. VAT / tax reductions or exemptions, etc. where necessary • Training programmes for repair/maintenance of vehicles, infrastructure (academic, professional)
Dedicated vehicles	Electric locomotives are required; commercially available; no changes to other rolling stock required.
Dedicated infrastructure	Electrification of rail lines is required where catenary is not available.
Contribution 2030 (CP-specific)	0% - 3.8%
Co-benefits	▪ Decarbonisation and pollutant emission reduction from road transport; (freight) traffic reduction on the roads ▪ Reducing dependence on fossil energy imports; no logistics for the fuel supply of locomotives ▪ Development of domestic manufacturing capacities (locomotive and rail equipment)

Figure 48: Option 9: Rail electrification

Where rail lines are electrified, increasing renewable power generation in the national mix increases the renewable consumption in rail operations. Consequently, existing policy instruments aiming at increase renewable power generation also support renewable transport targets. These policy instruments could be amended to incentivise the installation of renewable capacities specifically dedicated to and connected with the rail electricity network in order to avoid increased electricity consumption in transport cannibalizing on the renewable electricity in the conventional electricity sector.

Transport strategies can be developed to include such elements in connection with programmes to maintain and expand existing rail infrastructure and rolling stock.

Installing catenaries on so far non-electrified rail lines, or closing non-electrified gaps in the rail network, increases electricity consumption, and thus contributes to the RES-T target. Such activities are closely linked with other transport objectives, and thus should be pursued based on existing rail policies. The latter may be developed to shorten planning and approval processes.

Complementary policies would be of a supportive nature. However, the inverse perspective may also be appropriate: targets for renewable energies in transport are an additional aspect fostering the expansion and modernization of rail infrastructure and operation. In any case, ensuring the long-term financial viability of rail is an important prerequisite to securing the contributions of rail to RES-T goals. Inter-ministerial co-operation and co-ordination and clear responsibilities are important. Furthermore, academic and professional training ensure the availability of qualified staff.

This option should be seen in close connection with option 12 on hydrogen use in rail.

5.2.10 Option 10: Electric public transport (bus, trolleybus, tram, metro)

Drivers for growth	Increased renewable electricity share in national electricity mix and dedicated renewable capacities for public transport contribute to the RES-T target. Electrifying public transport (vehicles, infrastructure) allows using (renewable) electricity. Expanding public transport allows shifting transport from individual transport to public transport.
Policy framework	**Central key policies: Develop dedicated Electric Public Transport Strategy** • Increase RES share in electricity in general in existing policy instruments • Amend existing policies to incentivise development of dedicated RES electricity capacities for public transport • Increase number of electric buses, trolleybuses, tram, metro (set 2030 targets) by financial incentives (tax/ custom reductions/ exemptions, investment support) on vehicles, services, components for domestic production; counter financing by higher duties on conventional • Establish dedicated charging infrastructure at bus depots by providing financial incentives; develop charging infrastructure build-up strategy; design clear legal framework for charging infrastructure; expand existing trolley, tram, metro infrastructure **Complementary policies:** • Communication: Increase public awareness for electric public transport • Municipal lighthouse projects, financial support programmes to fleet operators, public procurement • Training programmes for repair/maintenance of vehicles, infrastructure (academic, professional) • Zero/low emission zones in polluted city centres, limitation of old (unsafe, polluting) vehicles
Dedicated vehicles	Dedicated vehicles (battery electric bus, battery-powered trolleybus, trolleybus, tram, metro) required; commercially available
Dedicated infrastructure	For battery vehicles, dedicated electricity charging infrastructure is required. For trolleybuses, tram, metro specific dedicated catenary infrastructure is required.
Contribution 2030 (CP-specific)	0.03% - 0.07%
Co-benefits	▪ Decarbonisation and pollutant emission reduction from road transport (notably in cities, but also in rural areas) ▪ Reducing dependence on fossil energy imports ▪ Development of national manufacturing capacities

Figure 49: Option 10: Electric public transport (bus, trolleybus, tram, metro)

Public transport based on overhead lines for trolleybuses, tramways or metros contributes to RES-T goals by using the national electricity mix. Similar to rail, expanding these traffic modes or increasing the renewable share in the national electricity mix increases the RES-T contribution. Policies related to public transport are relevant to fostering this option.

Important complementary policies include communications, lighthouse projects at municipal level, local zero/low emission zones, academic and professional training, etc. Public procurement can be an important instrument for fostering zero emission public transport[203].

This option should be seen in close connection with option 13 on hydrogen buses and coaches.

203 See e.g. the European Clean Vehicles Directive requiring increasing share of low and zero emission vehicles to be purchased through public procurement: Directive (EU) 2019/1161 of the European Parliament and of the Council of 20 June 2019 amending Directive 2009/33/EC on the promotion of clean and energy-efficient road transport vehicles; OJ L 188, 12.7.2019, p. 116–130.

5.2.11 Option 11: Electric road vehicles (passenger cars and trucks)

Drivers for growth	Increased renewable electricity share in national electricity mix and dedicated renewable capacities for road transport contribute to the RES-T target. Electrifying road transport (vehicles, infrastructure) allows using (renewable) electricity and reducing conventional fuels. Establishing charging infrastructure (government and private sector) is crucial to vehicle fleet growth.
Policy framework	**Central key policies: Develop dedicated Electric Vehicle Strategy** • Increase RES share in electricity in general in existing policy instruments • Amend existing policies to incentivise development of dedicated RES electricity capacities for road transport • Increase number of electric road vehicles (set 2030 targets) by financial incentives (tax/ custom reductions/ exemptions, investment support) on vehicles, services, components for domestic production; counter financing by higher duties on conventional • Dedicated public and fleet (fast) charging infrastructure based on build-up strategy; financial incentives for infrastructure operators (e.g. reduction/exemption of VAT, custom, taxes etc. for construction/ operation); clear legal framework for infrastructure operators **Complementary policies:** • Communication: Increase public awareness for electric public transport • Municipal lighthouse projects, financial support programmes to fleet operators (taxi, delivery services etc.), public procurement • Training programmes for repair/maintenance of vehicles, infrastructure (academic, professional) • Zero/low emission zones in polluted city centres, limitation of old (unsafe, polluting) vehicles; free parking, use of bus lanes, etc.
Dedicated vehicles	Dedicated vehicles (BEV) required; passenger cars and light duty vehicles commercially available; no suitable electric vehicle solutions for long haul freight transport; electric medium/ heavy duty trucks suitable for distribution purposes.
Dedicated infrastructure	Dedicated public electricity (fast) charging infrastructure and dedicated charging infrastructure for vehicles fleets is required.
Contribution 2030 (CP-specific)	0.07% - 0.6%
Co-benefits	▪ Decarbonisation and pollutant emission reduction from road transport (notably in cities, but also in rural areas) ▪ Reducing dependence on fossil energy imports ▪ Development of national manufacturing capacities for electric vehicles, charging infrastructure and components

Figure 50: Option 11: Electric road vehicles (passenger cars and trucks)

Policies aimed at fostering consumption of renewable electricity in road transport need to focus on three elements:

1. Increasing the number of vehicles (cars and light trucks);
2. Establishing a recharging infrastructure including fast charging;
3. Increasing renewable electricity for consumption in transport.

The latter can be achieved by adjusting existing policies towards higher renewables targets, and/ or dedicated renewables capacities for transport.

For a national charging infrastructure, planning and co-ordination are important as well as financial incentives and a clear legal framework for security of investments. Electricity distribution grids may require reinforcements where the consumption increases significantly through electric vehicles, which may require adjustments to the regulatory framework.

The increase of the number of electric vehicles can be enhanced by fiscal and financial incentives in the taxation system, and through direct investment support, and by disincentivising conventional vehicles for counter financing.

Complementary policies are similar to option 10.

This option should be seen in close connection with option 14 on hydrogen road vehicles road vehicles (passenger cars and trucks).

5.2.12 Option 12: Hydrogen in rail

Drivers for growth	Increased renewable electricity share in national electricity mix and dedicated renewable capacities for hydrogen production for rail contribute to the RES-T target. Hydrogen allows for zero emissions on rail lines not suitable for electrification. Potential synergies in hydrogen refuelling infrastructure with road freight transport. Long-term investment cycles in rail.
Policy framework	**Central key policies: Develop dedicated Hydrogen Strategy including transport** • Increase targets for the RES share in electricity in general in existing policy instruments • Amend existing policies to incentivise development of dedicated RES electricity capacities for hydrogen production for transport • Define national hydrogen targets in transport/ rail • Create long-term agreements, provide financial support (tax incentives, investment support, etc.) for hydrogen use in rail • Mandate/ fund rail operators to procure hydrogen rail and infrastructure **Complementary policies:** • Communication: Increase public awareness for hydrogen in rail; commitment of public stakeholders for hydrogen in rail • Improve inter-ministerial co-operation in implementation of the transport/ rail strategy • Training programmes for repair/maintenance of vehicles, infrastructure (academic, professional); synergies with electric vehicles
Dedicated vehicles	Dedicated hydrogen (fuel cell) trains required; commercially available (limited number of providers)
Dedicated infrastructure	Dedicated hydrogen refuelling and storage infrastructure is required.
Contribution 2030 (CP-specific)	0% - 0.02%
Co-benefits	▪ Decarbonisation and pollutant emission reduction from road transport; (freight) traffic reduction on the roads ▪ Reducing dependence on fossil energy imports ▪ Development of national manufacturing capacities for hydrogen vehicles, infrastructure, components; synergies with other H_2 uses ▪ Grid integration of high shares of fluctuating renewable electricity, grid ancillary services

Figure 51: Option 12: Hydrogen in rail

Where electrification of rail lines is not a viable option (see option 9), hydrogen fuel cell-based rail operation is an attractive option for clean operation. Renewable hydrogen is based on renewable electricity, and has the additional advantage that it can store fluctuating power from wind or solar PV. Long travel distances are possible with zero emissions, quiet operation. Policy instruments are very similar to rail electrification (see option 9); however, no catenaries are required, and hydrogen production facilities and refuelling infrastructure are needed. Financing instruments are essential, and may also be sought from international sources such as development banks. As this technology and the related products are new, communication and training are important.

5.2.13 Option 13: Hydrogen bus and coach (urban and long-distance)

Drivers for growth	Increased renewable electricity share in national electricity mix and dedicated renewable capacities for hydrogen production for buses contribute to the RES-T target. Hydrogen allows for zero emissions buses and coaches. Potential synergies in hydrogen refuelling infrastructure with other road transport.
Policy framework	**Central key policies: Develop dedicated Hydrogen Strategy including transport** • Increase targets for the RES share in electricity in general in existing policy instruments • Amend existing policies to incentivise development of dedicated RES electricity capacities for hydrogen production for transport • Define national hydrogen targets in transport/ buses and coaches • Increase number of hydrogen buses and coaches (set 2030 targets) by financial incentives (tax/ custom reductions/ exemptions, investment support) on vehicles, services, components for domestic production; counter financing by higher duties on conventional • Hydrogen refuelling infrastructure at bus depots and along major coach routes based on build-up strategy; financial incentives for infrastructure operators (e.g. reduction/exemption of VAT, custom, taxes etc. for construction/ operation); clear legal framework **Complementary policies:** • Communication: Increase public awareness for hydrogen in buses & coaches; commitment of public stakeholders • Municipal lighthouse projects, financial support programmes to fleet operators, public procurement • Training programmes for repair/maintenance of vehicles, infrastructure (academic, professional); synergies with electric vehicles • Zero/low emission zones in polluted city centres, limitation of old (unsafe, polluting) vehicles
Dedicated vehicles	Dedicated vehicles (fuel cell bus / fuel cell hybrid bus) required; commercially available (limited number of providers)
Dedicated infrastructure	Dedicated hydrogen refuelling infrastructure is required.
Contribution 2030 (CP-specific)	0.001% - 0.3%
Co-benefits	▪ Decarbonisation and pollutant emission reduction from road transport (notably in cities, but also in rural areas) ▪ Reducing dependence on fossil energy imports ▪ Development of national manufacturing capacities for hydrogen vehicles, infrastructure, components; synergies with other H_2 uses ▪ Grid integration of high shares of fluctuating renewable electricity, grid ancillary services

Figure 52: Option 13: Hydrogen bus and coach (urban and long-distance)

Where driving distance are longer than viable for battery-vehicles (see option 10), hydrogen fuel cell-electric vehicles come in. Amending existing policies for renewable power generation to increase the targets, and to incentivise the development of dedicated renewable capacities for hydrogen generation will foster hydrogen uptake. Buses and coaches should be an important element in a national hydrogen strategy. Financial incentives for purchasing vehicles, or components required by domestic producers will support early market uptake, including tax and customs reductions or exemptions, and investment support. The necessary hydrogen refuelling infrastructure at bus depots or along coach routes can be supported financially through investment funding, and/or tax reductions/ exemptions. A clear legal framework is key to security of investments.

Important complementary policies include communications, lighthouse projects at municipal level, local zero/low emission zones, academic and professional training, etc. Public procurement can be an important instrument for fostering zero emission public transport[204].

[204] See e.g. the European Clean Vehicles Directive requiring increasing share of low and zero emission vehicles to be purchased through public procurement: Directive (EU) 2019/1161 of the European Parliament and of the Council of 20 June 2019 amending Directive 2009/33/EC on the promotion of clean and energy-efficient road transport vehicles; OJ L 188, 12.7.2019, p. 116–130.

5.2.14 Option 14: Hydrogen road vehicles (passenger cars and trucks)

Drivers for growth	Increased renewable electricity share in national electricity mix and dedicated renewable capacities for hydrogen production for road transport contribute to the RES-T target. Hydrogen allows for zero emission road transport.
Policy framework	**Central key policies: Develop dedicated Hydrogen Strategy including transport** • Increase targets for the RES share in electricity in general in existing policy instruments • Amend existing policies to incentivise development of dedicated RES electricity capacities for hydrogen production for transport • Define national hydrogen targets in road transport • Increase number of hydrogen vehicles (set 2030 targets) by financial incentives (tax/ custom reductions/ exemptions, investment support) on vehicles, services, components for domestic production; counter financing by higher duties on conventional • Public and fleet hydrogen refuelling infrastructure based on build-up strategy; financial incentives for infrastructure operators (e.g. reduction/exemption of VAT, custom, taxes etc. for construction/ operation); clear legal framework **Complementary policies** • Communication: Increase public awareness for hydrogen vehicles; commitment of public stakeholders • Municipal lighthouse projects, financial support programmes to fleet operators (taxi, delivery, heavy duty, etc.), public procurement • Training programmes for repair/maintenance of vehicles, infrastructure (academic, professional); synergies with electric vehicles • Zero/low emission zones in polluted city centres, limitation of old (unsafe, polluting) vehicles, free parking, use of bus lanes, etc.
Dedicated vehicles	Dedicated vehicles (cars, trucks) required; commercially available (limited number of providers)
Dedicated infrastructure	Dedicated public and fleet hydrogen refuelling infrastructure is required
Contribution 2030 (CP-specific)	0.02% - 0.1%
Co-benefits	▪ Decarbonisation and pollutant emission reduction from road transport (notably in cities, but also in rural areas) ▪ Reducing dependence on fossil energy imports ▪ Development of national manufacturing capacities for hydrogen vehicles, infrastructure, components; synergies with other H_2 uses ▪ Grid integration of high shares of fluctuating renewable electricity, grid ancillary services

Figure 53: Option 14: Hydrogen road vehicles (passenger cars and trucks)

Hydrogen road vehicles provide zero emission transport with long driving distances and short refuelling times suitable for both passenger cars and light to heavy duty trucks, and thus ideally complement battery-electric vehicles (see option 11).

Policies aimed at fostering consumption of renewable hydrogen in road transport need to focus on three elements:

1. Increasing the number of vehicles (cars and trucks);
2. Establishing a hydrogen refuelling infrastructure;
3. Increasing renewable electricity for hydrogen production.

The latter can be achieved by adjusting existing policies towards higher renewables targets, and/ or dedicated renewables capacities for hydrogen production for transport.

For a national hydrogen refuelling infrastructure, planning and co-ordination are important. Fleet vehicles need dedicated refuelling stations that are highly utilised, while other vehicles need a network of stations in cities and along corridors between them, growing into the more rural areas over time. This requires financial incentives and a clear legal framework for security of investments.

The increase of the number of hydrogen fuel cell-electric vehicles can be enhanced by fiscal and financial incentives in the taxation system, and through direct investment support, and by disincentivising conventional vehicles for counter financing.

Complementary policies are similar to option 13.

5.2.15 Option 15: Hydrogen in refineries

Drivers for growth	Decarbonisation in refineries, early market for renewable hydrogen transport contribute to the RES-T target
Policy framework	**Central key policies: Develop dedicated Hydrogen Strategy including transport** • Include renewable hydrogen in refineries in blending mandate for renewable fuels in transport **Complementary policies** • Identify local stakeholders/ potentially interested partners and discuss • Where necessary, provide financial incentives
Dedicated vehicles	No
Dedicated infrastructure	No
Contribution 2030 (CP-specific)	0% for all CPs (to be confirmed)
Co-benefits	▪ Decarbonisation of conventional fuels ▪ Reducing dependence on fossil energy imports

Figure 54: Option 15: Hydrogen in refineries

RED II established the option of counting renewable electricity used for the generation of intermediate products for conventional transportation fuels towards the RES-T target. Refineries of consume large quantities of hydrogen, which is either a by-product of other refinery processes, or is produced on purpose. The latter can be replaced by renewable hydrogen production, which then contributes to the RES-T target. A number of such activities have been started with public funding in Europe, some of them with the explicit objective of developing related business models. Including this option in renewable fuel obligations is the key policy instrument, which can be complemented by financial incentives. The number of refineries being limited, opportunities can be developed in direct exchange with stakeholders.

5.2.16 Synergies and conflicts between options

Between the 15 options, there are several synergies and a few conflicts that are partly mentioned in the options above, and are elaborated in the following. This section does not assess synergies or conflicts with other policy areas.

5.2.16.1 Synergies

Electrification of road vehicles and public transport (options 10 and 11) can both benefit from public charging infrastructure. This relates to synergies in the development of policies and regulations as well as in the build-up of capacities in public and private entities. While charging infrastructure for e.g. city buses may not be shared with private vehicles, recharging infrastructure may be shared by taxis, commercial vehicles such as delivery vans, and private cars. Within road transport in general, there are different needs related to vehicle charging, which bear synergies: fleet vehicles return regularly to a depot, or at least operate in a rather small geographical area, and thus require few charging points that are highly utilized, while non-fleet vehicles float freely and require a nationwide network of charging point. Fleet vehicles, including public transport, can be a nucleus of a nationwide charging infrastructure. In terms of charging infrastructure, both options thus benefit from similar policies to foster this infrastructure. Home charging is a complement to a public charging network.

Hydrogen use for all road vehicles (options 13 and 14) benefits from the same public refuelling infrastructure in a similar fashion as described above for electric charging. However, hydrogen vehicles rely on refuelling stations, while home refuelling will remain exceptional. Heavy duty vehicles such as city buses and coaches or trucks require significantly higher hydrogen quantities for refuelling than passenger cars or delivery vehicles. Also, pressure levels are different with 35 MPa typical for heavy duty vehicles, and 70 MPa for lighter vehicles. However, both pressure levels and different throughput capacities can be offered at the same refuelling station.

Both battery-electric vehicles and hydrogen-powered fuel cell-electric vehicles have electric drivetrains, which require specific skills and competences of service and repair staff, drivers, etc. In this sense, policies aimed at fostering both vehicle types leverage synergies in this area.

There can also be synergies between rail and road duty hydrogen vehicles as rail requires comparably large amounts of hydrogen. Train hydrogen refuelling stations could thus additionally support duty vehicles, and possibly even cars.

Several liquid renewable fuels including both biofuels and RFNBOs can be blended into diesel for road transport as well as used in shipping, aviation and rail – this can give synergies but potentially also competing demands. In any case, it offers fuel suppliers multiple markets. Therefore, it should be ensured that sustainability requirements and certification are harmonized between these markets.

5.2.16.2 Conflicts

Ethanol limits in gasoline (typically E5 in Europe today, step by step being extended to E10) and FAME limits in diesel (typically B7 in Europe today) can limit the potential to blend in these fuels in the road sector. For higher ethanol blends, vehicles must be suitable (which is increasingly the case), and for higher diesel blends, HVO and RFNBOs are suitable, while biodiesels are not.

There is likely to be competition for renewable power for use directly in vehicles and for the production of hydrogen and, to a lesser extent, liquid RFNBO fuels. Additionality frameworks are intended to ease this competition aiming at renewable capacities being established for transport that are not cannibalizing on renewables in the electricity sector. However, direct use of electricity in road has a more instant power demand that hydrogen generation, which is more flexible to use fluctuating renewable power when it is available. Policies for fostering renewable electricity and renewable hydrogen in transport should thus aim at increasing the build-up of renewable power for transport in addition to the targets for the electricity sector.

Strong policy support for electric vehicles may undercut the case for hydrogen vehicles (or vice versa) given the need for two additional refuelling infrastructures. Detailed studies have shown that charging and refuelling infrastructures require upfront investments, but have a small share in the total cost of ownership of vehicles. Building up both infrastructures has been shown to be appropriate and cost-effective for achieving high shares in clean transport.

Electricity in transport or for hydrogen or liquid RFNBO production can be counted as 100% renewable under certain circumstances. In these cases, the electricity is not counted towards the national renewable electricity share.

6 ALBANIA

6.1 Executive Summary

The implementation of the revised Renewable Energy Directive (EU) 2018/2001 (RED II) on the promotion of the use of energy from renewable sources has started to be discussed within the Energy Community. Currently, RED II is not a part of the Energy Community acquis; but the adaptation and transposition by the Contracting Parties could be envisaged. Assuming for this study that the provisions of RED II are transposed into Albanian law without changes, we develop a roadmap for Albania to achieve the 2030 target for renewables in transport of 14%[205].

Albania has a share of renewable energy in transport of 0% according to RED provisions as the biofuels consumed in Albania do not comply with the sustainability requirements of RED.

Albania can choose from a number of options to achieve the 2030 RES-T target of 14%. In fact, over-achievement beyond 15% is possible. However, even with more than 15% contribution in 2030, the anticipated consumption growth over the coming decade is expected to result in increased fossil fuel imports relative to 2018.

Of the 14%, crop-based biofuels are capped at 7%, while 7% need to be achieved by other renewable fuels. Biofuels are anticipated to contribute most to the target, including crop-based, waste-based and advanced biofuels. Options for renewable fuels production beyond the 2030 target may give opportunities for exports.

Electrification of rail lines can make important additional contributions to the 2030 target, based on an anticipated 100% renewable share in national electricity generation. Rail projects under development envisaging rehabilitation including electrification and connection with neighbouring countries represent promising opportunities for introducing electricity consumption into the transport sector, and for increasing the RES-T share.

Electric road vehicles can contribute to the 2030 target, with a strong growth potential beyond 2030. Hydrogen and battery-electric vehicles are complementary where hydrogen enables long driving distances, and heavy-duty operation alike; a small contribution by 2030 and dynamic growth thereafter is anticipated.

Additional benefits of achieving the 2030 RES-T target include the reduction of fossil energy import dependence, additional national value creation, new or enhanced national value chains with related economic benefits and possible job creation as well as additional contributions to the national climate targets, etc.[206]

[205] The overall target for RES-T of 14% can be reduced as far as the cap on crop-based biofuels is lower than 7%. The crop-cap can be lowered down to 0, which would lead to an overall RES-T target of 7%.

[206] Such benefits are not analysed in this study, but have been assessed in various studies, e.g. for hydrogen in Fuel Cells and Hydrogen Joint Undertaking (2019): Hydrogen Roadmap Europe – a sustainable pathway for the

As a proven policy tool, Albania should adopt a 2030 target for renewable energies in transport based on RED II.

The draft Law on the Production, Transportation and Trade of Biofuels and Other Renewable Fuels for Transport currently being discussed in the Parliamentary Committees of the Albanian Parliament introduces major elements of RED. However, full compliance of sustainability requirements should be checked with the provisions of RED. Furthermore, the more stringent RED II sustainability framework should be introduced into Albanian law.

A major success factor for achieving a 2030 target for renewable energy in transport is to establish legal obligations on economic operators including enforcement. Certification ensuring the compliance of economic operators with the sustainability requirements is another.

Without prejudice to any possible legal, political or contractual obligations, all elements of the regulatory framework should be in place at the latest by the end of 2022 in order to give industry as much time as possible to plan, invest, implement and operate.

Further key policy elements need to be established in order achieve the 2030 RES-T target including notably a strategy and support mechanisms for electricity and for hydrogen in transport. Complementary policies are recommended to be established in order to ensure target achievement and maximum benefits to the Albanian economy.

Rail projects currently under development envisaging rehabilitation including electrification and connection with neighbouring countries should be pursued towards construction and commissioning in order to introduce electricity consumption into the transport sector based on renewable power.

Co-benefits with other policy areas should be actively developed. This includes air quality improvements in urban areas and other environmental and health issues as well as economic benefits such as reduced fossil fuel imports, job creation, national value creation, etc.

Furthermore, co-operation with other Contracting Parties, and more generally with other countries, allows synergies and should thus be pursued.

Policies should be revised and possibly adjusted in around 2025 based on a policy and results evaluation.

The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target.

European energy transition; and inFuel Cells and Hydrogen Joint Undertaking (2020): Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans.

6.2 Introduction

The Energy Community Contracting Parties including Albania have the obligation to reach binding targets for renewable energy in gross final energy consumption by 2020. For the transport sector, the binding target is a minimum 10% of renewable energy (RES-T) by 2020. Albania will not achieve this target in spite of an already high share of biofuels in transport – this is due to the fact that the biofuels do not comply with the sustainability criteria defined in the Renewable Energy Directive.

The implementation of the revised Renewable Energy Directive (EU) 2018/2001 (RED II) on the promotion of the use of energy from renewable sources has started to be discussed within the Energy Community. Currently, RED II is not a part of the Energy Community acquis; but the adaptation and transposition by the Contracting Parties could be envisaged.

It is assumed here that the provisions of RED II are transposed into Albanian law without changes. On this basis, we develop a roadmap for Albania to achieve the 2030 target for renewables in transport of 14%[207].

As a starting point, this study analyses the status quo of energy consumption in transport in Albania, and provides 2030 projections including a business as usual scenario, and a scenario for compliance with the 2030 target for renewable energies in transport according to RED II.

In the second section, we assess the potential of national renewable energy sources suitable for use in transport, or for the production of transportation fuels together with the status of fuel pathway deployment in Albania.

The third section describes the regulatory status quo related to renewable energies in transport. On this basis, we develop a roadmap for Albania to achieve the 2030 target for renewables in transport on the three pillars of biofuels, electricity and hydrogen covering all transport sectors.

The final section provides conclusions and recommendations.

6.3 Status quo and 2030 projections of renewable energy consumption in transport

The objective of this chapter is to review the current status of renewable energies in transport (RES-T) in Albania, and to develop scenarios of the development of renewable energy shares in transport by 2030.

6.3.1 Status Quo

The following data includes neither international aviation nor international navigation as these two segments are generally excluded from statistics such as the Eurostat energy balances.

[207] It is assumed for this study that the overall target for RES-T of 14% will be applicable for Albania as the consumption of crop-based biofuels is higher than 7% in 2018, which is anticipated to be continued to 2020. The authors of this study interpret the provisions of RED II to specify this independent of the non-compliance of 2020 biofuel consumption in Albania with the sustainability requirements of RED.

6.3.1.1 Transport Indicators

Transport by car has increased continuously during the past years. Transport by bus has remained approximately constant since 2011. Passenger transport by other means is negligible compared to car and bus.

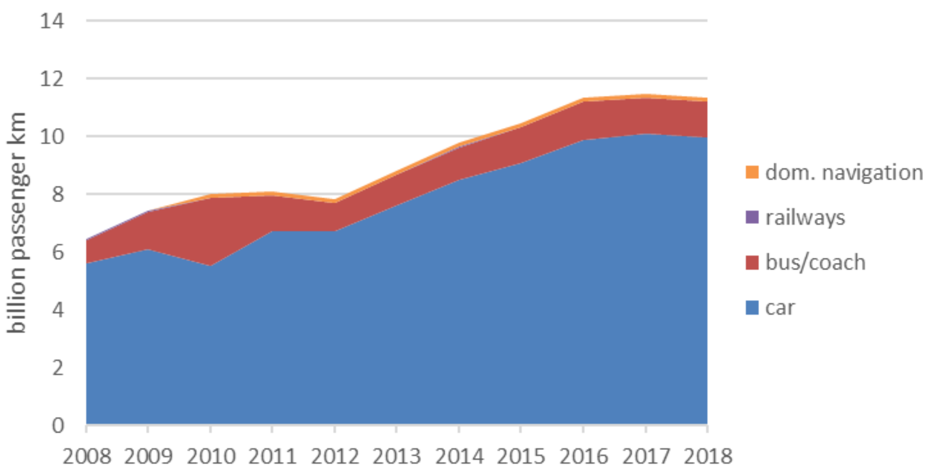

Figure 55: Passenger transport by transport mode[208] [209]

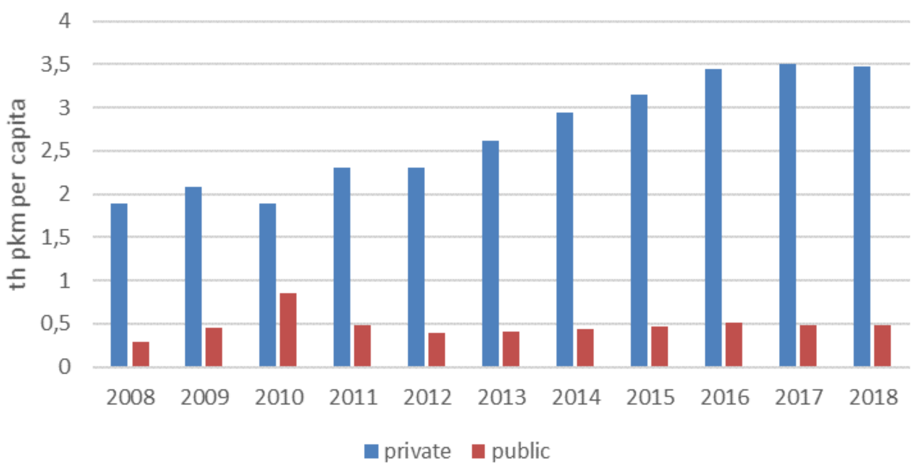

Figure 56: Comparison of public and private passenger transport per capita[210] [211]

[208] European Commission, Directorate-General for Mobility and Transport: EU Transport in Figures - Statistical Pocketbook. Luxembourg 2019: https://ec.europa.eu/transport/facts-fundings/statistics/pocketbook-2019_en

[209] Personal communication (E-mail) from the Albanian Ministry of Infrastructure and Energy to SEEC, 6 July 2020, based on data from the National Agency of Natural Resources of Albania

[210] TU Wien/Energy Economics Group, Joanneum Research, REKK: Study on 2030 overall targets (energy efficiency, RES, GHG emissions reduction) for the Energy Community. Vienna 2019

[211] Personal communication (E-mail) from the Albanian Ministry of Infrastructure and Energy to SEEC, 6 July 2020, based on data from the National Agency of Natural Resources of Albania

Passenger kilometres by car are counted as private while all other modes of transport (bus/coach, railways, domestic navigation[212]) are counted as public transport. The volume of public transport has increased slightly since 2012 while private transport by car has increased continuously since 2012 with a dip in 2018.

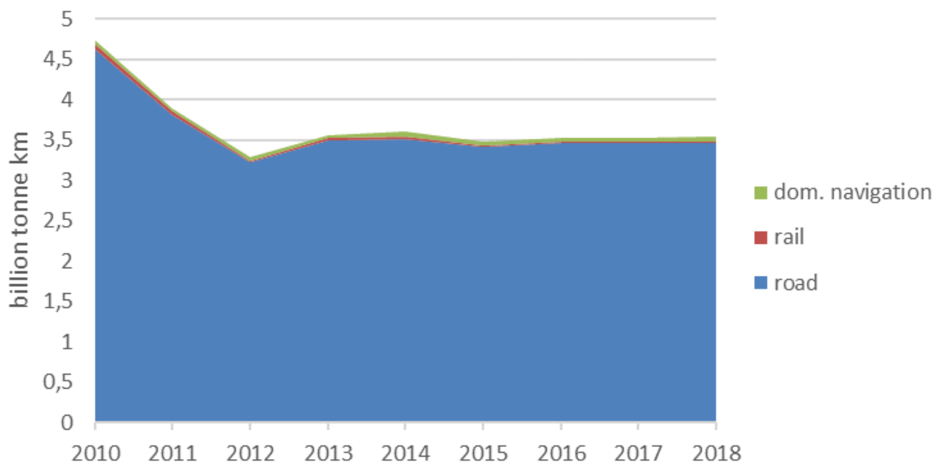

Figure 57: Freight transport by transport mode[213] [214] [215]

Freight transport data are available since 2010. Freight transport is dominated by road transport, which has remained constant since 2013. Domestic navigation and rail contribute small shares to freight transport.

6.3.1.2 Registered Road Vehicles

After a moderate growth until 2012 the number of cars has increased rapidly by more than 50% in the six subsequent years. The growth was interrupted only by a temporary decrease in 2017. The number of buses and coaches has remained roughly constant during the past years. After a rapid decrease and subsequent partial rebound the number of commercial vehicles has fluctuated around 70,000 since 2014. Data for commercial vehicles is only available from 2010 onwards.

Data for domestic navigation are available since 2010

[213] European Commission, Directorate-General for Mobility and Transport: EU Transport in Figures - Statistical Pocketbook. Luxembourg 2019: https://ec.europa.eu/transport/facts-fundings/statistics/pocketbook-2019_en

[214] Institute of Statistics (INSTAT): Statistical Yearbook. Tirana, 2019: http://www.instat.gov.al/media/6562/sv-eng-2019.pdf

[215] Personal communication (E-mail) from the Albanian Ministry of Infrastructure and Energy to SEEC, 6 July 2020, based on data from the National Agency of Natural Resources of Albania

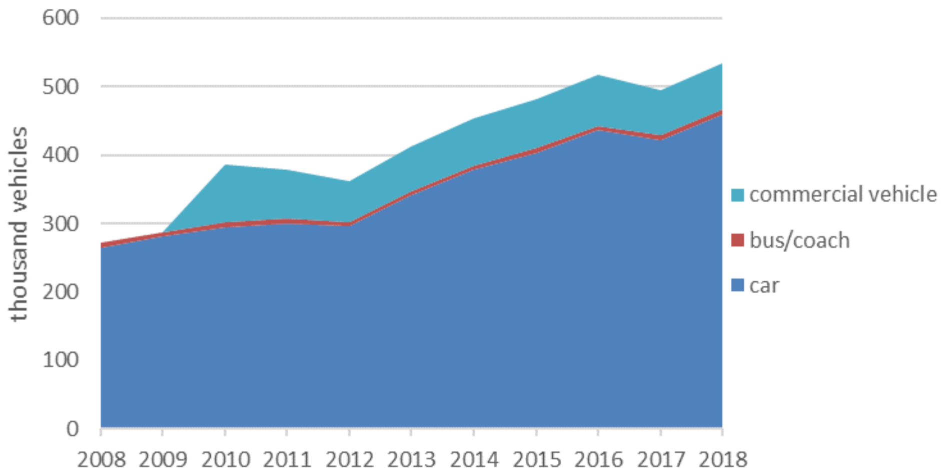

Figure 58: **Registered road vehicles by type of vehicle**[216 217]

The number of passenger vehicles per capita has increased in the past years while the number of freight vehicles per capita has fluctuated around a constant value.

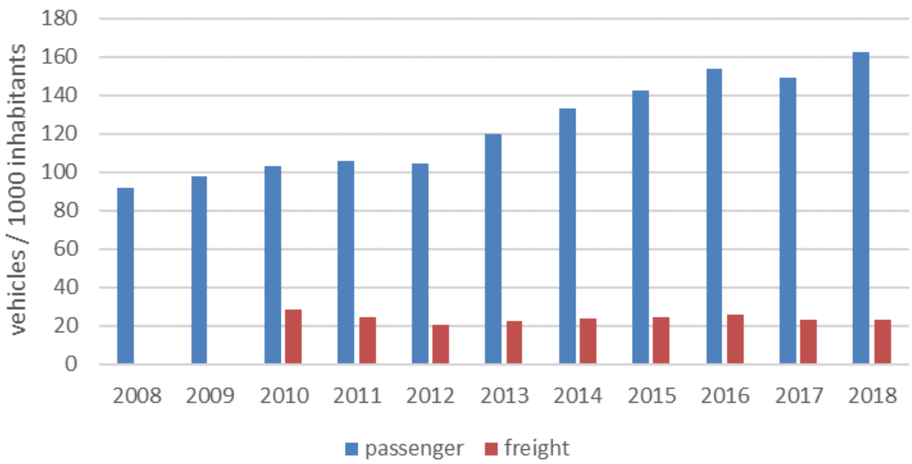

Figure 59: **Comparison of passenger and freight vehicles per capita**

6.3.1.3 Energy Consumption in Transport

The total energy consumption in transport has seen a slight increase during the last decade. However, since 2014 it has remained relatively constant. The share of transport in final energy consumption has been between 40% and 45%.

216 European Commission, Directorate-General for Mobility and Transport: EU Transport in Figures - Statistical Pocketbook. Luxembourg 2019: https://ec.europa.eu/transport/facts-fundings/statistics/pocketbook-2019_en

217 UNECE statistical database -Transport. (n.d.). Available at https://w3.unece.org/PXWeb2015/pxweb/en/STAT/STAT__40-TRTRANS/, last accessed 02. APR 2020

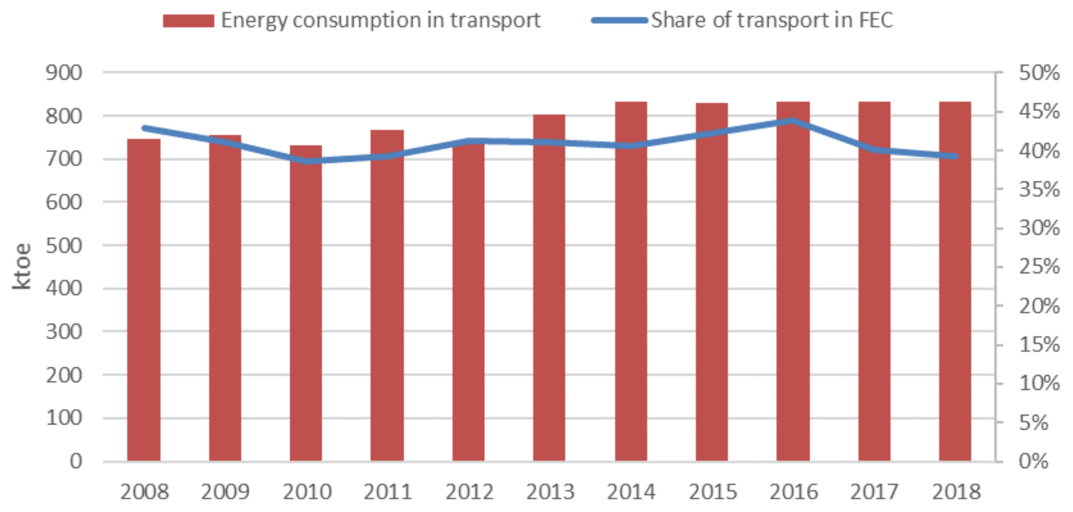

Figure 60: Energy consumption in transport[218]

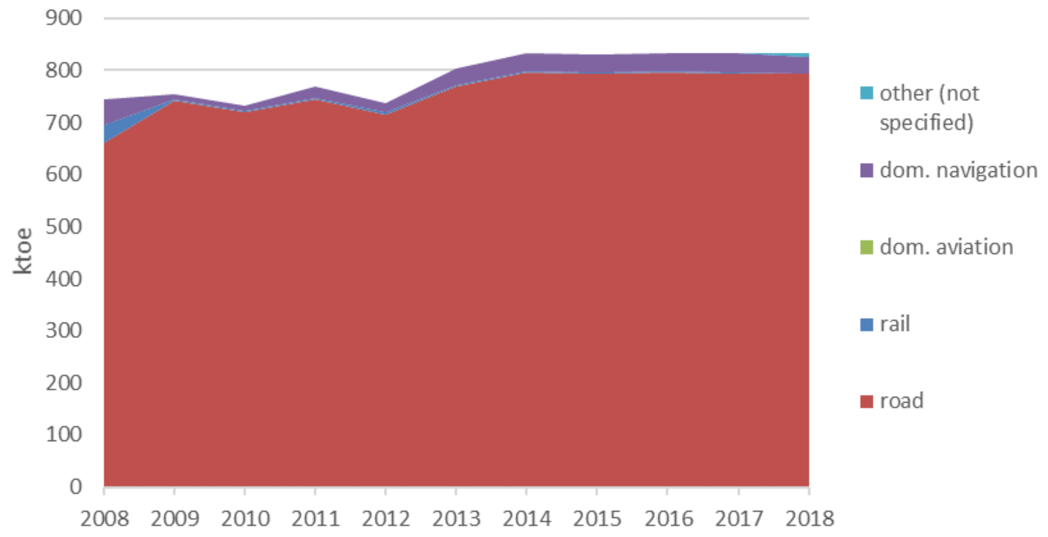

Figure 61: Energy consumption in transport by sub-sector[219]

The vast majority of energy is used for road transport. Additionally, domestic navigation has a small share in energy consumption while other modes of transport are negligible energetically.

[218] European Commission Energy Balances: Albania-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

[219] European Commission Energy Balances: Albania-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

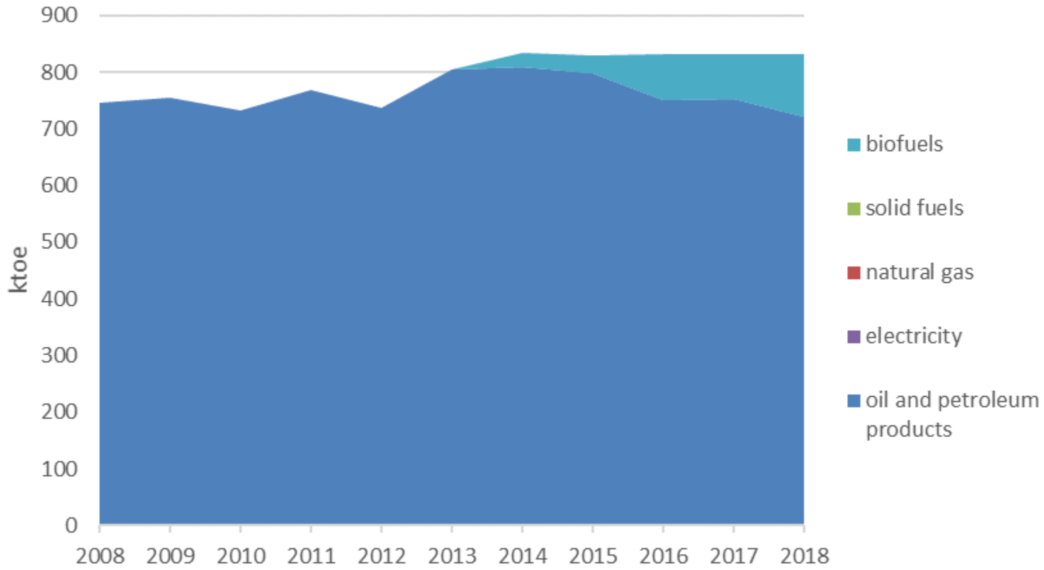

Figure 62: Energy consumption in transport by type of fuel[220]

Electricity, natural gas and solid fuels have not been used in transport. Oil and petroleum products used to be the only fuel. Since 2014 there has been an increasing share of biofuels, which are not compliant with RED requirements.

For this study, we use the Energy Balances data[221], which are based on official data submissions by Albania. For the consumption of biofuels, it should be noted, however, that other official sources of Albania provide lower data; e.g. the National Renewable Energy Action Plan (NREAP) of Albania includes significantly lower biofuels consumption data. The results developed in this study are also useful and robust for other values for consumption of biofuels. This is due to the fact that the overall target for 2030 of 14% RES-T can be reduced if the contribution of crop-based biofuels is lower than 7%. This is determined by the percentage of transport energy coming from food and feed crops in 2020 and adding an extra one percent, up to a maximum of 7%; however, Member States are free to set a lower target (see section 3.1.1).

If in 2020, the share of transport energy from food and fee crops in Albania is above 7% as assumed here based on Energy Balances data the cap is 7%, and the overall target is 7%+7%=14%. If, however, the 2020 biofuels consumption from food and feed crops was e.g. 3%, then the cap for biofuels based on food and feed crops could be set at a maximum of 4%, and the overall target would be 4%+7%=11%. Therefore, the required contributions from all other options do not change if the overall target is changed based on the cap for food and

220 European Commission Energy Balances: Albania-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

221 European Commission Energy Balances: Albania-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

feed crop-based biofuels. In this sense, the results of this study remain valid even if data for past consumption of biofuels in Albania are different from those assumed here.

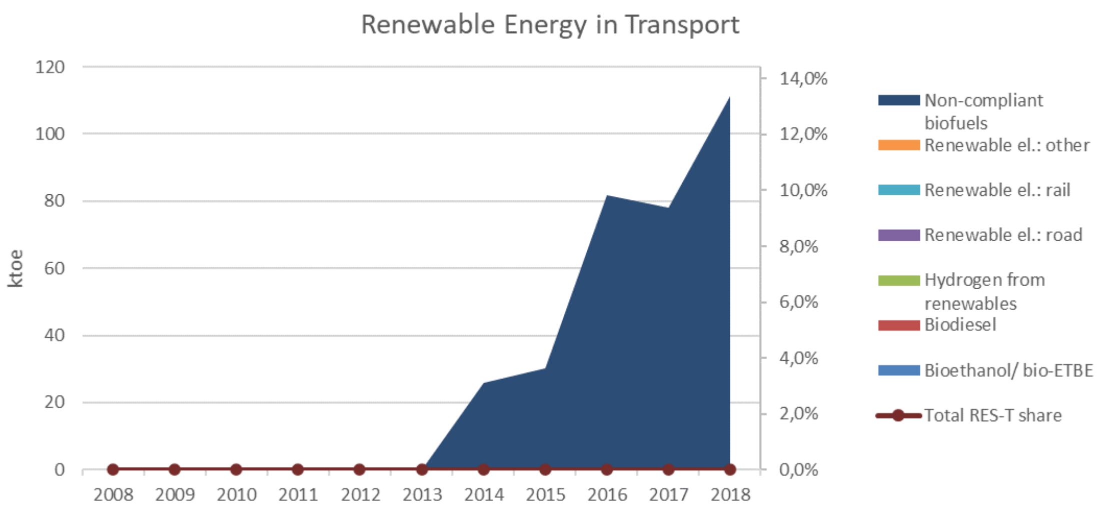

Figure 63: Renewable Energy consumption in transport[222]

The growing share of biofuels in fuel for transport since 2014 is all non-compliant with RED requirements and, thus, not included in the calculation of total RES-T share. Therefore, the total RES-T share is zero for all years. IIf the consumed biofuels had been RED compliant, the renewables share in transport would have been 13.4% in 2018, and thus the 2020 target would be achieved. However, no verification system is in place in Albania, and no information is available whether the consumed biofuels could comply with RED requirements.

6.3.2 2030 Projections

A scientific study published in 2014[223] modelling energy planning in Albania seems somewhat outdated for application here. The National Energy Strategy for the period 2018-2030 of March 2018[224] includes several scenarios for total final energy consumption until 2030. Unfortunately, it does not specify the final energy consumption in transport, and can thus not be used here for 2030 projections of transport energy consumption. However, the growth in total final energy consumption in the "Renewable energy sources (RES)" scenario[225] of the Energy Strategy coincides well with the growth of final energy consumption in

[222] Eurostat (2019) *SHARES detailed results 2018.* Available at: https://ec.europa.eu/eurostat/web/energy/data/shares

[223] Zucchetti, M.; Gerboni, R.; Grosso, D.: Models and Scenarios for Energy Planning: Albania versus Italy Case Studies. International Journal of Ecosystems and Ecology Science, 2014, 4, 365-376

[224] Decision Nr. 480, dated 31.7.2018, by the Council of Ministers on the approval of the National Energy Strategy for the period 2018-2030

[225] This scenario ensures that Albania meets the commitments of the Energy Community Treaty related to renewable energies, which is also assumed in this study under the business as usual scenario.

transport calculated in this study based on the approach applied here as described in the following.

A simple projection has been made for this study based on available data (see section 6.3.1). To this end, data on energy consumption in transport over the period from 2008 to 2018 have been correlated to the Gross Domestic Product (GDP). This correlation has been extrapolated to 2030 based on GDP projections for 2030 [226] to give a total energy consumption in transport of 1,115 ktoe, up from 832 ktoe in 2018. Assuming an overall efficiency gain of 10% leads to a projected energy consumption in transport of 1,003 ktoe, a 20.6% growth from 2018, as a business as usual scenario (see middle column in Figure 64).

Lacking detailed studies, it is assumed that the shares of fuels and transport modes as shown in Figure 64 remain unchanged between 2018 and 2030 in the business as usual scenario.

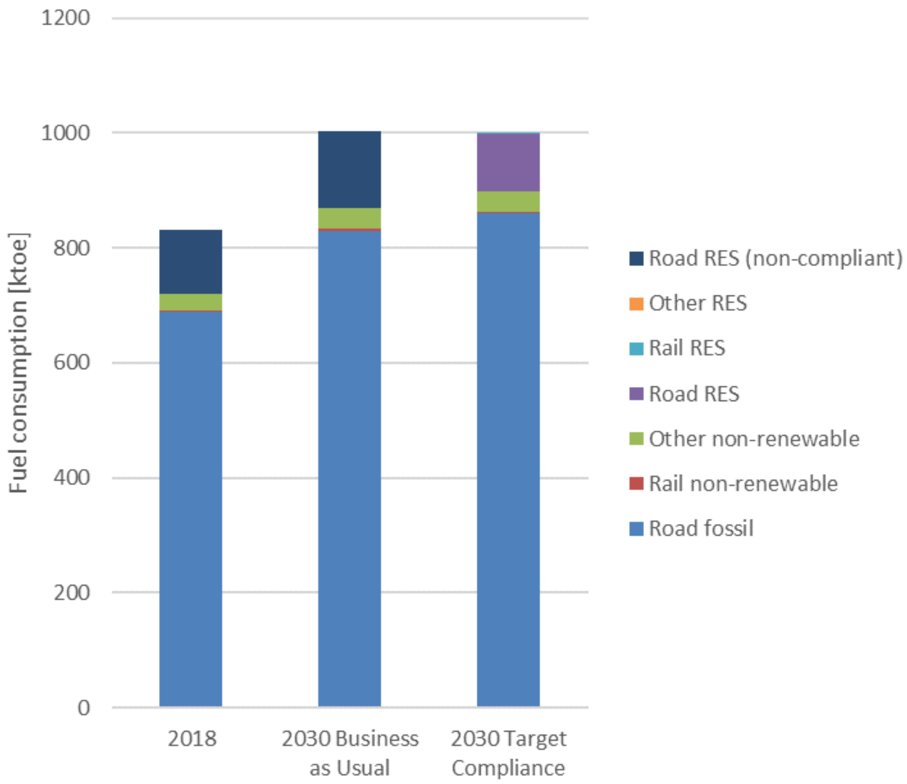

Figure 64: Energy consumption in transport in two scenarios for 2030

In a target compliance scenario achieving the 14% renewables in transport target for 2030, the roadmap as described in section 6.5.2 has been assumed to be implemented. This is represented by the right-hand column in Figure 64. The 9% renewable energies are broken down by options as described in section 0, and are shown in detail in Figure 65. It should be

[226] TU Wien/Energy Economics Group, Joanneum Research, REKK: Study on 2030 overall targets (energy efficiency, RES, GHG emissions reduction) for the Energy Community. Vienna 2019

noted that for target compliance, multipliers are used for certain options; however, the energy quantities shown in Figure 64 show the physical energies, i.e. without multipliers. Therefore, the actual renewable energy contribution in 2030 is less than 14% of total consumption in transport.

The total energy consumption in transport in the target compliance scenario is slightly lower than in the business as usual scenario as battery-electric vehicles and hydrogen fuel cell-electric vehicles are more energy efficient than internal combustion engine vehicles.

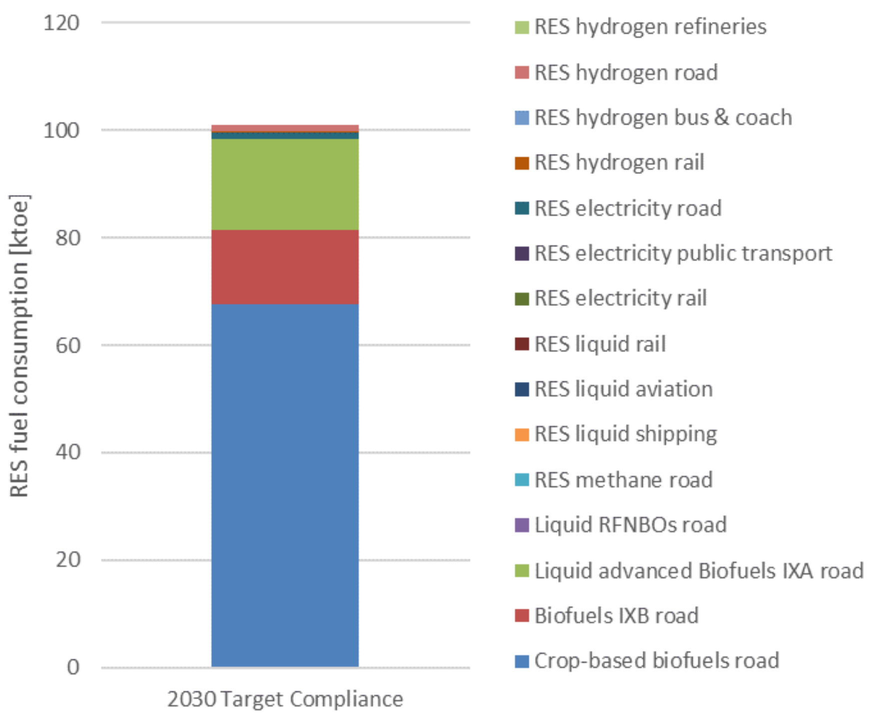

Figure 65: Renewable energy consumption in transport in 2030 by option

The strong growth of fuel consumption leads to a significantly higher fossil fuel consumption in 2030 in both scenarios. In order to reduce fossil fuel imports and CO_2 emissions from transport, either the growth in transport energy consumption needs to be avoided, or the target for renewables in transport needs to be much more ambitious.

6.4 National renewable energy sources to meet the 2030 renewables in transport target

6.4.1 Potential of national renewable energy sources

The potential renewable fuel that could be produced from each of the feedstocks considered, is presented in Figure 66. Note these estimates relate to total feedstock potential and do not take into account competing uses, see section 3.2.1 for detailed description of sources and data used. Current transport energy demand (road and rail) in Albania is larger than the potential renewable fuel that can be produced from all feedstocks apart from renewable power, at 122% of the potential. If the potential renewable fuel produced from all feedstocks including renewable power is considered, then current fuel use is 16% of Albania's potential fuel production.

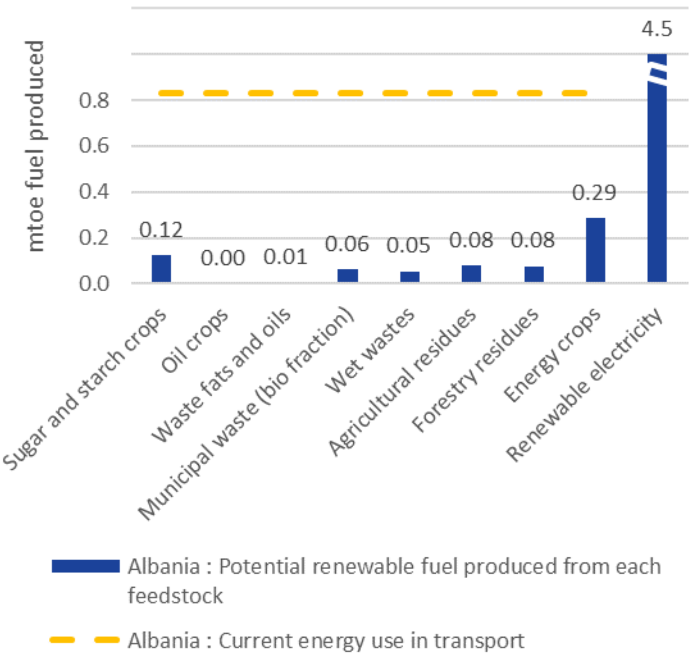

Figure 66: Albania: Potential renewable fuel production, compared to current energy use in road and rail transport

6.4.2 Current status of national transportation fuel pathway deployments

There is currently one operational biofuel plant in Albania, producing biodiesel via esterification of imported vegetable oils. It is located in Porto Romano and Green Fuel is the main developing company. It has a reported production capacity of 100 ktonnes/annum, but actual production is between 10 and 15 ktonnes/annum. All the produced biodiesel is reported to be exported, mainly to Italy.

6.5 Roadmap for achieving the renewable energy in transport target for 2030

6.5.1 Regulatory status quo

6.5.1.1 General data

In respect of the renewable energy in the transport sector, Albania is not compliant with the RED, except determining the RES-T target of 10% by 2020 by the National Action Plan for Renewable Energy Resources (NREAP). Albania has a consumption of biofuels exceeding 10%. However, no sustainability framework is established in Albania, and consumed biofuels are not certified according to sustainability requirements according to RED. As a consequence, consumed biofuels are not compliant with RED, and the 10% target of RED for 2020 will not be achieved. On the other hand, ensuring compliance with the sustainability requirements of RED could have allowed Albania to achieve the 2020 target. Other options for target compliance are limited, but can be developed until 2030 (see section 6.5.2 detailing options for target compliance in 2030).

In 2019, the Energy Community started the process of setting 2030 targets in line with the Policy Guidelines on the development of integrated National Energy and Climate Plans (NECP) under Recommendation 2018/01/MC-EnC. Renewable energy targets as well as policies and measures will be addressed under the 'Decarbonisation of the economy' dimension of the NECP in an integrated way, which recognizes the interactions between the different dimensions.

Renewable energy targets, policies and measures for 2030 will thus be included in the NECP. However, the National Energy Strategy for the period 2018-2030 defines that the share of renewable energy sources in transport should be 10% in 2020 and 10% in every year afterwards until 2030.The body competent for monitoring the implementation of the NREAP is the National Agency of Natural Resources which submits the annual monitoring report to the Ministry of Energy and Infrastructure. Every two years the Ministry of Energy and Infrastructure submits to the Council of Ministers a report on the implementation of the NREAP and the fulfilment of national objectives for energy from renewable sources.

Although the competent bodies for monitoring have been designated, non-compliance with renewable targets is not regulated as an offense, so no penalties are imposed. Law No. 9876 for Production, Transportation and Trade of Biofuels and Other Renewable Fuels for Transport, which is currently in force in Albania, defines a binding biofuels target of 10% by 2015 onwards. However, it does not establish any measures to enforce the blending obligation, such as penalties for fuel suppliers that do not fulfil their obligations. Furthermore, the law does not define sustainability criteria, nor conditions regarding fuel quality.

Albania does not have any provision for support measures available to purchasers of alternative-fuelled vehicles, nor provisions in respect of the compatibility of vehicles with various alternative fuel types.

6.5.1.2 Energy efficiency in transport

Law No. 124/2015 on Energy Efficiency amended by law no. 5/2019 in 2019 regulates the relations between government authorities and natural and/or legal persons, public or private, operating in the residential, service, industry, transport, agriculture, as well as all other sectors of the economy, in order to promote the use of energy efficiency and market development for energy services. The law stipulates that the national energy savings objective should be achieved through energy services, which aim to increase energy efficiency in specific sectors of the economy, including the transport sector.

Based on the Law No. 124/2015 on Energy Efficiency the National Action Plan for Energy Efficiency for the period 2010-2018 (NEEAP) has been adopted that defines the targets for energy savings in the transport sector, as well as possible measures to achieve them. In 2017, Albania adopted the 2nd and 3rd National Energy Efficiency Action Plan for the period 2017-2020, which reviews the achievements of the first NEEAP for the period from 2010 to 2014, and outlines a plan for meeting the new targets emerging for the period up to 2020. The measures and objectives for energy efficiency proposed by the new NEEAP include savings in primary energy and end use and, for the latter, address measures for the use of energy in transport, among others.

It should be mentioned that the measures for 2030 regarding energy efficiency shall be included in the NECP.

The Energy Efficiency Agency is the institution which is established in Albania with the main goal of implementing policies and measures which promote energy efficiency in all sectors, including the transport sector. The Energy Efficiency Agency has created and updates a national database regarding the final energy consumption and achievements in energy savings, which serves as a basis to assess whether the energy efficiency objectives are achieved.

6.5.1.3 Production and supply of fuel

A significant law is the No. 9876 for Production, Transportation and Trade of Biofuels and Other Renewable Fuels for Transport, which was adopted in 2008 and amended in 2014. It stipulates that in order to promote the use of biofuels and other renewable fuels in the transport sector, the minimum annual market percentage of biofuels and other renewable fuels should be set in the annual national target, in relation to the annual amount of gasoline and diesel used in the transport sector. The Council of Ministers, upon the proposal of the minister responsible for the transport sector and the minister of energy and infrastructure, determines the minimum annual amount of biofuels and other renewable fuels that will be used during the following year in the transport sector.

Furthermore, the law defines that the minimum annual quantity of biofuels and other renewable fuels on the market cannot be less than 10% from 2015 onwards.

If the minimum annual quantity of biofuels and other renewable fuels offered on the market by domestic producers is larger than the minimum annual quantity determined by the Council of Ministers, each legal entity that owns plants for the production of biofuels and other renewable fuels guarantees to place on the market minimum annual quantities of these products, which does not restrict their right to trade even larger quantities, in line with market demand. When the legal entities that own plants for the production of biofuels and other renewable fuels foresee, based on the annual development programs, that the annual domestic production of these products does not cover the whole annual minimum quantity that needs to be placed on the market and which is determined by the Council of Ministers, wholesale companies holding the "trading licenses" for petroleum products, are obliged to guarantee the supply of the market with this minimum annual amount.

Besides the above-mentioned law, in 2017 the Law No 7/2017 on the Promotion of the Use of Energy from Renewable Sources was adopted. However, this law only briefly mentions the transport sector in Article 19, which stipulates that the use of renewable energy sources in the transport sector shall be determined by a separate law, which refers to the draft Law on the Production, Transportation and Trade of Biofuels and Other Renewable Fuels for Transport.

Since the Law No. 9876 for Production, Transportation and Trade of Biofuels and Other Renewable Fuels for Transport was not compliant with RED, the Ministry of Energy and Infrastructure has initiated a new draft Law on the Production, Transportation and Trade of Biofuels and Other Renewable Fuels for Transport. Currently, this draft law is being discussed in the Parliamentary Committees of the Albanian Parliament and is expected to be approved. The draft law defines the targets for the use of biofuels in transport, the requirements for meeting the sustainability criteria according to RED, the manner of calculating and reporting, as well as other issues related to the organization of the market. The draft law defines that the responsible administrative body for the verification of sustainability criteria verifies whether economic operators have complied with the sustainability criteria. The Council of Ministers, upon the proposal of the minister responsible for energy and infrastructure, approves the decision on determination of the responsible body and methodology for verifying the fulfilment of the sustainability criteria. There are several gaps in the legislation relative to RED II, which may be filled in the future. This refers among others to renewable fuels of non-biological origin – RFNBO defined in RED II, for the production of which no criteria related to electricity for their production are defined.

As per the draft law, the minimum annual quantity of biofuels and other renewable fuels to be used during the following year in the transport sector is determined in relation to the annual quantity of gasoline and diesel placed on the market for transport by each wholesale company. The Council of Ministers, on the proposal of the minister of energy and infrastructure, approves the instruction regarding determination of the minimum annual quantity of biofuels and other renewable fuels which needs to be placed on the market. The minister of energy and infrastructure based on that instruction determines the minimum annual quantity of biofuels and other renewable fuels that will be used during the next year in the transport sector, including the minimum amount of biofuels to be marketed by any wholesale company.

The draft law stipulates that the minimum annual quantity of biofuels and other renewable fuels on the market cannot be less than 5% in 2018 and 2019, while from 2020 onwards, this amount cannot be less than 10%.

It should be mentioned that each company holding a license for "Wholesale trade of oil, gas, by-products, including bio, as well as fuels, with code VIII.1.A". for wholesale trade in the market must take measures to ensure the placement on the market of the minimum quantity of biofuels and other renewable fuels. These quantities must meet the sustainability criteria.

If the annual domestic production of biofuels and other renewable fuels does not cover the entire minimum annual amount determined by the minister of energy and infrastructure to be placed on the market, licensed wholesale trading companies oil products are obliged to guarantee the supply of the market with this minimum annual quantity through imports.

It should be mentioned that there is no defined obligation imposed on the fuel suppliers to meet certain greenhouse gas emissions standards. However, according to the draft law On the Production, Transportation and Trade of Biofuels and Other Renewable Fuels for Transport, GHG emission savings from the use of biofuels and bioliquids must be at least 35%, while RED in Article 17(2) requires reduction by 50% from 2018 for old production installations, and of 60% for installations starting operation after 5 October 2015.

Also, in Albania there is no regulation containing provisions defining minimum GHG reduction requirements for gasoline, or diesel. Specific legislation on sustainability criteria for biofuels, bioliquids or biomass fuels does not exist in Albania. After the draft law On the Production, Transportation and Trade of Biofuels and Other Renewable Fuels for Transport is approved by the Parliament, enforcement of sustainability criteria shall be possible.

With respect to reporting obligations in Albania, in accordance with the Law No. 9876 for Production, Transportation and Trade of Biofuels and Other Renewable Fuels for Transport, one reporting obligation is imposed in view of transparent competition: The holders of the "production license" for the production plants of biofuels and other renewable fuels are obliged to report to the Ministry of Energy and Infrastructure the production costs (ex-factory) of these products. The same provision is defined by the new draft Law on the Production, Transportation and Trade of Biofuels and Other Renewable Fuels for Transport.

The rules concerning production of electricity from renewable sources are set by the Law No. 43/2015 on the Power Sector. In accordance with the law, the subject that intends to perform this energy activity must have a license issued by the Albanian Energy Regulatory Authority. The license is granted based on the technical and economic documentation together with the approvals from the relevant bodies including environmental permissions, water usage permission and permissions obtained from the Transmission System Operator and the Distribution System Operator. The producers of renewable energy with the obtained license conclude a Power Purchase Agreement with the Electricity Power Distribution System Operator. As well, in the field of renewable energy sources, the Energy Regulatory Authority is competent for the issuance of guarantees of origin.

Also, it should be noted that the Law No. 43/2015 on the Power Sector defines the producers of electricity from renewable energy sources as priority producers.

It should be noted that there are no regulations which contain provisions related to electricity used directly in transport.

In respect of the area of E-mobility there are no provisions which refer to obligations of certain subjects such as public parkings or public garages to have electric vehicle charging stations. Furthermore, there are no incentives or simplified procedures for construction/licensing of electricity charging stations for road vehicles, or for construction/licensing of hydrogen refuelling stations.

Excise duties are defined by the Law no. 61/2012 on Excises in the Republic of Albania, amended several times. The law prescribes that the excise is reimbursed for biofuels used in the transport sector and stored in the territory of the Republic of Albania for the value of excise duty paid corresponding to the mass of the “bio” product in the product declared for consumption after confirmation by the customs chemical laboratory and after verification by the customs authority, up to 5%. Reimbursement for the quantity of biofuels is made until 2020.

According to Annex No. 1 of the Law no. 61/2012 on Excises in the Republic of Albania, excise tax rate is calculated based on the unit of measurement, and for some of the most important energy products is as follows:

Diesel that requires a specific process	50 ALL (approx. 0.40€)/l
Light oils (gasoline and benzene); Unleaded petrol and benzene, with a lead content not exceeding 0,013 g/l With less than 95 octanes With 95-98 octanes With 98 and more octanes	37 ALL (approx. 0.30€)/l
Leaded gasoline, with a lead content of more than 0.013 g/l With less than 98 octanes With 98 or more octanes	50 ALL (approx. 0.40€)/l
Fuels, kerosene type;	20 ALL (approx. 0.16€)/l
Heavy oils (diesel)	37 ALL (approx. 0.30€)/l
Heavy oils as fuels (fuel, solar, mazut)	37 ALL (approx. 0.30€)/l
Biodiesel with petroleum oils	37 ALL (approx. 0.30€)/l
Petroleum gases and other gaseous hydrocarbons for use as motor vehicle fuels	8 ALL (approx. 0.064€)/l
Petroleum gases and other gaseous hydrocarbons for use other than as fuel for motor vehicles	0 ALL/l
Fatty acids / Biodiesel with less than 70% petroleum oils of Chapter 27	37 ALL (approx. 0.30€)/l

Additionally, in accordance with the Law No. 9975 On National Taxes, two types of taxes are stipulated:

- Turnover tax for gasoline[227]
  This tax on gasoline and diesel is set at 27 ALL (approx. 0.22€) per liter for gasoline and 27 ALL (approx. 0.22€) per liter for diesel, and is paid on the quantity of gasoline and diesel imported or produced in Albania, with the exception of the quantity of gasoline and diesel produced in Albania, but exported outside the territory of Albania.
- Carbon tax for gasoline[228]
  The carbon tax is set at 1.5 ALL (approx. 0.012€) per liter of gasoline, 3 ALL (approx. 0.024€) per liter of diesel, 3 ALL (approx. 0.024€) per kilogram of coal, 3 ALL (approx. 0.024€) per liter of solar fuels, 3 ALL (approx. 0.024€) per liter of fuel oil, 3 ALL (approx. 0.024€) per liter of kerosene and 3 ALL (approx. 0.024€) per kilogram of oil coke. However, this tax is not paid on the quantities of gasoline and diesel that are exported.

6.5.1.4 Passenger transport sector

The Law No. 9975 On National Taxes defines two types of taxes for the owners of vehicles:

- The annual tax on used vehicles, and
- Luxury vehicle tax.

The annual tax on used vehicles is valid for 365 days and is determined according to the formula:

Cylinders displacement (cm^3) x fixed coefficient according to age of the vehicle x fixed tax for the type of fuel

The coefficient according to the age of the vehicle is listed in Annex 1 of the law, and the coefficient is determined until 24th year of the vehicle. After the 24th year of use, for buses the coefficient increases by 0.03, while for motor vehicles, cars and vehicles for mixed transport increases by 0.04, and for all other vehicles increases by 0.0. Vehicles up to 3 years of age are not subject to this tax, while the coefficient is higher in case of the older vehicle. The obligation to pay the tax is on the owner of the vehicle. The annual tax on vehicles is collected before performing the mandatory annual technical inspection of the vehicle.

[227] Article 3 Paragraph 1 Item 2 of the Law No. 9975 On National Taxes defines that turnover tax for gasoline applies to the products according to NKM tariff codes 2710 12 41; 2710 12 45; 2710 12 49; 2710 12 51; 2710 12 59) and for diesel (according to NKM tariff codes 2710 19 31; 2710 19 35; 2710 19 43; 2710 19 46; 2710 19 47; 2710 19 48), as well as for gasoline or diesel found in the content of biofuel (according to the tariff codes of NKM 27102011 to the code 27102019, 27102090, as well as the classification in subheading 38 26 00).

[228] Article 3 Paragraph 1 Item 6 of the Law No. 9975 On National Taxes defines that carbon tax for gasoline applies to the products according to NKM tariff codes 2710 12 41; 2710 12 45; 2710 12 49; 2710 12 51; 2710 12 59), for diesel (according to NKM codes 2710 19 31; 2710 19 35; 2710 19 43; 2710 19 46; 2710 19 47; 2710 19 48), for coal (according to the heads of NKM 2701; 2702), for kerosene (according to the tariff codes of NKM 27 10 19 11 to 27 10 19 29), for solar (according to NKM codes 2710 19 62 to 2710 19 68), for fuel oil (according to NKM codes 2710 19 62 to 2710 19 68) and for coke oil (according to NKM codes- of 2713 11 00; 2713 12 00), as well as for gasoline or diesel found in the content of biofuel (according to the tariff codes of NKM 27102011 to the code 27102019, 27102090, as well as the classification in subheading 38 26 00).

The fixed tax for the type of fuel amounts to 12.5 ALL (approx. 0.10€) for oil and 10 ALL (approx. 0.080€) for gasoline.

The owner of the vehicle, who does not make the payment of this tax within 10 days from the expiration of the validity period is obliged to pay a fine of 5% of the amount of unpaid obligation for each month of delay, but not more than 25% for each year.

From the payment of the annual tax on vehicles, the following are exempted:

- assets owned by embassies and international organizations, which enjoy diplomatic status, accredited in the Republic of Albania, by applying the principle of reciprocity;
- natural or legal persons who declare that they will not circulate with vehicles owned by them during the calendar year, temporarily only once within a calendar year, or will be permanently out of circulation and who submit the license plate and the permit of turnover, provided that they have paid arrears, if any;
- tax payers of blocked vehicles by decision of the court, of the prosecution, for the period in which the vehicle was blocked, and tax payers of stolen, burned, destroyed vehicles by accidents, certified by the prosecution bodies;
- type-approved vehicles up to 4 + 1 seats and with cylinders not more than 2500 cm^3, when these vehicles are owned by invalid persons and war veterans against the Nazi occupiers of the Albanian people, people incapacitated for work, blind people, paraplegic invalid people and tetraplegics, who acquire this status under the relevant laws, and who use the vehicle only for their personal needs and not for private activities;
- agricultural machines.

The luxury vehicle tax is imposed on the owners of luxury vehicles which are defined as a vehicle up to 6 + 1 seats, which fulfils at least one of the following conditions:

- cylinder capacity equal to or larger than 3000 cm^3, or
- the value/price equal to or more than 5,000,000 ALL (approx. 40,182 €)

Regardless of the payment of the annual tax on vehicles, a registration tax of 70,000 ALL (approx. 562€) is applied on luxury vehicles for registration, as well as the annual tax of 21,000 ALL (approx. 168€). The annual tax on luxury vehicles is valid for 365 days. The obligation to pay the tax is on the owner of the vehicle. The luxury vehicle tax is collected together with the collection of the annual tax on vehicles.

The owner of the vehicle, who does not make the payment of this tax within 10 days from the expiration of the validity period is obliged to pay a fine of 5% of the amount of unpaid obligation for each month of delay, but not more than 25% for each year.

In accordance with the Decision no. 633 of 2018 on Measures against air pollution by emissions of motor vehicles and reduction of air emissions of pollutant gases and solids from spark-ignition engines and compression ignition engines burning natural gas or liquids in vehicles, imported vehicles must meet the following criteria:

- for new vehicles to meet at least the EURO 5 engine standard, and
- for used vehicles to meet at least the EURO 4 engine standard, and they must have been produced not more than 10 years before the date of first registration in Albania.

Custom taxes for vehicles which are imported into Albania are defined by the Customs Tariff of the Republic of Albania. Imported vehicles are subject to the customs rate of 0%. However, the imported vehicle owners are obliged to pay VAT of 20%, while the supply of new vehicles with zero-km electric engine, not previously registered in any other country, is entirely exempted from VAT.

Albania does not have any regulation providing incentives for import or purchase of hydrogen fuel cell vehicles, while for electric vehicles one of the incentives is the exemption from VAT in case of supply of new electric vehicles not previously registered in any other country.

Furthermore, the sector of public transport is not regulated in Albania. That means there are no incentives for the use of electricity or renewable fuels in public transport, nor any restrictions, limitations or obligations related to this.

6.5.1.5 Freight transport sector

The same annual duty as for the owners of passenger vehicles, defined by the Law No. 9975 On National Taxes, is imposed on owners of freight vehicles, namely the annual tax on vehicles, which is valid for 365 days.

The rules regarding the persons who are obligated to pay the annual tax on vehicles, as well as the formula for calculation of its amount, the manner of its collection and the consequences of non-payment of the tax are the same as for passenger vehicles.

In accordance with the Decision no. 633 of 2018 – Measures against air pollution by emissions of motor vehicles and reduction of air emissions of pollutant gases and solids from spark-ignition engines and compression ignition engines burning natural gas or liquids in vehicles, the imported freight vehicles must meet the following criteria:

- for new vehicles to meet at least the EURO 5 engine standard, and
- for used vehicles to meet at least the EURO 3 engine standard, and they must have been produced not more than 15 years before the date of first registration in Albania.

6.5.1.6 Railway sector

The railway sector in Albania is governed by the Railway Code of the Republic of Albania which imposes certain authorizations related to the railway sector. Furthermore, technical inspection of the rail vehicles must be carried out before putting them into operation.

The railway undertaking license is the permit issued by the Railway Licensing Authority for a railway undertaking, which confirms the ability of the entity to provide rail transport services. This license may be limited to the provision of certain types of services.

Security certificate is a document issued by the Railway Safety Authority proving that the railway undertaking has established safety management systems and that it is able to operate safely in the required area of operation, within which this undertaking meets the technical specification for interoperability (TSI) and other legal criteria on railway safety in terms of risk control and safe provision of transport services in the railway network.

Security authorization is a document given by the Railway Safety Authority to the responsible body or company having the role of an infrastructure manager, after it has established the security management systems and which gives it the right to manage and use railway infrastructure.

Table 22: Authorizations related to the railway sector in Albania

Type	Subjects	Competent authority for issuance
Railway undertaking license	Railway undertaking – i.e. any public or private entity, licensed in accordance with the Railway Code, and any other undertaking, public or private, whose activity is intended to provide the carriage of goods and/or passengers by rail, which must provide towing (of vehicles), including undertakings providing only towing (of railway vehicles).	The Railway Licensing Authority
Security certificate	Railway undertaking – i.e. any public or private entity, licensed in accordance with the Railway Code, and any other undertaking, public or private, whose activity is intended to provide the carriage of goods and/or passengers by rail, which must provide towing (of vehicles), including undertakings providing only towing (of railway vehicles).	The Railway Safety Authority
Security authorization	infrastructure manager	The Railway Safety Authority

An important issue in the railway sector for this study is the fact that the railway network is not electrified at all at the moment and that the majority of the railway infrastructure in Albania is not in good conditions and requires significant investment. All existing railway lines are currently single lines. Also, Albania has only one railway cross-border connection with Montenegro which is used for freight transport.

However, there are a number of projects under development which envisage rehabilitation including electrification and connection with neighbouring countries. One of them is a project of improving mobility in metropolitan areas like one for the line Tirana – Durres (single) which is at present the busiest section. The project is under consultation for hybrid trains, high tech, which allows DMU[229] and EMU[230] operations with EU Member States. This project is related to the concept of electric traction/power supply.

There are no provisions on incentives or obligations for use of electric locomotives, and also there is no act which imposes the use of renewable energy for railway transport.

6.5.2 Roadmap to achieve the 2030 target

The roadmap developed here for Albania to achieve the 2030 target of 14% renewable energies in transport builds on the provisions of RED II as described in section 3.1.1. It is assumed that these provisions are transposed into Albanian law without changes including the calculation method for renewables in transport, the caps and minimum values for various types of renewable energies, the multipliers, the provisions related to electricity and RFNBOs etc. Also, sustainability criteria need to be transposed into national law in order to fully comply with RED II, and it must be ensured that certification schemes are in place (national or voluntary) that are compliant with RED II requirements.

For this study, we apply the renewable share in the national electricity mix anticipated for 2030. On the one hand, this tends to overestimate the renewable share as values for the year 2028 that should be applied are not available, but should in general be lower than the 2030 values. On the other hand, dedicated renewable power plants may be erected that are counted as 100% renewable for transport.

For Albania, a 100% renewable electricity mix is anticipated for 2030 based on literature values.[231] This is without prejudice to 2030 targets to be defined and included in the NECP.

It should be noted that the high renewables share in the national mix may open up opportunities for RFNBO production for export, notably to European Union Member States applying the RED II provisions. Should Albania, however, not achieve the 100% renewable electricity target, the contributions of fuel options based on electricity will be reduced accordingly.

229 A diesel multiple unit (DMU) is a multiple-unit train powered by on-board diesel engines.

230 An electric multiple unit (EMU) is a multiple-unit train consisting of self-propelled carriages using electricity as the motive power.

231 TU Wien/Energy Economics Group, Joanneum Research, REKK: Study on 2030 overall targets (energy efficiency, RES, GHG emissions reduction) for the Energy Community. Vienna 2019

6.5.2.1 Potential contributions from all options

Based on the assessment of all options for Albania, a total RES-T share of 15.3% in 2030 can be achieved as a combination of all options (see Table 23). Further limited potentials exist in renewable liquid fuels in shipping, aviation and rail, which are assumed to be zero here.

Biofuels potentially contribute most in 2030.

The 100% renewable share in the national electricity mix anticipated for 2030 leads to full accounting of electricity in transport as renewable, which gives a boost to electric transport.

The contributions shown here assume that ethanol is blended up to 5% in gasoline, and rely on a blend of 12.4% biofuel in road transport diesel fuel. This would either require a FAME blend above B7 (for example B20 or B100 in fleets) and/or use of HVO. Selling some gasoline with >5% ethanol would also ease blending limits.

Electric and hydrogen vehicles can already make small contributions by 2030, and have a strong growth potential thereafter.

Table 23: Potential RES-T contributions from all options in Albania

Option		Contribution to RES-T target (%) incl. multiple counting	Amount of renewable fuel used (ktoe)
Biofuels and liquid RFNBOs	1. Crop-based biofuels in road transport	7,0%	67,7
	2. Liquid fuels produced from Annex IX B feedstocks in road transport	3,4%	16,4
	3. Liquid advanced Biofuels (based on Annex IX A feedstocks) in road transport	3,5%	16,9
	4. Liquid RFNBOs in road transport	0,749%	7,24
	5. Renewable methane in road transport	0,0%	0,00
	6. Renewable liquid fuels in shipping	0,00%	0,00
	7. Renewable liquid fuels in aviation	0,0%	0,00
	8. Renewable liquid fuels in rail	0,0%	0,00
Electricity	9. Rail electrification	0,0%	0,00
	10. Electric public transport (bus, trolleybus, tram, metro)	0,014%	0,05
	11. Electric road vehicles (passenger cars and trucks)	0,49%	1,19
Hydrogen	12. Hydrogen in rail	0,005%	0,05
	13. Hydrogen bus and coach (urban bus, long distance coaches)	0,005%	0,05
	14. Hydrogen road vehicles (passenger cars and trucks)	0,12%	1,19
	15. Hydrogen in refineries	0,0%	0,00
Total		15,3%	111

As the possible contributions of battery-electric vehicles depend on many factors, the following considerations are intended to provide some insight into the dynamics and opportunities (see Figure 67). The graph is based on a number of approximate assumptions, and should thus be understood as rough indication showing the general trends.

Battery-electric cars' contribution to the RES-T target is calculated by applying the renewable share in the national electricity mix to the use of electricity in BEVs[232].

Electricity provided through public charging stations is covered in statistics as energy consumed in transport, and thus counted accordingly; charging through private charging units is not covered in statistics. Therefore, RED II foresees a multiplier of four for electricity consumed in road transport (based on data from statistics).

The RES-T contribution of battery cars depends on:

- The number of battery cars (horizontal axis in Figure 67);
- The share of public charging (green/ blue line in Figure 67 assuming 25% and 100% public charging, respectively);
- The renewable share in the national electricity mix in 2028 (100% for Albania); lower RES shares would reduce the contribution accordingly.

Assuming 25% public charging, 200 thousand battery cars would approximately contribute 4.7% RES-T by 2030 (see Figure 67).

As battery cars are more energy efficient than conventional cars and the electricity is only partly covered in statistics energy consumption in transport decreases with increasing battery cars (dotted lines in Figure 67).

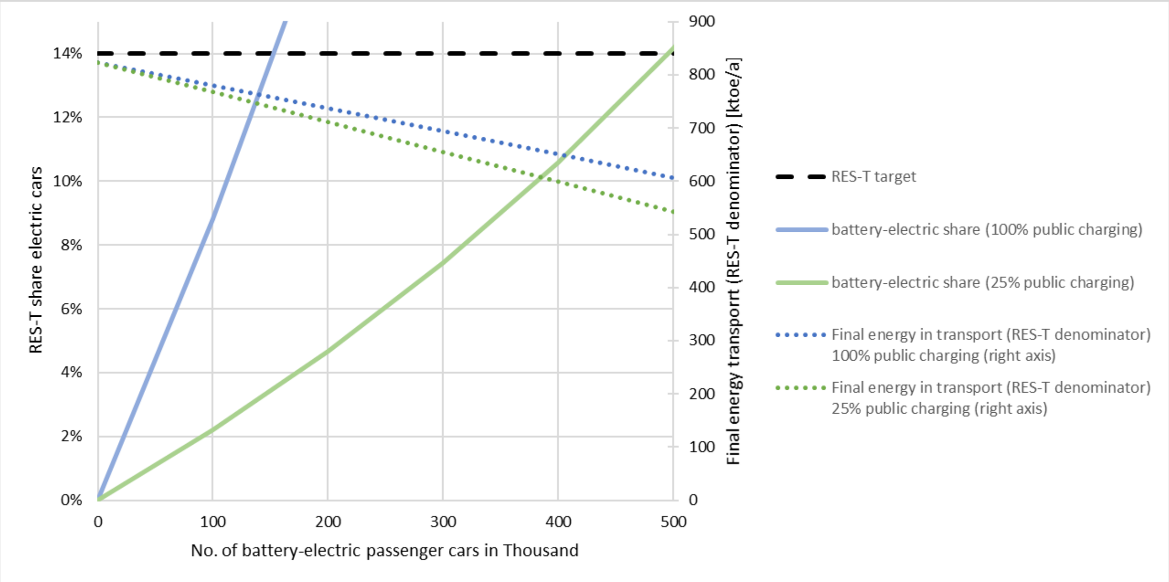

Figure 67: Possible contributions of battery cars to Albania's 2030 RES-T target

[232] However, if certain criteria are met (see RED II), renewable electricity can be counted as 100% renewable. This is not assumed in this study for option 11.

6.5.2.2 Choice of options to meet RES-T target

The potential contributions of all options exceeding the target allows for the reduction of contributions from several options. The reductions are based on the general considerations described in section 5.1, and on the specific circumstances in Albania as described in the following:

1. In order to limit the competition with food and animal feed production, crop-based biofuels are capped at 7% by RED II, which is assumed to be fully used. For comparison, the current operational biodiesel plant in Albania, with reported production capacity of 100 ktonnes/annum, would produce approximately 90 ktoe/yr of fuel if operating at full capacity, more than enough to supply a 7% target of 67.7 ktoe.
2. Biofuels based on Annex IXB biofuels can be reduced to 2.9%, which is below the maximum capped level. 50% of this supply could be met from domestic collectable UCO and tallow resources. For comparison, this is 14ktoe demand, equivalent to about 15% of the capacity of the existing biodiesel plant[233];
3. Liquid biofuels based on Annex IXA feedstocks ("advanced biofuels") are developed to meet the minimum targets defined in RED II. For context, this is equivalent to approximately half the output of an advanced ethanol plant at typical scale of 63 million l fuel/year;
4. Relatively expensive RFNBOs are not required in road transport to meet the 2030 target;
5. Albania has no use of methane in transport currently; therefore, it is assumed this is not introduced;
6. No renewable fuels in shipping are required to meet Albania's RED II target;
7. No renewable fuels in aviation are required to meet Albania's RED II target;
8. No renewable fuels in rail are required to meet Albania's RED II target;
9. Electrification of rail lines is not assumed here;
10. The introduction of battery buses and the expansion or establishment of trolley bus systems, or trams in cities is assumed here;
11. The market uptake of battery-electric road vehicles (cars and light/ medium duty trucks) leads to electricity consumption in transport;
12. Existing and new rail lines not suitable for electrification allow establishing zero emission hydrogen fuel cell trains;

[233] NB This does not imply that supply need necessarily come from this plant, or from domestic production, nor that this plant is suitable for processing waste oils

13. Introduction of hydrogen fuel cell buses in urban areas, and (long-distance) coaches in applications not suitable for battery-electric vehicles (high daily driving range, long-distance);
14. Start of market uptake of hydrogen fuel cell-electric road vehicles (cars and light to heavy duty trucks) for long-distance, high driving ranges;
15. Use of renewable hydrogen in refineries could be an option for the future, but is not assumed here for a contribution by 2030.

This results in the following contributions by 2030 assumed to be realistic and reducing the most challenging or expensive[234] options to meet the defined 2030 RES-T target:

Table 24: Contribution to Albania's RES-T target from options chosen

	Option	Multiplier	2030 Contribution to RES-T target incl. Multipliers	2030 Amount of renewable fuel used (ktoe)
Biofuels and liquid RFNBOs	1. Liquid crop-based biofuels in road transport	1	7.0%	67.7
	2. Liquid fuels produced from Annex IX B feedstocks in road transport	2	2.9%	13.8
	3. Advanced liquid biofuels (based on Annex IX A feedstocks) in road transport	2	3.5%	16.9
	4. Liquid RFNBOs in road transport	1	0.0%	0.0
	5. Renewable methane in road transport	2	0.0%	0.0
	6. Renewable liquid fuels in shipping	2	0.0%	0.0
	7. Renewable liquid fuels in aviation	2	0.0%	0.0
	8. Renewable liquid fuels in rail	2	0.0%	0.0
Electricity	9. Rail electrification	1.5	0.0%	0.0
	10. Electric public transport (bus, trolleybus, tram, metro)	4 (road) 1 (tram, metro)	0.014%	0.1
	11. Electric road vehicles (passenger cars and trucks)	4	0.49%	1.2
Hydrogen	12. Hydrogen in rail	1	0.005%	0.1
	13. Hydrogen bus and coach (urban bus, long distance coaches)	1	0.005%	0.1
	14. Hydrogen road vehicles (passenger cars and trucks)	1	0.12%	1.2
	15. Hydrogen in refineries	1	0.0%	0.0
Total			**14.0%**	**101.0**

Strong contributions are made by all three types of biofuels; moderate contributions are made by electric road vehicles and hydrogen road vehicles; limited contributions are made by electric public transport, by hydrogen buses and coaches as well as by hydrogen in rail.

The high proportion of Annex IXA (advanced) biofuels is driven by the sub-target in RED II and relies on successful scale-up in production of liquid Annex IXA biofuels globally. Should this prove not to be feasible, crop-based biofuels or biofuels based on Annex IXB could be increased, which would, however, not allow the sub-target for advanced biofuels in RED II to be met.

These contributions lead to a breakdown of fuel consumption in 2030 as shown in section 6.3.2.

[234] Detailed cost assessments have not been carried out in this study. Rough cost judgements are made here based on cost information provided in chapter 3.

6.5.2.3 Roadmap for Albania

The roadmap for Albania to achieve the 2030 target for renewable energies in transport (see Figure 68) involves key policies to be developed and adopted in the coming few years, building on the existing regulatory framework and policy elements already under development (see section 6.5.1). The development of the regulatory framework so far focuses on biomass-based fuels; direct electricity use and hydrogen use in road transport has received less emphasis so far, but should be taken up as two additional central pillars for renewables in transport.

The roadmap foresees that the last elements of the regulatory framework should be in place by the end of 2022.

The appropriateness, effectiveness and efficiency of this policy framework should be evaluated in around 2025, and should be adjusted where necessary to ensure target compliance by 2030. The European Union is currently developing the details of the European Green Deal, which aims to make the European Union climate neutral by 2050 by turning climate and environmental challenges into opportunities, and making the transition just and inclusive for all. Based on a set of policy initiatives by the European Commission, climate ambitions by 2030 are anticipated to be increased, which includes adjustments to RED II. A revision of the policy framework in Albania around the middle of the decade would be timely for taking up decisions to be taken at European Union level by then.

Around 2028 would be a suitable point in time to set targets for the 2040 timeframe, and to revise and adjust the strategies and policies accordingly.

Currently, Albania is developing its first National Energy and Climate Plan (NECP), which has a planning and a monitoring function. The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target, and will be helpful for the 2025 revision of the policy framework.

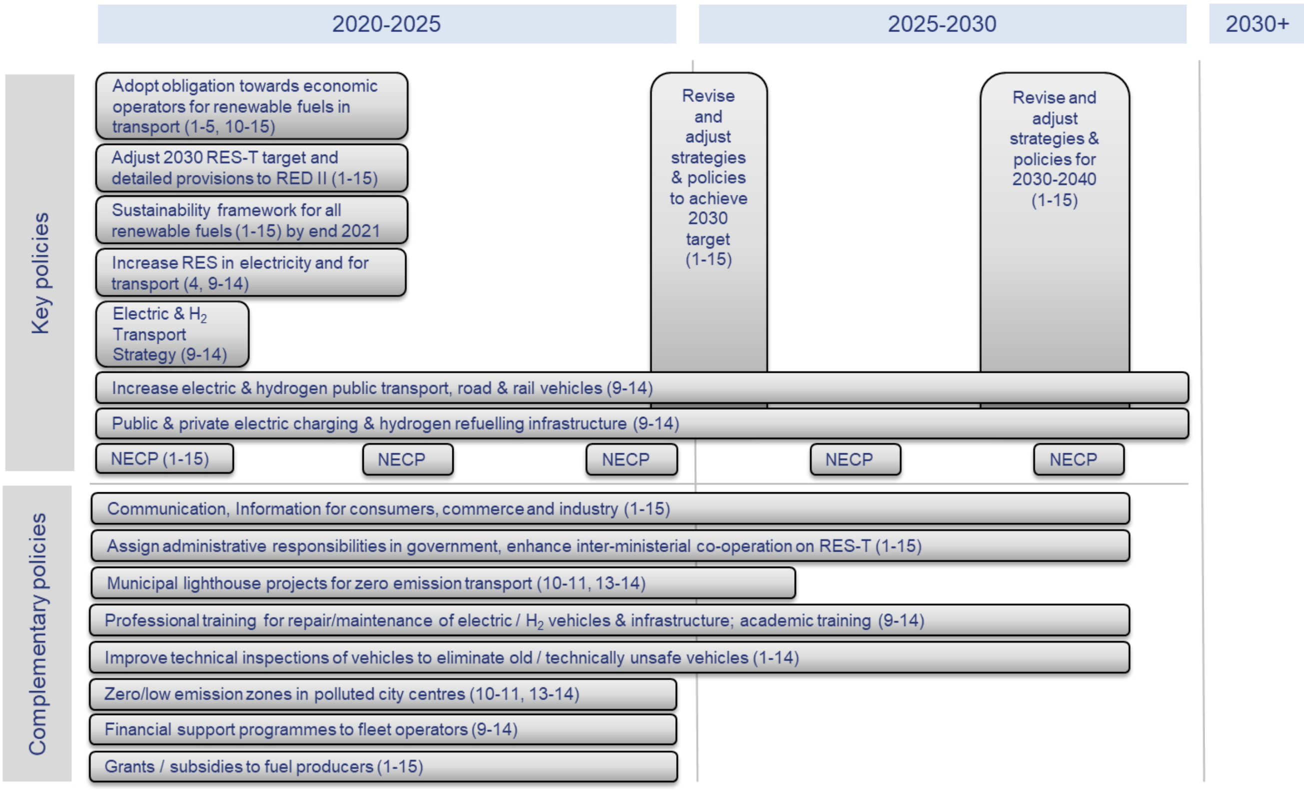

Figure 68: Overview roadmap for Albania

The priority in the roadmap for biofuels is to modify Albanian law and procedures to ensure that they meet the requirements of RED II. As described above, the new draft Law on the Production, Transportation and Trade of Biofuels and Other Renewable Fuels for Transport, is being discussed in the Parliamentary Committees of the Albanian Parliament and is expected to be approved. The draft law defines the targets for the use of biofuels in transport, the requirements for meeting the sustainability criteria, the manner of calculating and reporting, and other details. It needs to be ensured that this law meets all of the requirements of RED II, including increasing the target for renewables in transport from 10% to 14% and ensuring sustainability criteria match. Additional attention may need to be given to criteria on production of liquid RFNBOs, alongside the rules on hydrogen (below) as these do not appear to be covered within existing activities. A unit within the relevant government ministry must be designated responsible for implementing, reviewing and updating the policy as a whole, ensuring sustainability certification of fuels, administering the scheme, data collection and reporting.

Several other measures that are complementary to this demand-side policy have also been important in other countries, namely support for domestic fuel production, such as capital grants for plants and information provision for consumers on fuel switching and vehicle compatibility.

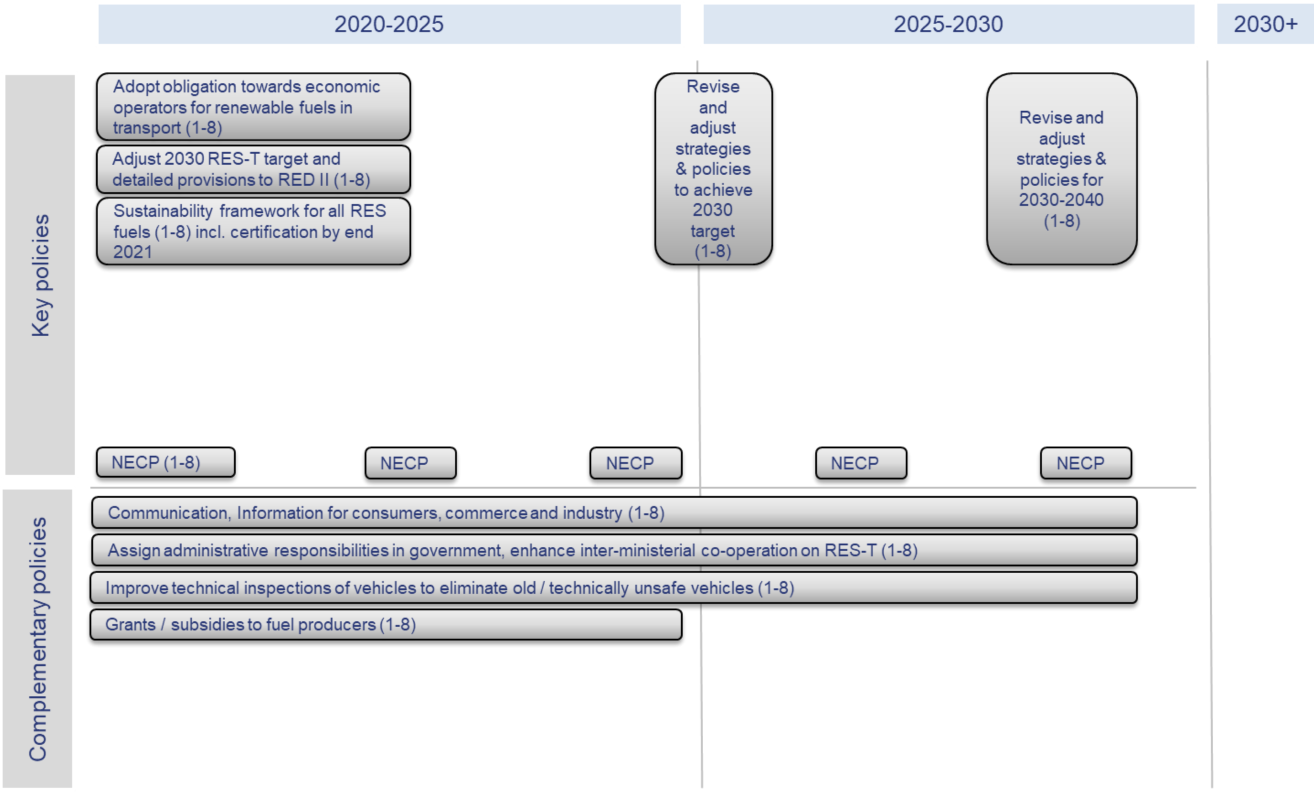

Figure 69: Roadmap for Albania – Biofuels and liquid RFNBOs

Direct electricity use in transport is not yet well-established in Albania. Policies supporting renewables in transport should include establishing and strengthening electricity use in rail, public transport and in road transport including passenger cars and delivery vehicles.

Battery-electric road transport including passenger cars, public transport and delivery vehicles has a significant growth potential. Developing a national electric transport strategy would be an appropriate starting point for a coherent and effective policy framework in this area. Various policies for fostering electric transport could be envisioned, such as putting an obligation on electricity suppliers for providing renewable electricity to transport, etc.

An additionality framework for renewable electricity would define rules for counting electricity as renewable based on RED II[235], and detailed provisions are currently under development by the European Commission. This aims at fostering additional renewable power capacities for transport not compromising the achievement of renewables electricity targets in conventional electricity consumption.

In parallel, existing policies for increasing renewable electricity production should be adjusted by increasing renewable targets for 2030 that would include additional renewable electricity demand from transport in order to achieve 100% renewable electricity supply by

[235] See RED II Art. 27(3)

2030 including transport. Fostering dedicated renewable capacities for transport could be a new element introduced into existing legislation, covering rail, public transport and road.

Increasing the number of electric vehicles in road, rail and public transport is a major lever for increasing the consumption of electricity in transport, and reducing conventional fuel consumption. Elements for such policies include providing direct financial support for purchasing electric vehicles, and adjusting the tax and import duty structures to incentivize purchases of electric vehicles. The vehicle charging infrastructure is the second major lever. Policies to coordinate and incentivize the build-up of a public network of charging stations include elements of financial incentives through grants, subsidies and loans, clear permitting rules, and coordination to ensure an appropriate nationwide network structure. In addition, financial support to charging infrastructures for public transport and fleet operators is an effective and efficient instrument for rapid growth.

The appropriate administrative structures must be established including enhanced inter-ministerial co-operation, and related responsibilities assigned in government.

Further complementary policies supporting electric transport include communication and information campaigns, lighthouse projects at local/ municipal level, the establishment of zero or low emission zones in urban areas for reduced air pollution, professional and academic training, technical inspections of vehicles (both electric and conventional), etc.

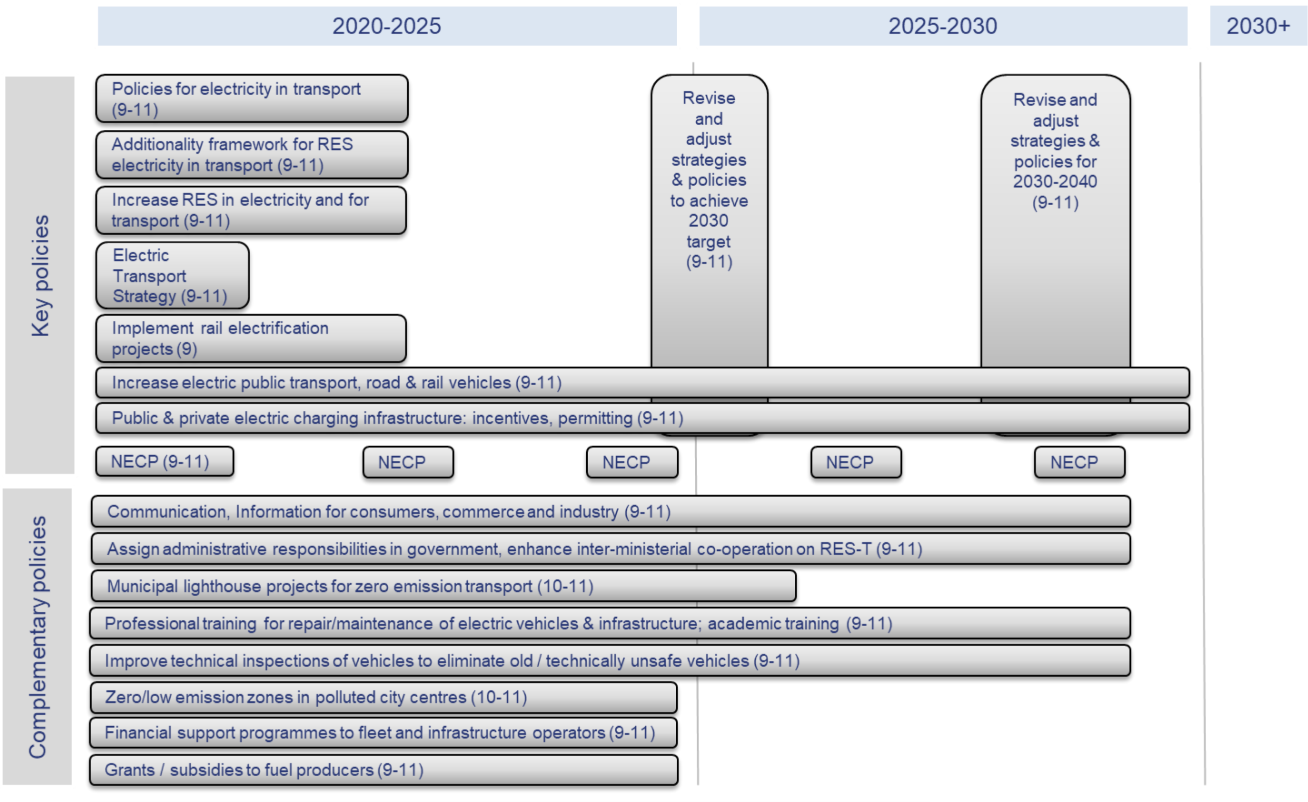

Figure 70: **Roadmap for Albania – Electricity in Transport**

Hydrogen in transport using fuel cell-electric vehicles is in early phases of commercialization world-wide, and shows major potential for decarbonizing transport in a complementary fashion to battery-electric vehicles. On non-electrified rail lines, first commercial hydrogen trains are in operation, and fuel cell vehicles are coming onto the market. A focus will be on vehicles for longer distances and for duty purposes such as trucks and buses.

Hydrogen can be included in the obligation on fuel suppliers as an option, as provided for in RED II. Further key policy elements are rather similar to electricity in transport: developing a national strategy, defining an additionality framework, increasing renewable electricity capacities for hydrogen production, supporting the market uptake of vehicles, and supporting the establishment of hydrogen refuelling stations.

Also, the complementary policies are similar to electricity.

The related policies should be established together with those for biofuels and electricity, while the market may take up a few years later based on an earlier status in commercialization.

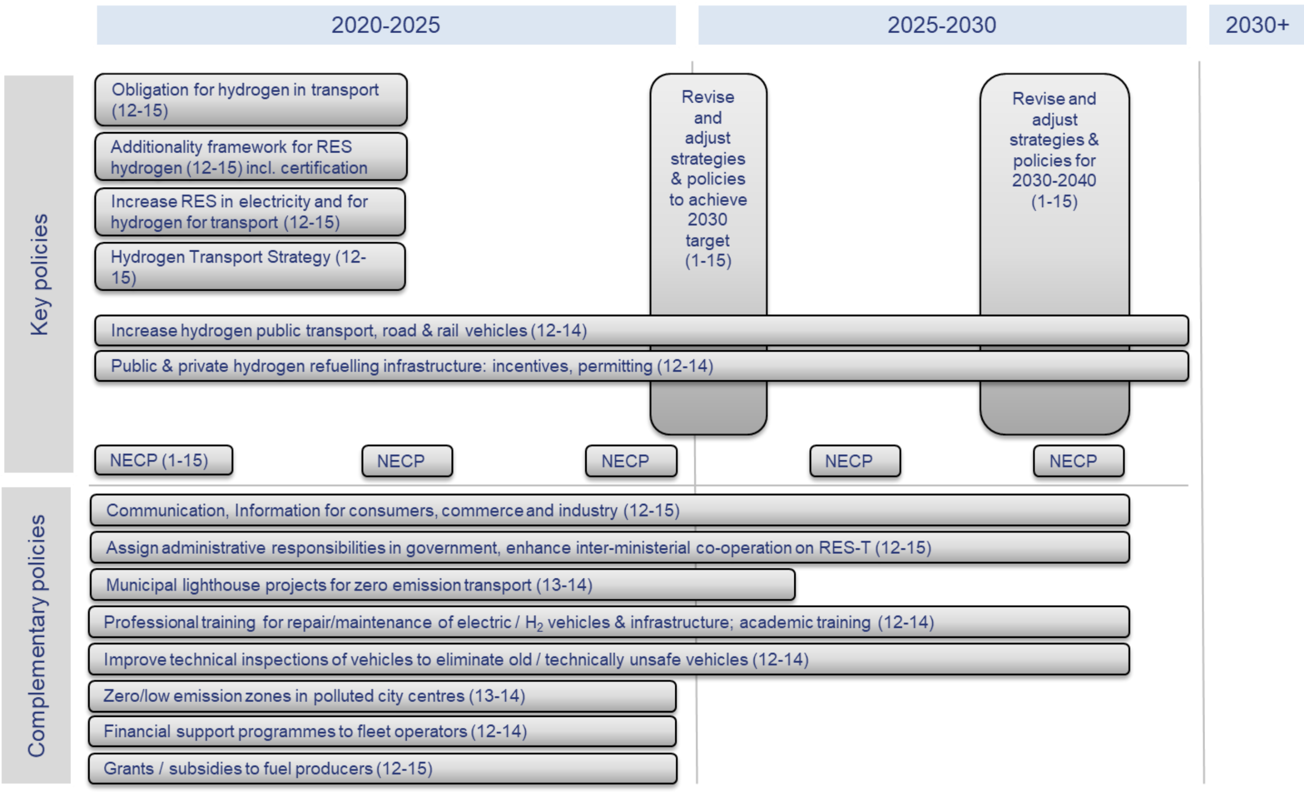

Figure 71: Roadmap for Albania – Hydrogen in Transport

6.6 Conclusions and recommendations

6.6.1 Conclusions

Albania already has a high consumption of biofuels; however, these are not compliant with RED/ RED II requirements. Albania has defined a target of 10% renewable energies in transport by 2030, unchanged from the 10% target for 2020.

Albania can choose from a number of options to achieve the 2030 RES-T target of 14%. In fact, over-achievement beyond 15% is possible. It should be noted that even with more than 15% renewable energy in transport in 2030, the anticipated consumption growth over the coming decade is expected to result in increased fossil fuel imports relative to 2018. Therefore, even higher ambitions could be beneficial in economic and environmental terms for Albania.

Options for renewable fuels production beyond the 2030 target may provide opportunities for exports, e.g. by producing and exporting biofuels based on used cooking oil and tallow, or by producing liquid fuels from renewable electricity (RFNBO).

Of the 14% overall renewables target in transport, crop-based biofuels are capped at 7%, while 7% need to be achieved by other renewable fuels. The current consumption of non-compliant crop-based biofuels represented 13.4% of transport energy consumption in 2018. If these biofuels were compliant, the quantities would be above the maximum contribution of 7%, and the quantities beyond 7% could not be counted towards the 2030 target according to RED II provisions.

Biofuels are anticipated to contribute most to the target, including crop-based, waste-based and advanced biofuels.

Electrification of rail lines can make important additional contributions to the 2030 target, based on an anticipated 100% renewable share in national electricity generation. Rail projects under development envisaging rehabilitation including electrification and connection with neighbouring countries represent promising opportunities for introducing electricity consumption into the transport sector, and for increasing the RES-T share.

Electric road vehicles have notable potential, which is anticipated to be used towards 2030 with a dynamic growth potential beyond 2030 to allow for a major RES-T share by 2050.

Hydrogen and battery-electric vehicles are complementary as hydrogen fuel cell vehicles enable longer driving distances, and are suitable for cars and heavy-duty transport alike; dynamic growth beyond 2030 is anticipated.

Additional benefits of achieving the 2030 RES-T target include the reduction of fossil energy import dependence and related financial flows out of the territory, additional national value creation, new or enhanced national value chains with related economic benefits and possible job creation as well as additional contributions to the national climate targets, etc.

6.6.2 Recommendations

As a proven policy tool, Albania should adopt a 2030 target for renewable energies in transport based on RED II.

Based on the Law No. 9876 of 2008 and amended in 2014, which does not cover important elements of RED, a new draft Law on the Production, Transportation and Trade of Biofuels and Other Renewable Fuels for Transport is currently being discussed in the Parliamentary Committees of the Albanian Parliament. This draft law introduces major elements of RED. However, full compliance of sustainability requirements should be checked with the provisions of RED. Furthermore, the more stringent RED II sustainability framework should be introduced into Albania law.

A major success factor for achieving a 2030 target for renewable energy in transport is to establish legal obligations towards economic operators including their enforcement. Certification ensuring the compliance of economic operators with the sustainability requirements is another.

Without prejudice to any possible legal, political or contractual obligations, all elements of the regulatory framework should be in place at the latest by the end of 2022 in order to give industry as much time as possible to plan, invest, implement and operate.

Further key policy elements need to be established in order achieve the 2030 RES-T target:

- strategy and support mechanisms for electricity in transport
- strategy and support mechanisms for hydrogen in transport

Complementary policies are recommended to be established in order to ensure target achievement and maximum benefits to the Albanian economy.

Rail projects currently under development envisaging rehabilitation including electrification and connection with neighbouring countries should be pursued towards construction and commissioning in order to introduce electricity consumption into the transport sector based on renewable power.

Co-benefits with other policy areas should be actively developed. This includes air quality improvements in urban areas and other environmental and health issues as well as economic benefits such as reduced fossil fuel imports, job creation, national value creation, etc.

Furthermore, co-operation with other Contracting Parties, and more generally with other countries, allows synergies and should thus be pursued.

Policies should be revised and possibly adjusted in around 2025 based on a policy and results evaluation.

The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target.

7 BOSNIA AND HERZEGOVINA

7.1 Executive Summary

The implementation of the revised Renewable Energy Directive (EU) 2018/2001 (RED II) on the promotion of the use of energy from renewable sources has started to be discussed within the Energy Community. Currently, RED II is not a part of the Energy Community acquis; but the adaptation and transposition by the Contracting Parties could be envisaged. Assuming for this study that the provisions of RED II are transposed into the law of Bosnia and Herzegovina without changes, we develop a roadmap for Bosnia and Herzegovina to achieve the 2030 target for renewables in transport of 9%[236].

Bosnia and Herzegovina has a share of renewable energy in transport of 0.6%[237] through electricity consumption in rail. Biofuels are not consumed in Bosnia and Herzegovina yet.

Bosnia and Herzegovina has a number of options to achieve the 2030 RES-T target of 9%. It should be noted that even with target achievement, the anticipated strong consumption growth will result in increased fossil fuel imports relative to 2018. Therefore, even higher ambitions could be beneficial in economic and environmental terms.

The existing obligations on fuel suppliers in the two entities (Federation of Bosnia and Herzegovina: 2008, Republika Srpska: 2016) are not enforced; as a consequence, no biofuels are consumed in Bosnia and Herzegovina.

Of the 9% overall renewables target in transport, crop-based biofuels are capped at 2%, while 7% need to be achieved by other renewable fuels. Biofuels are anticipated to contribute most to the 2030 target.

Electricity use in rail can make a relevant contribution if the renewable electricity share reaches the 2030 value of 53% as assumed for this study, and if rail is extended to keep its share in growing transport energy consumption.

Electric road vehicles can contribute to the 2030 target, with a strong growth potential beyond 2030. Hydrogen and battery-electric vehicles are complementary where hydrogen enables long driving distances, and heavy-duty operation alike; a small contribution by 2030 and dynamic growth thereafter is anticipated.

Additional benefits of achieving the 2030 RES-T target include the reduction of fossil energy import dependence, additional national value creation, new or enhanced national value

236 The overall target for RES-T of 14% can be reduced as far as the cap on crop-based biofuels is lower than 7%. As the cap on crop-based biofuels for Bosnia and Herzegovina is 2% based on the 2020 biofuels consumption, the overall target is reduced to 9%.

237 Status 2017

chains with related economic benefits and possible job creation as well as additional contributions to the national climate targets, etc. [238] .

As a proven policy tool, Bosnia and Herzegovina should adopt a 2030 target for renewable energies in transport based on RED II.

Bosnia and Herzegovina should revise and expand the existing legislation on renewable energies in transport to include all elements of RED including most notably obligations on fuel suppliers including their enforcement, and a sustainability framework including certification. It is recommended to base such legislation on RED II in order to have a legislative framework based on the latest relevant policies as well as technological and commercial developments.

Without prejudice to any possible legal, political or contractual obligations, all elements of the regulatory framework should be in place at the latest by the end of 2022 in order to give industry as much time as possible to plan, invest, implement and operate.

Further key policy elements need to be established in order achieve the 2030 RES-T target including a revision and adjustment of the taxation system to provide incentives for renewable fuels as well as electric and hydrogen vehicles, and disincentives for fossil fuels, and a strategy and support mechanisms for electricity and for hydrogen in transport. Complementary policies are recommended to be established in order to ensure target achievement and maximum benefits to the economy in Bosnia and Herzegovina.

Co-benefits with other policy areas should be actively developed. This includes air quality improvements in urban areas and other environmental and health issues as well as economic benefits such as reduced fossil fuel imports, job creation, national value creation, etc.

Furthermore, co-operation with other Contracting Parties, and more generally with other countries, allows synergies and should thus be pursued.

Policies should be revised and possibly adjusted in around 2025 based on a policy and results evaluation.

The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target.

[238] Such benefits are not analysed in this study, but have been assessed in various studies, e.g. for hydrogen in Fuel Cells and Hydrogen Joint Undertaking (2019): Hydrogen Roadmap Europe – a sustainable pathway for the European energy transition; and in
Fuel Cells and Hydrogen Joint Undertaking (2020): Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans.

7.2 Introduction

The Energy Community Contracting Parties including Bosnia and Herzegovina have the obligation to reach binding targets for renewable energy in gross final energy consumption by 2020. For the transport sector, the binding target is a minimum 10% of renewable energy (RES-T) by 2020. Bosnia and Herzegovina will not achieve this target.

The implementation of the revised Renewable Energy Directive (EU) 2018/2001 (RED II) on the promotion of the use of energy from renewable sources has started to be discussed within the Energy Community. Currently, RED II is not a part of the Energy Community acquis; but the adaptation and transposition by the Contracting Parties could be envisaged.It is assumed here that the provisions of RED II are transposed into the law of Bosnia and Herzegovina without changes. On this basis, we develop a roadmap for Bosnia and Herzegovina to achieve the 2030 target for renewables in transport of 9%.

As a starting point, this study analyses the status quo of energy consumption in transport in Bosnia and Herzegovina, and provides 2030 projections including a business as usual scenario, and a scenario for compliance with the 2030 target for renewable energies in transport according to RED II.

In the second section, we assess the potential of national renewable energy sources suitable for use in transport, or for the production of transportation fuels together with the status of fuel pathway deployment in Bosnia and Herzegovina.

The third section describes the regulatory status quo related to renewable energies in transport. On this basis, we develop a roadmap for Bosnia and Herzegovina to achieve the 2030 target for renewables in transport on the three pillars of biofuels, electricity and hydrogen covering all transport sectors.

The final section provides conclusions and recommendations.

7.3 Status quo and 2030 projections of renewable energy consumption in transport

The objective of this chapter is to review the current status of renewable energies in transport (RES-T) in Bosnia and Herzegovina, and to develop scenarios of the development of renewable energy shares in transport by 2030.

The following data includes neither international aviation nor international navigation.

7.3.1 Status Quo

The following data includes neither international aviation nor international navigation as these two segments are generally excluded from statistics such as the Eurostat energy balances.

7.3.1.1 Transport Indicators

Transport by bus and coach has seen a decrease until 2014, but has remained constant since then. Railways have a very small share of passenger transport. Tram is only available in Sarajevo. Data for transport by car is not available.

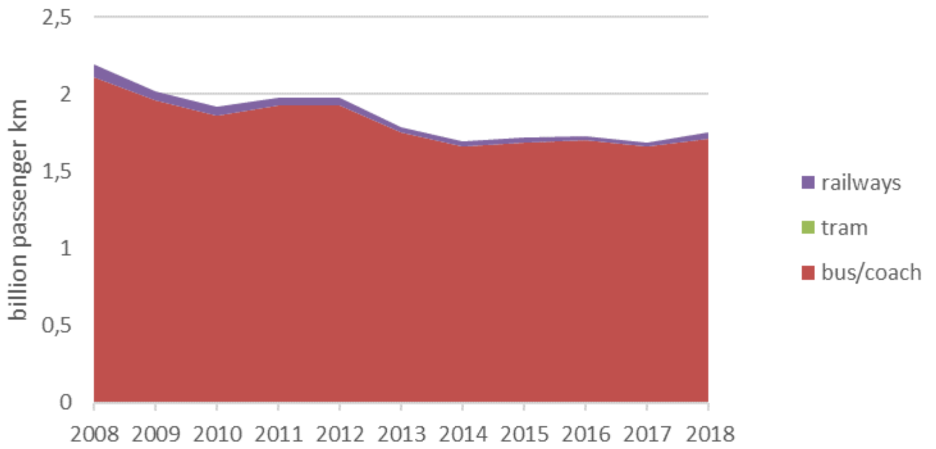

Figure 72: Passenger transport by transport mode[239]

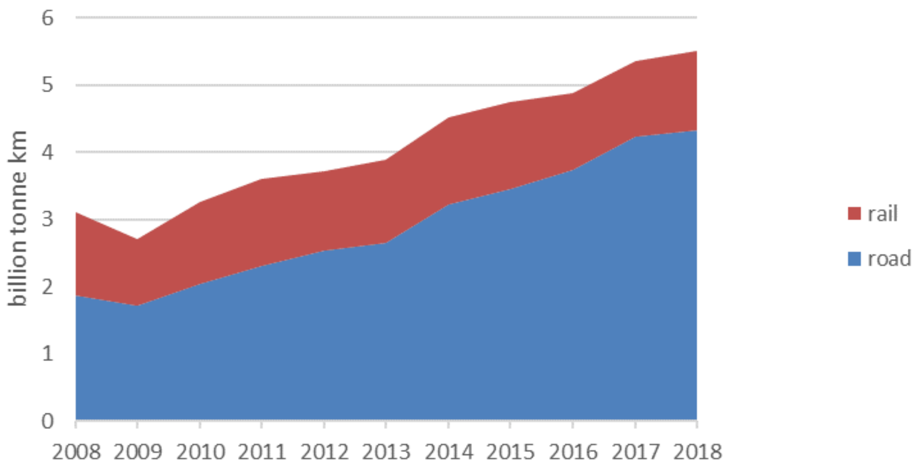

Figure 73: Freight transport by transport mode[240]

Transport by road has increased rapidly and continuously in the last decade. The volume of transport has more than doubled since 2009. Rail transport has relevant share of freight transport, but has remained constant during the past years in absolute terms.

---

[239] UNECE statistical database -Transport (n.d.). Available at https://w3.unece.org/PXWeb2015/pxweb/en/STAT/STAT__40-TRTRANS/, last accessed 02. APR 2020

[240] Agency for Statistics of the Bosnia and Herzegovina (BHAS): Transport Statistics BiH in 2009 and 2018/Road transport, railway transport and air transport - 4th quarter 2010, 2011, 2012, 2013, 2014, 2015,2 016, 2017: http://www.bhas.ba/index.php?option=com_publikacija&view=publikacija_pregled&ids=5&id=22&n=Saobra%C4%87aj%20i%20komunikacije&Itemid=0&lang=sr, last accessed 02. APR 2020

7.3.1.2 Registered Road Vehicles

The number of private cars has seen a slow but steady increase in the past years with the exception of a temporary plateau in 2016. After a phase of fluctuation since 2014, the number of commercial vehicles and buses has increased significantly in 2018.

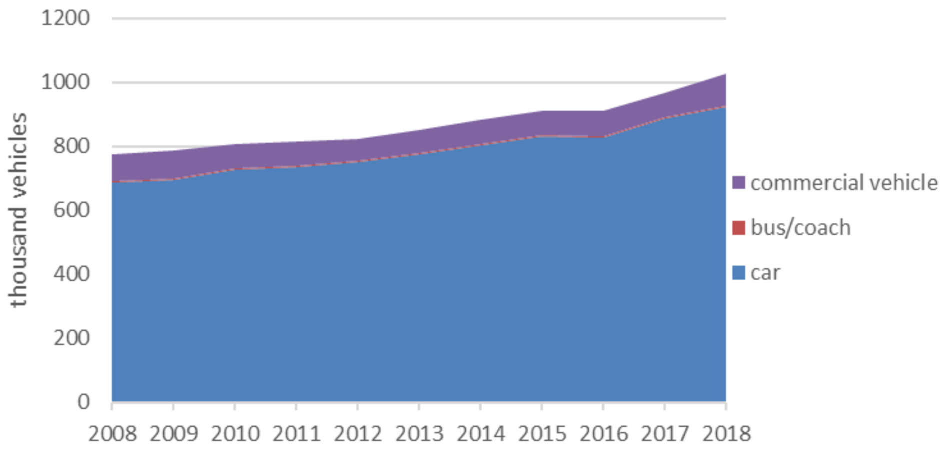

Figure 74: Registered road vehicles by type of vehicle[241] [242] [243]

Figure 75: Comparison of passenger and freight vehicles per capita

241 Agency for Statistics of the Bosnia and Herzegovina (BHAS): Statistics of Traffic 2005-2009. Sarajevo 2010. http://www.bhas.ba/saopstenja/TRA_2005-2009_001_01-bh.pdf, last accessed 02. APR 2020

242 Agency for Statistics of the Bosnia and Herzegovina (BHAS): Registered road motor vehicles for 201x year. Sarajevo 2011-2018a: http://www.bhas.ba/index.php?option=com_publikacija&view=publikacija_pregled&ids=5&id=22&n=Saobraćaj%20i%20komunikacije&Itemid=&lang=en

243 Agency for Statistics of the Bosnia and Herzegovina (BHAS): First time registered road motor vehicles for 201x year. Sarajevo 2011-18b: http://www.bhas.ba/index.php?option=com_publikacija&view=publikacija_pregled&ids=5&id=22&n=Saobraćaj%20i%20komunikacije&Itemid=&lang=en

The number of private vehicles per capita has increased continuously with the exception of a temporary plateau in 2016. Commercial vehicles per capita have seen a reduction and subsequent increase with the lowest figure in 2013. In 2017 and 2018, there has been a very rapid increase compared to the previous years.

7.3.1.3 Energy Consumption in Transport

Data on energy consumption in transport is only available from 2014 onwards. The energy consumption in transport has increased by about 20% from 2014 to 2018. The share of transport in final energy consumption (FEC) has been between 30% and 40%.

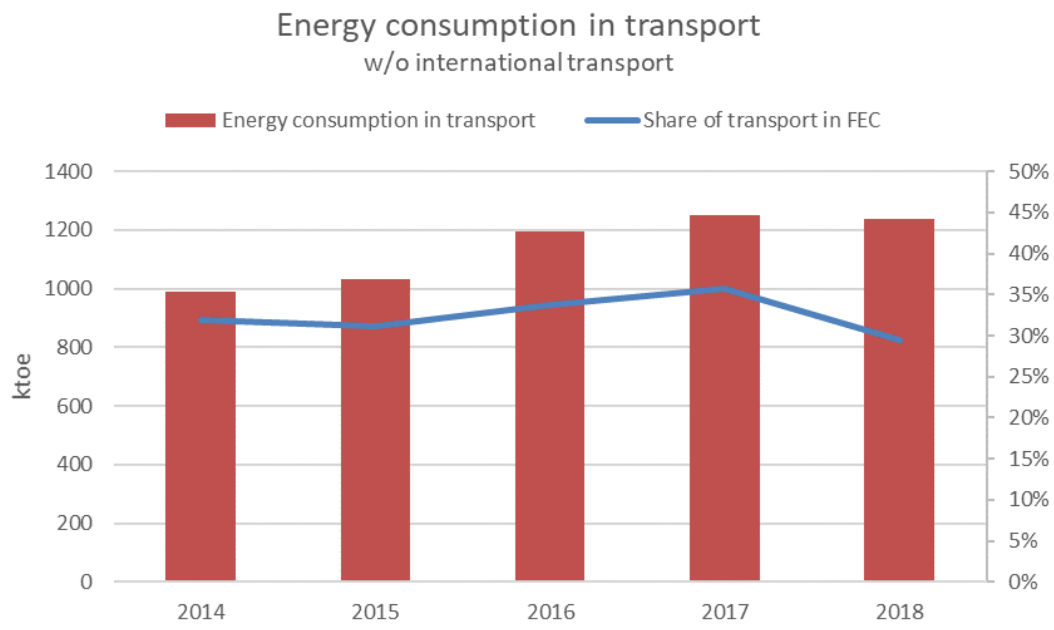

Figure 76: Energy consumption in transport[244]

Almost all transport energy is consumed in road transport. The consumption in other transport sectors is negligible.

Almost all energy is provided by oil and petroleum products. There is only a small share of electricity which is used by trains and the tramway in Sarajevo, and a tiny consumption of natural gas in road transport.

[244] European Commission Energy Balances: September 2019 / draft EUROSTAT energy balances BiH 2018: https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

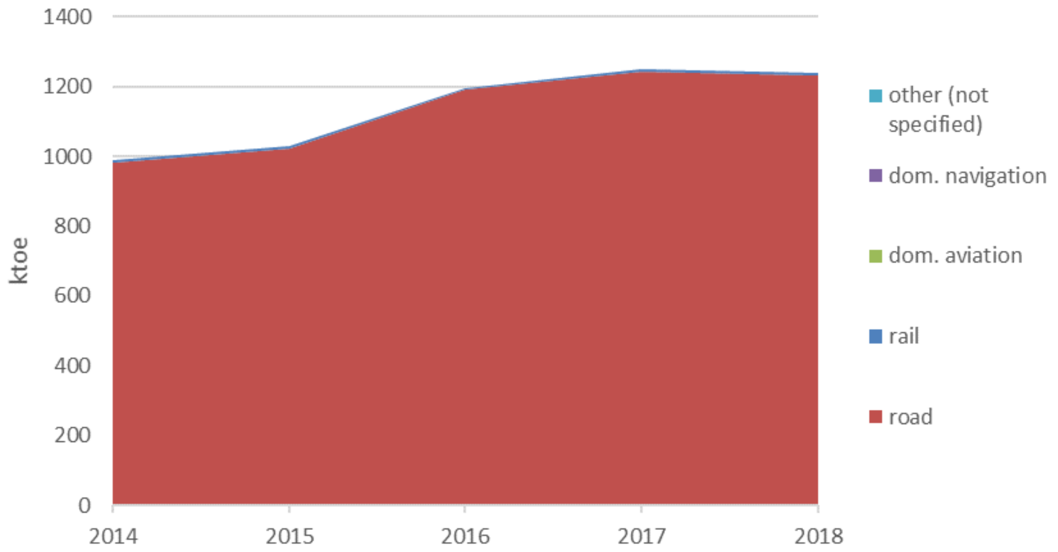

Figure 77: Energy consumption in transport by sub-sector[245]

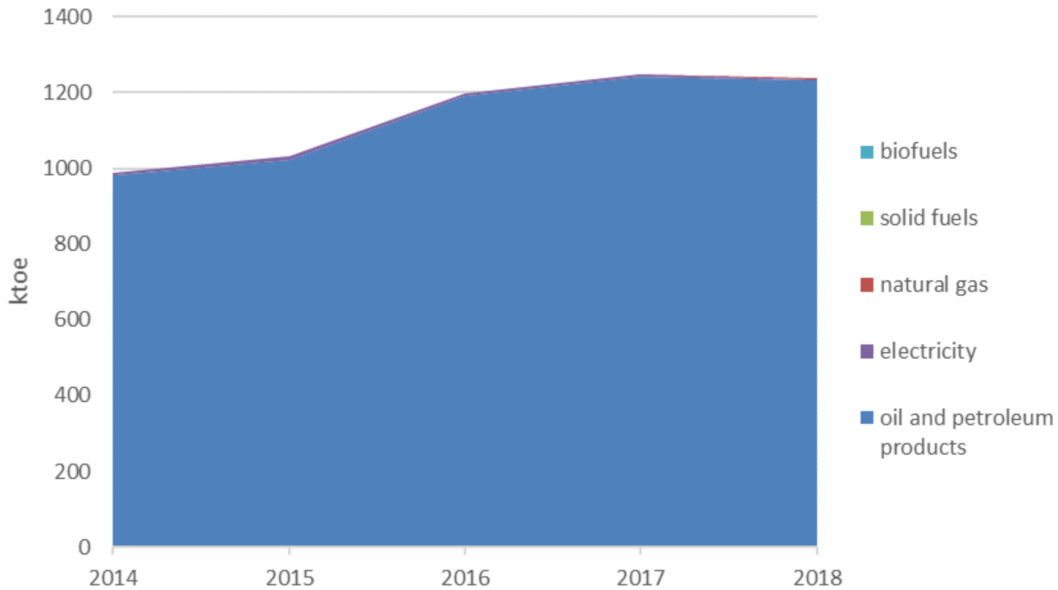

Figure 78: Energy consumption in transport by type of fuel[246]

[245] European Commission Energy Balances: September 2019 / draft EUROSTAT energy balances BiH 2018: https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

[246] Ibid.

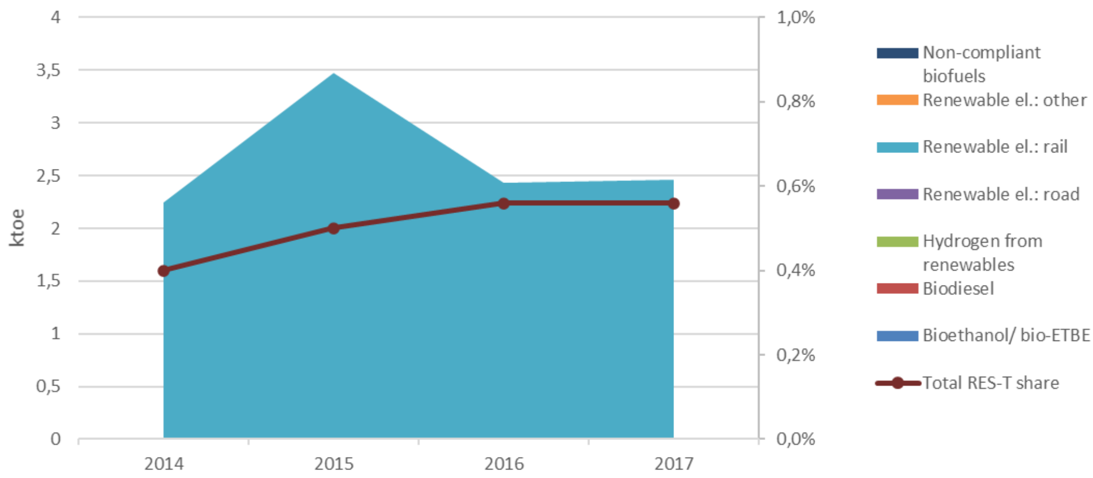

Figure 79: Renewable Energy consumption in transport[247 248]

After a rapid growth in 2014, the consumption of renewable energy has decreased again in 2016 and has remained constant the year thereafter. Renewable energy in transport is only consumed as electricity in rail transport. The share of RES in transport has an increasing tendency. Data is available only from 2014 to 2017.

7.3.2 2030 Projections

As of July 2020, no projections of energy consumption for Bosnia and Herzegovina for the year 2030 are available. Therefore, a simple projection has been made for this study based on available data (see section 7.3.1). To this end, data on energy consumption in transport over the period from 2014 to 2018 have been correlated to the Gross Domestic Product (GDP). This correlation has been extrapolated to 2030 based on GDP projections for 2030[249] to give a total energy consumption in transport of 2,365 ktoe, up from 1,237 ktoe in 2018. Assuming an overall efficiency gain of 10% leads to a projected energy consumption in transport of 2,129 ktoe, as a business as usual scenario (see middle column in Figure 80).

Lacking detailed studies, it is assumed that the shares of fuels and transport modes as shown in Figure 80 remain unchanged between 2018 and 2030 in the business as usual scenario.

---

[247] European Commission Energy Balances: September 2019 / draft EUROSTAT energy balances BiH 2018: https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

[248] First and Third Progress Reports under Renewable Energy Directive 2009/28/EC as adopted by the Ministerial Council Decision 2012/04/MC-EnC

[249] TU Wien/Energy Economics Group, Joanneum Research, REKK: Study on 2030 overall targets (energy efficiency, RES, GHG emissions reduction) for the Energy Community. Vienna 2019

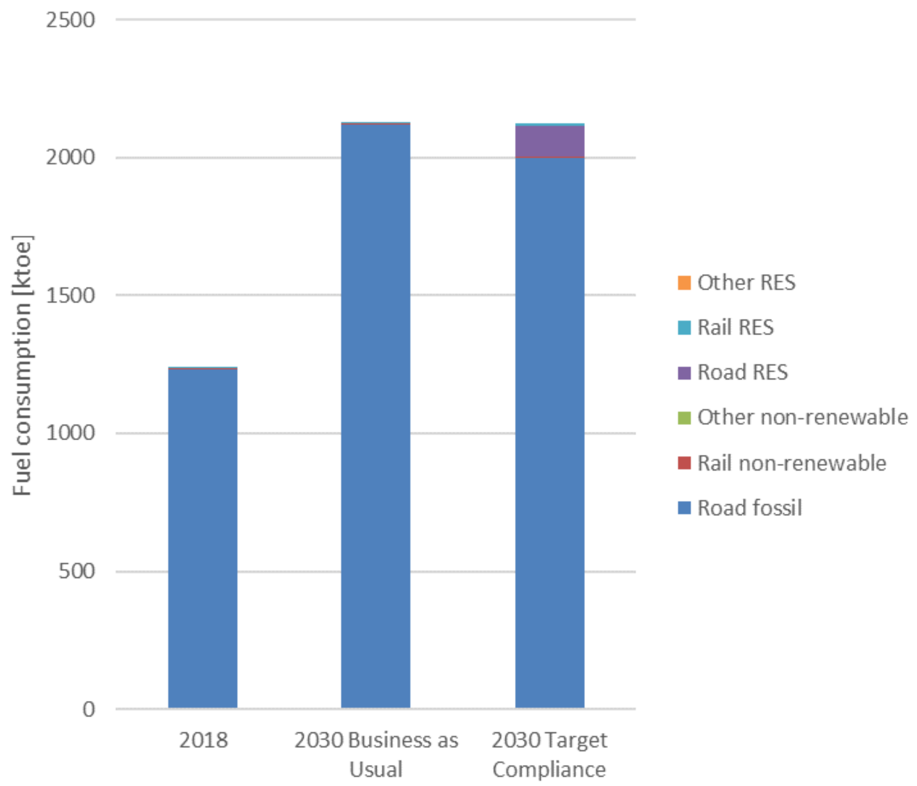

Figure 80: Energy consumption in transport in two scenarios for 2030

In a target compliance scenario achieving the 9% renewables in transport target for 2030, the roadmap as described in section 7.5.2 has been assumed to be implemented. This is represented by the right-hand column in Figure 80. The 9% renewable energies are broken down by options as described in section 0, and are shown in detail in Figure 81. It should be noted that for target compliance, multipliers are used for certain options; however, the energy quantities shown in Figure 80 show the physical energies, i.e. without multipliers. Therefore, the actual renewable energy contribution in 2030 is less than 9% of total consumption in transport.

The total energy consumption in transport in the target compliance scenario is slightly lower than in the business as usual scenario as battery-electric vehicles and hydrogen fuel cell-electric vehicles are more energy efficient than internal combustion engine vehicles.

The very strong growth of fuel consumption leads to a significantly higher fossil fuel consumption in 2030 even in the target compliance scenario. In order to reduce fossil fuel imports and CO_2 emissions from transport, either the growth in transport energy consumption needs to be avoided, or the target for renewables in transport needs to be much more ambitious.

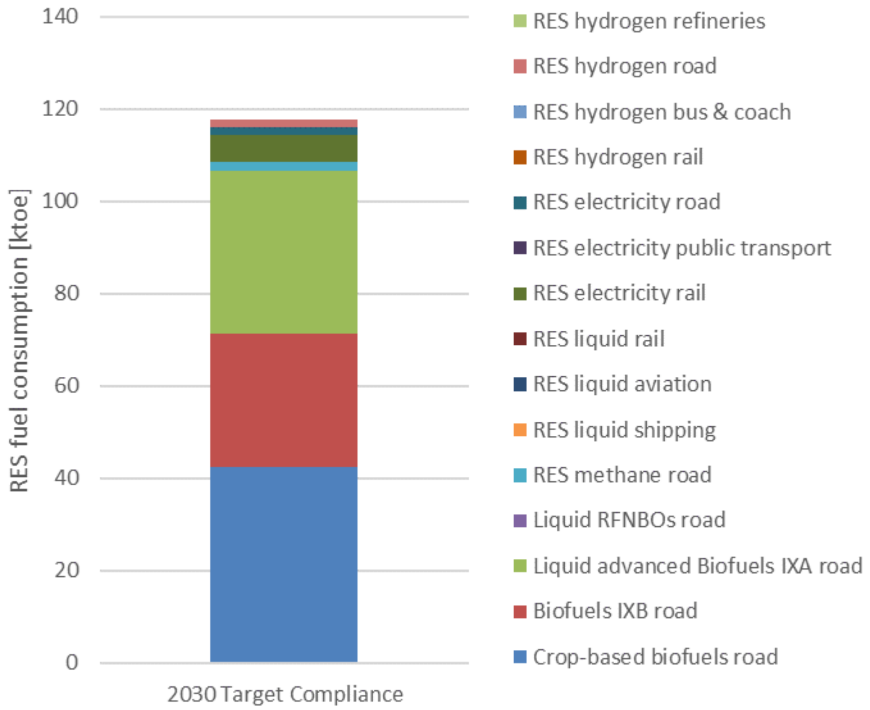

Figure 81: Renewable energy consumption in transport in 2030 by option

7.4 National renewable energy sources to meet the 2030 renewables in transport target

7.4.1 Potential of national renewable energy sources

The potential renewable fuel that could be produced from each of the feedstocks considered, is presented in Figure 82. Note these estimates relate to total feedstock potential and do not take into account competing uses, see section 3.2.1 for detailed description of sources and data used. Compared to the current energy use in road and rail transport, Bosnia and Herzegovina has a significant potential for forestry residues and energy crops, and a relatively large existing production of sugar and starch crops: current transport energy use (road and rail) in Bosnia and Herzegovina is 67% of the potential renewable fuel that could be produced from all feedstocks apart from renewable power. When renewable power is included, the current transport energy use is 21% of the potential renewable fuel produced from all feedstocks.

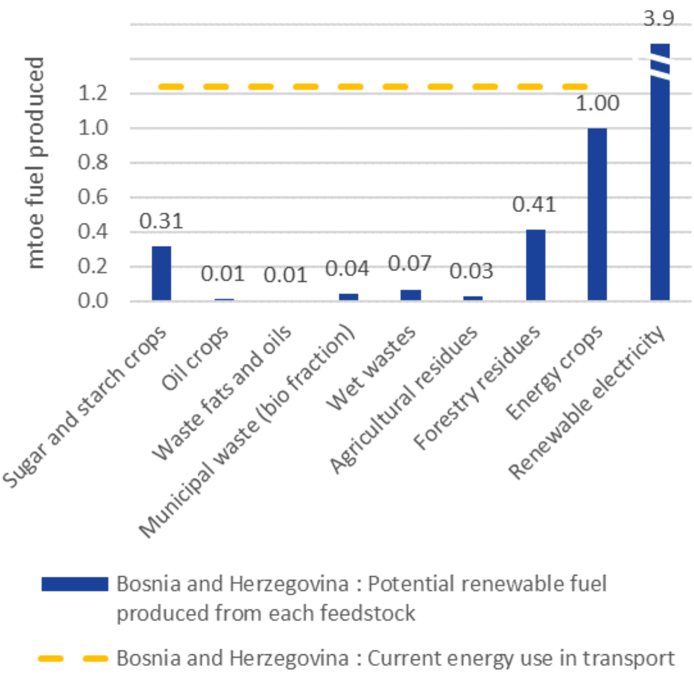

Figure 82: Bosnia and Herzegovina: Potential renewable fuel production, compared to current energy use in road and rail transport

7.4.2 Current status of national transportation fuel pathway deployments

There is currently one operating biofuel plant in Bosnia and Herzegovina, producing biodiesel via esterification of vegetable oils, used cooking oils and animal fats. It is located in Srbac and is operated by System Ecologica. The plant has a production capacity of 500 tonnes per day. In the end of 2019[250] and beginning of 2020[251] there were media reports that the plant is under investigation for alleged tax fraud.

Goldwater SRL have plans to develop a bioethanol plant in the region of Semberija. The ethanol is expected to be produced from lignocellulosic feedstocks through enzymatic hydrolysis and fermentation.

[250] https://www.capital.ba/inspektori-eu-ispituju-milionsku-prevaru-sa-biodizelom-iz-srpca-sistem-ecologica/

[251] https://www.capital.ba/olaf-potvrdio-da-istrazuje-malverzacije-fabrike-biodizela-iz-srpca/

http://ba.n1info.com/Vijesti/a401982/Americki-biodizel-preko-BiH-bez-taksi-zavrsio-na-evropskom-trzistu.html

7.5 Roadmap for achieving the renewable energy in transport target for 2030

7.5.1 Regulatory status quo

7.5.1.1 General data

National progress reports show that Bosnia and Herzegovina is not on track of achieving the RES-T target of 10% by 2020, determined by the National Renewable Energy Action Plan (NREAP).

In 2019, the Energy Community started the process of setting 2030 targets in line with the Policy Guidelines on the development of integrated National Energy and Climate Plans (NECP) under Recommendation 2018/01/MC-EnC. Renewable energy targets as well as policies and measures will be addressed under the 'Decarbonisation of the economy' dimension of the NECP in an integrated way, which recognizes the interactions between the different dimensions.

Renewable energy targets, policies and measures for 2030 will thus be included in the NECP, the first preliminary draft of which has already been submitted.

In accordance with information from the NREAP, the report on its realization will be regularly prepared by the Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina, and it will be based on the reports of entities (**Federation of Bosnia and Herzegovina**, **Republika Srpska**[252]) on the realization of their action plans, as well as on the report on implementation of measures on state level. However, reporting will be done under the NECP.

The body competent for monitoring the implementation of the Plan of the **Federation of Bosnia and Herzegovina** on the Use of Renewable Energy is the Federal Ministry of Energy, Mining and Industry, which informs the Federation Government once a year regarding implementation of the Action Plan.

In the **Republika Srpska**, the body competent for monitoring the implementation of the Action Plan on Energy Efficiency is the Ministry of Energy and Mining of Republika Srpska, which informs the Government of Republika Srpska once a year regarding implementation of the Action Plan.

However, non-compliance with renewable targets is not regulated as an offense by entities, so the competent authorities are not authorized to impose penalties.

Bosnia and Herzegovina does not have any provision for support measures available to purchasers of alternative-fuelled vehicles. In relation to the compatibility of vehicles with various alternative fuel types two Regulations adopted by the entities should be mentioned: Regulation on types, content and quality of biofuels in fuels for motor vehicles of the Federation of Bosnia and Herzegovina, and the Regulation on types, content, quality and participation of biofuels in transport of the Republika Srpska, both of which define which

[252] In order to facilitate reading, the administrative unit to which certain information relates is printed in bold.

requirements biofuels must meet in order to be placed on the market in the respective entities.

7.5.1.2 Energy efficiency in transport

The state-level Energy Efficiency Action Plan (EEAP BH) was adopted by the Council of Ministers in December 2017 based on the entities' Energy Efficiency Action Plans. EEAP BH sets energy savings targets for primary and final energy consumption for Bosnia and Herzegovina, the Federation of Bosnia and Herzegovina, the Republika Srpska and the Brčko District up to 2020, including the transport sector.

It should be mentioned that the measures for 2030 regarding energy efficiency shall be included in the NECP.

Based on the Law on Energy Efficiency of the **Republika Srpska** the Energy Efficiency Action Plan up to 2018 was adopted in 2013, and amended in 2017. According to the Law on Energy Efficiency, the municipalities that have more than 20,000 habitants have the obligation to adopt their own energy efficiency action plan by which energy efficiency in the transport sector should be elaborated.

The Ministry of Energy and Mining of the Republika Srpska has prepared templates and Instructions for Preparing Annual Reports on Implementation of the Energy Efficiency Action Plan of Municipalities. Also, indicative targets for every municipality which include transport sector are determined, but there is no information on fulfilling these targets.

The **Federation of Bosnia and Herzegovina** has adopted its own Energy Efficiency Action Plan up to 2018 based on the Law on Energy Efficiency of the Federation of Bosnia and Herzegovina. According to the law, municipalities should adopt energy efficiency action plans which should include savings achieved in the transport sector. As well, reporting should be done in accordance with the Rulebook on the Energy Efficiency Information System of the Federation of Bosnia and Herzegovina.

The **Brčko District** has not adopted any regulation regarding energy efficiency in the transport sector. Targets regarding energy efficiency in transport are included in the EEAP BH.

7.5.1.3 Production and supply of fuel

Another relevant law is the Law on Renewable Energy Sources and Efficient Cogeneration adopted in the **Republika Srpska** as well as in the **Federation of Bosnia and Herzegovina**. Both laws define that one of its purposes is the promotion of the use of energy from renewable energy sources in the transport sector.

Based on this law, the Federation of Bosnia and Herzegovina and the Republika Srpska have adopted their Action Plans for the Use of Energy from Renewable Energy Sources. Both Action Plans define that the share of renewable energy in transport in 2020 shall be 10% in both entities.

In **Bosnia and Herzegovina**, there is no obligation on the fuel suppliers to meet certain greenhouse gas emissions standards. Also, there are no provisions defining minimum GHG reduction requirements for gasoline and diesel.

None of the **two entities** in Bosnia and Herzegovina has approved specific legislation on sustainability criteria for biofuels, bioliquids or biomass. However, two regulations are relevant here:

- Regulation on types, content, quality and participation of biofuels in transport, which is in force in the Republika Srpska (adopted in 2016), and
- Regulation on types, content and quality of biofuels in fuels for motor vehicles, which is in force in the Federation of Bosnia and Herzegovina (adopted in 2008).

The purpose of the Regulation on types, content, quality and participation of biofuels in transport of the **Republika Srpska** is to place on the market biofuels and other renewable fuels of the prescribed quality, as substitutes for diesel or gasoline in transport, in order to fulfill the obligations related to the protection of the environment, securing fuel supply in an environmentally acceptable way and the promotion of the use of renewable energy sources in transport.

In accordance with the regulation, biofuels must meet the quality requirements in accordance with the prescribed standards. Biofuels may be placed on the market as pure biofuels or as biofuels blended with diesel fuel or motor gasoline, only if they meet prescribed technical requirements for fuel quality and if they are marked in accordance with the regulation on fuel quality. Biofuels, which are placed on the market in the Republika Srpska has to be accompanied by the statement of compliance with the prescribed limit values of biofuel quality parameters.

Furthermore, this regulation defines that the Government of the Republika Srpska, at the proposal of the Ministry of Industry, Energy and Mining and with an opinion of the Ministry responsible for environmental protection, adopts a plan which determines the annual content of biofuels in the total share of fuels that must be placed on the market. If a fuel supplier does not fulfil the obligation determined by the plan, the Minister of Industry, Energy and Mining shall issue a decision by which the fuel supplier is obligated in the current year to place on the market the determined amount of biofuels increased by the difference between the amount of biofuel that is not placed on the market in the previous calendar year.

The Regulation on types, content and quality of biofuels in fuels for motor vehicles of the **Federation of Bosnia and Herzegovina** defines the types of biofuels which are placed on the market, as well as quality standards they must fulfil. Biofuels placed on the market have to be accompanied by the Statement of compliance with the prescribed values of quality parameters of biofuels.

In addition, this regulation defines the average annual content of biofuels in all fuels for motor vehicles as follows:

- From 2008 up to 2.00%

- From 2009 up to 3.00%
- From 2010 up to 5.75%

In order to achieve the indicative targets, the Government of the Federation at the suggestion of the Federal Ministry of Energy, Mining and Industry, in agreement with the Federal Ministry of Agriculture, Water-Management and Forestry and the Federal Ministry of Environment and Tourism, determines the annual percentage of biofuels in the total share of fuel on the market, and the annual amount of biofuels to be placed on the market. In accordance with the decision of the Government of the Federation the Federal Ministry of Energy, Mining and Industry adopts the plan of placing biofuels on the market, which determines the annual quantity of biofuels that certain fuel suppliers have to place on the market.

However, the abovementioned targets have not been fulfilled as there has been no enforcement of the blending obligation.

According to the Law on Renewable Energy Sources and Efficient Cogeneration of the Federation of Bosnia and Herzegovina, the Government should have adopted the Regulation on amendments and additions of Regulation on types, content and quality of biofuels in fuels for motor vehicles which should define:

- the minimum share of biofuels in the fuel mix sold to the end users for each year during the period from 2012 up to 2020;
- procedures by which fuel suppliers may prove compliance with the obligation prescribed by the Regulation;
- punitive measures for fuel suppliers that do not fulfil the obligations prescribed by the Regulation.

However, this Regulation on amendments and additions of the Regulation on types, content and quality of biofuels in fuels for motor vehicles has not been adopted to date.

With respect to reporting obligations in the Federation of Bosnia and Herzegovina and the Republika Srpska, abovementioned entities' Regulations contain certain provisions regulating this matter.

Fuel suppliers in the **Republika Srpska** are obligated to submit to the Ministry of Industry, Energy and Mining the following documents:

- an annual plan for turnover of biofuels on the market for the next calendar year;
- a report for the previous calendar year on fulfilment of the obligation regarding the share of biofuels which has to be placed on the market in accordance with the annual plan adopted by the Government;
- quarterly reports on placing biofuels on the market which include data on origin, type, quality, quantity and content of biofuels placed on the market blended with fossil fuels for transport purposes, as well as data on end users.

Fuel suppliers that do not submit reports on placing biofuels on the market shall be punished for an offense with a fine of between 1,000 KM (approx. 500€) and 3,000 KM (approx. 1500€), or with a fine of 500 KM (approx. 250€) to 1,500 KM (approx. 750€) in case the fuel supplier is an entrepreneur.

Table 25: Reporting obligations in Republika Srpska

	Reporting by	Reporting to	Frequency	Monitoring	Exemptions
Regulation on types, content, quality and participation of biofuels in transport of the Republika Srpska	Fuel suppliers (company or entrepreneur that produce, import or place on market of the Republika Srpska liquid fuels)	Ministry of Industry, Energy and Mining	Once a year :/ Quarterly	NA	Fuel suppliers do not have the obligation to report the placing of biofuels on the market of the Republika Srpska for liquid petroleum fuels into which biofuels are blended up to limit value of 7% (v/v) of methyl ester fatty acids or 5% (v/v) of bioethanol.

Fuel suppliers in **Federation of Bosnia and Herzegovina** are obligated to submit to the Federal Ministry of Energy, Mining and Industry the following documents:

- data from records on quantity and type of biofuel, pure or blended, that is placed on the market (monthly);
- report for the previous calendar year on fulfilment of obligations from the plan of placing biofuels on the market which determines the annual amount of biofuel that certain fuel suppliers have to place on the market. An integral part of this report is a report on monitoring performance, made by the appointed inspection body engaged in the performance of the monitoring program.

No penalties are imposed in case fuel suppliers do not comply with the reporting obligations.

Table 26: Reporting obligations in Federation of Bosnia and Herzegovina

	Reporting by	Reporting to	Frequency	Monitoring	Exemptions
Regulation on types, content and quality of biofuels in fuels for motor vehicles of the Federation of Bosnia and Herzegovina	Fuel suppliers (legal or natural person that produce, import and/or place on the market, or extract liquid fuels or is final user of imported, extracted or produced fuel)	Federal Ministry of Energy, Mining and Industry	Monthly / Once a year	NA	None

Rules concerning production of electricity from renewable sources are defined on entity level. The **Federation of Bosnia and Herzegovina** has adopted the Law on Electricity which governs the production of electricity from renewable sources. In accordance with the law, an entity which intends to perform this energy activity must have a permit issued by the Energy Regulatory Commission of the Federation of Bosnia and Herzegovina. Operators of renewable energy sources and efficient cogeneration are eligible for receiving guarantees of origin and for receiving the privileged producer status.

The Law on Renewable Energy Sources and Efficient Cogeneration defines that the Federal Ministry of Energy, Mining and Industry is the competent authority for issuing an energy permit, which is a necessary condition for building renewable energy installations in the Federation of Bosnia and Herzegovina.

In June 2020, the **Republika Srpska** has adopted a new Law on Electricity, which has as a main goal the liberalization of the electricity market. As well, this law stipulates that any entity which intends to perform the energy activity of electricity production must have a permit issued by the Energy Regulatory Commission of the Republika Srpska. Furthermore, the Energy Regulatory Commission of the Republika Srpska is the competent authority for the issuance of guarantees of origin. The Incentives System Operator has been established for performing activities incentivizing electricity production from renewable energy sources.

Furthermore, the new Law on Electricity defines charging services of electric vehicles which may be provided by suppliers to final customers or by owners of public places or by persons managing public places, without the obligation to have issued a permit for electricity supply. However, providers of electric vehicle charging services are obliged to register with the Energy Regulatory Commission of the Republika Srpska.

Charging services of electric vehicles at public places are provided on an ad hoc basis, without concluding a contract with the provider of the charging service. Prices charged by owners of public places for charging have to be justified, easily and clearly comparable and non-discriminatory.

If it is technical feasible and economically justified, publicly available places for charging of electric vehicles use advanced intelligent measuring devices with remote reading and control. Charging points must meet technical requirements defined by the relevant standards for the appropriate type:

- low power charging points for charging of motor vehicles with alternating current – allow transmission of electricity to electric vehicles of power equal to or less than 22 kW, except devices of power less than or equal to 3.7 kW which are installed in private households or whose primary purpose is not charging of electric vehicles, and which are not available to the public;
- high power charging points for charging of motor vehicles with alternating current – allows transmission of electricity to electric vehicle of power more than 22 kW;
- charging points for charging of motor vehicles with direct current;
- charging points for charging of motor vehicles wirelessly;
- points for replacement of batteries of motor vehicles;
- charging points for charging of suitable motor vehicles on two, three or four wheels, including bicycles with auxiliary motor, mopeds and motorcycles on two, three or four wheels;
- charging points for charging of electric busses.
- It should be mentioned that the Energy Regulatory Commission of the Republika Srpska passes the general conditions for delivery and supply to final customers, defined as follows:
- conditions and manner of issuance of electro-energy for connection of new system users, for increase of power of existing system users, including points for charging or supply to electric vehicles;
- conditions and manner of providing the service of electricity supply of electric vehicle charging points.

In addition, in accordance with the Law on Renewable Energy Sources and Efficient Cogeneration of the Republika Srpska, a certificate for production plants may be obtained by an electricity producer for a production plant that generates electricity from renewable sources or that uses efficient cogeneration, in an economically appropriate manner, and in accordance with environmental protection requirements, and which provides all energy data. Obtaining a certificate is a necessary condition for exercising the right to incentives that refer to the production of electricity from renewable energy sources and efficient cogeneration, or for issuance of a guarantees of origin. The certificate for a production plant is issued after obtaining a use permit issued by the competent authority in accordance with the regulations on spatial planning and construction.

The certificate for the production facility is issued by the Energy Regulatory Commission of the Republika Srpska. The certificate shall be issued with a validity period of:

- 15 years for a production plant that uses the energy potential of watercourses, wind energy and solar energy;
- 5 years for a production plant that uses other forms of renewable energy;
- 1 year for an efficient cogeneration plant.

It is important to note that there are no regulations which contain provisions with required criteria related to electricity used directly in transport.

There are several gaps in the legislation which may be filled in the future. This refers among others to renewable fuels of non-biological origin – RFNBO defined in RED II. For the production of RFNBOs no criteria related to electricity used to produce RFNBOs are defined.

Excise duties are regulated at **state level** by the Law on Excise Duties in Bosnia and Herzegovina. According to the law, for petroleum products excise duty is paid per liter, as follows:

▪ diesel fuel and other gas oils	0.30 KM (approx. 0.15€)
▪ kerosene	0.30 KM (approx. 0.15€)
▪ motor gasoline - unleaded	0.35 KM (approx. 0.18€)
▪ motor gasoline	0.40 KM (approx. 0.20€)
▪ heating oil extra light and light special (EL and LS)	0.45 KM (approx. 0.23€)
▪ liquefied petroleum gas for motor vehicles	0.00 KM
▪ biofuels and bioliquids	0.30 KM (approx. 0.15€)

Additionally, a toll as a type of indirect tax shall be paid on:

- biofuels and bioliquids;
- motor gasolines, including unleaded, regardless of octane value and commercial name;
- diesel fuel and other gas oils;
- liquefied petroleum gas for motor vehicles.

The toll amounts to:

- 0.15 KM (approx. 0.08€) per liter of product, or per kilogram of liquefied petroleum gas for roads, and
- 0.25 KM (approx. 0.13€) per liter of product, or per kilogram of liquefied petroleum gas for construction of highways and for construction and reconstruction of other roads, of which 0.20 KM (approx. 0.10€) refers to the construction of highways, and 0.05 KM (approx. 0.026€) to the construction and reconstruction of other roads.

In accordance with the Law on Excise Duties, the toll is not paid on diesel fuel used for the needs of mines, thermal power plants and railway (for the propulsion of rail vehicles), in a quantity approved by the Management Board of the Indirect Taxation Authority of Bosnia and Herzegovina on the proposal of the Governments of **entities and Brčko District** of Bosnia and Herzegovina. In December 2019, the Management Board of the Indirect Taxation Authority of Bosnia and Herzegovina adopted the decision about the quantities of diesel fuel on which are no toll is paid for 2020. The mines and railways of **the Federation of Bosnia and Herzegovina** shall be exempted from the obligation to pay toll for diesel fuel of a total amount of 38,518,760.80 liters for 2020, and the mines, thermal power plants and railways of **the Republika Srpska** shall be exempted from the obligation to pay toll for diesel fuel of a total amount of 32,295,667 liters for 2020.

The regulation of **Bosnia and Herzegovina** does not contain provisions regarding incentives or simplified procedures for construction/licensing of electricity charging stations for road vehicles, or for construction/licensing of hydrogen refueling stations. Certain subjects, such as public garages or public parkings are not obliged to have electric vehicle charging stations.

It should be mentioned that according to available information, there are between 15 and 20 public electric vehicle charging stations in Bosnia and Herzegovina. In the past, in addition to charging stations in Sarajevo, which are public and free of charge, the Public Enterprise Electric Utility of Bosnia and Herzegovina has also installed charging stations in Bihać, Goražde, Mostar, Travnik, Tuzla and Zenica.

7.5.1.4 Passenger transport sector

In accordance with the regulation of **Bosnia and Herzegovina**, registration of cars and other motor vehicles as well as technical inspection and prices are regulated at state level. However, payment of other fees and taxes, which are necessary for vehicle registration, is regulated at entity level, but in the Federation of Bosnia and Herzegovina is regulated at cantonal level[253] and at the level of Brčko District of Bosnia and Herzegovina.

In the **Federation of Bosnia and Herzegovina**, following annual costs are imposed on owners of vehicles:

- tax for ownership of the passenger motor vehicle;
- fee for environmental pollution;
- fee for usage of public roads;
- special fee for water protection.

Tax for ownership of the passenger motor vehicle is regulated on cantonal level and the amount of tax depends on the engine displacement and age of the vehicle – the tax is lower the older the vehicles. However, the tax scale related to the engine displacement and the age of the vehicle differs by cantons. Owners of vehicles older than 10 years are not obliged to

[253] The Federation of Bosnia and Herzegovina consists of ten administrative units called cantons: Unsko-sanski canton, Posavski canton, Tuzlanski canton, Zenicko-dobojski canton, Bosansko-podrinjski canton, Srednjobosanski canton, Hercegovacko-neretvanski canton, Zapadnohercegovacki canton, Sarajevo canton and Canton 10. The cantons were established by the Law on Federal Units (Cantons) on 12th June 1996. and each canton is divided into municipalities. The cantons have the competences not expressly granted to the authorities of Federation of Bosnia and Herzegovina.

pay the tax in Canton 10, Zapadno-hercegovacki canton and Posavski canton, while in Bosansko-podrinjski canton the owners of vehicles up to 2000 cm^3 do not pay the tax regardless of the age of the vehicle. In Hercegovacko-neretvanski canton, this tax depends on the age of the vehicle and on the engine power. In one canton (Tuzlanski canton), owners of electric vehicles are exempted from paying this tax.

The Law on the Environmental Protection Fund of the Federation of Bosnia and Herzegovina and the Regulation on the special environmental fee payable at the registration of motor vehicles regulate the fee for environmental pollution. For passenger motor vehicles the fee amounts to 15 KM (approx. 7.5€) per year and it increases depending on the type of engine and fuel, engine displacement and the age of the vehicle. It should be mentioned that the correction coefficient for the type of engine and fuel is lower for electric and alternative-fueled vehicles. In addition, the correction coefficient which refers to the age of the vehicle is the lowest for vehicles from 0 up to 5 years of age, and the maximum amount shall be paid for vehicles over 30 years of age.

The fee for usage of public roads is determined by the Law on Roads of the Federation of Bosnia and Herzegovina and the Regulation on the amount of the annual fee for public roads which is paid at the registration of motor vehicles and trailers. It defines that the basic fee amounts to 30 KM (approx. 15€), but the total amount of the fee increases depending on the engine displacement of the vehicle (from less than 1001 cm^3 up to 2500 cm^3 and above). In case of LPG, CNG and hybrid vehicles, the corresponding correction coefficient is increased for 25%. It should be mentioned that this fee do not pay owners of passenger vehicles who are disabled persons with 80% or more of body damage, i.e. persons having disability of the lower extremities of 60% or more.

The special fee for water protection is regulated by the Law on Waters and it is paid by the owners of vehicles that use petroleum or petroleum products, and it is calculated based on the amount of water pollution during one year, expressed in terms of population equivalent.

In the **Republika Srpska**, the following annual costs are imposed on owners of vehicles:

- tax on use of passenger motor vehicles, vans and motorcycles;
- fee for environmental pollution;
- fee for usage of public roads;
- special fee for water protection.

The Law on Taxes on the Use, Possession and Carrying of Goods defines that the tax on the use of passenger motor vehicles, vans and motorcycles is paid annually, and is based on their engine displacement. This tax is paid by natural persons and legal entities that own registered passenger motor vehicles, vans and motorcycles.

Table 27: Tax on use of passenger motor vehicles, vans and motorcycles

Cat.	Motor vehicle / Vans Engine capacity, cm^3	Annual tax, KM/approx. €	Motorcycle Engine capacity, cm^3	Annual tax, KM/approx. €
1.	up to 1.150	30/15	up to 125	15/7.5
2.	over 1.150 up to 1.300	40/20	over 125 up to 250	25/12.5
3.	over 1.300 up to 1.600	50/25	over 250 up to 500	50/25
4.	over 1.600 up to 2.000	75/38	over 500 up to 750	250/125
5.	over 2.000 up to 2.500	200/100	over 750 up to 1.100	300/150
6.	over 2.500 up to 3.000	650/325	over 1.100	600/300
7.	over 3.000	1000/500		

The Law stipulates that the annual tax shall be reduced by 5% for each year of age of the vehicle, though the total discount may not exceed 50%.

The Decision on unit fees for environmental pollution by motor vehicles passed by the government of the Republika Srpska defines that the unit fee for passenger motor vehicles amounts to 5 KM (approx. 2.5€) per year. The total amount of fee increases depending on a correction coefficient which refers to the type of engine and fuel, engine displacement and vehicle emission class. It should be mentioned that the correction coefficient for the type of engine and fuel is less for electric and hybrid vehicles, as well as for alternative-fueled vehicles. In addition, the correction coefficient which refers to the vehicle emission class is the lowest for vehicles with EURO 5 and EURO 6 engine standard.

The Regulation on the amount of the annual fee for public roads, which is paid at the registration of motor vehicles and trailers, defines that the fee for passenger motor vehicle depends on its engine displacement. The amount of the fee varies from 35 KM (approx. 17.5€) per year (up to 1100 cm^3) up to 350 KM (approx. 175€) per year (over 3000 cm^3).

The special fee for water protection is regulated by the Law on Waters and by the Government's Decision on rates of special water charges. It is imposed on owners, i.e. users of vehicles which use petroleum or petroleum products, and it depends on the power of the drive unit expressed in terms of population equivalent on the base of 2.00 KM (approx. 1€) /ES.

In the **Brčko District** of Bosnia and Herzegovina, following annual costs are imposed on owners of vehicles:

- fee for usage of public roads;
- special fee for water protection.

The Decision on the amount of the annual fee for the use of roads paid at the registration of vehicles in the Brčko District of Bosnia and Herzegovina defines that the fee for passenger motor vehicles depends on its engine displacement. The amount of the fee varies from 15 KM (approx. 7.5€) per year (up to 900 cm^3) up to 230 KM (approx. 115€) per year (over 3150 cm^3).

The special fee for water protection is regulated by the Water Protection Law and amounts to 9.60 KM (approx. 4.80€) per year for passenger vehicles.

It should be mentioned that in the Brčko District of Bosnia and Herzegovina there are neither taxes for ownership of passenger vehicles, nor fees for environmental pollution.

In March 2019, the Ministry of Communications and Transport of **Bosnia and Herzegovina** has adopted the Decision on the lowest technical requirements for newly manufactured and used vehicles at the approval of a vehicle type and the approval of an individual vehicle and for parts, appliances and equipment, introducing new regulation concerning the import of new and used vehicles.

As per this Decision, from 1st June 2019 vehicles which are imported or placed on the market in Bosnia and Herzegovina for the first time, must fulfil the following minimum exhaust emission standards:

- new vehicles must meet EURO 6 engine standard, and
- used vehicles must meet at least the EURO 5 engine standard.

Custom taxes for vehicles which are imported into Bosnia and Herzegovina are defined on the state level by the Customs Tariff.

The customs rate is 0% for imported vehicles originating from the European Union and the same customs rate applies to vehicles originating from countries which are signatories of CEFTA and EFTA agreements, and for vehicles originating from Turkey. In other cases, the customs rate varies between 5% and 15%. Besides the payment of the customs rate, vehicle owners pay VAT of 17%. There are no special incentives for electric and hybrid vehicles related to customs rate and VAT, except for a customs rate of 5% for vehicles operated on electricity only, if they are originating from countries which are not members of the European Union, or signatories of CEFTA and EFTA agreements, or from Turkey.

The sector of public transport is not regulated in Bosnia and Herzegovina. That means there are no incentives for the use of electricity or renewable fuels in public transport, nor are there any restrictions, limitations or obligations regarding renewable energies in public transport.

7.5.1.5 Freight transport sector

In the area of freight transport, registration of vehicles, as well as technical inspection and prices are regulated at state level. However, payment of other fees and taxes, which are necessary for vehicle registration, is regulated at entity level, but in the Federation of Bosnia and Herzegovina it is regulated at cantonal level and at the level of the Brčko District.

In the **Federation of Bosnia and Herzegovina** owners of freight vehicles are obligated to pay the following fees annually, upon the registration of a vehicle:

- fee for environmental pollution;
- fee for usage of public roads;
- special fee for water protection.

The Law on the Environmental Protection Fund of the Federation of Bosnia and Herzegovina and the Regulation on the special environmental fee payable at the registration of motor vehicles regulate the fee for environmental pollution. For freight vehicles the fee amounts to 90 KM (approx. 45€) per year and it increases depending on the type of engine and fuel, engine displacement and the age of the vehicle.

The fee for usage of public roads is determined by the Regulation on the amount of the annual fee for public roads which is paid at the registration of motor vehicles and trailers. It defines that the basic fee amounts to 30 KM (approx. 15€) per year, but the total amount of the fee increases depending on a correction coefficient which refers to the maximum authorized mass of the vehicle (from less than 1 t up to 32 t and above). In case of LPG, CNG and hybrid vehicles, the corresponding correction coefficient is increased for 25%.

The special fee for water protection is regulated by the Law on Waters and is paid by the owners of vehicles that use petroleum or petroleum products. It is calculated based on the amount of water pollution during one year, expressed in terms of population equivalent.

In addition, in some cantons of the Federation of Bosnia and Herzegovina there is a tax for ownership of freight vehicles whose amount depends on the mass of the freight vehicle. In one canton, owners of electric freight vehicles are exempted from paying this tax.

In the **Republika Srpska** owners of freight vehicles are obligated to pay the following fees annually, upon the registration of vehicle:

- fee for environmental pollution;
- fee for usage of public roads;
- special fee for water protection.

The Decision on unit fees for environmental pollution for motor vehicles passed by the Government of Republika Srpska defines that the unit fee for freight vehicles amounts to 15 KM (approx. 7.5€) per year. The total amount of the fee increases depending on a correction coefficient which refers to the type of engine and fuel, engine displacement and vehicle emission class.

The Regulation on the amount of the annual fee for public roads which is paid at the registration of motor vehicles and trailers defines that the fee for freight vehicles depends on the maximum authorized mass of the vehicle (from less than 1 t up to 12 t and above). The amount of the fee varies from 25 KM (approx. 12.5€) per year up to 300 KM (approx. 150€) per year and higher for freight vehicles whose mass is over 12 t.

The special fee for water protection is regulated by the Law on Waters and by the Government's Decision on rates of special water charges. It is imposed on the owners, i.e. users of vehicles which use petroleum or petroleum products, and it depends on the power of the drive unit expressed in terms of population equivalent on the base of 2.00 KM (approx. 1€)/ES.

In the **Brčko District** of Bosnia and Herzegovina owners, i.e. users of freight vehicles are obligated to pay the following fees upon the registration of vehicle:

- fee for usage of public roads;
- special fee for water protection.

The Decision on the amount of the annual fee for the use of roads paid at the registration of vehicles in the Brčko District of Bosnia and Herzegovina defines that the fee for freight vehicles depends on the mass of the vehicle. The amount of the fee varies from 50 KM (approx. 25€) per year (for vehicles up to 3 t, and it is paid for each ton) up to 520 KM (approx. 260€) per year and higher for freight vehicles whose mass is over 10 t.

The special fee for water protection is regulated by the Water Protection Law and amounts to 24 KM (approx. 12€) per year.

Rules related to exhaust emissions of vehicles imported or placed on the market in Bosnia and Herzegovina for the first time are listed in section 7.5.1.5.

7.5.1.6 Railway sector

The Law on Railway of **Bosnia and Herzegovina** prescribes that any person that intends to engage in rail transport services or management of infrastructure in Bosnia and Herzegovina is obliged to submit a request for issuing a license, security certificate or permit.

A license is defined as the authorization by which the status of a railway operator is acquired. By safety certificate, railway operators prove that they fulfil defined safety conditions for safe transport, and a permit is the authorization by which the status of infrastructure manager is acquired.

There are no provisions on incentives or obligations for use of electric locomotives, and also there is no act which imposes the use of electricity from renewable energy for railway transport.

Table 28: Authorizations related to the railway sector in Bosnia and Herzegovina

Type	Subjects	Competent authority for issuance
License	Railway operator	Railway Regulatory Board of Bosnia and Herzegovina
Security certificate	Railway operator	Railway Regulatory Board of Bosnia and Herzegovina
Permit	Infrastructure manager	Railway Regulatory Board of Bosnia and Herzegovina

7.5.2 Roadmap to achieve the 2030 target

The roadmap developed here for Bosnia and Herzegovina to achieve the 2030 target of 9% renewable energies in transport builds on the provisions of RED II as described in section 3.1.1. It is assumed that these provisions are transposed into the law of Bosnia and Herzegovina without changes including the calculation method for renewables in transport, the caps and minimum values for various types of renewable energies, the multipliers, the provisions related to electricity and RFNBOs etc. Also, sustainability criteria need to be transposed into national law in order to fully comply with RED II, and it must be ensured that certification schemes are in place (national or voluntary) that are compliant with RED II requirements.

For this study, we apply the renewable share in the national electricity mix anticipated for 2030. On the one hand, this tends to overestimate the renewable share as values for the year 2028 that should be applied are not available, but should in general be lower than the 2030 values. On the other hand, dedicated renewable power plants may be erected that are counted as 100% renewable for transport.

For Bosnia and Herzegovina, a 53% renewable electricity mix is anticipated for 2030 based on literature values.[254] This is without prejudice to 2030 targets to be defined and included in the NECP.

It should be noted that the national electricity mix is applied to electricity in transport for calculating the contribution of renewable electricity to the 20303 RES-T target. However, RED II allows electricity to be counted as 100% renewable if it is based on dedicated capacities for transport, and further criteria are met.

[254] TU Wien/Energy Economics Group, Joanneum Research, REKK: Study on 2030 overall targets (energy efficiency, RES, GHG emissions reduction) for the Energy Community. Vienna 2019

7.5.2.1 Potential contributions from all options

Based on the assessment of all options for Bosnia and Herzegovina, a total RES-T share of 9.9% in 2030 can be achieved as a combination of all options (see Table 29). Further limited potentials exist in renewable liquid fuels in aviation, which are assumed to be zero here.

Biofuels potentially contribute most in 2030. Renewable electricity in rail represents the only renewable energy consumption in transport today, and can be expanded through increasing the renewable share in the national electricity mix, and by expanding electrified rail transport.

Electric and hydrogen vehicles can already make small contributions by 2030, and have a strong growth potential thereafter.

Table 29: Potential RES-T contributions from all options in Bosnia and Herzegovina

Option		Contribution to RES-T target (%) incl. multiple counting	Amount of renewable fuel used (ktoe)
Biofuels and liquid RFNBOs	1. Crop-based biofuels in road transport	2.0%	42.6
	2. Liquid fuels produced from Annex IX B feedstocks in road transport	3.4%	36.2
	3. Liquid advanced Biofuels (based on Annex IX A feedstocks) in road transport	3.3%	35.4
	4. Liquid RFNBOs in road transport	0.180%	3.84
	5. Renewable methane in road transport	0.176%	1.88
	6. Renewable liquid fuels in shipping	0.000%	0.00
	7. Renewable liquid fuels in aviation	0.000%	0.00
	8. Renewable liquid fuels in rail	0.000%	0.00
Electricity	9. Rail electrification	0.414%	5.9
	10. Electric public transport (bus, trolleybus, tram, metro)	0.007%	0.06
	11. Electric road vehicles (passenger cars and trucks)	0.306%	1.63
Hydrogen	12. Hydrogen in rail	0.000%	0.00
	13. Hydrogen bus and coach (urban bus, long distance coaches)	0.003%	0.06
	14. Hydrogen road vehicles (passenger cars and trucks)	0.076%	1.63
	15. Hydrogen in refineries	0.000%	0.00
Total		9.9%	129

As the possible contributions of battery-electric vehicles depend on many factors, the following considerations are intended to provide some insight into the dynamics and opportunities (see Figure 83). The graph is based on a number of approximate assumptions, and should thus be understood as rough indication showing the general trends.

Battery-electric cars' contribution to the RES-T target is calculated by applying the renewable share in the national electricity mix to the use of electricity in BEVSs[255].

Electricity provided through public charging stations is covered in statistics as energy consumed in transport, and thus counted accordingly; charging through private charging units is not covered in statistics. Therefore, RED II foresees a multiplier of four for electricity consumed in road transport (based on data from statistics).

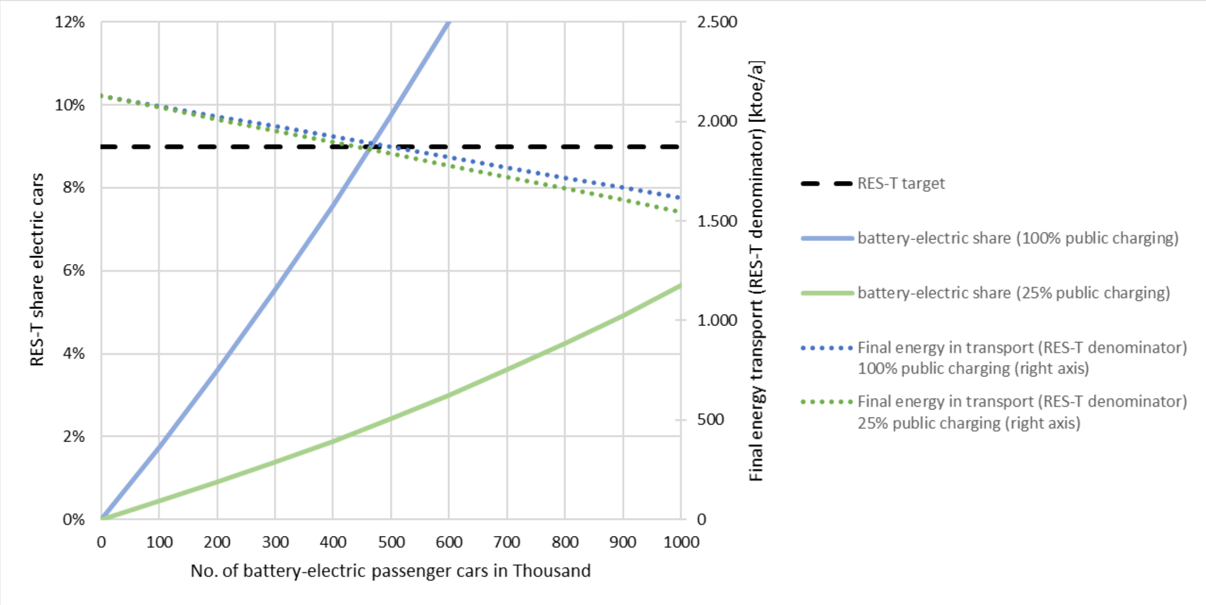

Figure 83: **Possible contributions of battery cars to Bosnia and Herzegovina's 2030 RES-T target**

The RES-T contribution of battery cars depends on:

- The number of battery cars (horizontal axis in Figure 83);
- The share of public charging (green/ blue line in Figure 83 assuming 25% and 100% public charging, respectively);
- The renewable share in the national electricity mix in 2028 (53% for Bosnia and Herzegovina); higher/ lower RES shares would reduce the contribution accordingly.

Assuming 25% public charging, 400 thousand battery cars would approximately contribute 1.9% RES-T by 2030 (see Figure 83).

[255] However, if certain criteria are met (see RED II), renewable electricity can be counted as 100% renewable. This is not assumed in this study for option 11.

As battery cars are more energy efficient than conventional cars and the electricity is only partly covered in statistics energy consumption in transport decreases with increasing battery cars (dotted lines in Figure 83).

7.5.2.2 Choice of options to meet RES-T target

The potential contribution of all options exceeds the target, and thus allows reducing the contributions from some options. The reductions are based on the general considerations described in section 5.1, and on the specific circumstances in Bosnia and Herzegovina as described in the following:

1. Crop-based biofuels are used up to the 2% cap. For comparison, if Bosnia and Herzegovina's current operational biodiesel plant operated at full capacity, it would produce approximately 160 ktoe/yr of fuel: more than enough to supply the 2% target, which equates to 42.6 ktoe.
2. Biofuels based on Annex IXB biofuels can be reduced to 2.7%. For comparison, this amounts to 42.6 ktoe, or approximately 27% of the existing plant's capacity[256]. 30% of this supply could be met from domestic collectable UCO and tallow resources;
3. Liquid biofuels and biomethane based on Annex IXA feedstocks ("advanced biofuels") are developed to meet the minimum targets defined in RED II. For context, this is equivalent to approximately the output of an advanced ethanol plant at typical scale of 63 million l fuel/year;
4. Relatively expensive RFNBOs are not required in road transport to meet the 2030 target;
5. Biomethane is used in small quantities in existing gas vehicles, up to a level equivalent to the current amount of biomethane used in electricity production, to contribute to the advanced biofuels target (see No. 3 above);
6. There is no domestic navigation in Bosnia and Herzegovina;
7. No renewable fuels in aviation are required to meet Bosnia and Herzegovina's RED II target;
8. No liquid fuels are consumed in rail today, so no renewable liquid fuels for rail are assumed here;
9. Increasing the national renewable share in electricity, maintaining and installing catenaries at non-electrified rail lines or closing non-electrified rail gaps as well as keeping the share of rail electricity in overall transport energy consumption by extending rail transport accordingly are assumed;

[256] NB This does not imply that supply need necessarily come from this plant, or from domestic production, nor that this plant is suitable for processing waste oils

10. The introduction of battery buses and the expansion or establishment of trolley bus systems, or trams in cities is assumed here;
11. The market uptake of battery-electric road vehicles (cars and light/ medium duty trucks) leads to electricity consumption in transport;
12. Rail lines in Bosnia and Herzegovina are largely electrified; therefore, no contributions of hydrogen in rail are assumed here. However, existing and potentially new rail lines not suitable for electrification allow establishing zero emission hydrogen fuel cell trains;
13. Introduce hydrogen fuel cell buses in urban areas, and (long-distance) coaches in applications not suitable for battery-electric vehicles (high daily driving range, long-distance);
14. Start of market uptake of hydrogen fuel cell-electric road vehicles (cars and light to heavy duty trucks) for long-distance, high driving ranges;
15. Use of renewable hydrogen in refineries could be an option for the future, but is not assumed here for a contribution by 2030. Current hydrogen production and opportunities for renewable hydrogen use in the Bosanski Brod refinery. Possible hydrogen demand that would be served from renewable sources could contribute to the RES-T target.

This results in the following contributions by 2030 assumed to be realistic and reducing the most challenging or expensive[257] options to meet the defined 2030 RES-T target:

Table 30: Contribution to Bosnia and Herzegovina's RES-T target from options chosen

	Option	Multiplier	2030 Contribution to RES-T target incl. Multipliers	2030 Amount of renewable fuel used (ktoe)
Biofuels and liquid RFNBOs	1. Liquid crop-based biofuels in road transport	1	2.0%	42.6
	2. Liquid fuels produced from Annex IX B feedstocks in road transport	2	2.7%	28.7
	3. Advanced liquid biofuels (based on Annex IX A feedstocks) in road transport	2	3.3%	35.4
	4. Liquid RFNBOs in road transport	1	0%	0
	5. Renewable methane in road transport	2	0.176%	1.9
	6. Renewable liquid fuels in shipping	2	0%	0%
	7. Renewable liquid fuels in aviation	2	0%	0%
	8. Renewable liquid fuels in rail	2	0%	0%
Electricity	9. Rail electrification	1.5	0.41%	5.9
	10. Electric public transport (bus, trolleybus, tram, metro)	4 (road) 1 (tram, metro)	0.007%	0.1
	11. Electric road vehicles (passenger cars and trucks)	4	0.31%	1.6
Hydrogen	12. Hydrogen in rail	1	0%	0
	13. Hydrogen bus and coach (urban bus, long distance coaches)	1	0.003%	0.1
	14. Hydrogen road vehicles (passenger cars and trucks)	1	0.076%	1.6
	15. Hydrogen in refineries	1	0%	0
Total			**9.0%**	**118**

[257] Detailed cost assessments have not been carried out in this study. Rough cost judgements are made here based on costs information provided in chapter 3.

Strong contributions are made by all three types of biofuels; moderate contributions are made by electricity in rail, electric road vehicles and biomethane in road transport; limited contributions are made by electric public transport and by hydrogen in road vehicles, buses and coaches.

The contribution from electricity in rail and all other forms of transport assumes a 53% share of renewable electricity in power by 2030. If this was lower, all options using electricity directly or hydrogen would make a smaller contribution to the 2030 target. A higher renewable share in the national electricity mix or dedicated renewable capacities would increase the renewable contribution of rail and all other forms of transport, which are based on electricity or hydrogen.

The high proportion of Annex IXA (advanced) biofuels is driven by the sub-target in RED II and relies on successful scale-up in production of liquid Annex IXA biofuels globally. Should this prove not to be feasible, crop-based biofuels or biofuels based on Annex IXB could be increased, which would, however, not allow the sub-target for advanced biofuels in RED II to be met.

These contributions lead to a breakdown of fuel consumption in 2030 as shown in section 7.3.2.

7.5.2.3 Roadmap for Bosnia and Herzegovina

The roadmap for Bosnia and Herzegovina to achieve the 2030 target for renewable energies in transport (see Figure 84) involves key policies to be developed and adopted in the coming few years, building on the existing regulatory framework and policy elements already under development (see section 7.5.1). The development of the regulatory framework so far focuses on biomass-based fuels, but already includes certain policy elements targeting direct electricity use in road vehicles. Hydrogen use in road transport has received less emphasis so far, but should be taken up as additional central pillar for renewables in transport together with biofuels and electricity.

The roadmap foresees that the last elements of the regulatory framework should be in place by the end of 2022.

The appropriateness, effectiveness and efficiency of this policy framework should be evaluated in around 2025, and should be adjusted where necessary to ensure target compliance by 2030. The European Union is currently developing the details of the European Green Deal, which aims to make the European Union climate neutral by 2050 by turning climate and environmental challenges into opportunities, and making the transition just and inclusive for all. Based on a set of policy initiatives by the European Commission, climate ambitions by 2030 are anticipated to be increased, which includes adjustments to RED II. A revision of the policy framework in Bosnia and Herzegovina around the middle of the decade would be timely for taking up decisions to be taken at European Union level by then.

Around 2028 would be a suitable point in time to set targets for the 2040 timeframe, and to revise and adjust the strategies and policies accordingly.

Currently, Bosnia and Herzegovina is developing its first National Energy and Climate Plan (NECP), which has a planning and a monitoring function. The biannual progress reports and the regular revisions of the National Energy and Climate Plans are the appropriate instrument for monitoring successful implementation and development towards the 2030 target, and will be helpful for the 2025 revision of the policy framework.

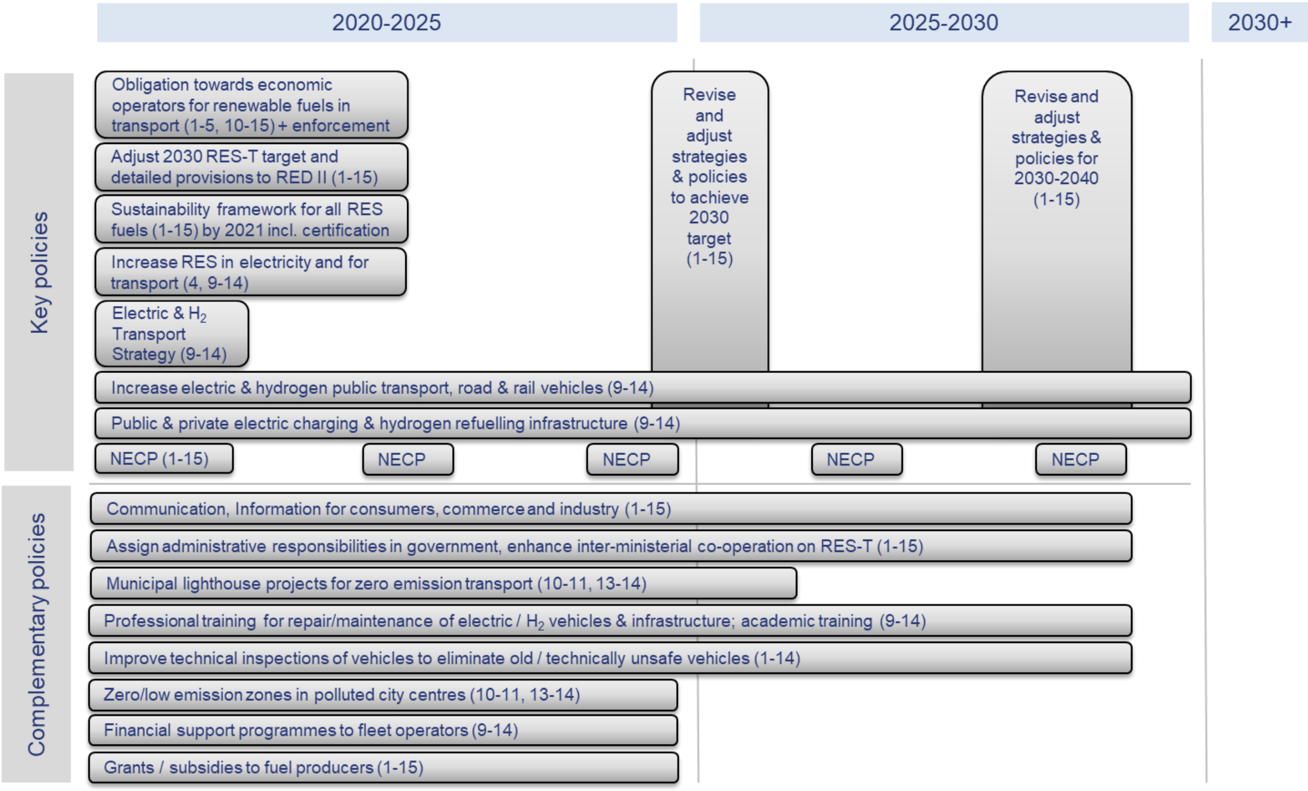

Figure 84: Overview roadmap for Bosnia and Herzegovina

The priority in the roadmap for biofuels is to establish policy to drive uptake of these fuels through an obligation on fuel suppliers to supply a minimum proportion of these fuels, through a regulation similar to the biofuels blending regulations in place today, which are not currently enforced. Revision and implementation of this policy mechanism should be started as soon as possible, to allow industry as much time as possible to adjust and prepare to meet 2030 targets. This obligation needs to be supported through a number of other policy elements such as rules for certification and compliance of biofuels, sustainability criteria for biofuels, and rules for calculating the impact of biofuels on the greenhouse gas emissions, developed based on the provisions of RED II. Additional attention may need to be given to criteria on production of liquid RFNBOs, alongside the rules on hydrogen (below) as these do not appear to be covered within existing activities. A unit within the relevant government ministry must be designated responsible for implementing, reviewing and updating the policy as a whole, ensuring sustainability certification of fuels, administering the scheme, data collection and reporting.

Several other measures that are complementary to this demand-side policy have also been important in other countries, namely support for domestic fuel production, such as capital grants for plants, and information provision for consumers on fuel switching and vehicle compatibility, and a review of taxation policy to ensure that these align with the desired policy outcomes. Some tax and customs elements currently provide counterproductive incentives including e.g. exempting LPG from excise duties at national level while biofuels are taxed.

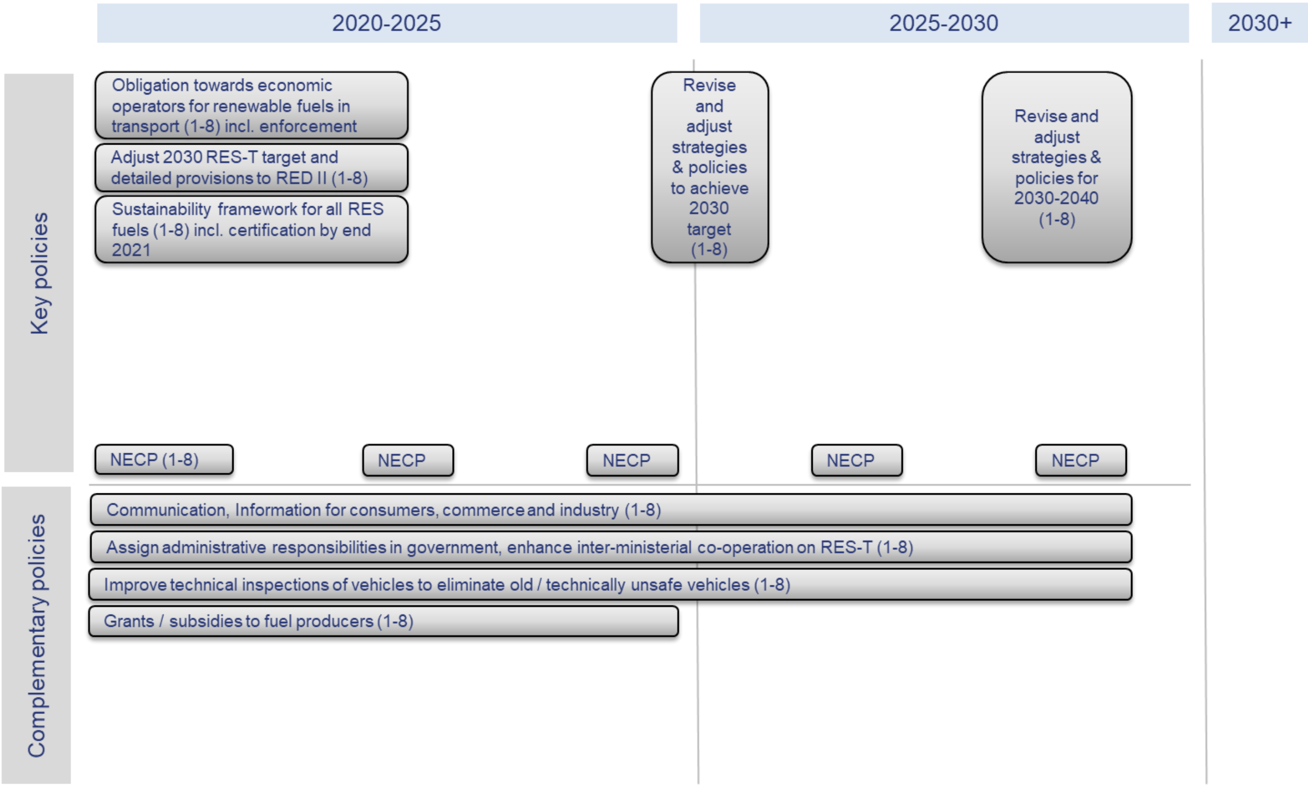

Figure 85: Roadmap for Bosnia and Herzegovina – Biofuels and liquid RFNBOs

Direct electricity use in transport is already established in Bosnia and Herzegovina in the rail sector, but only represents a small share of transport energy consumption, and also in the tramway in Sarajevo. Policies supporting renewables in transport should include maintaining and further strengthening electricity use in these sectors.

Battery-electric road transport including passenger cars, public transport and delivery vehicles is in an early stage of development in Bosnia and Herzegovina, and has a significant growth potential. Developing a national electric transport strategy would be an appropriate starting point for a coherent and effective policy framework in this area. Various policies for fostering electric transport could be envisioned, such as including renewable electricity in the obligation on fuel suppliers for increasing the share of renewable energies in transportation fuels (see above), or putting an obligation on electricity suppliers for providing renewable electricity to transport, etc.

An additionality framework for renewable electricity would define rules for counting electricity as renewable based on RED II[258], and detailed provisions are currently under development by the European Commission. This aims at fostering additional renewable power capacities for transport not compromising the achievement of renewables electricity targets in conventional electricity consumption.

In parallel, existing policies for increasing renewable electricity production should be adjusted by increasing renewable targets for 2030 that would include additional renewable electricity demand from transport. Fostering dedicated renewable capacities for transport could be a new element introduced into existing legislation, covering rail, public transport and road.

Increasing the number of electric vehicles in road, rail and public transport is a major lever for increasing the consumption of electricity in transport, and reducing conventional fuel consumption. Elements for such policies include providing direct financial support for purchasing electric vehicles, and adjusting the tax and import duty structures to incentivize purchases of electric vehicles[259]. The vehicle charging infrastructure is the second major lever. Policies to coordinate and incentivize the build-up of a public network of charging stations include elements of financial incentives through grants, subsidies and loans, clear permitting rules, and coordination to ensure an appropriate nationwide network structure. In addition, financial support to charging infrastructures for public transport and fleet operators is an effective and efficient instrument for rapid growth.

The appropriate administrative structures must be established including enhanced inter-ministerial co-operation, and related responsibilities assigned in government.

Further complementary policies supporting electric transport include communication and information campaigns, lighthouse projects at local/ municipal level, the establishment of zero or low emission zones in urban areas for reduced air pollution, professional and academic training, technical inspections of vehicles (both electric and conventional), etc.

[258] See RED II Art. 27(3)

[259] Incentives for electric vehicles are limited and fragmented; see section 7.5.1.

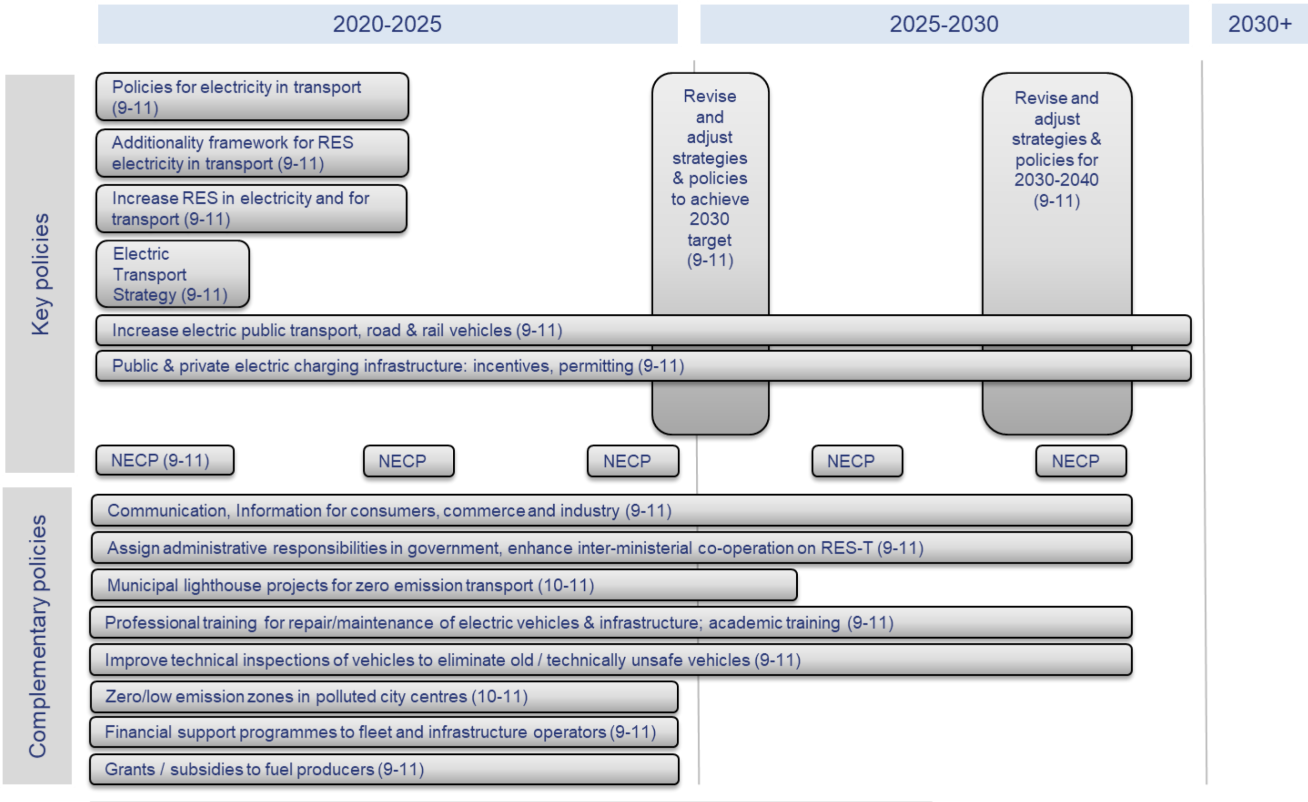

Figure 86: Roadmap for Bosnia and Herzegovina – Electricity in Transport

Hydrogen in transport using fuel cell-electric vehicles is in early phases of commercialization world-wide, and shows major potential for decarbonizing transport in a complementary fashion to battery-electric vehicles. On non-electrified rail lines, first commercial hydrogen trains are in operation, and fuel cell vehicles are coming onto the market. A focus will be on vehicles for longer distances and for duty purposes such as trucks and buses.

Hydrogen can be included in the obligation on fuel suppliers as an option, as provided for in RED II. Further key policy elements are rather similar to electricity in transport: developing a national strategy, defining an additionality framework, increasing renewable electricity capacities for hydrogen production, supporting the market uptake of vehicles, and supporting the establishment of hydrogen refuelling stations. Renewable hydrogen use in refineries could be an additional opportunity.

Also, the complementary policies are similar to electricity.

The related policies should be established together with those for biofuels and electricity, while the market may take up a few years later based on an earlier status in commercialization.

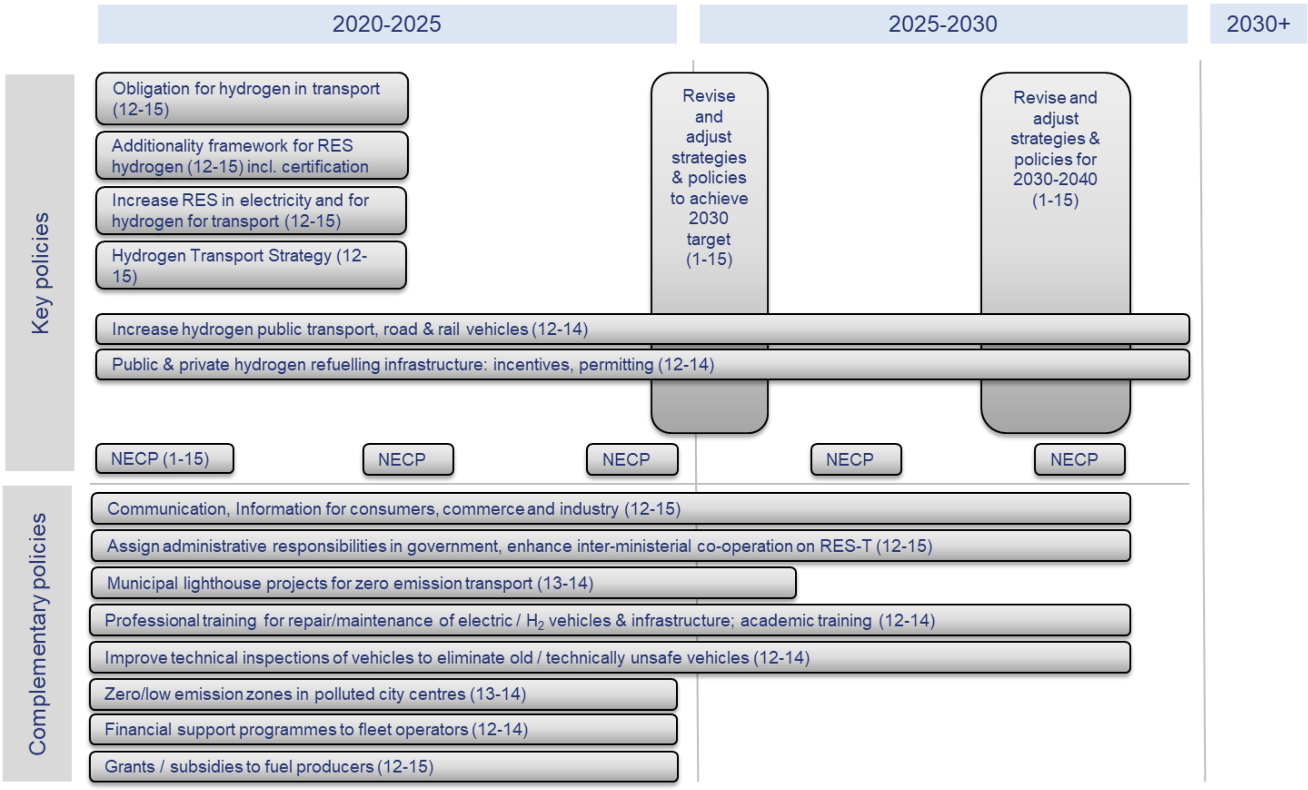

Figure 87: Roadmap for Bosnia and Herzegovina – Hydrogen in Transport

7.6 Conclusions and recommendations

7.6.1 Conclusions

Bosnia and Herzegovina has a number of options to achieve the 2030 RES-T target of 9%.

It should be noted that even with target achievement, the anticipated strong consumption growth will result in increased fossil fuel imports relative to 2018. Therefore, even higher ambitions could be beneficial in economic and environmental terms.

The existing obligations on fuel suppliers in the two entities (Federation of Bosnia and Herzegovina: 2008, Republika Srpska: 2016) are not enforced; as a consequence, no biofuels are consumed in Bosnia and Herzegovina.

Of the 9% overall renewables target in transport, crop-based biofuels are capped at 2%, while 7% need to be achieved by other renewable fuels.

Biofuels are anticipated to contribute most to the 2030 target.

Electricity use in rail can make a relevant contribution if the renewable electricity share reaches the 2030 value of 53% as assumed for this study, and if rail is extended to keep its share in transport energy consumption.

Electric road vehicles have notable potential, which is anticipated to be used towards 2030 with a dynamic growth potential beyond 2030 to allow for a major RES-T share by 2050.

Hydrogen and battery-electric vehicles are complementary as hydrogen fuel cell vehicles enable longer driving distances, and are suitable for cars and heavy-duty transport alike; dynamic growth beyond 2030 is anticipated.

Additional benefits of achieving the 2030 RES-T target include the reduction of fossil energy import dependence and related financial flows out of the territory, additional national value creation, new or enhanced national value chains with related economic benefits and possible job creation as well as additional contributions to the national climate targets, etc.

7.6.2 Recommendations

As a proven policy tool, Bosnia and Herzegovina should adopt a 2030 target for renewable energies in transport based on RED II.

In Bosnia and Herzegovina, legislation is in place setting obligations for certain quantities of biofuels on the market. However, these are not enforced, and targets are not achieved. Bosnia and Herzegovina should revise and expand the legislation to include all elements of RED including most notably obligations on fuel suppliers including their enforcement, and a sustainability framework including certification. It is recommended to base such legislation on RED II in order to have a legislative framework based on the latest relevant policies as well as technological and commercial developments.

All elements of the regulatory framework should be in place by the end of 2022.

Further key policy elements need to be established in order achieve the 2030 RES-T target:

- Check and adjust taxation system to provide incentives for renewable fuels as well as electric and hydrogen vehicles, and disincentives for fossil fuels
- strategy and support mechanisms for electricity in transport
- strategy and support mechanisms for hydrogen in transport

Complementary policies are recommended to be established in order to ensure target achievement and maximum benefits to the economy in Bosnia and Herzegovina.

Co-benefits with other policy areas should be actively developed. This includes air quality improvements in urban areas and other environmental and health issues as well as economic benefits such as reduced fossil fuel imports, job creation, national value creation, etc.

Furthermore, co-operation with other Contracting Parties, and more generally with other countries, allows synergies and should thus be pursued.

Policies should be revised and possibly adjusted in around 2025 based on a policy and results evaluation.

The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target.

8 GEORGIA

8.1 Executive Summary

The implementation of the revised Renewable Energy Directive (EU) 2018/2001 (RED II) on the promotion of the use of energy from renewable sources has started to be discussed within the Energy Community. Currently, RED II is not a part of the Energy Community acquis; but the adaptation and transposition by the Contracting Parties could be envisaged. Assuming for this study that the provisions of RED II are transposed into Georgian law without changes, we develop a roadmap for Georgia to achieve the 2030 target for renewables in transport of 9%[260].

Georgia has a share of renewable energy in transport of around 2% through electricity consumption in rail. Biofuels are not consumed in Georgia yet; however, a first biofuel production plant started operation in July 2018.

Georgia can choose from a number of options to achieve the 2030 RES-T target of 9%. In fact, significant over-achievement beyond 13% is possible. However, even with more than 13% contribution in 2030, the anticipated consumption growth over the coming decade is expected to result in increased fossil fuel imports relative to 2018.

Crop-based biofuels are capped at 2% by RED II, and 7% need to be achieved by other renewable fuels. While crop-based and advanced biofuels are anticipated to contribute most to the target, electricity use in rail can contribute almost as much if the renewable electricity share reaches the 2030 value of 100% as assumed for this study. Electric road vehicles can contribute to the 2030 target, with a strong growth potential beyond 2030. Hydrogen and battery-electric vehicles are complementary where hydrogen enables long driving distances, and heavy-duty operation alike; a small contribution by 2030 and dynamic growth thereafter is anticipated.

Additional benefits of achieving the 2030 renewables target in transport include reduction of fossil energy import dependence and related financial flows out of the territory, export opportunities, additional national value creation, new or enhanced national value chains with related economic benefits and possible job creation as well as additional contributions to the national climate targets, etc. [261]

As a proven policy tool, Georgia should adopt a 2030 target for renewable energies in transport based on RED II.

---

[260] The overall target for RES-T of 14% can be reduced as far as the cap on crop-based biofuels is lower than 7%. As the cap on crop-based biofuels for Georgia is 2% based on the 2020 biofuels consumption, the overall target is reduced to 9%.

[261] Such benefits are not analysed in this study, but have been assessed in various studies, e.g. for hydrogen in Fuel Cells and Hydrogen Joint Undertaking (2019): Hydrogen Roadmap Europe – a sustainable pathway for the European energy transition; and in
Fuel Cells and Hydrogen Joint Undertaking (2020): Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans.

Georgia adopted the Law of Georgia on Promoting the Production and Use of Energy from Renewable Sources at the end of 2019. Major policy elements for renewables in transport are already foreseen to be established in Georgia by the end of 2021. Further key policy elements need to be established in order achieve the 2030 RES-T target, including most notably an obligation on fuel suppliers to provide renewable transportation fuels to the market, and its enforcement. A national strategy for electricity and hydrogen in transport should be developed in the short-term, and related policies including support mechanisms should be implemented. Complementary policies for all renewables in transport are recommended to be established in order to ensure 2030 target achievement and maximum benefits to the Georgian economy.

Without prejudice to any possible legal, political or contractual obligations, all elements of the regulatory framework should be in place at the latest by the end of 2022 in order to give industry as much time as possible to plan, invest, implement and operate.

Co-benefits with other policy areas should be actively developed. This includes air quality improvements in urban areas and other environmental and health issues as well as economic benefits such as reduced fossil fuel imports, job creation, national value creation, etc.

Furthermore, co-operation with other Contracting Parties, and more generally with other countries, allows synergies and should thus be pursued.

Policies should be revised and possibly adjusted in around 2025 based on a policy and results evaluation.

The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target.

8.2 Introduction

The Energy Community Contracting Parties including Georgia have the obligation to reach binding targets for renewable energy in gross final energy consumption by 2020. For the transport sector, the binding target is a minimum 10% of renewable energy (RES-T) by 2020. Georgia will not achieve this target.

The implementation of the revised Renewable Energy Directive (EU) 2018/2001 (RED II) on the promotion of the use of energy from renewable sources has started to be discussed within the Energy Community. Currently, RED II is not a part of the Energy Community acquis; but the adaptation and transposition by the Contracting Parties could be envisaged.

It is assumed here that the provisions of RED II are transposed into Georgian law without changes. On this basis, we develop a roadmap for Georgia to achieve the 2030 target for renewables in transport of 9%.

As a starting point, this study analyses the status quo of energy consumption in transport in Georgia, and provides 2030 projections including a business as usual scenario, and a scenario for compliance with the 2030 target for renewable energies in transport according to RED II.

In the second section, we assess the potential of national renewable energy sources suitable for use in transport, or for the production of transportation fuels together with the status of fuel pathway deployment in Georgia.

The third section describes the regulatory status quo related to renewable energies in transport. On this basis, we develop a roadmap for Georgia to achieve the 2030 target for renewables in transport on the three pillars of biofuels, electricity and hydrogen covering all transport sectors.

The final section provides conclusions and recommendations.

8.3 Status quo and 2030 projections of renewable energy consumption in transport

The objective of this chapter is to review the current status of renewable energies in transport (RES-T) in Georgia, and to develop scenarios of the development of renewable energy shares in transport by 2030.

The following data includes neither international aviation nor international navigation.

8.3.1 Status Quo

The following data includes neither international aviation nor international navigation as these two segments are generally excluded from statistics such as the Eurostat energy balances.

8.3.1.1 Transport Indicators

Passenger transport by road has the largest volume and has slowly but steadily increased in the past years. Available data do not distinguish between transport by car and transport by bus, unfortunately.

There are also significant shares of transport by metro and by train. Transport by train decreased until 2015 and has increased again in recent years. Transport by metro has continuously increased since 2010.

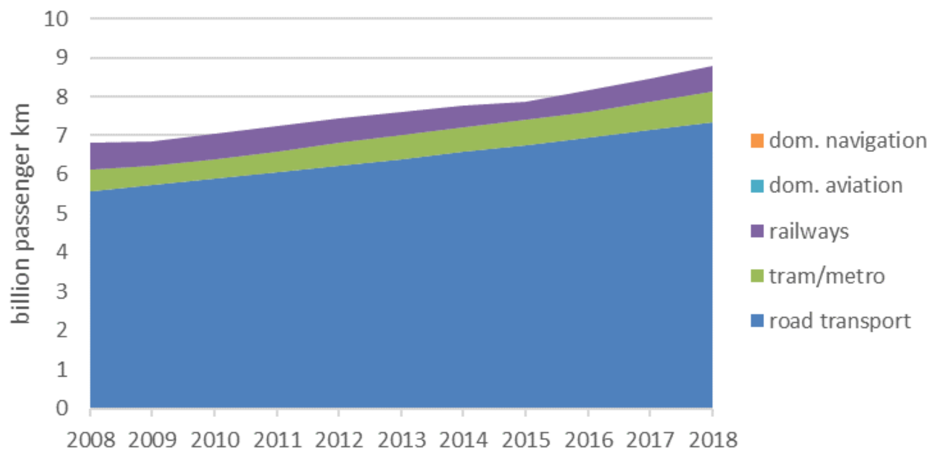

Figure 88: Passenger transport by transport mode[262]

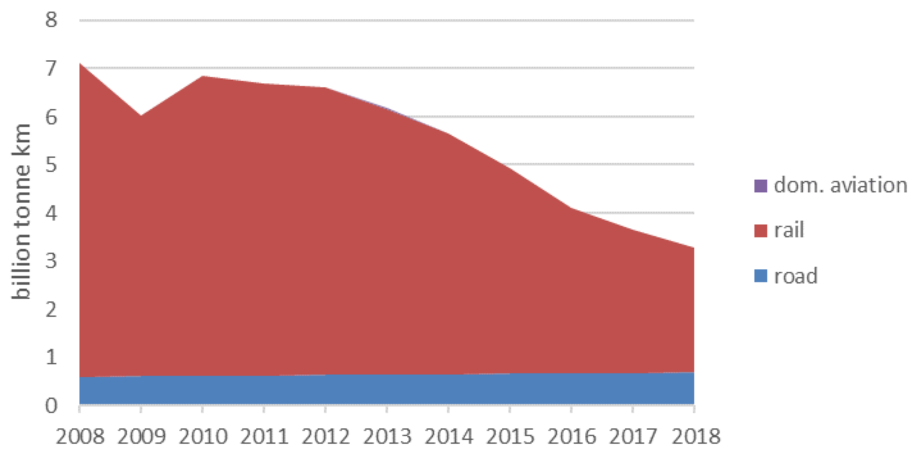

Figure 89: Freight transport by transport mode[263 264]

Rail is the dominant mode of transport for freight in Georgia. However, the volume of freight transport by rail has dropped by more than 50% since 2010. This decrease is the reason for

[262] National Statistics Office of Georgia (GEOSTAT): Environmental Indicators. (n.d.): Available at https://www.geostat.ge/en/modules/categories/565/environmental-indicators, last accessed 02. APR 2020

[263] National Statistics Office of Georgia (GEOSTAT): Statistical Yearbook of Georgia 2012. Tbilisi 2013: https://www.geostat.ge/media/20937/Yearbook_Georgia_2012.pdf

[264] National Statistics Office of Georgia (GEOSTAT): Statistical Yearbook of Georgia 2019. Tbilisi 2019: https://www.geostat.ge/media/28916/Yearbook_2019.pdf

the overall decrease in freight transport. Transport by road has remained constant during the past years. Data for domestic navigation is not available.

8.3.1.2 Registered Road Vehicles

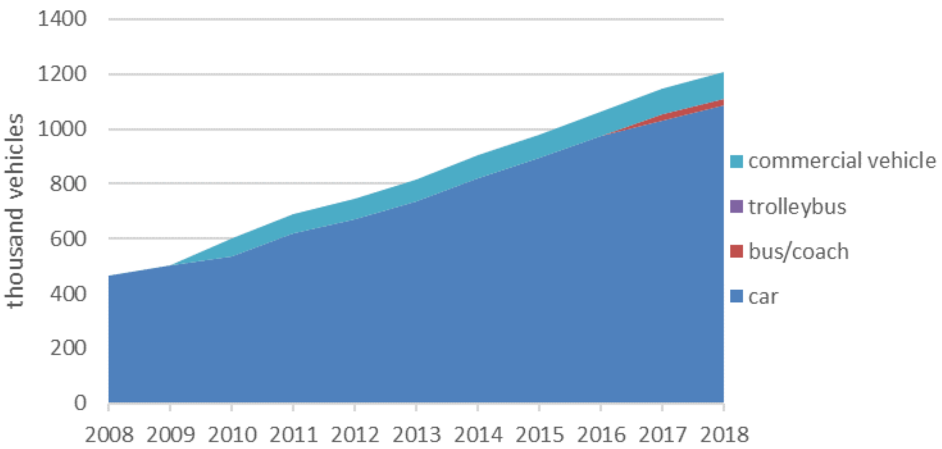

Figure 90: Registered road vehicles by type of vehicle[265]

The number of cars has increased continuously and rapidly in the past years. In 2018, there were more than twice as many cars as in 2008. Data for buses and coaches is available only for 2017 and 2018.

8.3.1.3 Energy Consumption in Transport

Data on energy consumption is only available from 2013 onwards.

After a rapid increase the energy consumption has decreased again since 2016. The share of transport in final energy consumption is between 30% and 40%.

The vast majority of energy is used for road transport. There is a small constant share of energy consumption by trains. All other sectors are negligible.

265 Ministry of Internal Affairs, Service Agency of MIA of Georgia

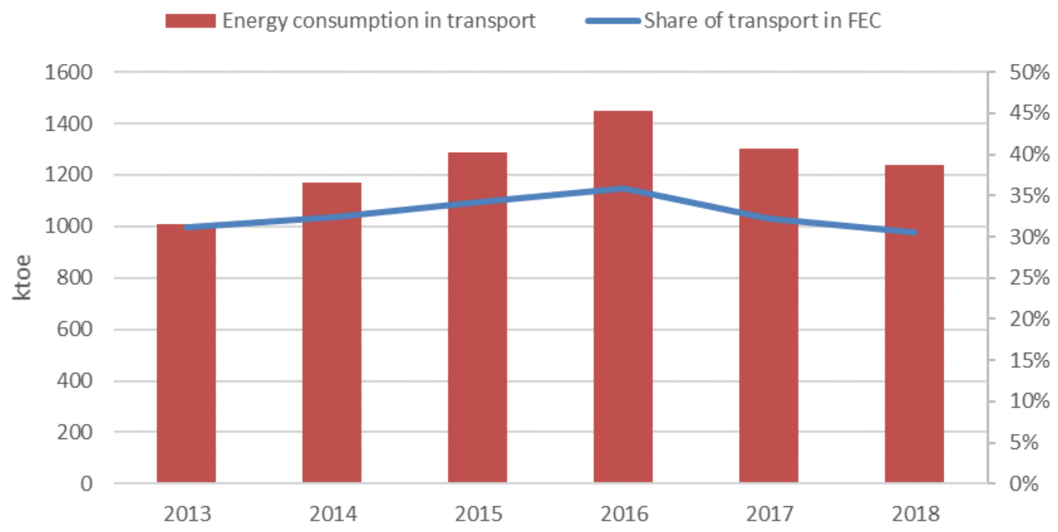

Figure 91: **Energy consumption in transport**[266]

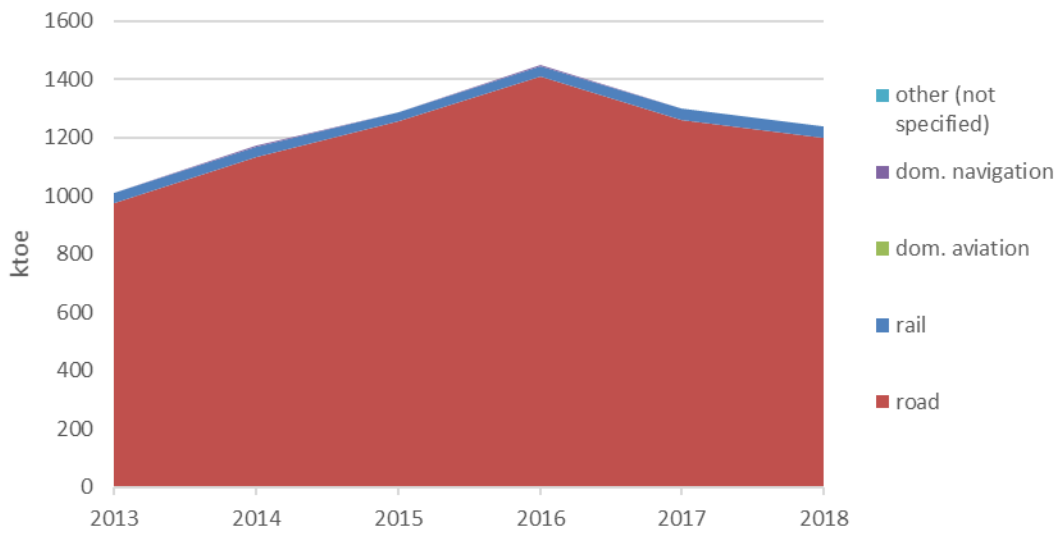

Figure 92: **Energy consumption in transport by sub-sector**[267]

Oil and petroleum products and natural gas are the main fuels. There is a small share of electricity use, notably in rail, but also for metro. Biofuels are not consumed in Georgia until 2018. However, a first biofuel production plant started operation in July 2018.

---

266 European Commission Energy Balances: GE-Energy-Balances-January-2020-edition, available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

267 European Commission Energy Balances: GE-Energy-Balances-January-2020-edition, available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

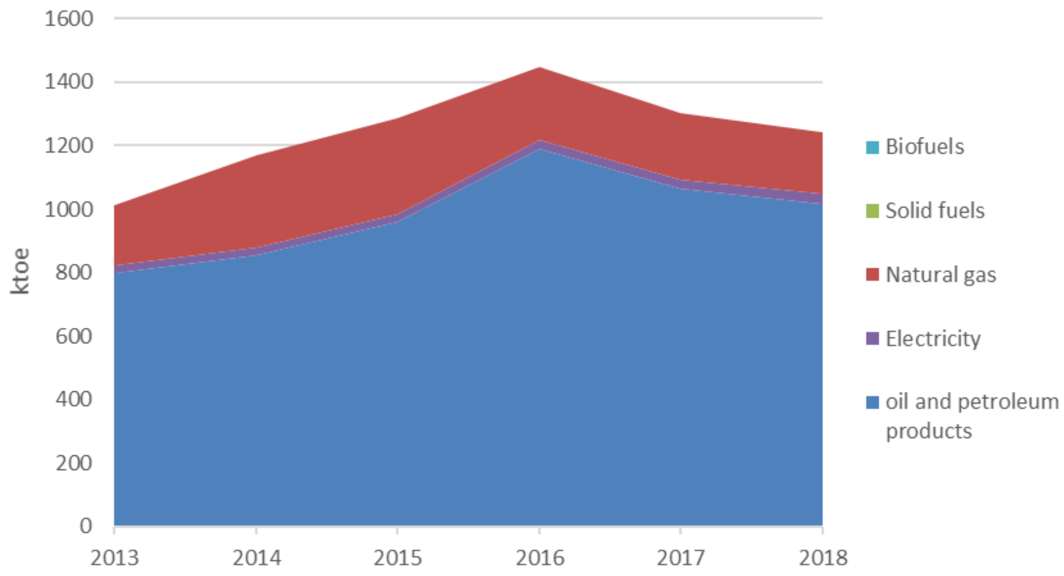

Figure 93: Energy consumption in transport by type of fuel[268 269]

In RED II, the share of renewable power in the national electricity mix two years before the year in question is applied to the electricity used in transport in order to calculate the renewable electricity consumption in transport. In 2016, renewable electricity generation, mainly from hydro power, had a share of 80.8% in electricity generation (see Figure 94).

8.3.2 2030 Projections

As of July 2020, no projections of energy consumption for Georgia for the year 2030 are available. Therefore, a simple projection has been made for this study based on available data (see section 8.3.1). To this end, data on energy consumption in transport over the period from 2013 to 2018 have been correlated to the Gross Domestic Product (GDP). This correlation has been extrapolated to 2030 based on GDP projections for 2030[270] to give a total energy consumption in transport of 2,306 ktoe, up from 1,236 ktoe in 2018. Assuming an overall efficiency gain of 10% leads to a projected energy consumption in transport of 2,075 ktoe, as a business as usual scenario.

Lacking detailed studies, it is assumed that the shares of fuels and transport modes as shown in Figure 94 remain unchanged between 2018 and 2030 in the business as usual scenario.

268 National Statistics Office of Georgia

269 European Commission Energy Balances: GE-Energy-Balances-January-2020-edition, available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

270 TU Wien/Energy Economics Group, Joanneum Research, REKK: Study on 2030 overall targets (energy efficiency, RES, GHG emissions reduction) for the Energy Community. Vienna 2019

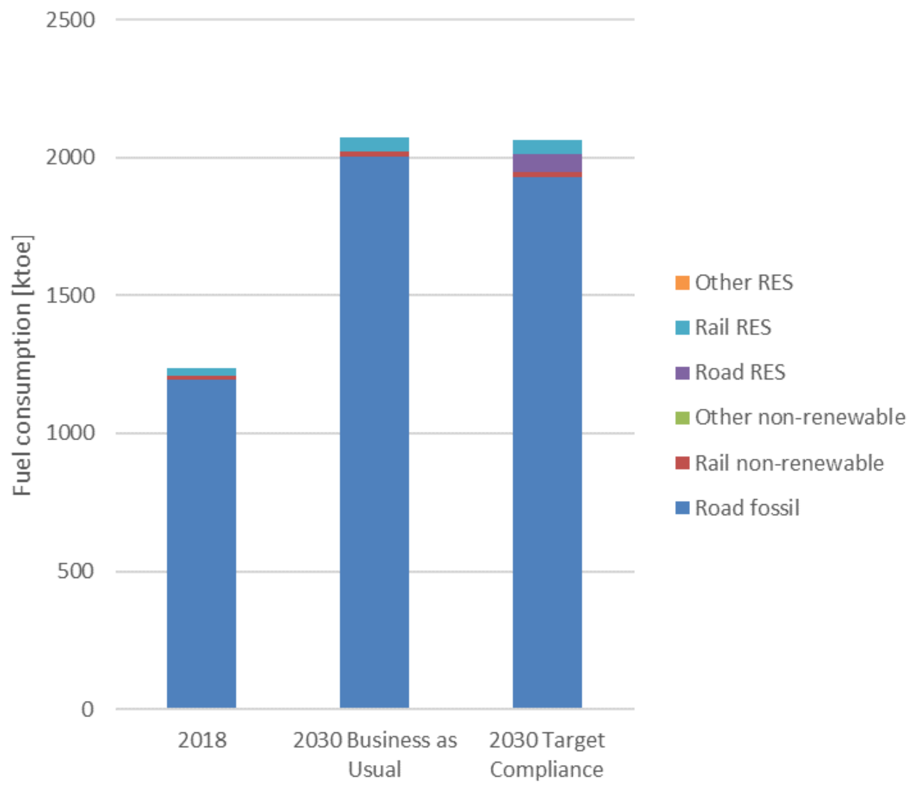

Figure 94: Energy consumption in transport in two scenarios for 2030

In a target compliance scenario achieving the 9% renewables in transport target for 2030, the roadmap as described in section 8.5.2 has been assumed to be implemented. This is represented by the right-hand column in Figure 94. The 9% renewable energies are broken down by options as described in section 0, and are shown in detail in Figure 95. It should be noted that for target compliance, multipliers are used for certain options; however, the energy quantities shown in Figure 94 show the physical energies, i.e. without multipliers. Therefore, the actual renewable energy contribution in 2030 is less than 9% of total consumption in transport.

The total energy consumption in transport in the target compliance scenario is slightly lower than in the business as usual scenario as battery-electric vehicles and hydrogen fuel cell-electric vehicles are more energy efficient than internal combustion engine vehicles.

The strong growth of fuel consumption leads to a significantly higher fossil fuel consumption in 2030 even in the target compliance scenario. In order to reduce fossil fuel imports and CO_2 emissions from transport, either the growth in transport energy consumption needs to be avoided, or the target for renewables in transport needs to be much more ambitious.

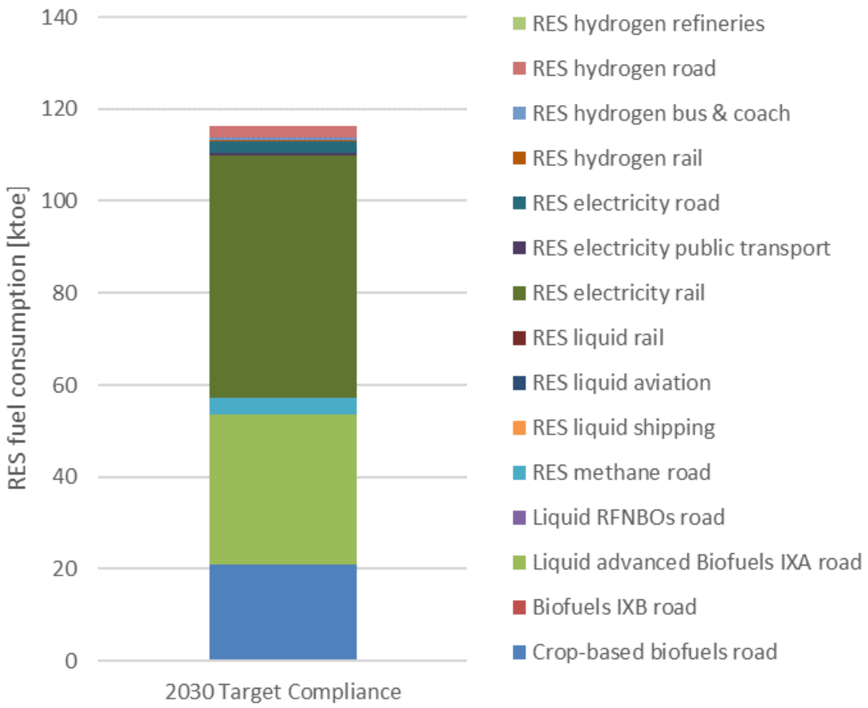

Figure 95: **Renewable energy consumption in transport in 2030 by option**

8.4 National renewable energy sources to meet the 2030 renewables in transport target

8.4.1 Potential of national renewable energy sources

The potential renewable fuel that could be produced from each of the feedstocks considered is presented in Figure 96. Note these estimates relate to total feedstock potential and do not take into account competing uses, see section 3.2.1 for detailed description of sources and data used. Compared to the current energy use in road and rail transport, Georgia has a significant potential for agricultural residues and forestry residues. It should be noted that figures were not available for wet waste or energy crop production in Georgia.

Compared to the current energy use in road and rail transport, Georgia has a significant potential for forestry residues and energy crops, and a relatively large existing production of sugar and starch crops: current transport energy demand (road and rail) in Georgia is approximately twice as large as the potential renewable fuel that could produced from all feedstocks apart from renewable power. When renewable power is considered, the current transport energy use (road and rail) is 22% of the potential renewable fuel produced from all feedstocks.

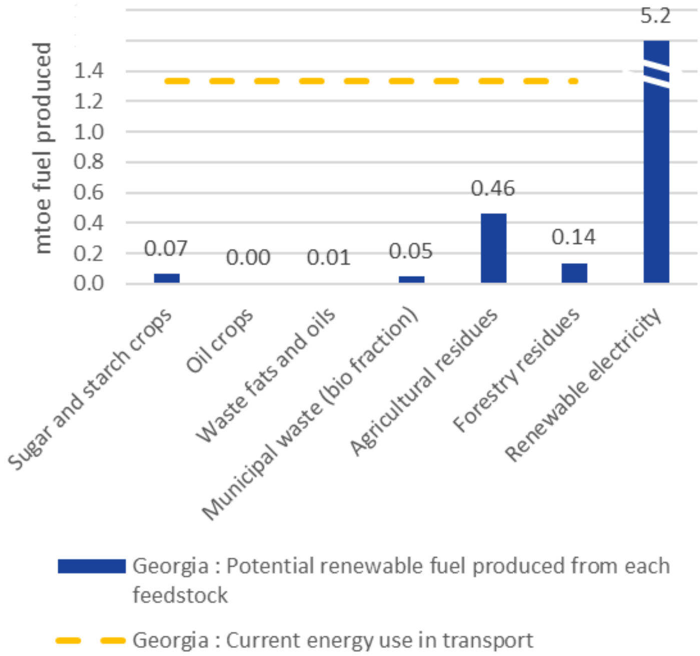

Figure 96: **Georgia: Potential renewable fuel production, compared to current energy use in road and rail transport**

8.4.2 Current status of national transportation fuel pathway deployments

Biodiesel Georgia LLC operate the only biofuel plant in Georgia, where they produce biodiesel via esterification. The reported capacity is 90 tonnes per month, and the plant utilises feedstocks such as rapeseed oil and UCO. The UCO collection rate is currently estimated at 50 tonnes per month. The company plans to build a second biodiesel plant with a much larger capacity: the intended scale of this project is yet to be confirmed.

As of 2017 there were, with the support of donors, 337 small biogas digesters functioning in Georgia[271], however it is understood that none of these are currently upgrading the biogas to produce biomethane.

8.5 Roadmap for achieving the renewable energy in transport target for 2030

8.5.1 Regulatory status quo

8.5.1.1 General data

Georgia is making progress in respect of the implementation of the provisions of RED into its energy sector and national regulatory framework. In late 2019, Georgia adopted several acts in order to achieve the objectives defined in RED.

[271] Georgia National Renewable Energy Action Plan (NREAP) (2017) unofficial English translation, Available from: http://www.economy.ge/uploads/files/2017/energy/samoqmedo_gegma/nreap_v_3_eng_21022020.pdf

The National Renewable Energy Action Plan of Georgia (NREAP) from 2019[272] sets a target for the share of energy from renewable sources in 2020 in the transport sector, by taking into account the effects of other policy measures relating to energy efficiency on the final consumption of energy. In December 2019, the Law of Georgia on Promoting the Production and Use of Energy from Renewable Sources was adopted. It sets mandatory national targets for the overall share of energy from renewable sources in gross final consumption of energy, as well as in the transport sector. According to this law, the energy from renewable sources in total energy consumption set for 2030 amounts to 35%.

The Government of Georgia targets by 2030 the share of energy from renewable sources in the consumption of all types of transport to be at least 10% of the final energy consumption on the territory of Georgia.

In 2019, the Energy Community started the process of setting 2030 targets in line with the Policy Guidelines on the development of integrated National Energy and Climate Plans (NECP) under Recommendation 2018/01/MC-EnC. Renewable energy targets as well as policies and measures will be addressed under the 'Decarbonisation of the economy' dimension of the NECP in an integrated way, which recognizes the interactions between the different dimensions.

Renewable energy targets, policies and measures for 2030 will thus be included in the NECP.

In respect of the bodies competent for monitoring of renewable energy, the state authorities in Georgia set related standards. The Government of Georgia is obligated to submit a report to the Secretariat of the Energy Community before 31st December 2024, as well as once every two years, in connection with the promotion of the energy from renewable sources and the progress made in the process of using such energy. However, after 2021, the main planning and monitoring document of energy and climate policies will be the NECP. Therefore, the previous reporting under NREAP will be done under the NECP.

Despite the fact that competent bodies for monitoring have been designated, in Georgia no penalty mechanism is enforced in the case of non-compliance with renewable energy targets.

Georgia does not have any official or regulated provision of information to consumers and businesses regarding compatibility of vehicles with various alternative fuel types, nor support measures available to purchasers of alternative-fuelled vehicles.

8.5.1.2 Energy efficiency in transport

In respect of the energy efficiency in transport, in May 2020 Georgia has adopted the Law of Georgia on Energy Efficiency. The purpose of this law is to maximize energy savings, increase energy security and energy independence, as well as to eliminate obstacles for improving energy efficiency in the energy market as much as possible. Furthermore, it provides the general legal basis for the necessary measures in respect of the promotion and implementation of energy efficiency in order to ensure the achievement of the goal set in

[272] The National Renewable Energy Action Plan of Georgia (NREAP) from 2019

the Protocol on the Accession of Georgia to the Constituent Agreement of the Energy Union, as well as basis for fulfilment of the obligations under the Energy Community Treaty and implementation of its acquis.

The Law of Georgia on Energy Efficiency establishes a procedure for the development of a national energy efficiency target, procedure for adoption of the energy efficiency action plan, energy efficiency commitment scheme and / or alternative policy measures to ensure energy savings, and it should implement energy efficiency policy, its coordination, control, supervision and monitoring.

The Law defines the obligations and responsibilities of public and private institutions, household customers, energy service providers, industry and other sectors of the economy in the process of efficient energy consumption, energy saving and energy market development.

The Law stipulates that the Ministry of Economy and Sustainable Development, through coordination and mobilization of funds with international and regional donor organizations, promotes and implements the programs, events and activities that should encourage the introduction of energy efficient technologies in the transport sector and improve the energy performance of transport used by administrative bodies.

The Ministry of Economy and Sustainable Development in cooperation with other government institutions will work on the preparation of secondary legislation necessary for the implementation of the law.

As well, in the area of energy efficiency Georgia has prepared the first National Energy Efficiency Action Plan (NEEAP) which establishes a set of measures (investments and policies) to be carried out in the future and aimed at optimizing and reducing the use of energy resources. The NEEAP has been developed in order to assist completion of a number of strategic goals of Georgia, such as setting out energy savings targets for the upcoming period and beyond in order to improve competitiveness.

It should be mentioned that the measures for 2030 regarding energy efficiency shall be included in the NECP.

8.5.1.3 Production and supply of fuel

The development of the National Energy and Climate Plan for 2021-2030 (NECP), which will review targets for renewable energy, energy efficiency and greenhouse gas emissions, is in front of the Energy Community Secretariat for informational review and recommendations.

In Georgia, a regulation regarding the minimum share of biofuels, bioliquids and biomass fuels consumed in transport does not exist. Since the Law of Georgia on Promoting the Production and Use of Energy from Renewable Sources was adopted end of 2019, there is no defined obligation imposed on fuel suppliers related to the share of renewable energy in the final consumption of energy in the transport sector, nor any obligation of the fuel suppliers to meet certain greenhouse gas emission standards.

However, the Law of Georgia on Promoting the Production and Use of Energy from Renewable Sources does contain special provisions related to energy from renewable sources used in transport which would help support an obligation. Namely, the Government of Georgia shall provide information to the public on the availability of energy from all types of renewable sources used in transport and on environmental benefits. If the percentage of biofuels in the mix of biofuels with mineral oil derivatives exceeds 10%, the Government of Georgia is authorized to determine the requirement to indicate this at the point of sale.

The Government of Georgia, upon the recommendation of the Ministry of Economy and Sustainable Development of Georgia, is obliged to ensure the approval of:

- the methodology for calculating the energy from renewable sources, until June 2020, which was adopted by the Government of Georgia on 22nd of June 2020;
- t;
- the National Renewable Energy Action Plan until December 2020;
- power generation and use support schemes from renewable sources, until December 2020;

Furthermore, the approval of the following elements, which are further detailed in the text below, should be ensured:

- the rules for certification and compliance of biofuels, biogas and bioliquids, until December 2021 ;
- the rules for licensing and pricing of biofuels, biogas and bioliquids, until December 2021;
- biofuels and bioliquids sustainability criteria until December 2021;
- the rules for calculating the impact of biofuels, bioliquids and their fossil fuel comparators on the greenhouse gas emissions, until December 2021.

The Law of Georgia on Promoting the Production and Use of Energy from Renewable Sources establishes sustainability criteria for biofuels and bioliquids. However, there are no sustainability criteria for biomass.

The Law of Georgia on Promoting the Production and Use of Energy from Renewable Sources stipulates that the energy obtained from biofuels and bioliquids, regardless of whether the raw material was cultivated on the territory of Georgia or outside it, shall be eligible for counting towards the below-mentioned purposes only if they satisfy the criteria for biofuels and bioliquids established by the law:

- determination of the compliance of the national common target indicators with the requirements of this law;
- determination of the compliance with the obligation related to renewable energy;
- the authorization to receive financial support for the use of biofuels and bioliquids.

For the purposes of this law, in addition to agricultural, aquaculture, fisheries and forest wastes, biofuels and bioliquids produced from other wastes shall be eligible for counting towards the abovementioned purposes only if biofuels and bioliquids comply with criteria established by Georgian legislation.

If biofuels and bioliquids are to be considered for the abovementioned purposes, the Government of Georgia is authorized to require from economic agents to certify biofuels and bioliquids in accordance with Georgian sustainability criteria. For these purposes, the Government of Georgia, upon the recommendation of the Ministry of Economy and Sustainable Development imposes an obligation for economic agents to use a mass balance system.

The Ministry shall ensure that the economic agents provide reliable information and at the request of the authorized body to make available the data on the basis of which this information was prepared. An independent audit should confirm that the systems used by the economic agents are accurate, reliable and protected from fraud. The Government of Georgia together with the Ministry of Economy and Sustainable Development shall ensure the uniform submission of information to the Secretariat of the Energy Community.

However, Criteria for Sustainability of Biofuels and Bioliquids Production has not been adopted yet, and the determined deadline is December 2021. The same deadline is determined for adoption of the following significant secondary legislation that refers to the biofuels and bioliquids:

- Rule on certification and compliance of biofuels, biogas and bioliquids;
- Rule on licensing and price setting on biofuels, biogas and bioliquids production.

Regarding regulation related to the greenhouse gas emissions savings, the Law of Georgia on Promoting the Production and Use of Energy from Renewable Sources prescribes that national and international voluntary schemes that set standards for biomass products must comply with standards of reliability and transparency, as well as with appropriate standards for conducting independent audits. If these schemes measure the net savings of greenhouse gas emissions, they must also meet the requirements of the methodology established by the rules for calculating the impact of greenhouse gases on biofuels, biofuels and their fossil fuel comparators. As per available information, the deadline for adoption of the Rule on calculation of the greenhouse gas impact of biofuels, bioliquids and their fossil fuel comparator is set for December 2021.

With respect to reporting obligations in Georgia, although the Law of Georgia on Promoting the Production and Use of Energy from Renewable Sources was adopted in 2019, no reporting obligation to the fuel suppliers in fuel markets regarding the share of renewable fuel or greenhouse gas reductions is imposed.

In accordance with the Law of Georgia on Licenses and Permits and the conditions provided in the Law on Energy and Water Supply, the Georgian National Energy and Water Supply Regulatory Commission is the competent authority for issuance of the licenses for the energy activity of electricity production.

It is important to mention that in Georgia there is no regulation containing provisions with required criteria related to electricity used directly in transport.

There are several gaps in the Georgian legislation which may be filled in the future. This refers to renewable fuels of non-biological origin – RFNBO defined in RED II. For the production of RFNBOs no criteria related to electricity used to produce RFNBOs are defined.

In the area of E-mobility, it should be noted that the Tbilisi City Hall has passed a decision aiming at encouraging the installation of electric chargers. Owners of electric vehicles have the option to apply to the government of the capital for the installation of an electric charger, which the City Hall will install without any financial contribution from the applicant. For each electric vehicle only one application may be made. It should be noted that the Tbilisi City Hall, based on the analysis of the incoming applications, selects the requested places for the chargers and installs them free of charge.

However, in Georgian legislation there are no provisions which refer to obligations of certain subjects such as public parkings or public garages to have electric vehicle charging stations.

8.5.1.4 Passenger transport sector

The Law of Georgia Tax Code of Georgia determines the amount of an excisable transaction, import of excisable goods and export of excisable goods for a motor vehicle (except for a sports vehicle) and a motorcycle (including a motor bicycle) according to their age and engine displacement.

Law of Georgia Tax Code of Georgia defines excise tax rates for motor vehicles in accordance with the difference between the year of the taxable transaction and the year of manufacture of the motor vehicle. In the case of import, the excise tax rate is defined according to the difference between the year of tax declaration registration and the year of manufacture of the motor vehicle.

In addition, the Law of Georgia Tax Code of Georgia determines that the excise rate for 0 up to 6 year old motor vehicles, in the case of left-hand drive hybrid motor vehicles, shall be reduced by 60 %. However, the excise rate for motor vehicles which are right hand drive or with converted steering, shall be three times as much as the excise rate for a motor vehicle of the respective category. Furthermore, the excise rate for electric engine motor vehicles, which are right hand drive or have converted steering, shall be the product of the excise rate defined under the same sub-paragraphs by 2000.

In accordance with above mentioned, it could be concluded that the applied excise tax model has a negative impact on vehicle fleet renewal and contributes to increasing the number of 4-11 year old motor vehicles. As a result, the number of 0-3 year old motor vehicles only represents approximately 1.2% of the total motor vehicle fleet.

Table 31: Excise tax rates for motor vehicles in Georgia

Cat.	Age of motor vehicle	Measure unit	Excise tax rate, GEL (approx. €)/cm³
1.	under 1 year	1 cm³	1.5 (approx. 0,40€)
2.	1 year	1 cm³	1.5 (approx. 0,40€)
3.	2 years	1 cm³	1.5 (approx. 0,40€)
4.	3 years	1 cm³	1.4 (approx. 0,37€)
5.	4 years	1 cm³	1.2 (approx. 0,32€)
6.	5 years	1 cm³	1.0 (approx. 0,27€)
7.	6 years	1 cm³	0.8 (approx. 0,21€)
8.	7 years	1 cm³	0.8 (approx. 0,21€)
9.	8 years	1 cm³	0.8 (approx. 0,21€)
10.	9 years	1 cm³	0.9 (approx. 0,24€)
11.	10 years	1 cm³	1.1 (approx. 0,29€)
12.	11 years	1 cm³	1.3 (approx. 0,34€)
13.	12 years	1 cm³	1.5 (approx. 0,40€)
14.	13 years	1 cm³	1.8 (approx. 0,48€)
15.	14 years	1 cm³	2.1 (approx. 0,56€)
16.	over 14 years	1 cm³	2.4 (approx. 0,64€)

It should be mentioned that the owners of motor vehicles, yachts (cutters), helicopters, and airplanes are considered to be property tax payers, in accordance with the Law of Georgia Tax Code of Georgia. However, if the person's family income of the year preceding the tax year does not exceed 40 000 GEL (approx. 10,521€), a natural person's taxable property shall be exempted from the obligation of paying the property tax.

Excise tax rate for motorcycles (including a motor bicycle) are defined in accordance with the difference between the year of a taxable transaction and the year of manufacture of a motorcycle (including a motor bicycle). In the case of import, the excise tax rate is defined according to the difference between the year of registration of a customs declaration and the year of manufacture of a motorcycle (including a motor bicycle).

Table 32: Excise tax rates for motorcycles in Georgia

Cat.	Age of motorcycles	Measure unit	Excise tax rate, GEL (approx. €)/cm³
1.	under 1 year	1 cm³	1.5 (approx. 0,40€)
2.	1 year	1 cm³	1.3 (approx. 0,34€)
3.	2 years	1 cm³	0.7 (approx. 0,19€)
4.	3 years	1 cm³	0.7 (approx. 0,19€)
5.	4 years	1 cm³	0.7 (approx. 0,19€)
6.	5 years	1 cm³	0.7 (approx. 0,19€)
7.	6 years	1 cm³	0.8 (approx. 0,21€)
8.	7 years	1 cm³	0.8 (approx. 0,21€)
9.	8 years	1 cm³	0.8 (approx. 0,21€)
10.	9 years	1 cm³	0.8 (approx. 0,21€)
11.	10 years	1 cm³	1.0 (approx. 0,27€)
12.	11 years	1 cm³	1.3 (approx. 0,34€)
13.	12 years	1 cm³	1.5 (approx. 0,40€)
14.	13 years	1 cm³	1.8 (approx. 0,48€)
15.	14 years	1 cm³	2.1 (approx. 0,56€)
16.	over 14 years	1 cm³	2.4 (approx. 0,64€)

A noteworthy exemption from import duty determined by the Law of Georgia Tax Code of Georgia is for electric engine vehicles[273].

As regards to the sector of public transport in Georgia, an incentive refers to the taxi vehicles equipped only with electric motors. These vehicles pay reduced periodic technical inspection fees (48 GEL (approx. 12.6€) instead of 60 GEL (approx. 15.8€)). Imposed burdens in the sector of public transport refer to busses and minibuses, which are obliged to pay higher inspection fees (plus 40 GEL (approx. 10.5€)) than other vehicles.

The competent authorities for performing control over the persons who have a right of incentives or who have additional burdens in the sector of public transport are the

[273] It should be clarified whether this include hydrogen fuel cell vehicles, wich are propelled by electric engines just as battery-electric vehicles are.

Government of Georgia and the Ministry of Economy and Sustainable Development of Georgia.

It should be mentioned that in Georgia there are no incentives for the use of electricity or renewable fuels in public transport.

8.5.1.5 Freight transport sector

In the freight transport sector, defined incentives and burdens (related to tax, other levies and public revenues, excises etc.) for vehicle owners, i.e. users, as well as limitations for registration, purchase or import of a vehicle (light duty trucks, heavy duty trucks) are listed in the section on passenger transport (8.5.1.4) above.

The authorities which perform control over the persons who have a right of incentives or who have additional burdens in freight transport sector are the Government of Georgia and the Ministry of Economy and Sustainable Development of Georgia.

8.5.1.6 Railway sector

One of the limitations defined in Georgian legislation in the railway sector refers to the registration, purchase and import of a locomotive in terms of its lifetime.

For the railway sector, there are no provisions imposing obligations in connection with:

- certain incentives, i.e. obligations for use of electric locomotives;
- use of electricity from renewable energy for railway transport.

8.5.2 Roadmap to achieve the 2030 target

The roadmap developed here for Georgia to achieve the 2030 target of 9% renewable energies in transport builds on the provisions of RED II as described in section 3.1.1. It is assumed that these provisions are transposed into Georgian law without changes including the calculation method for renewables in transport, the caps and minimum values for various types of renewable energies, the multipliers, the provisions related to electricity and RFNBOs etc. Also, sustainability criteria need to be transposed into national law in order to fully comply with RED II, and it must be ensured that certification schemes are in place (national or voluntary) that are compliant with RED II requirements.

For this study, we apply the renewable share in the national electricity mix anticipated for 2030. On the one hand, this tends to overestimate the renewable share as values for the year 2028 that should be applied are not available, but should in general be lower than the 2030 values. On the other hand, dedicated renewable power plants may be erected that are counted as 100% renewable for transport.

For Georgia, a 100% renewable electricity mix is anticipated for 2030 based on literature values.[274] This is without prejudice to 2030 targets to be defined and included in the NECP.

It should be noted that the high renewables share in the national mix may open up opportunities for RFNBO production for export, notably to European Union Member States applying the RED II provisions. Should Georgia, however, not achieve the 100% renewable electricity target, the contributions of fuel options based on electricity will be reduced accordingly.

8.5.2.1 Potential contributions from all options

Based on the assessment of all options for Georgia, a total RES-T share of 13.7% in 2030 can be achieved as a combination of all options (see Table 33). Further limited potentials exist in renewable liquid fuels in shipping, aviation and rail, which are assumed to be zero here.

Table 33: Potential RES-T contributions from all options in Georgia

Option		Contribution to RES-T target (%) incl. multiple counting	Amount of renewable fuel used (ktoe)
Biofuels and liquid RFNBOs	1. Crop-based biofuels in road transport	2.0%	41.6
	2. Liquid fuels produced from Annex IX B feedstocks in road transport	3.4%	35.4
	3. Liquid advanced Biofuels (based on Annex IX A feedstocks) in road transport	3.1%	32.7
	4. Liquid RFNBOs in road transport	0.35%	7.24
	5. Renewable methane in road transport	0.36%	3.71
	6. Renewable liquid fuels in shipping	0.00%	0.00
	7. Renewable liquid fuels in aviation	0.00%	0.00
	8. Renewable liquid fuels in rail	0.00%	0.00
Electricity	9. Rail electrification	3.80%	52.7
	10. Electric public transport (bus, trolleybus, tram, metro)	0.07%	0.56
	11. Electric road vehicles (passenger cars and trucks)	0.47%	2.44
Hydrogen	12. Hydrogen in rail	0.02%	0.37
	13. Hydrogen bus and coach (urban bus, long distance coaches)	0.03%	0.56
	14. Hydrogen road vehicles (passenger cars and trucks)	0.12%	2.44
	15. Hydrogen in refineries	0.00%	0.00
Total		13.7%	180

Biofuels and electric rail potentially contribute most in 2030. In Georgia, rail is almost 100% electrified and represents a relatively high share of transport fuel consumption today, which is assumed to be maintained towards 2030 by growing to the same extent as other transport energy consumption. In addition, the 100% renewable share in the national electricity mix

[274] TU Wien/Energy Economics Group, Joanneum Research, REKK: Study on 2030 overall targets (energy efficiency, RES, GHG emissions reduction) for the Energy Community. Vienna 2019

leads to full accounting of the electricity as renewable. The third element is the multiplier of 1.5 for electricity consumed in rail. Already today, the renewable contribution of electricity in rail transport is high based on this calculation method.

The contributions shown here assume that ethanol is blended up to 5% in gasoline, and rely on a blend of 10.7% biofuel in road transport diesel fuel. This would either require a FAME blend above B7 (for example B20 or B100 in fleets) and/or use of HVO. Selling some gasoline with >5% ethanol would also ease blending limits.

Georgia has an established use of methane in road transport. This can be used to introduce biomethane based on Annex IXA feedstocks, which have a suitable potential in Georgia.

Electric and hydrogen vehicles can already make small contributions by 2030, and have a strong growth potential thereafter.

As the possible contributions of battery-electric vehicles depend on many factors, the following considerations are intended to provide some insight into the dynamics and opportunities (see Figure 97). The graph is based on a number of approximate assumptions, and should thus be understood as rough indication showing the general trends.

Battery-electric cars' contribution to the RES-T target is calculated by applying the renewable share in the national electricity mix to the use of electricity in BEVs[275].

Electricity provided through public charging stations is covered in statistics as energy consumed in transport, and thus counted accordingly; charging through private charging units is not covered in statistics. Therefore, RED II foresees a multiplier of four for electricity consumed in road transport (based on data from statistics).

The RES-T contribution of battery cars depends on:

- The number of battery cars (horizontal axis in Figure 97);
- The share of public charging (green/ blue line in Figure 97 assuming 25% and 100% public charging, respectively);
- The renewable share in the national electricity mix in 2028 (100% for Georgia); lower RES shares would reduce the contribution accordingly.

Assuming 25% public charging, 200 thousand battery cars would approximately contribute 1.7% RES-T by 2030 (see Figure 97).

As battery cars are more energy efficient than conventional cars and the electricity is only partly covered in statistics energy consumption in transport decreases with increasing battery cars (dotted lines in Figure 97).

[275] However, if certain criteria are met (see RED II), renewable electricity can be counted as 100% renewable. This is not assumed in this study for option 11.

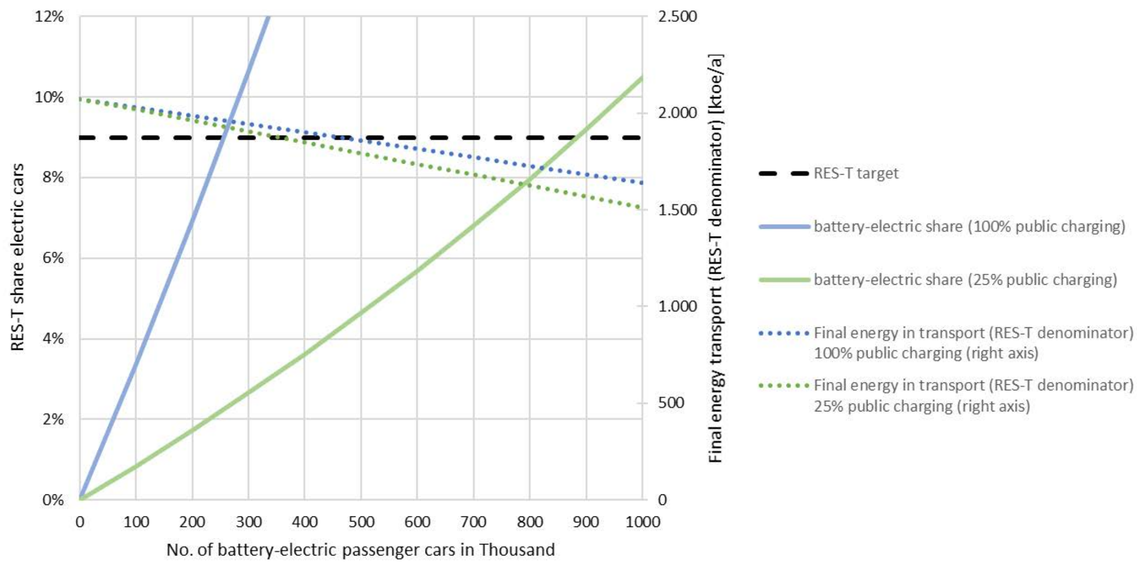

Figure 97: Possible contributions of battery cars to Georgia's 2030 RES-T target

8.5.2.2 Choice of options to meet RES-T target

The rather high potential contribution of all options allows the contributions from several options to be reduced. The reductions are based on the general considerations described in section 5.1, and on the specific circumstances in Georgia as described in the following:

1. In order to limit the competition with food and animal feed production, crop-based biofuels are capped at 2% by RED II; however, only 1% is required to achieve the 9% target, reducing the food and feed competition even further. If Georgia's currently operating biofuel plant operated at full capacity it could produce roughly 1 ktoe of fuel per year: much less than Georgia's roadmap target of 21 ktoe from crop-based biofuels. However, as noted in Section 8.4.2, a much larger plant is planned;
2. Biofuels based on Annex IXB biofuels are not required to meet the 2030 target;
3. Liquid biofuels based on Annex IXA feedstocks ("advanced biofuels") are developed to meet the minimum targets defined in RED II, aside from the contribution from biomethane (see point 5). For context, this is equivalent to approximately the output of an advanced ethanol plant at typical scale of 63 million l fuel/year;
4. Relatively expensive RFNBOs are not required in road transport to meet the 2030 target;
5. Biomethane is used in existing gas vehicles, up to a level equivalent to the current amount of biomethane used in electricity production, to contribute to the advanced biofuels target (see No. 3 above);
6. No renewable fuels in shipping are required to meet Georgia's RED II target;
7. No renewable fuels in aviation are required to meet Georgia's RED II target;

8. No renewable fuels in rail are required to meet Georgia's RED II target; expansion of electricity consumption in rail is seen as more promising (see next point)
9. Increasing the national renewable share in electricity, maintaining and installing catenaries at non-electrified rail lines or closing non-electrified rail gaps as well as keeping the share of rail electricity in overall transport energy consumption by extending rail transport accordingly are assumed;
10. The introduction of battery buses and the expansion or establishment of trolley bus systems, trams, or metros in cities is assumed here;
11. The market uptake of battery-electric road vehicles (cars and light/ medium duty trucks) leads to electricity consumption in transport;
12. Existing and new rail lines not suitable for electrification allow establishing zero emission hydrogen fuel cell trains;
13. Introduction of hydrogen fuel cell buses in urban areas, and (long-distance) coaches in applications not suitable for battery-electric vehicles (high daily driving range, long-distance);
14. Start of market uptake of hydrogen fuel cell-electric road vehicles (cars and light to heavy duty trucks) for long-distance, high driving ranges;
15. Use of renewable hydrogen in refineries could be an option for the future, but is not assumed here for a contribution by 2030. There are plans for establishing or increasing refinery capacities in Georgia. Possible hydrogen demand that would be served from renewable sources could contribute to the RES-T target.

This results in the following contributions by 2030 assumed to be realistic and reducing the most challenging or expensive[276] options to meet the defined 2030 RES-T target (see Table 34).

Strong contributions are made by electricity in rail and by liquid advanced biofuels; moderate contributions are made by crop-based biofuels, electric road vehicles and biomethane in road transport; limited contributions are made by electric public transport and hydrogen in road vehicles, buses and coaches as well as in rail.

The high contribution from electricity in rail assumes a 100% share of renewable electricity in power by 2030. If this was lower, all options using electricity directly or hydrogen would make a smaller contribution to the 2030 target.

The high proportion of Annex IXA (advanced) biofuels is driven by the sub-target in RED II and relies on successful scale-up in production of liquid Annex IXA biofuels globally. Should this prove not to be feasible, crop-based biofuels or biofuels based on Annex IXB could be

[276] Detailed cost assessments have not been carried out in this study. Rough cost judgements are made here based on costs information provided in chapter 3.

increased, which would, however, not allow the sub-target for advanced biofuels in RED II to be met.

These contributions lead to a breakdown of fuel consumption in 2030 as shown in section 8.3.2.

Table 34: Contribution to Georgia's RES-T target from options chosen

	Option	Multiplier	2030 Contribution to RES-T target incl. Multipliers	2030 Amount of renewable fuel used (ktoe)
Biofuels and liquid RFNBOs	1. Liquid crop-based biofuels in road transport	1	1.0%	21
	2. Liquid fuels produced from Annex IX B feedstocks in road transport	2	0%	0
	3. Advanced liquid biofuels (based on Annex IX A feedstocks) in road transport	2	3.1%	33
	4. Liquid RFNBOs in road transport	1	0%	0.0
	5. Renewable methane in road transport	2	0.36%	3.7
	6. Renewable liquid fuels in shipping	2	0%	0
	7. Renewable liquid fuels in aviation	2	0%	0
	8. Renewable liquid fuels in rail	2	0%	0
Electricity	9. Rail electrification	1.5	3.8%	53
	10. Electric public transport (bus, trolleybus, tram, metro)	4 (road) 1 (tram, metro)	0.07%	0.6
	11. Electric road vehicles (passenger cars and trucks)	4	0.47%	2.4
Hydrogen	12. Hydrogen in rail	1	0.02%	0.4
	13. Hydrogen bus and coach (urban bus, long distance coaches)	1	0.03%	0.6
	14. Hydrogen road vehicles (passenger cars and trucks)	1	0.12%	2.4
	15. Hydrogen in refineries	1	0%	0
Total			**9.00%**	**116.3**

8.5.2.3 Roadmap for Georgia

The roadmap for Georgia to achieve the 2030 target for renewable energies in transport (see Figure 98) involves key policies to be developed and adopted in the coming few years, building on the existing regulatory framework and policy elements already under development (see section 8.5.1). The development of the regulatory framework so far focuses on biomass-based fuels; direct electricity use and hydrogen use in road transport has received less emphasis so far, but should be taken up as two additional central pillars for renewables in transport. A stronghold of renewable energies in transport in Georgia is the rail sector, which has a strong weight in passenger and notably in freight transport, and which already benefits from a high share of renewable electricity in the national power mix. The roadmap foresees that the last elements of the regulatory framework should be in place by the end of 2022.

The appropriateness, effectiveness and efficiency of this policy framework should be evaluated in around 2025, and should be adjusted where necessary to ensure target compliance by 2030. The European Union is currently developing the details of the European Green Deal, which aims to make the European Union climate neutral by 2050 by turning climate and environmental challenges into opportunities, and making the transition just and inclusive for all. Based on a set of policy initiatives by the European Commission, climate ambitions by 2030 are anticipated to be increased, which includes adjustments to RED II. A revision of the policy framework in Georgia around the middle of the decade would be timely for taking up decisions to be taken at European Union level by then.

Around 2028 would be a suitable point in time to set targets for the 2040 timeframe, and to revise and adjust the strategies and policies accordingly.

Currently, Georgia is developing its first National Energy and Climate Plan (NECP), which has a planning and a monitoring function. The biannual progress reports and the regular revisions of the National Energy and Climate Plans are the appropriate instrument for monitoring successful implementation and development towards the 2030 target, and will be helpful for the 2025 revision of the policy framework.

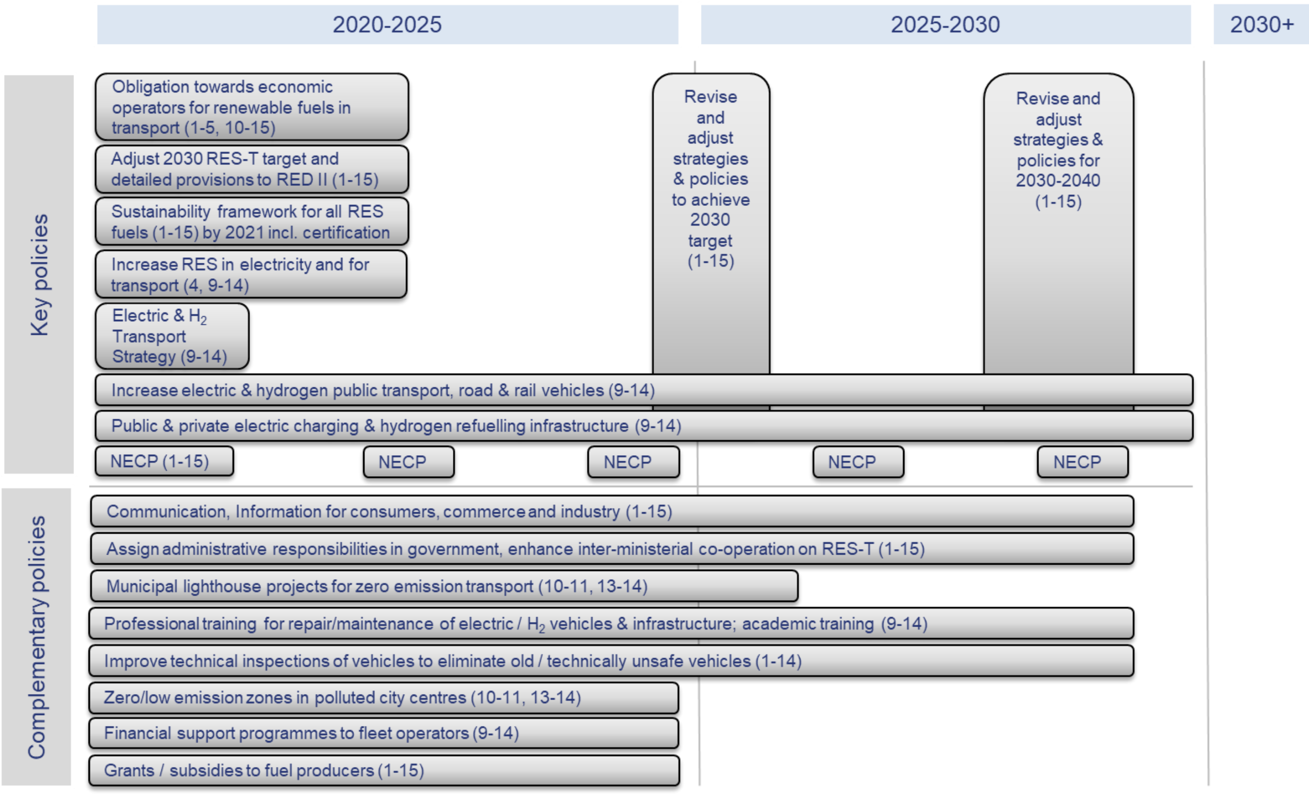

Figure 98: Overview roadmap for Georgia

The priority in the roadmap for biofuels is to establish policy to drive uptake of these fuels through an obligation on fuel suppliers to supply a minimum proportion of these fuels, which does not currently exist in Georgia. Development and introduction of this policy mechanism should be started as soon as possible, to allow industry as much time as possible to adjust and prepare to meet 2030 targets. This obligation needs to be supported through a number of other policy elements such as rules for certification and compliance of biofuels, sustainability criteria for biofuels, and rules for calculating the impact of biofuels on the greenhouse gas emissions. As described above, the development of these policy elements has already been started, with rules on each scheduled to be adopted by the end of 2021. These should be developed based on the provisions of RED II. Additional attention may need to be given to criteria on production of liquid RFNBOs, alongside the rules on hydrogen (below) as these do not appear to be covered within existing activities. A unit within the relevant government ministry must be designated responsible for implementing, reviewing and updating the policy as a whole, ensuring sustainability certification of fuels, administering the scheme, data collection and reporting.

Several other measures that are complementary to this demand-side policy have also been important in other countries, namely support for domestic fuel production, such as capital grants for plants, information provision for consumers on fuel switching and vehicle compatibility, and a review of taxation policy to ensure that these align with the desired policy outcomes. In particular, stakeholders mentioned the need to review/remove excise taxation for biofuel blends formed of blending components which have already been taxed separately, and to review the relative taxation of biofuel feedstocks such as UCO for export versus use in Georgia.

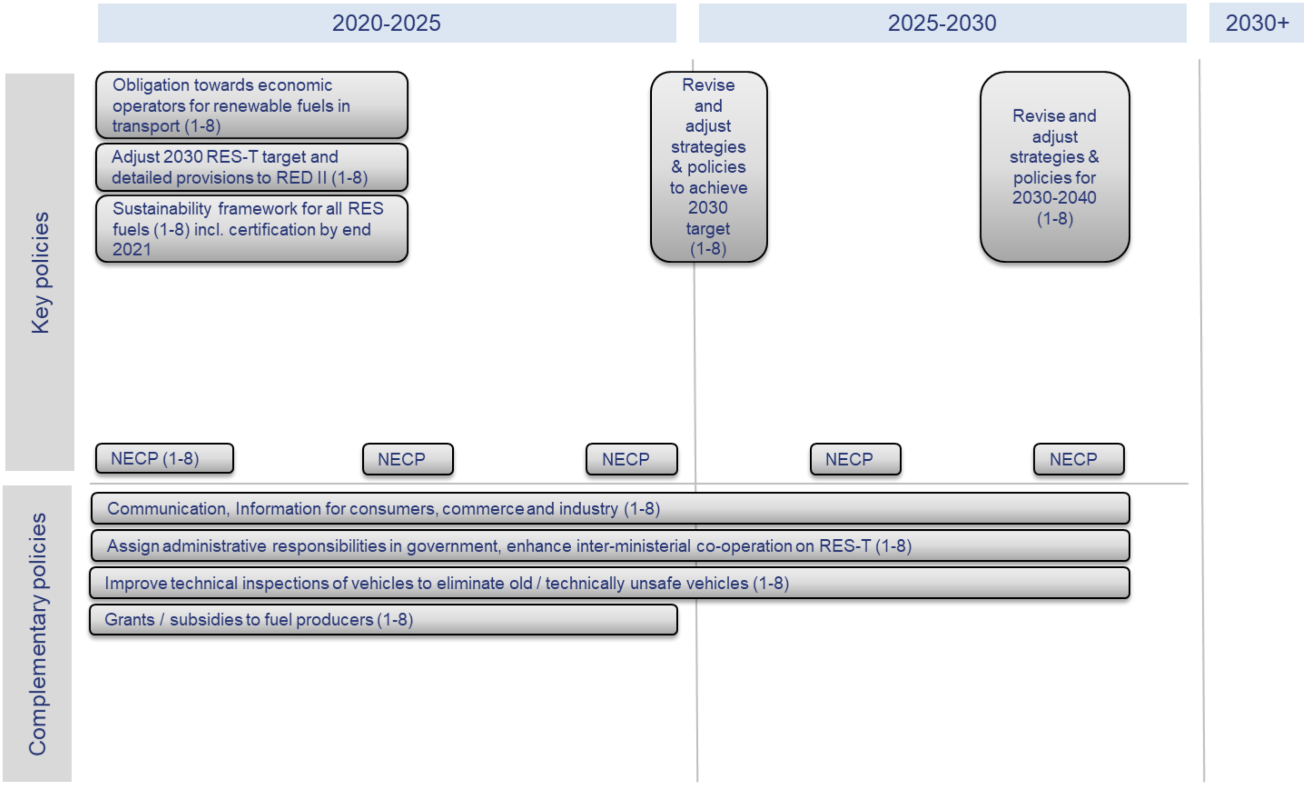

Figure 99: Roadmap for Georgia – Biofuels and liquid RFNBOs

Direct electricity use in transport is already well-established in Georgia in the rail sector, and also in the metro in Tbilisi. Tramways and trolleybuses were in operation in Georgia in the past, and may be re-established in the future as in many other countries of the world, including other Contracting Parties. Policies supporting renewables in transport should include maintaining and further strengthening electricity use in these sectors.

Battery-electric road transport including passenger cars, public transport and delivery vehicles is in an early stage of development in Georgia, and has a significant growth potential. Developing a national electric transport strategy would be an appropriate starting point for a coherent and effective policy framework in this area. Various policies for fostering electric transport could be envisioned, such as including renewable electricity in the obligation on fuel suppliers for increasing the share of renewable energies in transportation fuels (see above), or putting an obligation on electricity suppliers for providing renewable electricity to transport, etc.

An additionality framework for renewable electricity would define rules for counting electricity as renewable based on RED II[277], and detailed provisions are currently under development by the European Commission. This aims at fostering additional renewable power capacities for transport not compromising the achievement of renewables electricity targets in conventional electricity consumption.

In parallel, existing policies for increasing renewable electricity production should be adjusted by increasing renewable targets for 2030 that would include additional renewable electricity demand from transport. Fostering dedicated renewable capacities for transport could be a new element introduced into existing legislation, covering rail, public transport and road.

Increasing the number of electric vehicles in road, rail and public transport is a major lever for increasing the consumption of electricity in transport, and reducing conventional fuel consumption. Elements for such policies include providing direct financial support for purchasing electric vehicles, and adjusting the tax and import duty structures to incentivize purchases of electric vehicles. The vehicle charging infrastructure is the second major lever. Policies to coordinate and incentivize the build-up of a public network of charging stations include elements of financial incentives through grants, subsidies and loans, clear permitting rules, and coordination to ensure an appropriate nationwide network structure. In addition, financial support to charging infrastructures for public transport and fleet operators is an effective and efficient instrument for rapid growth.

The appropriate administrative structures must be established including enhanced inter-ministerial co-operation, and related responsibilities assigned in government.

Further complementary policies supporting electric transport include communication and information campaigns, lighthouse projects at local/ municipal level, the establishment of zero or low emission zones in urban areas for reduced air pollution, professional and academic training, technical inspections of vehicles (both electric and conventional), etc.

[277] See RED II Art. 27(3)

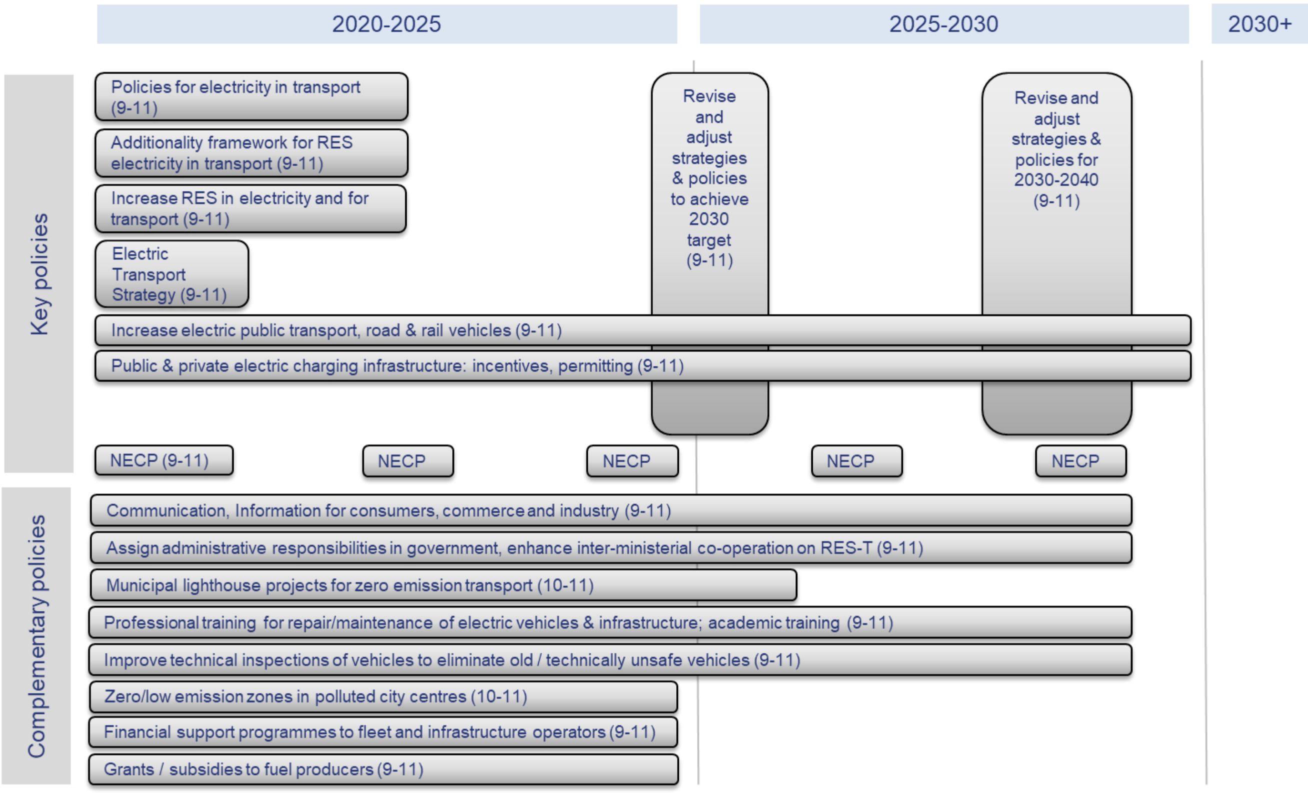

Figure 100: Roadmap for Georgia – Electricity in Transport

Hydrogen in transport using fuel cell-electric vehicles is in early phases of commercialization world-wide, and shows major potential for decarbonizing transport in a complementary fashion to battery-electric vehicles. On non-electrified rail lines, first commercial hydrogen trains are in operation, and fuel cell vehicles are coming onto the market. A focus will be on vehicles for longer distances and for duty purposes such as trucks and buses.

Hydrogen can be included in the obligation on fuel suppliers as an option, as provided for in RED II. Further key policy elements are rather similar to electricity in transport: developing a national strategy, defining an additionality framework, increasing renewable electricity capacities for hydrogen production, supporting the market uptake of vehicles, and supporting the establishment of hydrogen refuelling stations.

Also, the complementary policies are similar to electricity.

The related policies should be established together with those for biofuels and electricity, while the market may take up a few years later based on an earlier status in commercialization.

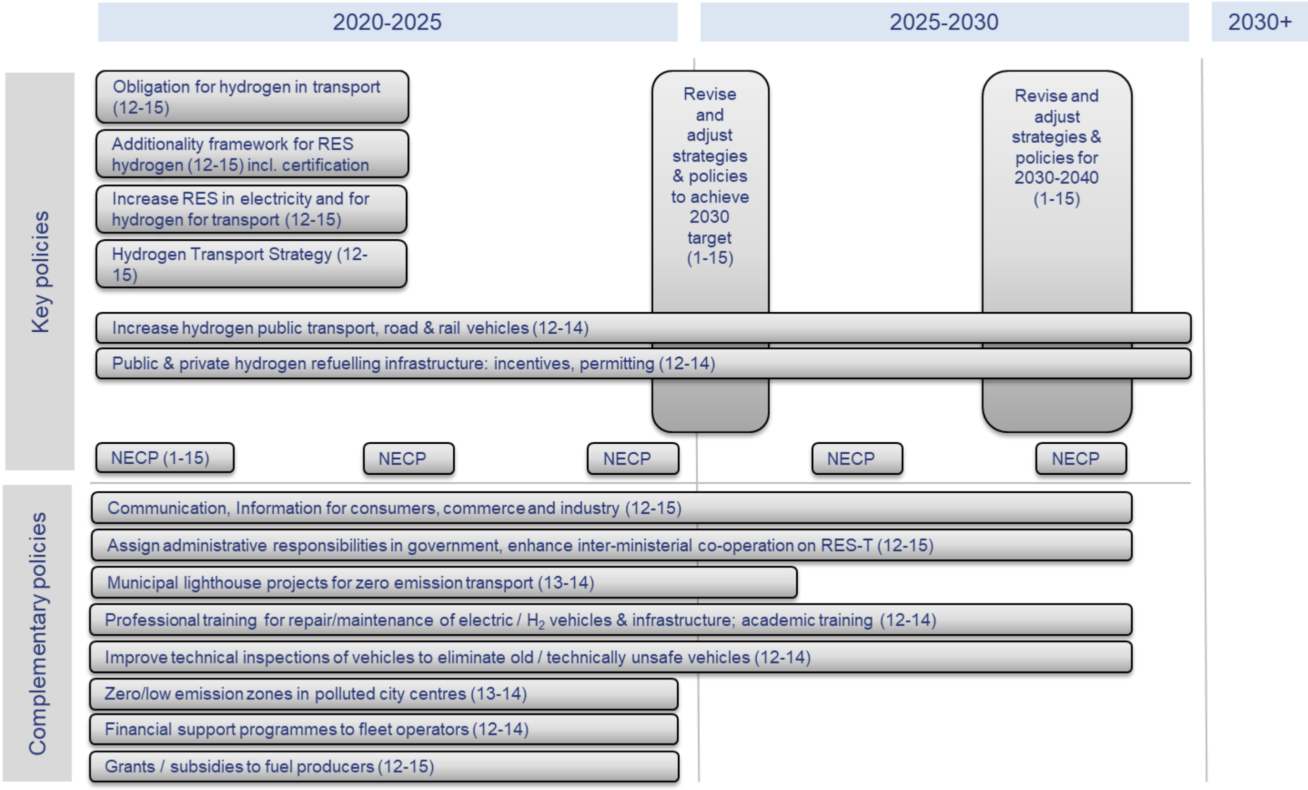

Figure 101: Roadmap for Georgia – Hydrogen in Transport

8.6 Conclusions and recommendations

8.6.1 Conclusions

Georgia can choose from a number of options to achieve the 2030 RES-T target of 9%. In fact, significant over-achievement beyond 13% is possible. It should be noted that even with more than 13% renewable energies in transport in 2030, the anticipated consumption growth over the coming decade is expected to result in increased fossil fuel imports relative to 2018. Therefore, even higher ambitions could be beneficial in economic and environmental terms for Georgia.

Options for renewable fuels production beyond the 2030 target may provide opportunities for exports, e.g. by producing and exporting biofuels based on used cooking oil and tallow, or by producing liquid fuels from renewable electricity (RFNBO).

Of the 9% overall renewables target in transport, crop-based biofuels are capped at 2%, while 7% need to be achieved by other renewable fuels.

While biofuels are anticipated to contribute most to the target, electricity use in rail can contribute almost as much if the renewable electricity share reaches the 2030 value of 100% as assumed for this study.

Electric road vehicles have notable potential, which is anticipated to be used towards 2030 with a dynamic growth potential beyond 2030 to allow for a major RES-T share by 2050

Hydrogen and battery-electric vehicles are complementary as hydrogen fuel cell vehicles enable longer driving distances, and are suitable for cars and heavy-duty transport alike; dynamic growth beyond 2030 is anticipated.

Additional benefits of achieving the 2030 RES-T target include the reduction of fossil energy import dependence and related financial flows out of the territory, additional national value creation, new or enhanced national value chains with related economic benefits and possible job creation as well as additional contributions to the national climate targets, etc.

8.6.2 Recommendations

As a proven policy tool, Georgia should adopt a 2030 target for renewable energies in transport based on RED II.

Georgia has adopted the Law of Georgia on Promoting the Production and Use of Energy from Renewable Sources at the end of 2019. Major policy elements are already foreseen to be established in Georgia by end 2021, including:

- rules for certification and compliance of biofuels, biogas and bioliquids
- rules for licensing and pricing of biofuels, biogas and bioliquids
- biofuels and bioliquids sustainability criteria
- rules for calculating the impact of biofuels, bioliquids and their fossil fuel comparators on the greenhouse gas emissions

This regulation should take up all provisions of RED II including sustainability criteria, certification, etc. The existing obligation on fuel suppliers to put renewable fuels on the market needs to be adjusted to RED II provisions.

All elements of the regulatory framework should be in place by the end of 2022.

Further key policy elements need to be established in order achieve the 2030 RES-T target:

- obligation towards economic operators for renewable fuels in transport; including its enforcement
- strategy and support mechanisms for electricity in transport
- strategy and support mechanisms for hydrogen in transport

Complementary policies are recommended to be established in order to ensure target achievement and maximum benefits to the Georgian economy.

Co-benefits with other policy areas should be actively developed. This includes air quality improvements in urban areas and other environmental and health issues as well as economic benefits such as reduced fossil fuel imports, job creation, national value creation, etc.

Furthermore, co-operation with other Contracting Parties, and more generally with other countries, allows synergies and should thus be pursued.

Policies should be revised and possibly adjusted in around 2025 based on a policy and results evaluation.

The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target.

9 Kosovo*

9.1 Executive Summary

The implementation of the revised Renewable Energy Directive (EU) 2018/2001 (RED II) on the promotion of the use of energy from renewable sources has started to be discussed within the Energy Community. Currently, RED II is not a part of the Energy Community acquis; but the adaptation and transposition by the Contracting Parties could be envisaged. Assuming for this study that the provisions of RED II are transposed into the law of Kosovo* without changes, we develop a roadmap for Kosovo* to achieve the 2030 target for renewables in transport of 9%[278].

Kosovo* has a share of renewable energy in transport of 0%.

Kosovo* has a number of options to achieve the 2030 RES-T target of 9%. It should be noted that even with target achievement, the anticipated strong consumption growth will result in increased fossil fuel imports relative to 2018. Therefore, even higher ambitions could be beneficial in economic and environmental terms.

Of the 9% overall renewables target in transport, crop-based biofuels are capped at 2%, while 7% need to be achieved by other renewable fuels. Biofuels are anticipated to contribute most to the 2030 target.

Electrification of rail lines currently under consideration can make additional contributions to the 2030 target.

Electric road vehicles can contribute to the 2030 target, with a strong growth potential beyond 2030. Hydrogen and battery-electric vehicles are complementary where hydrogen enables long driving distances, and heavy-duty operation alike; a small contribution by 2030 and dynamic growth thereafter is anticipated.

Additional benefits of achieving the 2030 RES-T target include the reduction of fossil energy import dependence, additional national value creation, new or enhanced national value chains with related economic benefits and possible job creation andas well asadditional contributions to the national climate targets, etc.[279] .

As a proven policy tool, Kosovo* should adopt a 2030 target for renewable energies in transport based on RED II.

[278] The overall target for RES-T of 14% can be reduced as far as the cap on crop-based biofuels is lower than 7%. As the cap on crop-based biofuels for Kosovo* is 2% based on the 2020 biofuels consumption, the overall target is reduced to 9%.

[279] Such benefits are not analysed in this study, but have been assessed in various studies, e.g. for hydrogen in Fuel Cells and Hydrogen Joint Undertaking (2019): Hydrogen Roadmap Europe – a sustainable pathway for the European energy transition; and in
Fuel Cells and Hydrogen Joint Undertaking (2020): Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans.

Starting from the first legal elements currently in parliament, Kosovo* should establish a legal framework on renewable energies in transport to include all elements of RED including most notably obligations on fuel suppliers including their enforcement, and a sustainability framework including certification. It is recommended to base such legislation on RED II in order to have a legislative framework based on the latest relevant policies as well as technological and commercial developments.

A major success factor for achieving a 2030 target for renewable energy in transport is to establish legal obligations towards economic operators including their enforcement. Certification ensuring the compliance of economic operators with the sustainability requirements is another.

Without prejudice to any possible legal, political or contractual obligations, all elements of the regulatory framework should be in place at the latest by the end of 2022 in order to give industry as much time as possible to plan, invest, implement and operate.

Further key policy elements need to be established in order achieve the 2030 RES-T target, including a strategy and support mechanisms for electricity and hydrogen in transport.

Complementary policies are recommended to be established in order to ensure target achievement and maximum benefits to the economy in Kosovo*.

Co-benefits with other policy areas should be actively developed. This includes air quality improvements in urban areas and other environmental and health issues as well as economic benefits such as reduced fossil fuel imports, job creation, national value creation, etc.

Furthermore, co-operation with other Contracting Parties, and more generally with other countries, allows synergies and should thus be pursued.

Policies should be revised and possibly adjusted in around 2025 based on a policy and results evaluation.

The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target.

9.2 Introduction

The Energy Community Contracting Parties including Kosovo* have the obligation to reach binding targets for renewable energy in gross final energy consumption by 2020. For the transport sector, the binding target is a minimum 10% of renewable energy (RES-T) by 2020. Kosovo* will not achieve this target.

The implementation of the revised Renewable Energy Directive (EU) 2018/2001 (RED II) on the promotion of the use of energy from renewable sources has started to be discussed within the Energy Community. Currently, RED II is not a part of the Energy Community acquis; but the adaptation and transposition by the Contracting Parties could be envisaged.

It is assumed here that the provisions of RED II are transposed into the law of Kosovo* without changes. On this basis, we develop a roadmap for Kosovo* to achieve the 2030 target for renewables in transport of 9%.

As a starting point, this study analyses the status quo of energy consumption in transport in Kosovo*, and provides 2030 projections including a business as usual scenario, and a scenario for compliance with the 2030 target for renewable energies in transport according to RED II.

In the second section, we assess the potential of national renewable energy sources suitable for use in transport, or for the production of transportation fuels together with the status of fuel pathway deployment in Kosovo*.

The third section describes the regulatory status quo related to renewable energies in transport. On this basis, we develop a roadmap for Kosovo* to achieve the 2030 target for renewables in transport on the three pillars of biofuels, electricity and hydrogen covering all transport sectors.

The final section provides conclusions and recommendations.

9.3 Status quo and 2030 projections of renewable energy consumption in transport

The objective of this chapter is to review the current status of renewable energies in transport (RES-T) in Kosovo*, and to develop scenarios of the development of renewable energy shares in transport by 2030.

The following data includes neither international aviation nor international navigation.

9.3.1 Status Quo

The following data includes neither international aviation nor international navigation as these two segments are generally excluded from statistics such as the Eurostat energy balances. Moreover, navigation is not applicable for Kosovo*.

9.3.1.1 Transport Indicators

For passenger transport, no data are available.

Freight transport by rail has decreased significantly since 2010. Data for freight transport on roads is not available.

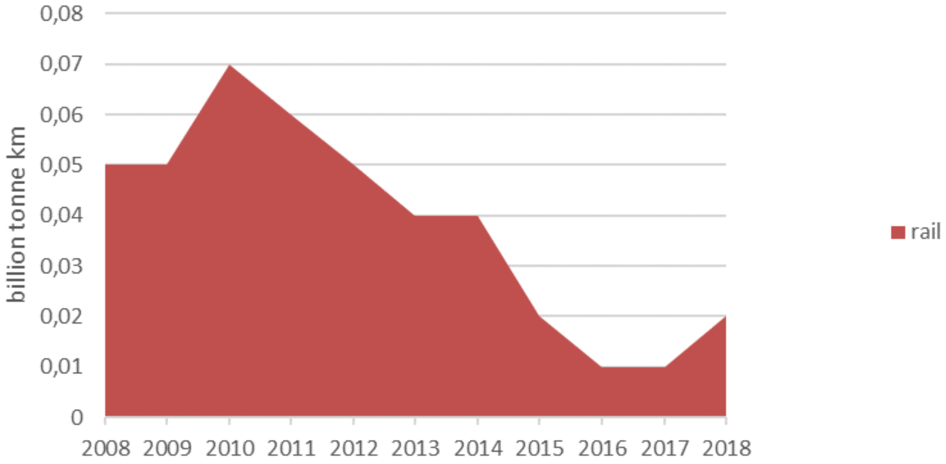

Figure 102: Freight transport by rail[280]

9.3.1.2 Registered Road Vehicles

Data on registered vehicles is available from 2011 onwards.

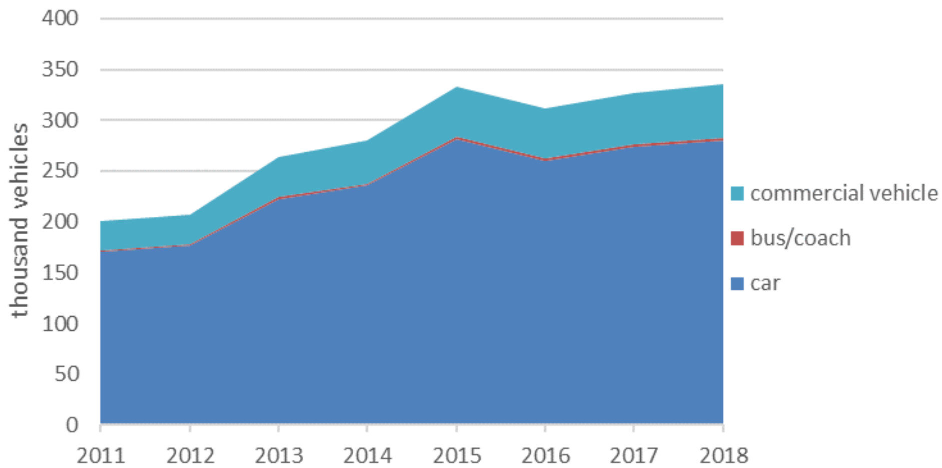

Figure 103: Registered road vehicles by type of vehicle[281]

After a rapid growth from 2011 to 2015, the number of commercial vehicles has increased only slightly. The number of passenger cars has increased strongly until 2015, and started to increase slightly again after a dip in 2016. The small number of buses almost doubled from 2011 to 2015, but has remained roughly constant since then with another increase in 2018.

280 Kosovo* Agency of Statistics (ASK): askdata - Transport. (n.d.). Available at https://askdata.rks-gov.net/PXWeb/pxweb/en/askdata/askdata__Transport/, last accessed 02. APR 2020

281 Kosovo* Agency of Statistics (ASK): askdata - Transport. (n.d.). Available at https://askdata.rks-gov.net/PXWeb/pxweb/en/askdata/askdata__Transport/, last accessed 02. APR 2020

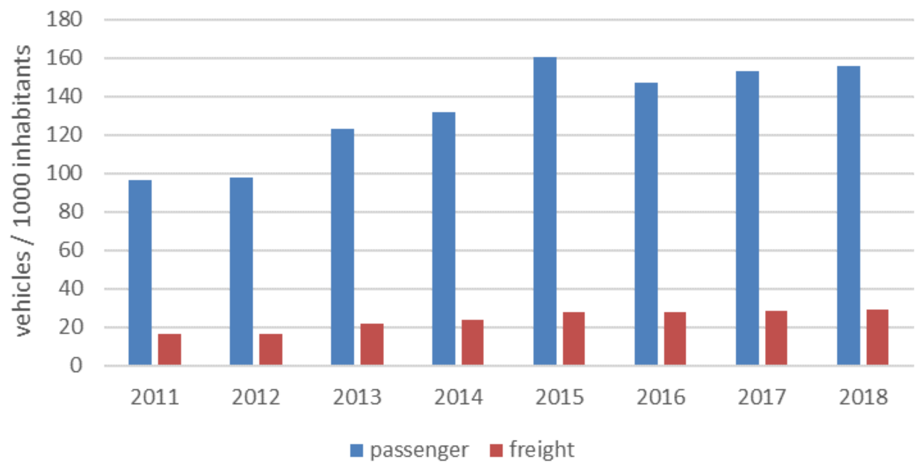

Figure 104: **Comparison of passenger and freight vehicles per capita**

After an increase from 2011 to 2015, the number of vehicles per capita of both categories has remained roughly constant since then.

9.3.1.3 Energy Consumption in Transport

After years of remaining roughly constant, the energy consumption in transport dropped significantly in 2013. Since then the energy consumption in transport has continuously increased. The share of transport in final energy consumption has been fluctuating around 28% in the past years.

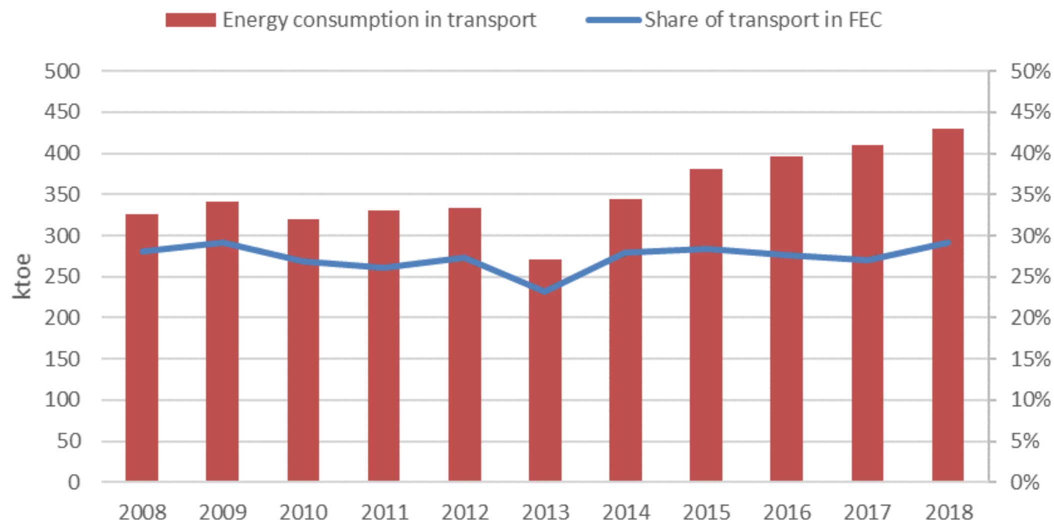

Figure 105: **Energy consumption in transport[282]**

[282] European Commission Energy Balances: XK-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

Almost all energy has been used for road transport. There is only a tiny share of energy used for rail transport. Although tiny, the consumption in this sector has more than tripled since 2014. The energy for transport has been provided exclusively by oil and petroleum products. No renewable energy has been used in transport.

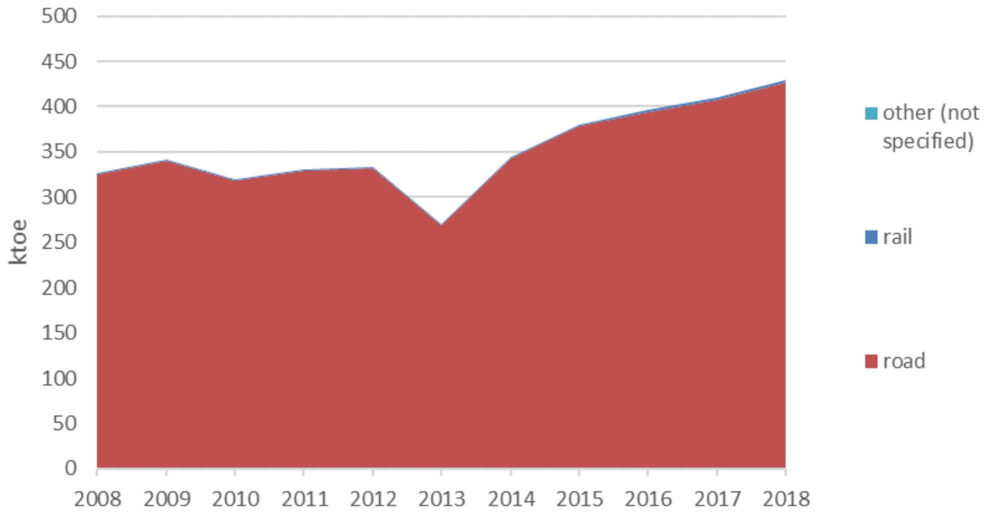

Figure 106: **Energy consumption in transport by sub-sector[283]**

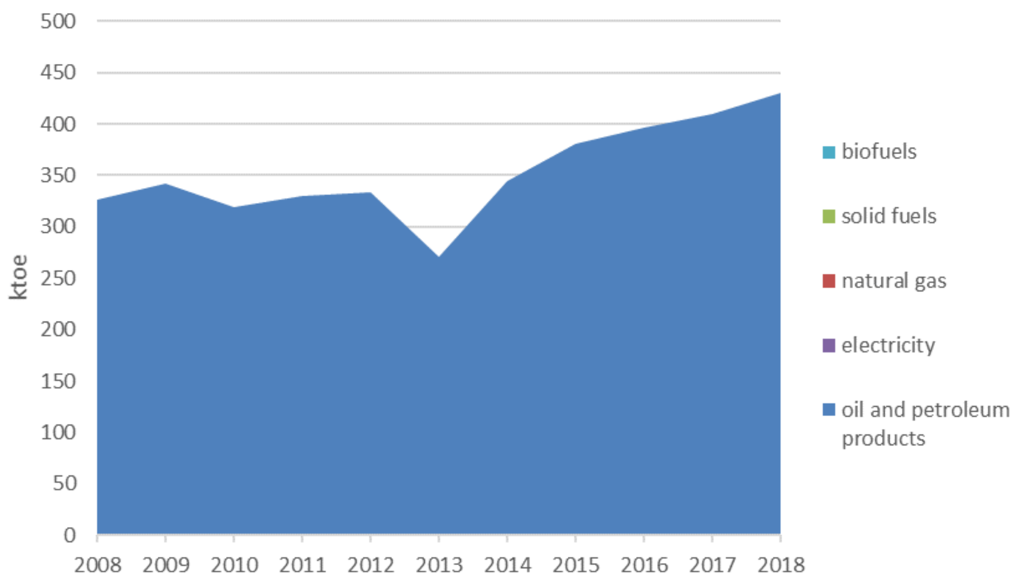

Figure 107: **Energy consumption in transport by type of fuel[284]**

283 European Commission Energy Balances: XK-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

284 European Commission Energy Balances: XK-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

9.3.2 2030 Projections

The 2030 projections used here rely on the Third National Plan of Action for Energy Efficiency (NEEAP) in Kosovo* of 2016[285]. In that document, a projection for energy consumption in transport is made, which is not broken down by transport sector or fuel. Here, we have scaled the transport consumption of 2018 from that document to the actual values as reported in the energy balances[286]. For the business as usual scenario (middle column in Figure 108) we have then assumed that the individual shares of the fuels in total consumption do not change between 2018 and 2030.

In 2030, the total energy consumption in transport in the business as usual scenario is 522 ktoe, up 21% from 430 ktoe in 2018.

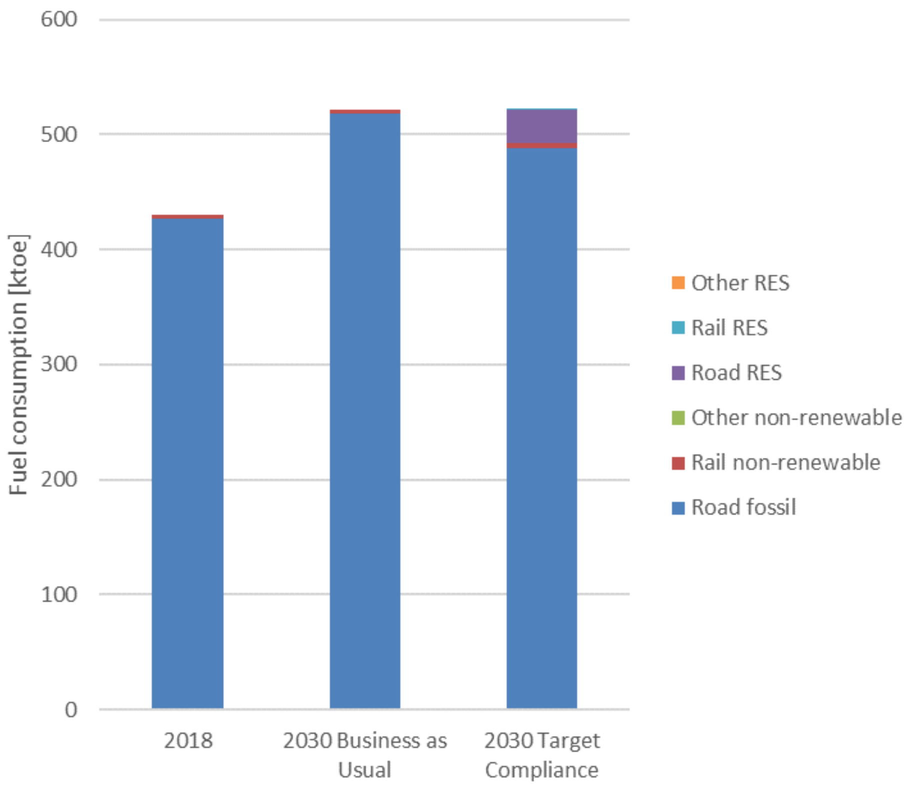

Figure 108: Energy consumption in transport in two scenarios for 2030

In a target compliance scenario achieving the 9% renewables in transport target for 2030, the roadmap as described in section 9.5.2 has been assumed to be implemented. This is represented by the right-hand column in Figure 108. The 9% renewable energies are broken

[285] Kosovo* Energy Efficiency Agency, Ministry of Economic Development: Third National Plan of Action for Energy Efficiency (NEEAP) in Kosovo*..*. 2016

[286] European Commission Energy Balances: XK-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

down by options as described in section 0, and are shown in detail in Figure 109. It should be noted that for target compliance, multipliers are used for certain options; however, the energy quantities shown in Figure 108 show the physical energies, i.e. without multipliers. Therefore, the actual renewable energy contribution in 2030 is less than 9% of total consumption in transport.

The total energy consumption in transport in the target compliance scenario is slightly lower than in the business as usual scenario as battery-electric vehicles and hydrogen fuel cell-electric vehicles are more energy efficient than internal combustion engine vehicles.

The very strong growth of fuel consumption leads to a significantly higher fossil fuel consumption in 2030 even in the target compliance scenario. In order to reduce fossil fuel imports and CO_2 emissions from transport, either the growth in transport energy consumption needs to be avoided, or the target for renewables in transport needs to be much more ambitious.

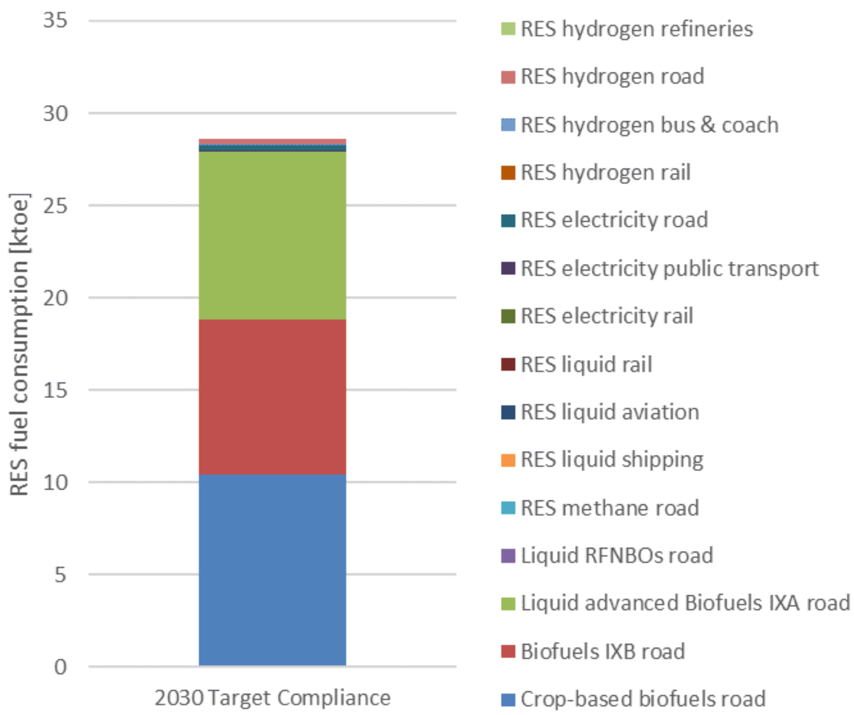

Figure 109: Renewable energy consumption in transport in 2030 by option

9.4 National renewable energy sources to meet the 2030 renewables in transport target

9.4.1 Potential of national renewable energy sources

The potential renewable fuel that could be produced from each of the feedstocks considered, is presented in Figure 110. Note these estimates relate to total feedstock potential and do not take into account competing uses, see section 3.2.1 for detailed description of sources and data used. Compared to the current energy use in road and rail transport, Kosovo* has a significant potential for energy crops. It should be noted that whilst the renewable power potential anticipated by IRENA is only 22PJ, the total technical potential is substantially higher. For example, Jacobson et al. (2019) state that the future potential for renewable power in Kosovo* could be 464PJ. It should also be noted that for Kosovo*, information on the production of starch and sugar crops is not currently available.

Current transport energy use (road and rail) in Kosovo* is 63% of the potential renewable fuel that could be produced from all feedstocks apart from renewable power. When renewable power is included, current transport energy use (road and rail) is 36% of the potential renewable fuel produced from all feedstocks.

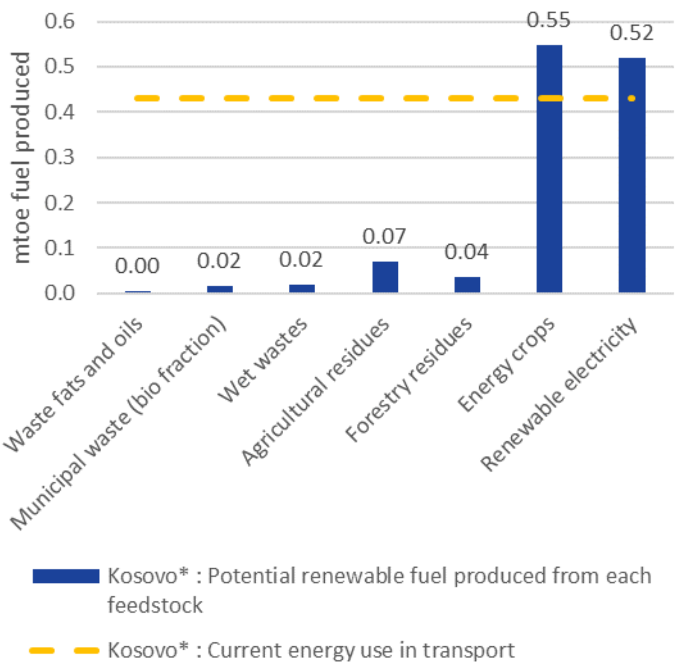

Figure 110: Kosovo*: Potential renewable fuel production, compared to current energy use in road and rail transport

9.4.2 Current status of national transportation fuel pathway deployments

There are no reported biofuel production plants in Kosovo*.

9.5 Roadmap for achieving the renewable energy in transport target for 2030

9.5.1 Regulatory status quo

9.5.1.1 General data

National progress reports show that Kosovo* is not on track of achieving the RES-T target of 10% by 2020, determined by the National Renewable Energy Action Plan (NREAP).

In 2019, the Energy Community started the process of setting 2030 targets in line with the Policy Guidelines on the development of integrated National Energy and Climate Plans (NECP) under Recommendation 2018/01/MC-EnC. Renewable energy targets as well as policies and measures will be addressed under the 'Decarbonisation of the economy' dimension of the NECP in an integrated way, which recognizes the interactions between the different dimensions.

Renewable energy targets, policies and measures for 2030 will thus be included in the NECP. The body competent for monitoring the implementation of the NREAP is the Ministry of Economy and Environment. Furthermore, the Energy Regulatory Office of Kosovo* is responsible for establishment and enforcement of a regulatory framework for the energy sector in Kosovo*, ensuring non-discrimination, effective competition, and the efficient functioning of energy markets.

However, non-compliance with renewable targets is not regulated as an offense, so no penalties are imposed.

Kosovo* does not have any provision for support measures available to purchasers of alternative-fueled vehicles, nor provisions in respect of the compatibility of vehicles with various alternative fuel types.

9.5.1.2 Energy efficiency in transport

The Law No. 06/L-079 on Energy Efficiency regulates activities aiming at reducing energy intensity in the national economy and contributing to the reduction of the negative impact to the environment from the activities related to the energy sector, and it applies to the transport sector as well. In Article 10, the law prescribes that the cumulative energy savings under the energy obligation scheme shall be equivalent to achieving new savings each year corresponding to the period from 1st January 2017 to 31st December 2020 of 0.7% of the annual energy sales to the final customers of all energy forms by volume, averaged over the most recent 3 years period prior to 1st January 2016. However, the sales of energy, by volume, which is used in transport shall be excluded from this calculation.

Based on the Law No. 06/L-079 on Energy Efficiency, in 2011 Kosovo* adopted the Energy Efficiency Action Plan (2010-2018) which covers the transport sector as well. The Energy Efficiency Action Plan sets energy savings targets and measures for energy efficiency improvement in the transport sector. In 2011, the first Mid-Term Energy Efficiency Action Plan was adopted covering the period 2010-2012; and in 2012, the second Mid-Term Energy Efficiency Action Plan covering the period 2013-2015 was adopted.

In 2016, the Third National Plan of Action for Energy Efficiency in Kosovo* was adopted covering the period 2016-2018, which contains estimated targets of energy savings which are lower than previously anticipated. In the Third National Plan of Action for Energy Efficiency measures are defined in the transport sector for improvement of the public transport system in Pristina city. The Energy Efficiency Agency of Kosovo* submitted to the Secretariat of the Energy Community the final draft of the 4th Energy Efficiency Action Plan in

October 2019 covering the period 2019 – 2021, but as per current information it has not been adopted yet.

The Law No. 06/L-079 on Energy Efficiency prescribes that starting from 28th February 2019 and every 3 years, municipalities shall prepare and submit to the Energy Efficiency Agency of Kosovo* draft Municipal Energy Efficiency Action Plans that shall include proposed energy efficiency policy and energy efficiency improvement measures covering all sectors operating at the municipal level. Annually, and no later than 30 April, the Municipal Assembly shall approve and submit to the Energy Efficiency Agency of Kosovo* the Progress Report on the implementation of the Municipal Energy Efficiency Action Plan for the previous year.

It should be mentioned that the measures for 2030 regarding energy efficiency shall be included in the NECP.

9.5.1.3 Production and supply of fuel

On the basis of Law No. 05/L – 081 on Energy the Administrative Instruction No. 05/2017 Renewable Energy Source Targets was adopted, which stipulates that the share of energy from renewable sources in all forms of transport in 2020 shall be at least 10% of the final consumption of energy in transport.

According to the NREAP, the mandatory target for the renewable energy share in the transport sector is 10% by the end of 2020. Until the end of 2017, the target was foreseen to be reached by imported biofuels only, after which domestic production should contribute to fulfilling the target. However, the actual share is still at 0% according to the information from national progress reports.

There is no defined obligation imposed on the fuel suppliers related to the share of renewable energy in the final consumption of energy in the transport sector, nor any obligation of the fuel suppliers to meet certain greenhouse gas emissions standards.

Also, in Kosovo* there is no regulation containing provisions defining minimum GHG reduction requirements for gasoline or diesel.

Kosovo* has not adopted specific legislation on sustainability criteria for biofuels, bioliquids or biomass fuels. According to the information from the NREAP regarding sustainability criteria for biofuels and bioliquids at the national level, the draft Law on petroleum and petroleum products market in Kosovo* shall govern biofuels related issues in general, while the targets for consumption of biofuels in transport and sustainability criteria will be set by the Administrative Instruction on Biofuel use in transport.

In 2018, the Ministry of Trade and Industry finalized the draft of the Law on Trade in Petroleum Products and Renewable Fuels and the Administrative Instruction on Biofuels and sent it to the Cabinet of Ministers. It should be mentioned that the adoption of the Administrative Instruction on Biofuels can be done only after the Law on Trade in Petroleum Products and Renewable Fuels is enforced. Although the law was submitted to the Parliament at the end of 2018, it has still not been adopted.

As per support schemes to promote the use of energy from renewable energy sources in transport sector, in accordance with the NREAP, the main measures to promote the use of energy from renewable resources will be a quota obligation for the use of biofuels in transport, as well as excise tax exemptions for biofuels placed on the market.

With respect to reporting obligations in Kosovo* no reporting obligation on the fuel suppliers in fuel markets regarding the share of renewable fuel or greenhouse gas reductions is imposed.

The rules concerning production of electricity from renewable sources are set by the Law No. 05/L-085 on Electricity. In accordance with the law, the subject that intends to perform this energy activity needs to obtain a license which is issued by the Energy Regulatory Office of Kosovo*. As well, in the field of renewable energy sources, the Energy Regulatory Office of Kosovo* is competent for the issuance of guarantees of origin.

It should be noted that there are no regulations containing provisions with required criteria related to electricity used directly in transport.

There are several gaps in the legislation which may be filled in the future. This refers among others to renewable fuels of non-biological origin – RFNBO defined in RED II. For the production of RFNBOs no criteria related to electricity used to produce RFNBOs is defined.

In respect of the area of E-mobility there are no provisions which refer to obligations of certain subjects such as public parkings or public garages to have electric vehicle charging stations. Furthermore, there are no imposed incentives or simplified procedures for construction/licensing of electricity charging stations for road vehicles, or for construction/licensing of hydrogen refueling stations.

Excise duties are defined by the Law No. 03/L-112 on Excise Tax Rate in Kosovo* which was amended by the Law No. 03/L-220. According to the law, the excise duty is paid per liter, as follows:

- Petroleum oils and oils obtained from bituminous minerals (other than crude oil), preparations that are not specified or included elsewhere, which contain by weight 70% or more of petroleum oils or oils obtained from bituminous minerals, with the fact that these oils are the basic ingredients of the preparations (except waste oils); 0.325 €/l
- Gas oils (petroleum); 0.360 €/l
- Alcohol for engines (gasoline), fuels of the alcohol type for jet engines and other light oils. 0.385 €/l

The Law No. 03/L-112 on Excise Tax rate in Kosovo* prescribes that petroleum gases and other gaseous hydrocarbons under tariff code 2711, used for production purposes, will be exempted from the excise tax rate.

9.5.1.4 Passenger transport sector

The Law No. 04/L-117 on Road and Ecological Tax for Vehicles stipulates annual duties for the owners of vehicles registered in Kosovo* based on their weight. The law defines two types of taxes imposed on vehicle owners:

- Road tax, and
- Ecological tax.

The road tax is paid by the owners of vehicles which are registered in Kosovo*, while the ecological tax is paid by the owners of vehicles which are registered in Kosovo*and by the owners of foreign vehicles that are entering into the territory of Kosovo*.

Both taxes are paid annually, upon the registration of the vehicle, which are registered in Kosovo*. The owners of foreign vehicles pay ecological tax when crossing when entering into theterritory of Kosovo*.

Motorcycles are exempted from both the road tax and the ecological tax.

Table 35: Road tax for vehicles in Kosovo*

Cat.	Vehicles, weight	Annual tax, €
1.	Under 3.5t	40
2.	3,5t and over 3,5t	90

Table 36: Ecological tax for vehicles in Kosovo*

Cat.	Vehicles, weight	Annual tax, €
1.	Under 3.5t	10
2.	3,5t and over 3,5t	30

The Law No. 05/L –132 on Vehicles imposes certain limitations for import of vehicles into the territory of Kosovo*. As per the law provisions, the imported vehicles cannot be older than 10 years, and they must meet EURO 4 engine standard as a minimum.

Kosovo* does not have any regulation with respect to incentives for import or purchase of electric vehicles or hydrogen fuel cell vehicles.

Custom taxes for vehicles which are imported into Kosovo* are defined by the Customs and Excise Code of Kosovo*. The customs rate is 0% for vehicles originating from countries which are signatories of the CEFTA agreement, and for some vehicles imported from the European Union as per the provisions of the Stabilization and Association Agreement. A reduced customs rate (7% or 9%) is applicable for some vehicles imported from Turkey. For countries that Kosovo* does not have a free trade agreement with, the customs rate is 10%.

Besides the payment of the customs rate, vehicle owners are obliged to pay VAT of 18% and the excise tax rate. In respect of the excise tax rate, its amount depends on the age of the vehicle and the engine displacement. The amount of excise tax rate is higher for older vehicles, and for vehicles with a higher engine displacement (over 2000 cm^3 and 3000 cm^3). For new vehicles with engine displacement up to 2000 cm^3 the excise tax rate is 0.00 €. There are no special incentives for electric and hybrid vehicles in respect of customs rate, VAT and excise tax rate.

Furthermore, the sector of public transport is not regulated in Kosovo*. That means there are no incentives for the use of electricity or renewable fuel in public transport, nor any restrictions, limitations or obligations in this regard.

9.5.1.5 Freight transport sector

The same annual duties are imposed on owners of freight vehicles registered in Kosovo* as for the owners of passenger vehicles, which are defined by the Law No. 04/L-117 on Road and Ecological Tax for Vehicles. The two types of taxes are:

- Road tax, and
- Ecological tax.

The rules regarding the persons who are obligated to pay these taxes, as well as determination of the amount of both taxes and the manner of their collection are the same as for the passenger vehicles.

In addition, the rules regarding limitations for import of freight vehicles are the same as for passenger vehicles: imported freight vehicles must not be older than 10 years, and they must meet the EURO 4 engine standard as a minimum.

9.5.1.6 Railway sector

The Law No. 04/L-063 on Kosovo* Railways from 2011 amended in 2019 imposes certain authorizations related to the railway sector.

A Railway license is a document which officially recognizes the company's ability to perform railway transport services, listed in this document.

A Security certificate is a document by which the railway company proves that it fulfils the conditions for safe traffic on certain lines or on the whole railway network.

A Security authorization is a document by which the infrastructure manager proves that it fulfils the requirements for providing secure infrastructure services.

Table 37: Authorizations related to the railway sector in Kosovo*

Type	Subjects	Competent authority for issuance
Railway license	Railway company, i.e. any public or private company, whose main activity is providing rail transport of goods and passengers with a request to provide towing of trains	Railway Regulatory Authority of Kosovo*
Security certificate	Railway company - any public or private company, whose main activity is providing rail transport of goods and/or passengers with a request to provide towing, which includes the companies that provide only towing services; Operators of railway transport of passengers, goods, railway equipment and tools for maintenance of railways and other special-purpose railway assets	Railway Regulatory Authority of Kosovo*
Security authorization	Infrastructure manager	Railway Regulatory Authority of Kosovo*

There are no electric locomotives in use in Kosovo*, and the railroads are completely non-electrified. Thus, there are no provisions on incentives or obligations for use of electric locomotives, and also there is no act which imposes the use of electricity from renewable energy for railway transport. However, certain projects exist for the modernization of the railroads which envisage electrification.

9.5.2 Roadmap to achieve the 2030 target

The roadmap developed here for Kosovo* to achieve the 2030 target of 9% renewable energies in transport builds on the provisions of RED II as described in section 3.1.1. It is assumed that these provisions are transposed into the law of Kosovo* without changes including the calculation method for renewables in transport, the caps and minimum values for various types of renewable energies, the multipliers, the provisions related to electricity and RFNBOs etc. Also, sustainability criteria need to be transposed into national law in order to fully comply with RED II, and it must be ensured that certification schemes are in place (national or voluntary) that are compliant with RED II requirements.

For this study, we apply the renewable share in the national electricity mix anticipated for 2030. On the one hand, this tends to overestimate the renewable share as values for the year 2028 that should be applied are not available, but should in general be lower than the 2030 values. On the other hand, dedicated renewable power plants may be erected that are counted as 100% renewable for transport.

For Kosovo*, a 39% renewable electricity mix is anticipated for 2030 based on literature values.[287] This is without prejudice to 2030 targets to be defined and included in the NECP.

It should be noted that the national electricity mix is applied to electricity in transport for calculating the contribution of renewable electricity to the 2030 RES-T target. However, RED II allows electricity to be counted as 100% renewable if it is based on dedicated capacities for transport, and further criteria are met.

9.5.2.1 Potential contributions from all options

Based on the assessment of all options for Kosovo*, a total RES-T share of 9.7% in 2030 can be achieved as a combination of all options (see Table 38). Further limited potentials exist in renewable liquid fuels in aviation and rail, which are assumed to be zero here.

Biofuels potentially contribute most in 2030.

Electric and hydrogen vehicles can already make small contributions by 2030, and have a strong growth potential thereafter.

[287] TU Wien/Energy Economics Group, Joanneum Research, REKK: Study on 2030 overall targets (energy efficiency, RES, GHG emissions reduction) for the Energy Community. Vienna 2019

Table 38: Potential RES-T contributions from all options in Kosovo*

Option		Contribution to RES-T target (%) incl. multiple counting	Amount of renewable fuel used (ktoe)
Biofuels and liquid RFNBOs	1. Crop-based biofuels in road transport	2.0%	10.4
	2. Liquid fuels produced from Annex IX B feedstocks in road transport	3.4%	8.9
	3. Liquid advanced Biofuels (based on Annex IX A feedstocks) in road transport	3.5%	9.1
	4. Liquid RFNBOs in road transport	0.541%	2.82
	5. Renewable methane in road transport	0.000%	0.00
	6. Renewable liquid fuels in shipping	0.000%	0.00
	7. Renewable liquid fuels in aviation	0.000%	0.00
	8. Renewable liquid fuels in rail	0.000%	0.00
Electricity	9. Rail electrification	0.000%	0.00
	10. Electric public transport (bus, trolleybus, tram, metro)	0.008%	0.02
	11. Electric road vehicles (passenger cars and trucks)	0.220%	0.29
Hydrogen	12. Hydrogen in rail	0.006%	0.03
	13. Hydrogen bus and coach (urban bus, long distance coaches)	0.003%	0.02
	14. Hydrogen road vehicles (passenger cars and trucks)	0.055%	0.29
	15. Hydrogen in refineries	0.000%	0.00
Total		9.73%	32

As the possible contributions of battery-electric vehicles depend on many factors, the following considerations are intended to provide some insight into the dynamics and opportunities (see Figure 111). The graph is based on a number of approximate assumptions, and should thus be understood as rough indication showing the general trends.

Battery-electric cars' contribution to the RES-T target is calculated by applying the renewable share in the national electricity mix to the use of electricity in BEVSs[288].

Electricity provided through public charging stations is covered in statistics as energy consumed in transport, and thus counted accordingly; charging through private charging units is not covered in statistics. Therefore, RED II foresees a multiplier of four for electricity consumed in road transport (based on data from statistics).

The RES-T contribution of battery cars depends on:

- The number of battery cars (horizontal axis in Figure 111);
- The share of public charging (green/ blue line in Figure 111 assuming 25% and 100% public charging, respectively);

[288] However, if certain criteria are met (see RED II), renewable electricity can be counted as 100% renewable. This is not assumed in this study for option 11.

- The renewable share in the national electricity mix in 2028 (39% for Kosovo*); lower RES shares would reduce the contribution accordingly.

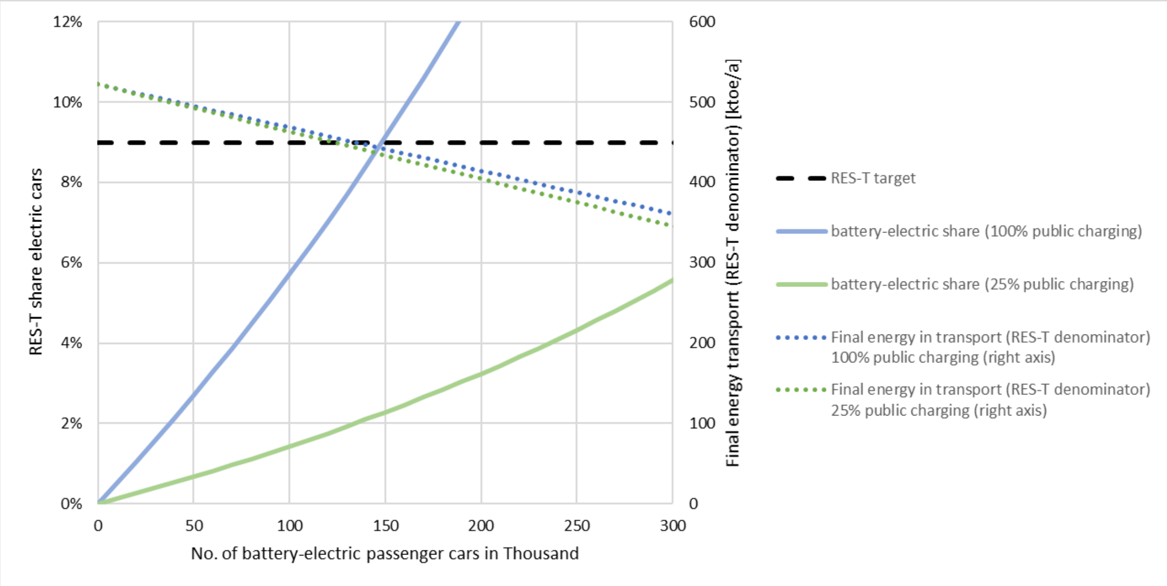

Figure 111: Possible contributions of battery cars to Kosovo*'s 2030 RES-T target

Assuming 25% public charging, 100 thousand battery cars would approximately contribute 1.4% RES-T by 2030 (see Figure 111).

As battery cars are more energy efficient than conventional cars and the electricity is only partly covered in statistics energy consumption in transport decreases with increasing battery cars (dotted lines in Figure 111).

9.5.2.2 Choice of options to meet RES-T target

The potential contribution of all options exceeds the target, and thus allows reducing the contributions from some options. The reductions are based on the general considerations described in section 5.1, and on the specific circumstances in Kosovo* as described in the following:

1. Crop-based biofuels are used up to the 2% cap
2. Biofuels based on Annex IXB biofuels can be reduced to 3.2%. 60% of this supply could be met from domestic collectable UCO and tallow resources;
3. Liquid biofuels and biomethane based on Annex IXA feedstocks ("advanced biofuels") are developed to meet the minimum targets defined in RED II. For context, this is less than a third of the output of an advanced ethanol plant at typical scale of 63 million l fuel/year;
4. Relatively expensive RFNBOs are not required in road transport to meet the 2030 target;

5. Kosovo* has no use of methane in transport currently; therefore, it is assumed this is not introduced
6. There is no domestic navigation in Kosovo*;
7. No renewable fuels in aviation are required to meet Kosovo*'s RED II target;
8. No renewable fuels in rail are required to meet Kosovo*'s RED II target;
9. No electricity consumption in rail transport is assumed here. Nonetheless, electrification of rail lines could be an opportunity for Kosovo* including for renewable energies in transport;
10. The introduction of battery buses and the expansion or establishment of trolley bus systems, or trams in cities is assumed here;
11. The market uptake of battery-electric road vehicles (cars and light/ medium duty trucks) leads to electricity consumption in transport;
12. Existing and new rail lines not suitable for electrification allow establishing zero emission hydrogen fuel cell trains;
13. Introduce hydrogen fuel cell buses in urban areas, and (long-distance) coaches in applications not suitable for battery-electric vehicles (high daily driving range, long-distance);
14. Start of market uptake of hydrogen fuel cell-electric road vehicles (cars and light to heavy duty trucks) for long-distance, high driving ranges;
15. There is no refining sector in Kosovo*.

This results in the following contributions by 2030 assumed to be realistic and reducing the most challenging or expensive[289] options to meet the defined 2030 RES-T target (see Table 39).

Strong contributions are made by all three types of biofuels; moderate contributions are made by electric and hydrogen road vehicles; limited contributions are made by electric public transport and by hydrogen in buses and coaches and in rail.

The contribution from electricity in rail and all other forms of transport assumes a 39% share of renewable electricity in power by 2030. If this was lower, all options using electricity directly or hydrogen would make a smaller contribution to the 2030 target. A higher renewable share in the national electricity mix or dedicated renewable capacities would increase the renewable contribution of rail and all other forms of transport, which are based on electricity or hydrogen.

The high proportion of Annex IXA (advanced) biofuels is driven by the sub-target in RED II and relies on successful scale-up in production of liquid Annex IXA biofuels globally. Should this

[289] Detailed cost assessments have not been carried out in this study. Rough cost judgements are made here based on costs information provided in chapter 3.

prove not to be feasible, crop-based biofuels or biofuels based on Annex IXB could be increased, which would, however, not allow the sub-target for advanced biofuels in RED II to be met.

Table 39: Contribution to Kosovo*'s RES-T target from options chosen

	Option	Multiplier	2030 Contribution to RES-T target incl. Multipliers	2030 Amount of renewable fuel used (ktoe)
Biofuels and liquid RFNBOs	1. Liquid crop-based biofuels in road transport	1	2.0%	10.4
	2. Liquid fuels produced from Annex IX B feedstocks in road transport	2	3.2%	8.4
	3. Advanced liquid biofuels (based on Annex IX A feedstocks) in road transport	2	3.5%	9.1
	4. Liquid RFNBOs in road transport	1	0%	0%
	5. Renewable methane in road transport	2	0%	0%
	6. Renewable liquid fuels in shipping	2	0%	0%
	7. Renewable liquid fuels in aviation	2	0%	0%
	8. Renewable liquid fuels in rail	2	0%	0%
Electricity	9. Rail electrification	1.5	0%	0
	10. Electric public transport (bus, trolleybus, tram, metro)	4 (road) 1 (tram, metro)	0.01%	0.02
	11. Electric road vehicles (passenger cars and trucks)	4	0.2%	0.3
Hydrogen	12. Hydrogen in rail	1	0.006%	0.03
	13. Hydrogen bus and coach (urban bus, long distance coaches)	1	0.003%	0.02
	14. Hydrogen road vehicles (passenger cars and trucks)	1	0.1%	0.3
	15. Hydrogen in refineries	1	0%	0
Total			**9.0%**	**29**

These contributions lead to a breakdown of fuel consumption in 2030 as shown in section 9.3.2.

9.5.2.3 Roadmap for Kosovo*

The roadmap for Kosovo* to achieve the 2030 target for renewable energies in transport (see Figure 112) involves key policies to be developed and adopted in the coming few years, building on the existing regulatory framework and policy elements already under development (see section 9.5.1). The regulatory framework for renewable energies in transport needs to be expanded substantially, and so far focuses on biomass-based fuels; direct electricity use and hydrogen use in road transport has received less emphasis so far, but should be taken up as two additional central pillars for renewables in transport.

The roadmap foresees that the last elements of the regulatory framework should be in place by the end of 2022.

The appropriateness, effectiveness and efficiency of this policy framework to be established in the short-term should be evaluated in around 2025, and should be adjusted where necessary to ensure target compliance by 2030. The European Union is currently developing the details of the European Green Deal, which aims to make the European Union climate neutral by 2050 by turning climate and environmental challenges into opportunities, and making the transition just and inclusive for all. Based on a set of policy initiatives by the European Commission, climate ambitions by 2030 are anticipated to be increased, which includes adjustments to RED II. A revision of the policy framework in Kosovo* around the middle of the decade would be timely for taking up decisions to be taken at European Union level by then.

Around 2028 would be a suitable point in time to set targets for the 2040 timeframe, and to revise and adjust the strategies and policies accordingly.

Currently, Kosovo* is developing its first National Energy and Climate Plan (NECP), which has a planning and a monitoring function. The biannual progress reports and the regular revisions of the National Energy and Climate Plans are the appropriate instrument for monitoring successful implementation and development towards the 2030 target, and will be helpful for the 2025 revision of the policy framework.

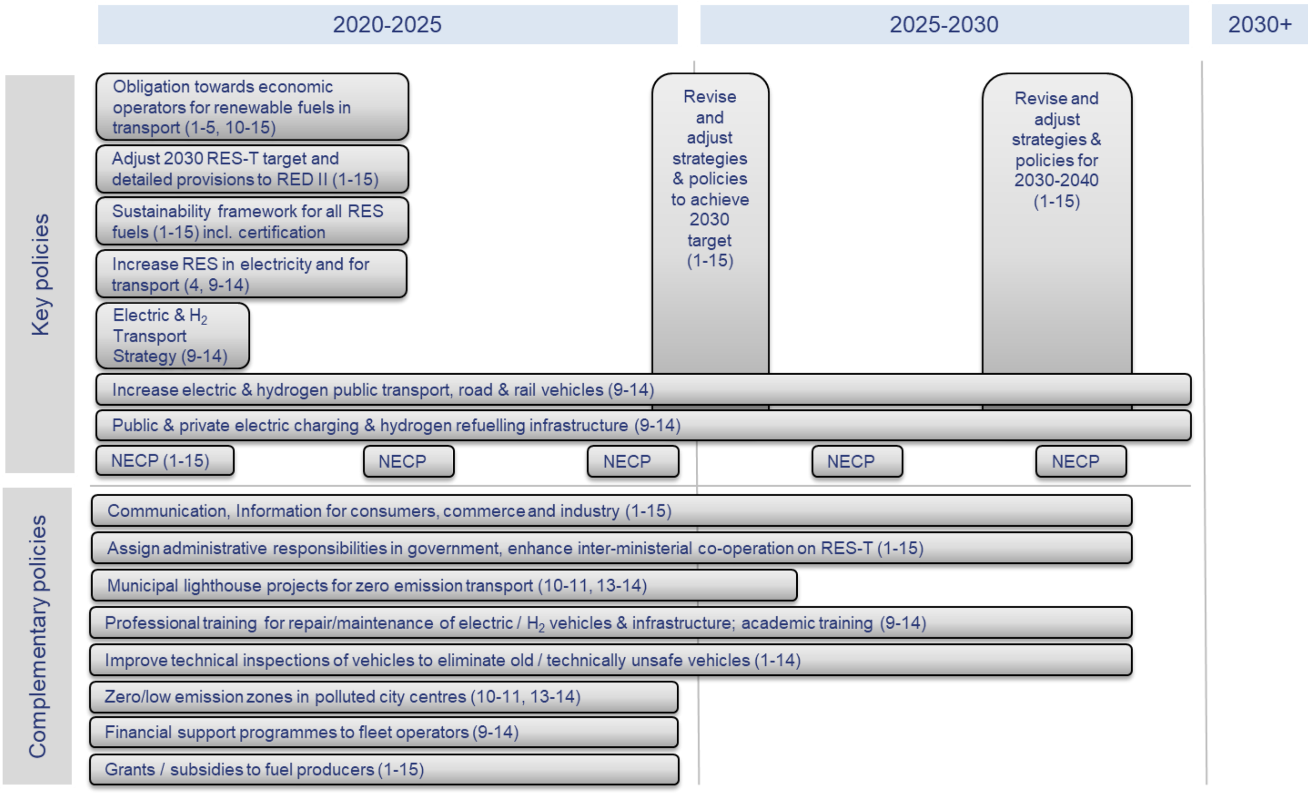

Figure 112: Overview roadmap for Kosovo*

The priority in the roadmap for biofuels is to establish policy to drive uptake of these fuels through an obligation on fuel suppliers to supply a minimum proportion of these fuels, which does not currently exist in Kosovo*. Development and introduction of this policy mechanism should be started as soon as possible, to allow industry as much time as possible to adjust and prepare to meet 2030 targets. This obligation needs to be supported through a number of other policy elements such as rules for certification and compliance of biofuels, sustainability criteria for biofuels, and rules for calculating the impact of biofuels on the greenhouse gas emissions. These should be developed based on the provisions of RED II. Additional attention may need to be given to criteria on production of liquid RFNBOs, alongside the rules on hydrogen (below). A unit within the relevant government ministry must be designated responsible for implementing, reviewing and updating the policy as a whole, ensuring sustainability certification of fuels, administering the scheme, data collection and reporting.

Several other measures that are complementary to this demand-side policy have also been important in other countries, namely support for domestic fuel production, such as capital grants for plants, and information provision for consumers on fuel switching and vehicle compatibility.

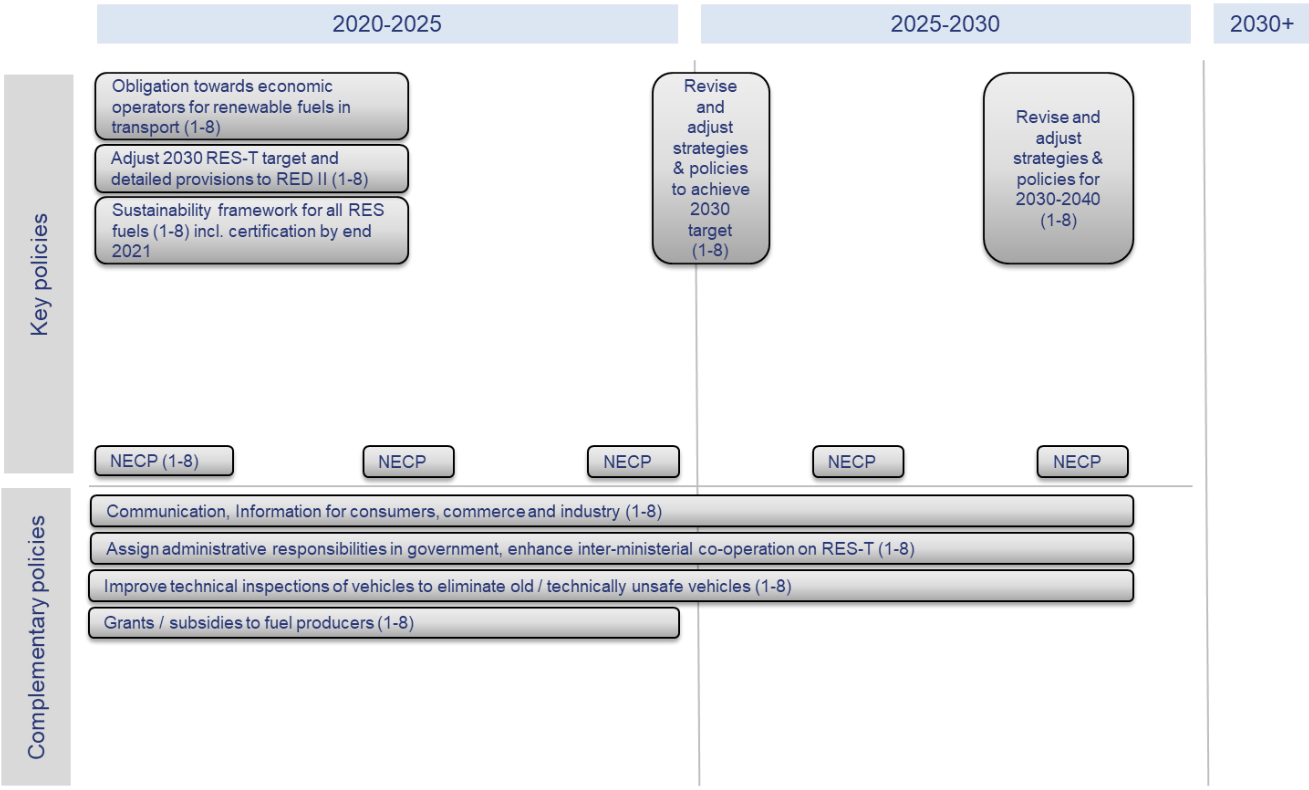

Figure 113: Roadmap for Kosovo* – Biofuels and liquid RFNBOs

Direct electricity use in transport is not established in Kosovo* yet. Electrification of rail and electricity-based public transport using trolleybuses or tramways should be considered.

Battery-electric road transport including passenger cars, public transport and delivery vehicles is in a very early stage of development in Kosovo*, and has a significant growth potential. Developing a national electric transport strategy would be an appropriate starting point for a coherent and effective policy framework in this area. Various policies for fostering electric transport could be envisioned, such as including renewable electricity in the obligation on fuel suppliers for increasing the share of renewable energies in transportation fuels (see above), or putting an obligation on electricity suppliers for providing renewable electricity to transport, etc.

An additionality framework for renewable electricity would define rules for counting electricity as renewable based on RED II[290], and detailed provisions are currently under development by the European Commission. This aims at fostering additional renewable power capacities for transport not compromising the achievement of renewables electricity targets in conventional electricity consumption.

In parallel, existing policies for increasing renewable electricity production should be adjusted by increasing renewable targets for 2030 that would include additional renewable electricity demand from transport. Fostering dedicated renewable capacities for transport could be a new element introduced into existing legislation, covering rail, public transport and road.

Increasing the number of electric vehicles in road, rail and public transport is a major lever for increasing the consumption of electricity in transport, and reducing conventional fuel consumption. Elements for such policies include providing direct financial support for purchasing electric vehicles, and adjusting the tax and import duty structures to incentivize purchases of electric vehicles. The vehicle charging infrastructure is the second major lever. Policies to coordinate and incentivize the build-up of a public network of charging stations include elements of financial incentives through grants, subsidies and loans, clear permitting rules, and coordination to ensure an appropriate nationwide network structure. In addition, financial support to charging infrastructures for public transport and fleet operators is an effective and efficient instrument for rapid growth.

The appropriate administrative structures must be established including enhanced inter-ministerial co-operation, and related responsibilities assigned in government.

Further complementary policies supporting electric transport include communication and information campaigns, lighthouse projects at local/ municipal level, the establishment of zero or low emission zones in urban areas for reduced air pollution, professional and academic training, technical inspections of vehicles (both electric and conventional), etc.

[290] See RED II Art. 27(3)

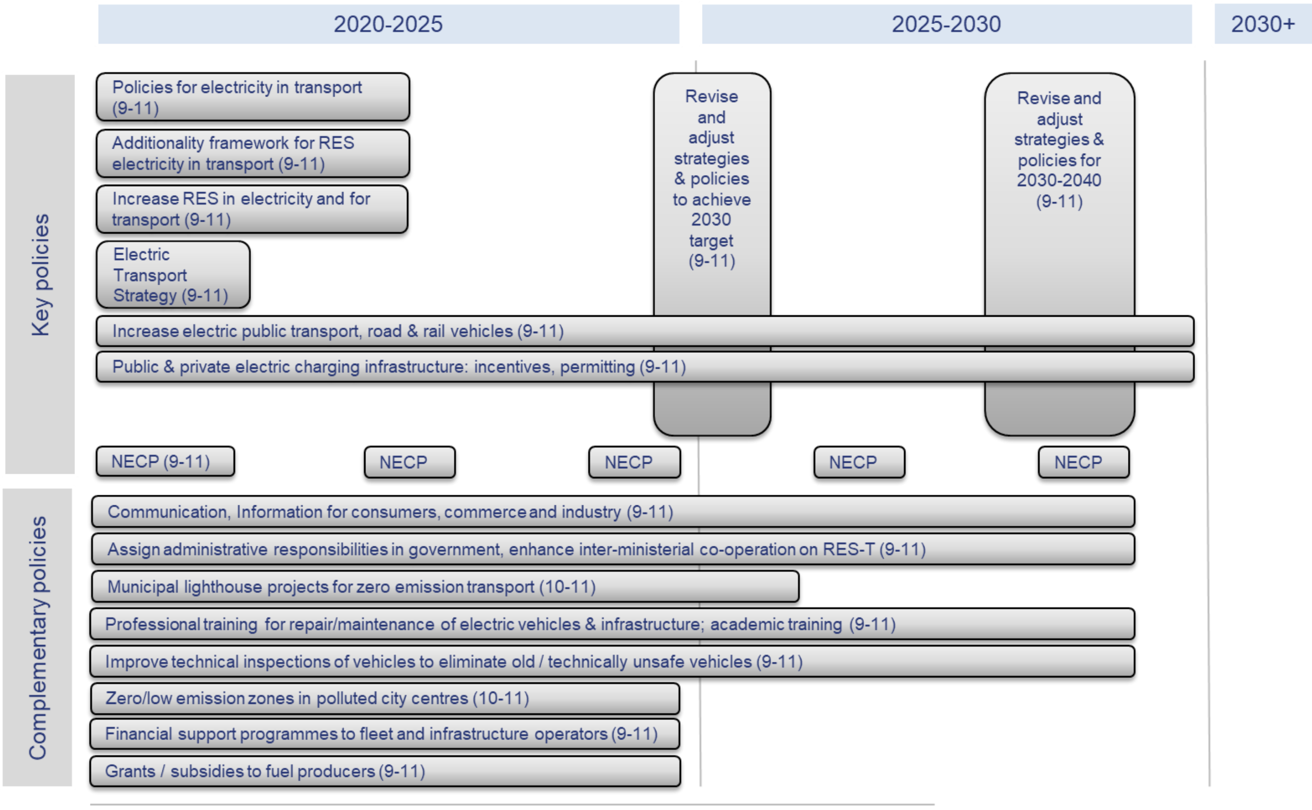

Figure 114: Roadmap for Kosovo* – Electricity in Transport

Hydrogen in transport using fuel cell-electric vehicles is in early phases of commercialization world-wide, and shows major potential for decarbonizing transport in a complementary fashion to battery-electric vehicles. On non-electrified rail lines, first commercial hydrogen trains are in operation, and fuel cell vehicles are coming onto the market. A focus will be on vehicles for longer distances and for duty purposes such as trucks and buses.

Hydrogen can be included in the obligation on fuel suppliers as an option, as provided for in RED II. Further key policy elements are rather similar to electricity in transport: developing a national strategy, defining an additionality framework, increasing renewable electricity capacities for hydrogen production, supporting the market uptake of vehicles, and supporting the establishment of hydrogen refuelling stations.

Also, the complementary policies are similar to electricity.

The related policies should be established together with those for biofuels and electricity, while the market may take up a few years later based on an earlier status in commercialization.

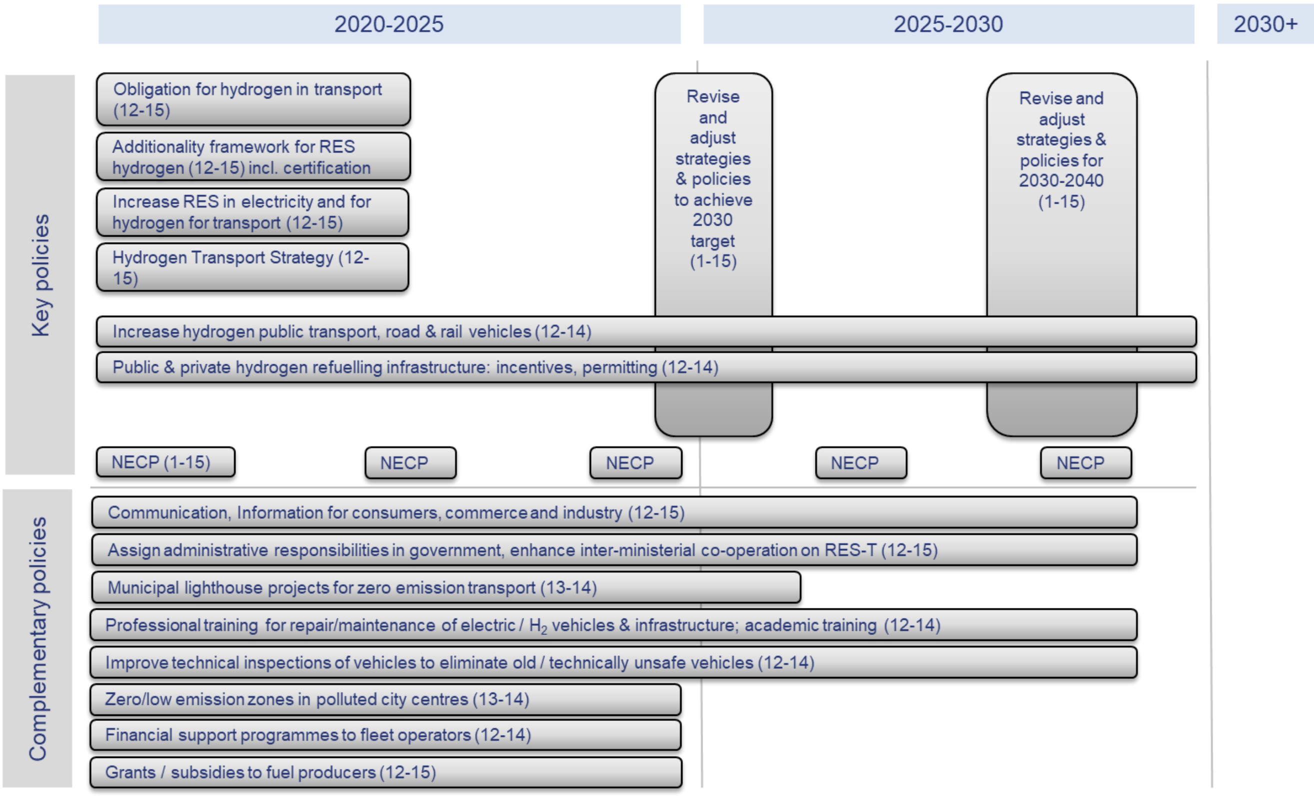

Figure 115: Roadmap for Kosovo* – Hydrogen in Transport

9.6 Conclusions and recommendations

9.6.1 Conclusions

Kosovo* can choose from a number of options to achieve the 2030 RES-T target of 9%. It should be noted that even with target achievement in 2030, the anticipated strong consumption growth will result in significantly increased fossil fuel imports relative to 2018. Therefore, higher ambitions could be beneficial in economic and environmental terms.

Of the 9% overall renewables target in transport, crop-based biofuels are capped at 2%, while 7% need to be achieved by other renewable fuels.

Biofuels are anticipated to contribute most to the target.

Electrification of rail lines currently under consideration can make additional contributions to the 2030 target.

Electric road vehicles have notable potential, which is anticipated to grow dynamically after 2030 to allow for a major RES-T shares by 2050.

Hydrogen and battery-electric vehicles are complementary as hydrogen fuel cell vehicles enable longer driving distances, and are suitable for cars and heavy-duty transport alike; dynamic growth beyond 2030 is anticipated.

Additional benefits of achieving the 2030 RES-T target include the reduction of fossil energy import dependence and related financial flows out of the territory, additional national value creation, new or enhanced national value chains with related economic benefits and possible job creation as well as additional contributions to the national climate targets, etc.

9.6.2 Recommendations

As a proven policy tool, Kosovo* should adopt a 2030 target for renewable energies in transport based on RED II.

First elements of a legal framework for renewable energies in transport are currently in parliament. However, these do not cover important policy elements of RED or RED II. Kosovo* should develop and adopt a legal framework that includes all major elements required for establishing renewable energies in transport. It is recommended to base such legislation on RED II in order to have a legislative framework based on the latest relevant policies as well as technological and commercial developments.

A major success factor for achieving a 2030 target for renewable energy in transport is to establish legal obligations towards economic operators including their enforcement. Certification ensuring the compliance of economic operators with the sustainability requirements is another.

All elements of the regulatory framework should be in place by the end of 2022.

Further key policy elements need to be established in order achieve the 2030 RES-T target:

- strategy and support mechanisms for electricity in transport

- strategy and support mechanisms for hydrogen in transport.

Complementary policies are recommended to be established in order to ensure target achievement and maximum benefits to the economy in Kosovo*.

Co-benefits with other policy areas should be actively developed. This includes air quality improvements in urban areas and other environmental and health issues as well as economic benefits such as reduced fossil fuel imports, job creation, national value creation, etc.

Furthermore, co-operation with other Contracting Parties, and more generally with other countries, allows synergies and should thus be pursued.

Policies should be revised and possibly adjusted in around 2025 based on a policy and results evaluation.

The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target.

10 Moldova

10.1 Executive Summary

The implementation of the revised Renewable Energy Directive (EU) 2018/2001 (RED II) on the promotion of the use of energy from renewable sources has started to be discussed within the Energy Community. Currently, RED II is not a part of the Energy Community acquis; but the adaptation and transposition by the Contracting Parties could be envisaged. Assuming for this study that the provisions of RED II are transposed into Moldovan law without changes, we develop a roadmap for Moldova to achieve the 2030 target for renewables in transport of 9%[291].

Moldova has a share of renewable energy in transport of around 0.3% through electricity consumption by trolleybuses. Biofuels are not consumed in Moldova yet.

Moldova can achieve the 2030 target of 9% renewable energies in transport. The anticipated growth of energy consumption in transport over the coming decade is expected to result in increased fossil fuel imports relative to 2018 in spite of an achievement of the 9% target.

Of the 9%, crop-based biofuels are capped at 2%, while 7% need to be achieved by other renewable fuels. Crop-based as well as advanced and waste-based biofuels are anticipated to contribute most to the 2030 target.

Electricity use in rail, road vehicles and public transport can also contribute; however, the limited renewable electricity share of 14% targeted for 2030 does not support major contributions to the transport target. Higher ambitions for cost-competitive renewables in the national mix or dedicated renewable capacities for electricity or hydrogen in transport would allow for relevant target contributions. With this in mind, electric road vehicles have notable potential, which is anticipated to develop to 2030 with a dynamic growth potential beyond 2030 to allow for a major RES-T share by 2050.

Hydrogen and battery-electric vehicles are complementary with hydrogen enabling long driving distances, and being suitable for cars and heavy-duty transport alike; dynamic growth beyond 2030 is anticipated.

Additional benefits of achieving the 2030 RES-T target include the reduction of the fossil energy import dependence, additional national value creation, new or enhanced national value chains with related economic benefits and possible job creation as well as additional contributions to the national climate targets, etc.[292]

---

[291] The overall target for RES-T of 14% can be reduced as far as the cap on crop-based biofuels is lower than 7%. As the cap on crop-based biofuels for Moldova is 2% based on the 2020 biofuels consumption, the overall target is reduced to 9%.

[292] Such benefits are not analysed in this study, but have been assessed in various studies, e.g. for hydrogen in Fuel Cells and Hydrogen Joint Undertaking (2019): Hydrogen Roadmap Europe – a sustainable pathway for the European energy transition; and in Fuel Cells and Hydrogen Joint Undertaking (2020): Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans.

As a proven policy tool, Moldova should adopt a 2030 target for renewable energies in transport based on RED II.

The existing obligation on fuel suppliers to put renewable fuels on the market needs to be adjusted to RED II provisions, and it needs to be enforced.

Moldova is currently developing a Regulation on biofuels sustainability criteria, which should take up the provisions of RED II, and should provide for a certification scheme or the applicability of voluntary schemes as foreseen by RED II.

Targets for renewable electricity production for 2030 should be increased based on the already low and further decreasing costs of solar PV and wind energy. This will benefit both the electricity sector and the transport sector.

Rail electrification through catenaries or through hydrogen for fuel cell trains should be developed through concrete projects.

Further key policy elements need to be established in order achieve the 2030 RES-T target:

- strategy and support mechanisms for electricity in transport;
- strategy and support mechanisms for hydrogen in transport.

Complementary policies are recommended to be established in order to ensure target achievement and maximum benefits to the Moldovan economy. For direct electricity use in road vehicles and public transport, fiscal and other incentives for increasing the number of battery vehicles in the registered vehicle fleet as well as the build-up of a public charging infrastructure are essential. Similarly, hydrogen vehicle uptake requires incentives, and a hydrogen refuelling station network needs to be built up. Co-benefits with other policy areas should be actively developed.

Without prejudice to any possible legal, political or contractual obligations, all elements of the regulatory framework should be in place at the latest by the end of 2022 in order to give industry as much time as possible to plan, invest, implement and operate.

Co-benefits with other policy areas should be actively developed. This includes air quality improvements in urban areas and other environmental and health issues as well as economic benefits such as reduced fossil fuel imports, job creation, national value creation, etc.

Furthermore, co-operation with other Contracting Parties, and more generally with other countries, allows synergies and should thus be pursued.

Policies should be revised and possibly adjusted in around 2025 based on a policy and results evaluation.

The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target. Co-benefits with other policy areas should be actively developed.

10.2 Introduction

The Energy Community Contracting Parties including Moldova have the obligation to reach binding targets for renewable energy in gross final energy consumption by 2020. For the transport sector, the binding target is a minimum 10% of renewable energy (RES-T) by 2020. Moldova will not achieve this target.

The implementation of the revised Renewable Energy Directive (EU) 2018/2001 (RED II) on the promotion of the use of energy from renewable sources has started to be discussed within the Energy Community. Currently, RED II is not a part of the Energy Community acquis; but the adaptation and transposition by the Contracting Parties could be envisaged.

It is assumed here that the provisions of RED II are transposed into Moldovan law without changes. On this basis, we develop a roadmap for Moldova to achieve the 2030 target for renewables in transport of 9%.

As a starting point, this study analyses the status quo of energy consumption in transport in Moldova, and provides 2030 projections including a business as usual scenario, and a scenario for compliance with the 2030 target for renewable energies in transport according to RED II.

In the second section, we assess the potential of national renewable energy sources suitable for use in transport, or for the production of transportation fuels together with the status of fuel pathway deployment in Moldova.

The third section describes the regulatory status quo related to renewable energies in transport. On this basis, we develop a roadmap for Moldova to achieve the 2030 target for renewables in transport on the three pillars of biofuels, electricity and hydrogen covering all transport sectors.

The final section provides conclusions and recommendations.

10.3 Status quo and 2030 projections of renewable energy consumption in transport

The objective of this chapter is to review the current status of renewable energies in transport (RES-T) in Moldova, and to develop scenarios of the development of renewable energy shares in transport by 2030.

The following data include neither international aviation nor international navigation.

10.3.1 Status Quo

The following data includes neither international aviation nor international navigation as these two segments are generally excluded from statistics such as the Eurostat energy balances.

10.3.1.1 Transport Indicators

The development of passenger transport is shown in Figure 116. Data for passenger cars are not available; statistics for cars only cover taxis. Since 2010 there has been a moderate upward trend in passenger transport. The increase is governed by transport by bus, the use of railways has decreased slowly but steadily in the past years. After a decline, the use of trolleybuses has steadily increased since 2014. Data on railways is not available for 2017 and 2018.

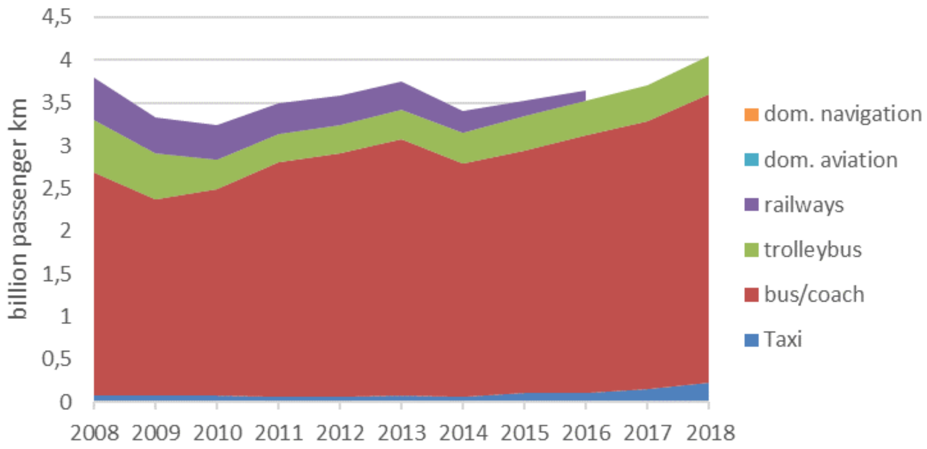

Figure 116: Passenger transport by transport mode[293 294 295]

[293] National Bureau of Statistics of the Republic of Moldova (MOLDSTAT): Economic statistics - Transport. (n.d.). Available at https://statbank.statistica.md/pxweb/pxweb/en/40%20Statistica%20economica/, last accessed 16. APR 2020

[294] Ministry of Agriculture, Regional Development and Environment of the Republic of Moldova (MADRM), United Nations Environment Program (UN): National Inventory Report: 1990-2016 - Greenhouse Gas Sources and Sinks in the Republic of Moldova. Chisinau 2018

[295] Civil Aviation Authority of the Republic of Moldova (CAA): Statistics. (n.d.). Available at http://www.caa.md/modules/filemanager/files/documentum/Statistica2019En.pdf, last accessed 16 APR 2020

In freight transport, there has been a clear increasing trend by road in the past years. The volume of transport has almost doubled since 2009. Transport by rail has remained roughly constant since 2009. Navigation and aviation are negligible for freight transport in terms of energy consumption.

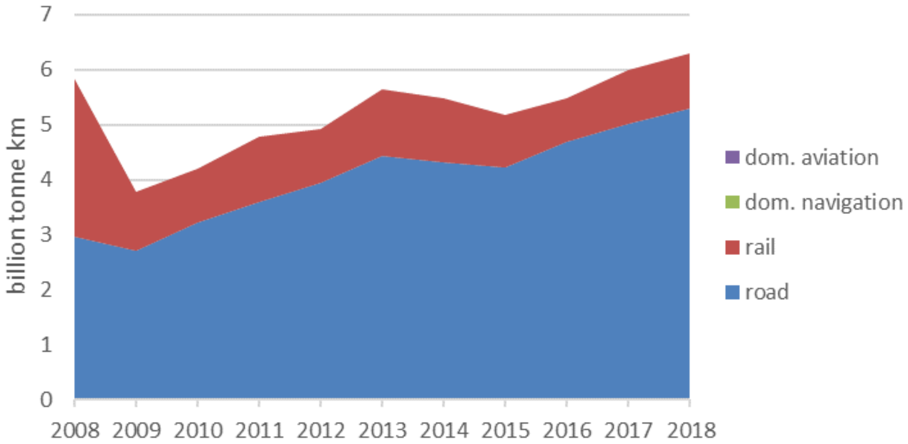

Figure 117: Freight transport by transport mode[296 297]

10.3.1.2 Registered Road Vehicles

The numbers of registered commercial vehicles and cars have increased steadily by 54% since 2008. The number of buses and coaches has remained constant in the past years.

The number of vehicles per capita in the two categories passenger cars and freight vehicles has increased steadily over the past 10 years.

[296] National Bureau of Statistics of the Republic of Moldova (MOLDSTAT): Statistical Yearbook of the Republic of Moldova. Chisinau, 2019: https://statistica.gov.md/public/files/publicatii_electronice/Anuar_Statistic/2019/Anuarul_statistic_2019.pdf

[297] Ministry of Agriculture, Regional Development and Environment of the Republic of Moldova (MADRM), United Nations Environment Program (UN): Second Biennial Update Report of the Republic of Moldova under the United Nations Framework Convention on Climate Change. Chisinau 2018. Available at https://unfccc.int/sites/default/files/resource/Moldova_BUR2_EN_web_27.12.2018_0.pdf

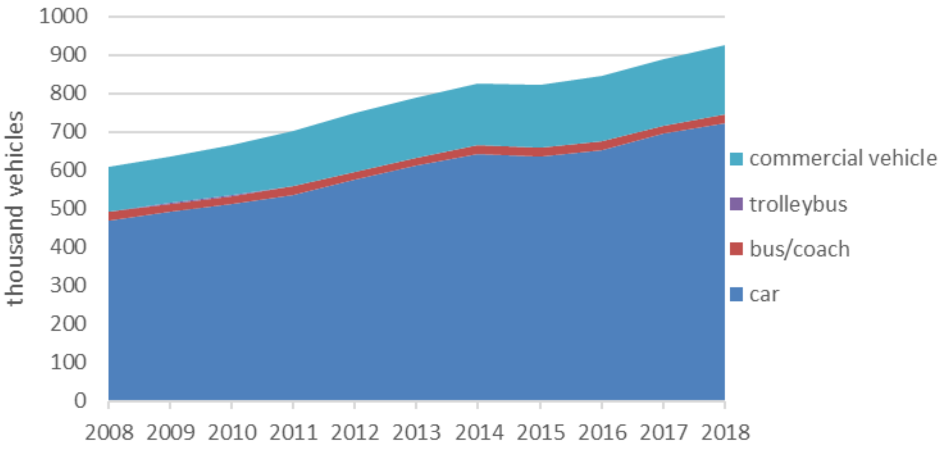

Figure 118: Registered road vehicles by type of vehicle[298] [299] [300] [301]

Figure 119: Comparison of passenger and freight vehicles per capita

---

[298] National Bureau of Statistics of the Republic of Moldova (MOLDSTAT): Statistical Yearbook of the Republic of Moldova. Chisinau, 2019. Available at https://statistica.gov.md/public/files/publicatii_electronice/Anuar_Statistic/2019/Anuarul_statistic_2019.pdf

[299] National Bureau of Statistics of the Republic of Moldova (MOLDSTAT): Statistical Yearbook of the Republic of Moldova. Chisinau 2015. Available at https://statistica.gov.md/public/files/publicatii_electronice/Anuar_Statistic/2015/Anuar_statistic_2015.pdf

[300] Ministry of Agriculture, Regional Development and Environment of the Republic of Moldova (MADRM), United Nations Environment Program (UN): Second Biennial Update Report of the Republic of Moldova under the United Nations Framework Convention on Climate Change. Chisinau 2018: https://unfccc.int/sites/default/files/resource/Moldova_BUR2_EN_web_27.12.2018_0.pdf

[301] Organisation Internationale des Constructeurs d'Automobiles (OICA): New PC Registrations or Sales. (n.d.). Available at http://www.oica.net/wp-content/uploads/pc_sales_2019.pdf, last accessed 16. APR 2020

10.3.1.3 Energy Consumption in Transport

Data on energy consumption in transport is available from 2010 onwards (red columns in Figure 120; left axis). The consumption has increased steadily since 2012, but the growth has slowed down since 2016. The share of transport in final energy consumption (blue line in Figure 120; right axis) fluctuates around 26%.

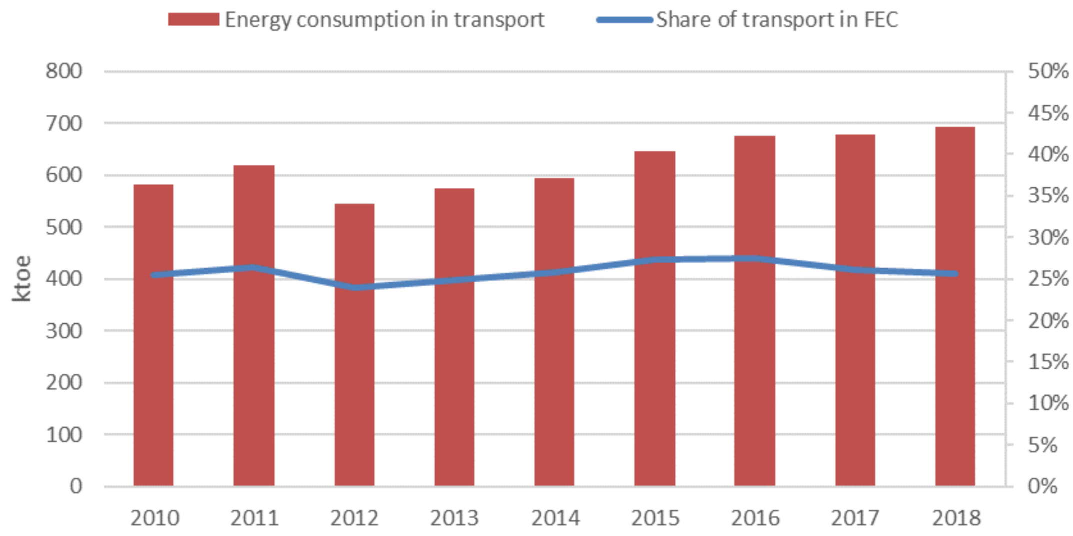

Figure 120: Energy consumption in transport[302]

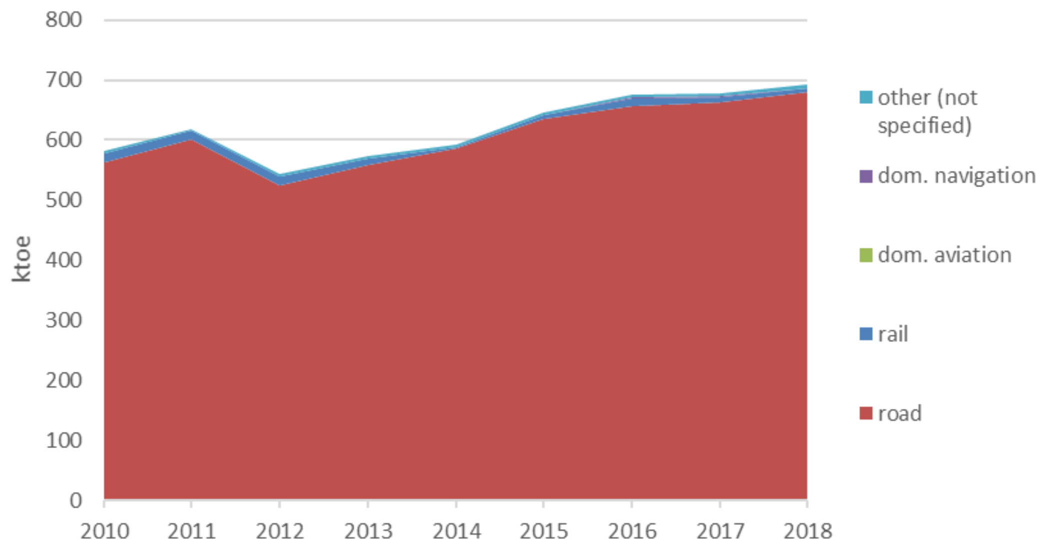

Figure 121: Energy consumption in transport by sub-sector[303]

302 European Commission Energy Balances: Moldova-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

303 European Commission Energy Balances: Moldova-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

The vast majority of energy is consumed in road transport. There is only a small amount of energy used for rail transport and non-specified transport.

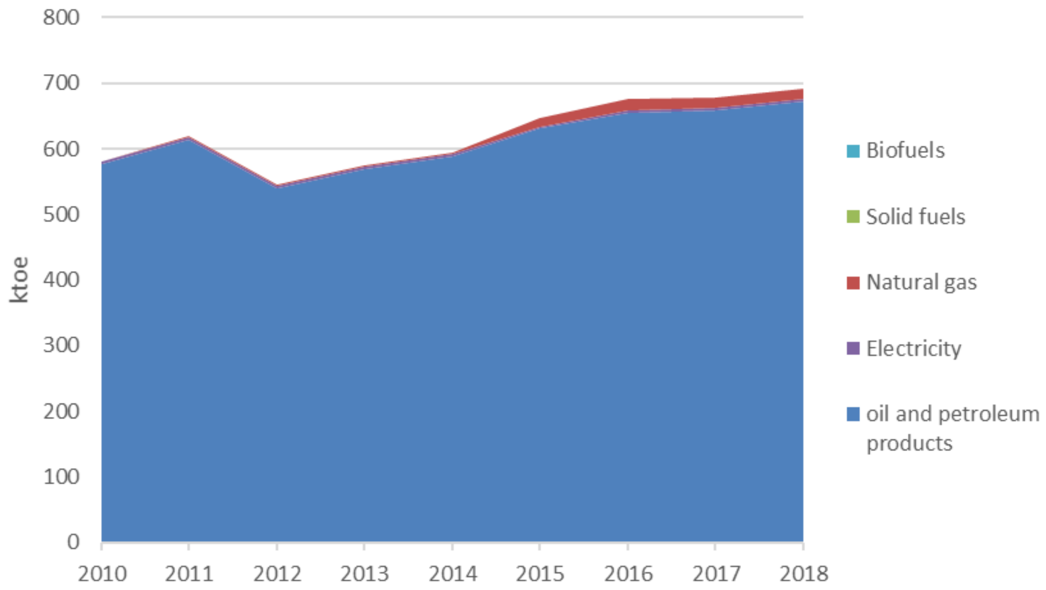

Figure 122: Energy consumption in transport by type of fuel[304]

Almost all energy for transport are oil and petroleum products. Since 2015, there has been a small share of natural gas.

Renewable energy in transport data are available for 2010-2018. Renewable energy in transport is only consumed as electricity in other transport, which is not specified in the source; however, it can be assumed that this is related to consumption by trolleybuses, which have been operated for many years in Moldova. The renewable electricity consumption in transport has grown significantly in recent years, but has gone down in 2018 compared to the previous year.

The total RES-T share has grown continuously since 2015 but remains at a very low level.

304 European Commission Energy Balances: Moldova-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

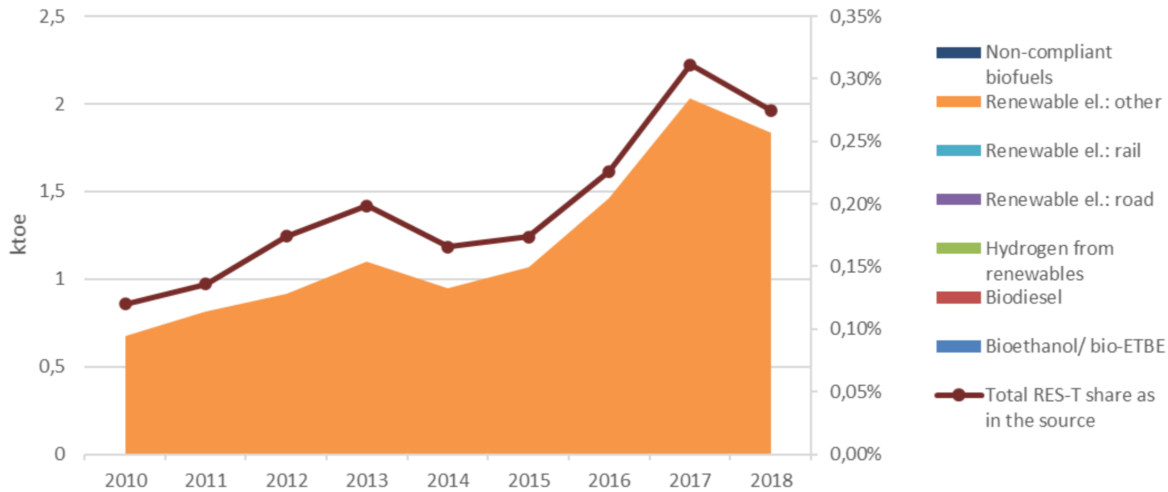

Figure 123: Renewable energy consumption in transport[305]

10.3.2 2030 Projections

For the 2030 projections of energy consumption in transport, the Energy Strategy of the Republic of Moldova to 2030 of 2013 seems outdated, and has thus not been used.

Therefore, a projection has been made for this study based on available data (see section 8.3.1). To this end, data on energy consumption in transport over the period from 2010 to 2018 have been correlated to the Gross Domestic Product (GDP). This correlation has been extrapolated to 2030 based on GDP projections for 2030 [306] to give a total energy consumption in transport of 967 ktoe, up from 692 ktoe in 2018. Assuming an overall efficiency gain of 10% leads to a projected energy consumption in transport of 871 ktoe, as a business as usual scenario.

Lacking detailed studies, it is assumed that the shares of fuels and transport modes as shown in Figure 94 remain unchanged between 2018 and 2030 in the business as usual scenario.

305 Moldovan input to the Eurostat SHARES instrument; personal communication (E-mail) from the Moldovan Ministry of Economy and Infrastructure to LBST, 26 October 2020

306 TU Wien/Energy Economics Group, Joanneum Research, REKK: Study on 2030 overall targets (energy efficiency, RES, GHG emissions reduction) for the Energy Community. Vienna 2019

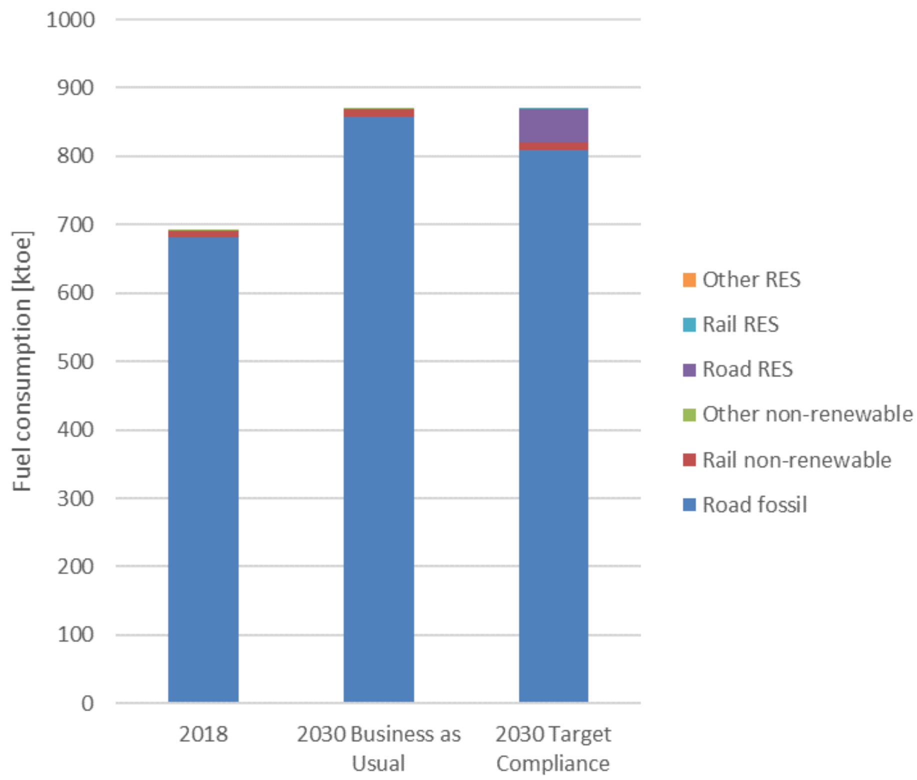

Figure 124: Energy consumption in transport in two scenarios for 2030

In a target compliance scenario achieving the 9% renewables in transport target for 2030, the roadmap as described in section 8.5.2 has been assumed to be implemented. This is represented by the right-hand column in Figure 124. The 9% renewable energies are broken down by options as described in section 0, and are shown in detail in Figure 125. It should be noted that for target compliance, multipliers are used for certain options; however, the energy quantities shown in Figure 124 show the physical energies, i.e. without multipliers. Therefore, the actual renewable energies in 2030 are less than 9% of total consumption in transport.

The total energy consumption in transport in the target compliance scenario is very slightly lower than in the business as usual scenario as battery-electric vehicles and hydrogen fuel cell-electric vehicles are more energy efficient than internal combustion engine vehicles.

The strong growth of fuel consumption leads to a significantly higher fossil fuel consumption in 2030 even in the target compliance scenario. In order to reduce fossil fuel imports and CO_2 emissions from transport, either the growth in transport energy consumption needs to be avoided, or the target for renewables in transport needs to be much more ambitious.

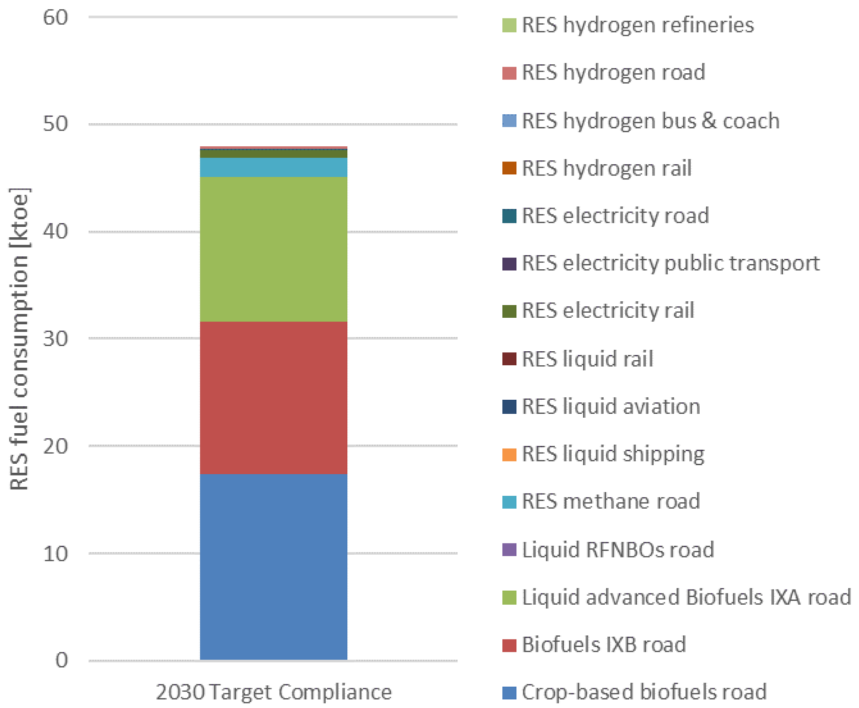

Figure 125: **Renewable energy consumption in transport in 2030 by option**

10.4 National renewable energy sources to meet the 2030 renewables in transport target

10.4.1 Potential of national renewable energy sources

The potential renewable fuel that could be produced from each of the feedstocks considered, is presented in Figure 126. Note these estimates relate to total feedstock potential and do not take into account competing uses, see section 3.2.1 for detailed description of sources and data used. Compared to the current energy use in road and rail transport, Moldova has a substantial production of MSW and a strong potential for energy crop production. FAO-Stat does not report any production currently of oil crops in Moldova. However, it is possible that given the potential to scale up ligno-cellulosic energy crop production, production of other crops could also be scaled up.

Current transport energy use (road and rail) in Moldova is approximately 37% of the potential renewable fuel that could be produced from all feedstocks apart from renewable power. When renewable power is included, current transport energy use (road and rail) is 9% of the potential renewable fuel produced from all feedstocks.

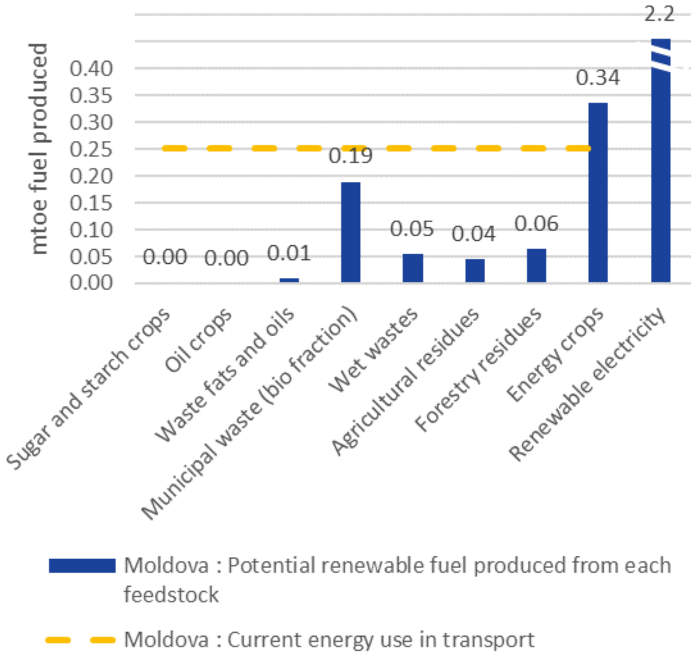

Figure 126: Moldova: Potential renewable fuel production, compared to current energy use in road and rail transport

10.4.2 Current status of national transportation fuel pathway deployments

There is currently only one operational biofuel plant in Moldova, producing ethanol via fermentation. It is operated by Garma-Grup SRL and has a reported capacity of 40 tonnes per day.

There used to be a biodiesel plant in Moldova, operated by Bio-Company-Raps. It produced biodiesel via the esterification of rapeseed oil and had a reported capacity of 50 tonnes per day, but production ended in 2009. This has therefore not been taken into account in further analysis.

10.5 Roadmap for achieving the renewable energy in transport target for 2030

10.5.1 Regulatory status quo

10.5.1.1 General data

Moldova is on its path of transposing the provisions of RED into its national regulatory framework. However, national progress reports show that Moldova is not on track to achieve the 2020 target.

Moldova has not adopted a National Renewable Energy Action Plan (NREAP) and the national Law on the promotion of the use of energy from renewable sources prescribes targets only until 2020.

In 2019, the Energy Community started the process of setting 2030 targets in line with the Policy Guidelines on the development of integrated National Energy and Climate Plans (NECP) under Recommendation 2018/01/MC-EnC. Renewable energy targets as well as policies and measures will be addressed under the 'Decarbonisation of the economy' dimension of the NECP in an integrated way, which recognizes the interactions between the different dimensions.

Renewable energy targets, policies and measures for 2030 will thus be included in the NECP.

The competent body for monitoring the national renewable energy targets is the Ministry of Economy and Infrastructure, being supported by the Energy Efficiency Agency.

Despite the fact that competent bodies for monitoring have been designated, in Moldova no penalty mechanism is enforced in the case of non-compliance with renewable energy targets.

Moldova does not have any provision related to the compatibility of vehicles with biofuels and biofuel blends, nor support measures available to purchasers of alternative-fuelled vehicles, so this matter may be improved in the future by adoption of appropriate legal acts.

10.5.1.2 Energy efficiency in transport

In 2018, Moldova adopted the Law on Energy Efficiency no. 139/2018 which is setting the national legal framework for energy efficiency in all sectors of the national economy, including the transport sector. Article 2 of the Law on Energy Efficiency, which defines subject and scope of the law, defines that the law regulates activities focused on improving the efficiency of the production and use of energy, on improving Moldova's energy security and on reducing the negative impact of the energy sectors on the environment by reducing greenhouse gas emissions.

It should be mentioned that the measures for 2030 regarding energy efficiency shall be included in the NECP.

The Ministry of Economy and Infrastructure is the central public authority responsible for the development of the national policy in the renewable energy sector, and for the elaboration of support schemes, mechanisms, incentives and other measures in the field of energy from renewable sources.

The authority which ensures the regulation and monitoring of an efficient functioning of the energy market and which conducts energy sector activities based on principles like accessibility, availability, reliability, continuity, fair competition and transparency, while respecting the standards of quality, security and environmental protection, is the National Energy Regulatory Agency.

10.5.1.3 Production and supply of fuel

The Law on the promotion of the use of energy from renewable sources no. 10/2016 sets the national goal regarding the share of renewable energy in transport until 2020 to at least 10% of final energy consumption in transport in 2020, calculated in accordance with the law. So it may be concluded that the renewable energy targets defined in RED are transposed into the law.

On the basis of the Law on the promotion of the use of energy from renewable sources a Methodology for calculating the impact of biofuels and bioliquids on greenhouse gas emissions was adopted. In February 2019, the Moldovan Government has passed the Decision no. 107/2019, by which the Methodology has been approved.

The purpose of the Methodology is to establish a procedure for calculating greenhouse gas emissions in order to facilitate compliance with obligations regarding climate change, to ensure the safety in the supply of gasoline and diesel fuel produced in appropriate environmental conditions, and to promote the use of renewable energy sources. GHG emissions from the production and use of fuel for transport, biofuels and bioliquids are calculated by the formula defined by the Methodology.

However, no obligations for fuel suppliers to meet greenhouse gas emission standards for biofuels are established yet in Moldova. Also, there are no provisions in place defining minimum GHG reduction requirements for gasoline or diesel.

Neither are fuel suppliers legally obligated to introduce renewable transport fuels to the market, or blend them into conventional fossil-based fuels.

Moldova has not approved specific legislation on sustainability criteria for biofuels, bioliquids or biomass fuels. The Ministry of Economy and Infrastructure is currently developing a Regulation on biofuels sustainability criteria that will set the sustainability criteria a biofuel shall meet in order to be produced, imported and used, i.e. blended with conventional fuels.

After the approval of the Regulation on biofuels sustainability criteria, the National Energy Regulatory Agency will establish the minimum annual quotas for biofuels to be purchased by major oil importers from local and/or imported producers, based on cost optimization, to be further mixed with major petroleum products, so as to achieve the national targets regarding the share of energy from renewable sources used in transport sector.

The Law on the promotion of the use of energy from renewable sources defines quarterly reporting obligations for fuel suppliers related to quantities of biofuels put on the market. Namely, the main importers of petroleum products are required to submit on paper and electronically information for the previous quarter of the quantities of biofuels used in combination with main petroleum products imported to the Energy Efficiency Agency and to the National Energy Regulatory Agency. In case of non-compliance with reporting obligations, a penalty equal to 1% from the importers' revenues may be imposed. However, at the present moment, the reporting obligation is not enforced, since the obligations regarding import and clarity on the quotas are not defined.

Table 40: Reporting obligations in Moldova

	Reporting by	Reporting to	Frequency	Monitoring	Exemptions
The Law on the promotion of the use of energy from renewable sources	The main importers of petroleum products	Energy Efficiency Agency and National Energy Regulatory Agency	Quarterly a year	A separate mechanism does not exist	None

The Law on the promotion of the use of energy from renewable sources no. 10/2016 and the Law on electricity no. 107/2016 set the legal framework regarding the production of electricity from renewable sources.

In accordance with the Law on electricity no. 107/2016 any public power plant of installed capacity of 5 MW or more in order to perform the energy activity of electricity production must have a license, which is issued by the National Energy Regulatory Agency. Furthermore, a license must be issued in case of a power plant generating electricity for domestic use and which has an installed capacity of 20 MW or more.

Moreover, the construction of a new power plant of installed capacity of 20 MW or more, as well as an increase of the capacity of existing thermal power plants in the case when the additional capacity exceeds 20 MW requires a permit by the Moldovan Government.

It is important to note that in Moldova there are no regulations which contain provisions with required criteria related to electricity used directly in transport.

There are several gaps in the Moldovan legislation which may be filled in the future. This refers among others to renewable fuels of non-biological origin – RFNBO defined in RED II. For the production of RFNBOs no criteria related to electricity used to produce RFNBOs is defined.

Furthermore, in Moldovan legislation there are no provisions referring to obligations of certain subject such as public parkings or public garages to have electric vehicle charging stations. However, it should be noted that such obligations are considered.

In accordance with existing legislation, no licensing procedure for electric vehicle charging stations is imposed. This is the only incentive in the area of E-mobility.

10.5.1.4 Passenger transport sector

Annex 2 of the Tax Code of the Republic of Moldova defines the value of the excises rates for import of vehicles. The level of excise rates is defined based on the following criteria:

- type of fuel
- engine capacity
- year of production (from 0 up to 10 years)

Excise tax rate for passenger vehicles is set in higher amount for older vehicles with larger engine capacity.

In accordance with the provisions of the Tax Code of the Republic Moldova certain incentives for vehicle owners, i.e. users depending on the fuels that vehicles use, are defined:

- for plug-in hybrid electric vehicles (PHEVs) incentive is reflected through 50% reduction to the excise tax rate;
- for hybrid vehicles excise tax rate on engine capacity and year of production is reduced by 25%. Though, this incentive does not apply to micro hybrid and mild hybrid vehicles.

Besides exemptions or reductions mentioned above, certain incentives are introduced for electric vehicles, including these vehicles being exempted from the obligation to pay excise taxes for import, as well as from fees for the use of roads.

Excise tax rate for motor vehicles of historical or ethnographic value is set depending on the vehicle age, as follows:

- from 30 to 39 years - 40,000 MLD (approx. 1,993€);
- from 40 to 49 years - 30,000 MLD (approx. 1,494€);
- over 50 years - 20,000 MLD (approx. 996€).

For the luxury passenger cars, the amount of the excise tax rate depends on the age and working volume of the engine cylinders and the excise rate of 2% of the customs value. An additional excise tax rate applies depending on the customs value; for customs values exceeding 600,000 MLD (approx. 29,896€), an additional excise rate of 2% is imposed increasing to a maximum of 10% for customs values exceeding 1,800,001 MLD (approx. 89,690€).

In addition, the Tax Code of the Republic of Moldova imposes a specific fee for the use of roads by vehicles registered and for those that are not registered in the Republic of Moldova.

Vehicles older than 10 years are not allowed to be imported in Moldova in accordance with the Custom Code of the Republic Moldova.

In the sector of public transport, vehicles older than 10 years are not allowed to be imported into Moldova. However, these vehicles may be used if the yearly technical revision is successfully passed.

There are no incentives for the use of electricity or hydrogen or renewable fuels in general in public transport.

Table 41: Subjects and objects of the fee for the use of roads in Moldova

Cat.	Subjects	Exemptions	Objects	Exemptions
Vehicles registered in Moldova	Individuals and legal entities - owners of vehicles registered in the Republic of Moldova.	None	Vehicles registered on a permanent or temporary basis in the Republic of Moldova, motorcycles, trucks, special vehicles on the chassis of cars or vans, special vehicles on the chassis of trucks, tractors, trailers, semi-trailers, vans, buses, tractors, other self-propelled cars.	tractors and trailers used in agricultural activities; electric cars for public use; vehicles included in the equipment of foreign military force, in accordance with international treaties, of which the Republic of Moldova is one of the parties.
Vehicles not registered in Moldova	Individuals and legal entities - owners of cars not registered in the Republic of Moldova, which enter into the territory of the Republic of Moldova or are in transit.	individuals and legal entities - residents who place cars under the customs regime of import; owners of vehicles registered in other countries that have permission to travel on international routes of the type “Exempted from paying fees”; diplomatic missions, consular missions and their personnel in respect of motor vehicles classified under heading 8703 and trailers for them classified under heading 8716.	Vehicle that is not registered in the Republic of Moldova, which enters into the territory of the Republic of Moldova or which is in transit.	vehicles included in the equipment of foreign military force, in accordance with international treaties, of which the Republic of Moldova is one of the parties; vehicles included in the equipment of international response teams/modules that participate in international exercises for managing the consequences of emergency situations, or represent international assistance for elimination of the consequences of emergency situations that arose in the territory of the Republic of Moldova or in the territories of other countries.

10.5.1.5 Freight transport sector

The following aspects are not regulated by the Moldovan legislation for the freight transport sector:

- incentives or burdens (related to tax, other levies and public revenues, excises etc.) for vehicle owners, i.e. users, intended to promote the use of electricity or hydrogen or renewable fuels in general;
- determination of the authority which shall perform control over the persons who obtained a right of incentives or who have additional burdens;
- defining the consequences of non-compliance with the burdens, i.e. limitations.

However, it should be noted that in Moldova customs checks the technical specifications of the vehicles when they are imported. Furthermore, the Public Services Agency, through specialized companies which perform activities of registration of vehicles, controls the appropriate application of the provisions of the Tax Code of the Republic of Moldova when registering the vehicles, and when performing annual technical revisions.

Freight vehicles older than 10 years are not allowed to be imported into Moldova.

10.5.1.6 Railway sector

In Moldovan legislation there are no provisions which regulate the following issues:

- determination of the limitations for registration, purchase or import or use of locomotives (diesel, steam) related to age or emission standard or fuel;
- provision of certain incentives or obligations for use of electric locomotives;
- use of electricity from renewable energy for railway transport.

10.5.2 Roadmap to achieve the 2030 target

The roadmap developed here for Moldova to achieve the 2030 target of 9% renewable energies in transport builds on the provisions of RED II as described in section 3.1.1. It is assumed that these provisions will be transposed into Moldovan law without changes including the calculation of renewables in transport, the caps and minimum values for various types of renewable energies, the multipliers, the provisions related to electricity and RFNBOs etc. Also, sustainability criteria need to be transposed into national law in order to fully comply with RED II, and it must be ensured that certification schemes are in place (national or voluntary) compliant with RED II requirements.

For this study, we apply the renewable share in the national electricity mix anticipated for 2030. On the one hand, this tends to overestimate the renewable share as values for the year 2028 that should be applied are not available, but should in general be lower than the 2030 values. On the other hand, dedicated renewable power plants may be erected that are counted as 100% renewable for transport.

For Moldova, a 14% renewable electricity mix is anticipated for 2030 based on literature values.[307] This is without prejudice to 2030 targets to be defined and included in the NECP.

It should be noted that the relatively low renewables share in the national electricity mix will limit the contribution of renewable electricity in transport in the standard calculation procedure. However, RED II allows electricity to be counted as 100% renewable if it is based on dedicated capacities for transport, and further criteria are met.

10.5.2.1 Potential contributions from all options

Based on the assessment of all options for Moldova, a total RES-T share of 9.2% in 2030 can be achieved as a combination of all options (see Table 42). Further very limited potentials exist in renewable liquid fuels in shipping, aviation and rail, which are assumed to be zero here.

Table 42: Potential RES-T contributions from all options in Moldova

Option		Contribution to RES-T target (%) incl. multiple counting	Amount of renewable fuel used (ktoe)
Biofuels and liquid RFNBOs	1. Crop-based biofuels in road transport	2.0%	17.4
	2. Liquid fuels produced from Annex IX B feedstocks in road transport	3.4%	14.8
	3. Liquid advanced Biofuels (based on Annex IX A feedstocks) in road transport	3.1%	13.5
	4. Liquid RFNBOs in road transport	0.12%	1.01
	5. Renewable methane in road transport	0.40%	1.72
	6. Renewable liquid fuels in shipping	0.0%	0.00
	7. Renewable liquid fuels in aviation	0.0%	0.00
	8. Renewable liquid fuels in rail	0.0%	0.00
Electricity	9. Rail electrification	0.12%	0.7
	10. Electric public transport (bus, trolleybus, tram, metro)	0.006%	0.02
	11. Electric road vehicles (passenger cars and trucks)	0.07%	0.16
Hydrogen	12. Hydrogen in rail	0.002%	0.02
	13. Hydrogen bus and coach (urban bus, long distance coaches)	0.002%	0.02
	14. Hydrogen road vehicles (passenger cars and trucks)	0.018%	0.16
	15. Hydrogen in refineries	0.0%	0.00
Total		9.2%	49.5

Biofuels and biogas potentially contribute most in 2030. Moldova has an established use of methane in road transport. This can be used to introduce biomethane based on Annex IXA feedstocks, which have a suitable potential in Moldova.

[307] TU Wien/Energy Economics Group, Joanneum Research, REKK: Study on 2030 overall targets (energy efficiency, RES, GHG emissions reduction) for the Energy Community. Vienna 2019

Electric and hydrogen vehicles can already make small contributions by 2030, and have a strong growth potential thereafter.

As the possible contributions of battery-electric vehicles depend on many factors, the following considerations are intended to provide some insight into the dynamics and opportunities (see Figure 127). The graph is based on a number of approximate assumptions, and should thus be understood as rough indication showing the general trends.

Battery-electric cars contribute to the RES-T target by applying the renewable share in the national electricity mix[308].

Electricity provided through public charging stations is covered in statistics as energy consumed in transport, and thus counted accordingly; charging through private charging units is not covered in statistics. Therefore, RED II foresees a multiplier of four for electricity consumed in road transport (based on data from statistics).

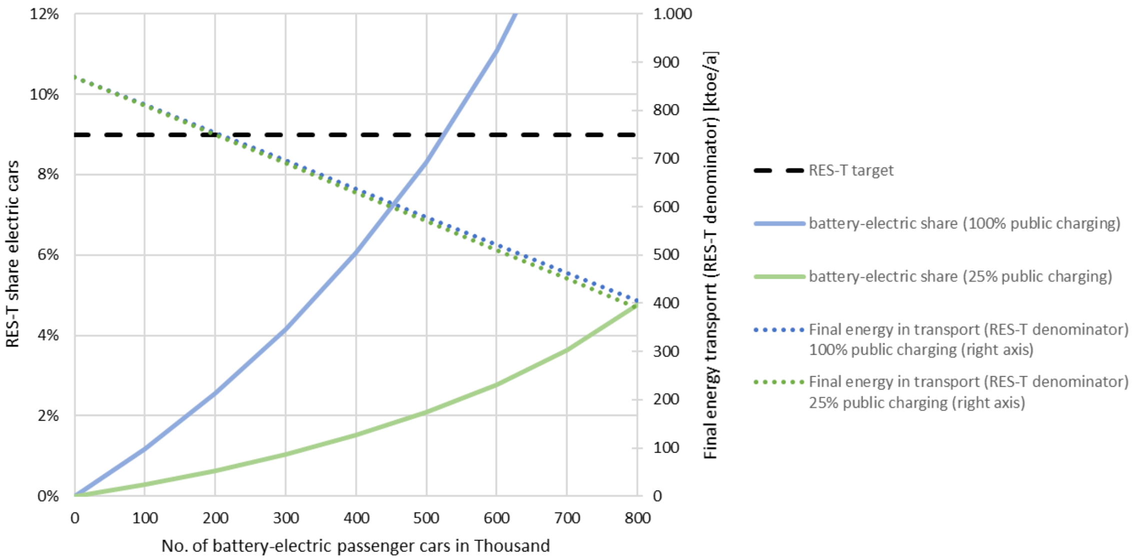

Figure 127: Possible contributions of battery cars to Moldova's 2030 RES-T target

The RES-T contribution of battery cars depends on:

- The number of battery cars (horizontal axis in Figure 127);
- The share of public charging (green/ blue line in Figure 127 assuming 25% and 100% public charging, respectively);
- The renewable share in the national electricity mix in 2028 (14% for Moldova); doubling the RES share would double the contribution.

[308] However, if certain criteria are met (see RED II), renewable electricity can be counted as 100% renewable. This is not assumed in this study for option 11.

Assuming 25% public charging, 500 thousand battery cars would approximately contribute 2% RES-T by 2030 (see Figure 127).

As battery cars are more energy efficient than conventional cars and the electricity is only partly covered in statistics energy consumption in transport decreases with increasing battery cars (dotted lines in Figure 127).

10.5.2.2 Choice of options to meet RES-T target

The potential contribution of all options somewhat exceeds the target, and thus allows reducing the contributions from some options. The reductions are based on the general considerations described in section 5.1, and on the specific circumstances in Moldova as described in the following:

1. Crop-based biofuels are used up to the 2% cap. If Moldova's operational biofuel plant operated at full capacity, this plant could produce over 9ktoe of crop-based biofuel per year: approximately 53% of Moldova's roadmap target of 17ktoe.
2. Biofuels based on Annex IXB biofuels can be slightly reduced from the maximum capped level, to 3.3%. For comparison, this amounts to 14ktoe, meaning that Moldova's operational biofuel plant could provide 64% of the target if it were to use Annex IXB feedstocks[309]. 58% of this supply could be met from domestic collectable UCO and tallow resources;
3. Liquid biofuels and biomethane based on Annex IXA feedstocks ("advanced biofuels") are developed to meet the minimum targets defined in RED II. Reaches 2030 target for Annex IXA for ("advanced") biofuels when summed with amount of renewable methane in road transport. For context, this is equivalent to approximately 40% of the output of an advanced ethanol plant at typical scale of 63 million l fuel/year;
4. Relatively expensive RFNBOs are not required in road transport to meet the 2030 target;
5. The current biomethane production for electricity generation is equal to only 0.52% of Moldovan total biomethane resource from manure. A 6-fold scale-up from current biomethane production is assumed, equal to 8% of 2030 methane demand, counting as advanced biofuel (see No. 3 above);
6. No renewable fuels in shipping are required to meet Moldova's RED II target;
7. No renewable fuels in aviation are required to meet Moldova's RED II target;
8. No renewable fuels in rail are required to meet Moldova's RED II target; expansion of electricity consumption in rail is seen as more promising (see next point)

[309] NB This does not imply that supply need necessarily come from this plant, or from domestic production, nor that this plant is suitable for processing waste oils

9. Increasing the national renewable share in electricity, maintaining and installing catenaries at non-electrified rail lines or closing non-electrified rail gaps as well as keeping the share of rail electricity in overall transport energy consumption by extending rail transport accordingly are assumed;
10. The introduction of battery buses and the expansion or establishment of trolley bus systems, trams, or metros in cities is assumed here;
11. The market uptake of battery-electric road vehicles (cars and light/ medium duty trucks) leads to electricity consumption in transport;
12. On existing and new rail lines not suitable for electrification zero emission hydrogen fuel cell trains can be operated;
13. Introduce hydrogen fuel cell buses in urban areas, and (long-distance) coaches in applications not suitable for battery-electric vehicles (high daily driving range, long-distance);
14. Start of market uptake of hydrogen fuel cell-electric road vehicles (cars and light to heavy duty trucks) for long-distance, high driving ranges;
15. Use of renewable hydrogen in the small refining sector of Moldova could be an option for the future, but is not assumed here for a contribution by 2030.

This results in the following contributions by 2030 assumed to be realistic and reducing the most challenging or expensive[310] options to meet the defined 2030 RES-T target:

Table 43: Contribution to Moldova's RES-T target from options chosen

	Option	Multiplier	2030 Contribution to RES-T target incl. Multipliers	2030 Amount of renewable fuel used (ktoe)
Biofuels and liquid RFNBOs	1. Liquid crop-based biofuels in road transport	1	2.0%	17
	2. Liquid fuels produced from Annex IX B feedstocks in road transport	2	3.3%	14
	3. Advanced liquid biofuels (based on Annex IX A feedstocks) in road transport	2	3.1%	13
	4. Liquid RFNBOs in road transport	1	0%	0
	5. Renewable methane in road transport	2	0.40%	1.7
	6. Renewable liquid fuels in shipping	2	0%	0
	7. Renewable liquid fuels in aviation	2	0%	0
	8. Renewable liquid fuels in rail	2	0%	0
Electricity	9. Rail electrification	1.5	0.12%	0.7
	10. Electric public transport (bus, trolleybus, tram, metro)	4 (road) 1 (tram, metro)	0.006%	0.02
	11. Electric road vehicles (passenger cars and trucks)	4	0.07%	0.2
Hydrogen	12. Hydrogen in rail	1	0.002%	0.02
	13. Hydrogen bus and coach (urban bus, long distance coaches)	1	0.002%	0.02
	14. Hydrogen road vehicles (passenger cars and trucks)	1	0.02%	0.2
	15. Hydrogen in refineries	1	0%	0
Total			9.0%	48

[310] Detailed cost assessments have not been carried out in this study. Rough cost judgements are made here based on costs information provided in chapter 3.

Strong contributions are made by crop-based biofuels, liquid fuels produced from Annex IXB feedstocks (used cooking oil, tallow), and advanced biofuels (Annex IXA); moderate contributions are made by biomethane in road transport, electric road vehicles and rail electrification; limited contributions are made by electric public transport, hydrogen in road vehicles, in rail as well as in buses and coaches.

The high proportion of Annex IXA (advanced) biofuels is driven by the sub-target in RED II and relies on a large scale-up in production of liquid Annex IXA biofuels. Should this prove not to be feasible, crop-based biofuels or biofuels based on Annex IXB could be increased, which would, however, not allow the sub-target for advanced biofuels in RED II to be fulfilled.

These contributions lead to a breakdown of fuel consumption in 2030 as shown in section 8.3.2.

10.5.2.3 Roadmap for Moldova

The roadmap for Moldova to achieve the 2030 target for renewable energies in transport (see Figure 128) involves key policies to be developed and adopted in the coming few years building on the existing regulatory framework and policy elements already under development (see section 8.5.1). The development of the regulatory framework so far focuses on biomass-based fuels; direct electricity use and hydrogen use in road transport has received less emphasis so far, but should be taken up as two additional central pillars for renewables in transport.

The challenge in increasing the renewable electricity consumption in transport is the limited renewable share in the national electricity mix. Increasing this share increases renewables in transport of electric vehicles both on the road and in rail. Furthermore, dedicated renewable energy capacities can be counted as 100% renewable under certain conditions.

The roadmap foresees that the last elements of the regulatory framework should be in place by the end of 2022.

The appropriateness, effectiveness and efficiency of this policy framework should be evaluated in around 2025, and should be adjusted where necessary to ensure target compliance by 2030. The European Union is currently developing the details of the European Green Deal, which aims to make the European Union climate neutral by 2050 by turning climate and environmental challenges into opportunities, and making the transition just and inclusive for all. Based on a set of policy initiatives by the European Commission, climate ambitions by 2030 are anticipated to be increased, which includes adjustments to RED II. A revision of the policy framework in Moldova around the middle of the decade would be timely for taking up decisions to be taken at European Union level by then.

Around 2028 would be a suitable point in time to set targets for the 2040 timeframe, and to revise and adjust the strategies and policies accordingly.

Currently, Moldova is developing its first National Energy and Climate Plan (NECP), which has a planning and a monitoring function. The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target, and will be helpful for the 2025 revision of the policy framework.

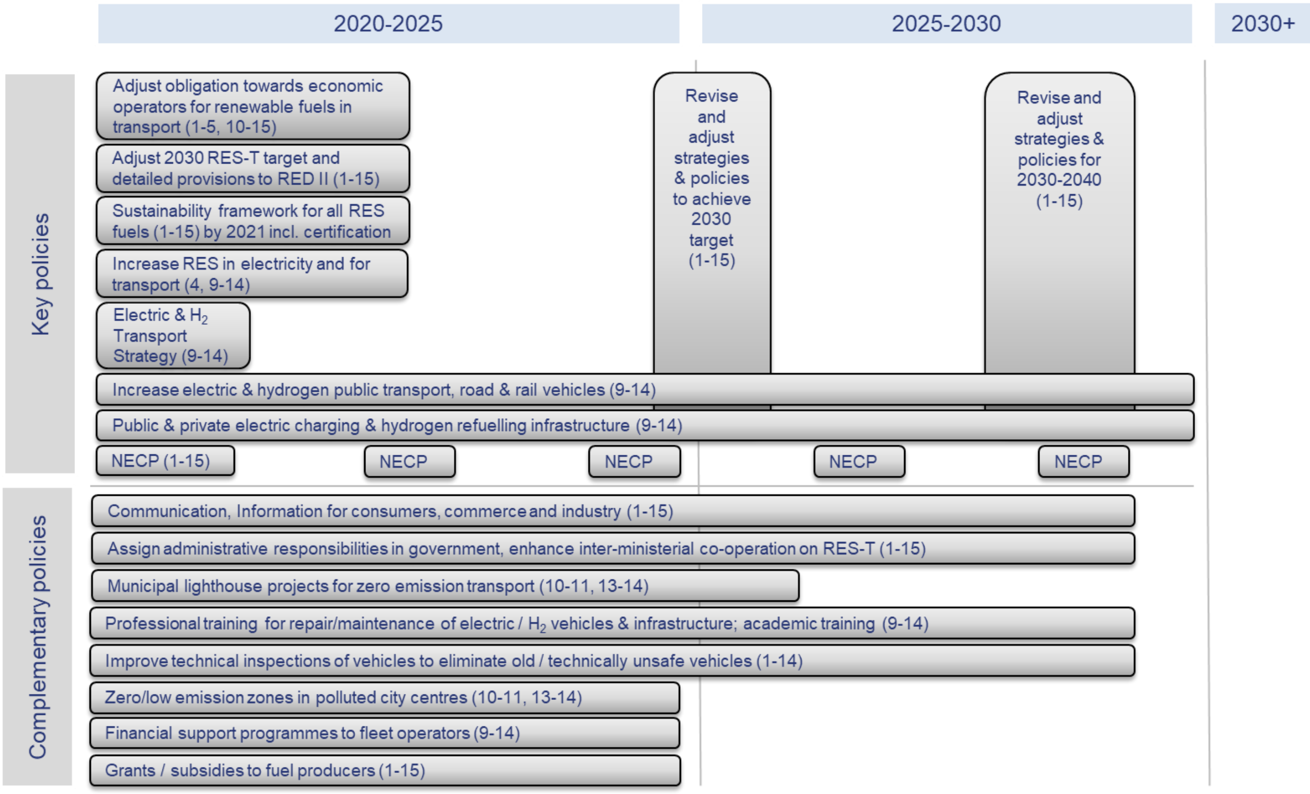

Figure 128: Overview roadmap for Moldova

The priority in the roadmap for biofuels is to establish policy to drive uptake of these fuels through an obligation on fuel suppliers to supply a minimum proportion of these fuels, which does not currently exist in Moldova. Introduction of this policy mechanism should be started as soon as possible, to allow industry as much time as possible to adjust and prepare to meet 2030 targets. This obligation needs to be supported through a number of other policy elements such as rules for certification and compliance of biofuels, sustainability criteria for biofuels, and rules for calculating the impact of biofuels on the greenhouse gas emissions. As described above, some of these policy elements are in place, but others, in particular sustainability criteria, need to be developed, based on the provisions of RED II. Additional attention may need to be given to criteria on production of liquid RFNBOs, alongside the rules on hydrogen (below) as these do not appear to be covered within existing activities. A unit within the relevant government ministry must be designated responsible for implementing, reviewing and updating the policy as a whole, ensuring sustainability certification of fuels, administering the scheme, data collection and reporting.

Several other measures that are complementary to this demand-side policy have also been important in other countries, namely support for domestic fuel production, such as capital grants for plants and information provision for consumers on fuel switching and vehicle compatibility.

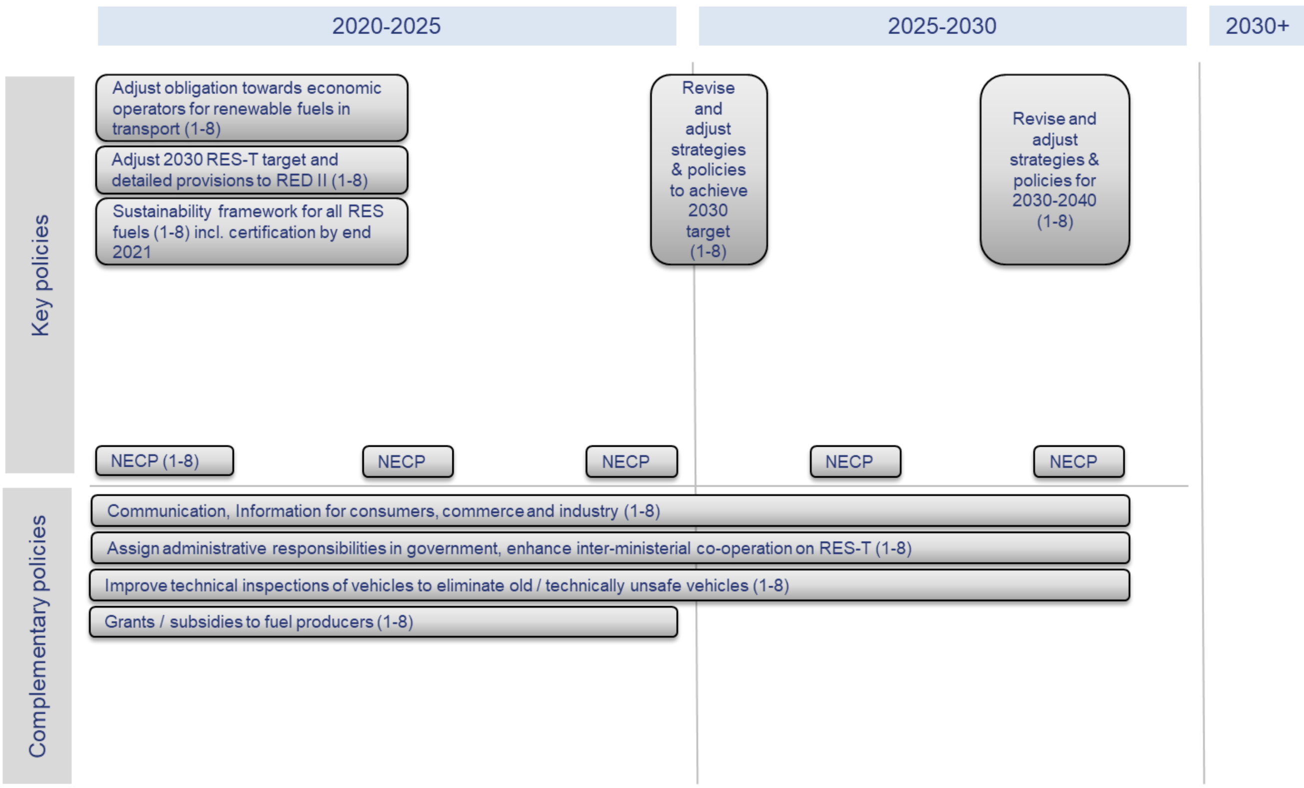

Figure 129: Roadmap for Moldova – Biofuels and liquid RFNBOs

Direct electricity use in transport is already well-established in Moldova using trolley buses; this may be extended, and complemented by tramways. The rail sector has a significant potential for electrification. Policies supporting renewables in transport should include maintaining and further strengthening electricity use in these sectors.

Battery-electric road transport including passenger cars, public transport and delivery vehicles is in an early stage of development in Moldova, and has a significant growth potential. Developing a national electric transport strategy would be an appropriate starting point for a coherent and effective policy framework in this area. Various policies for fostering electric transport could be envisioned, such as including renewable electricity in the obligation on fuel suppliers for increasing the share of renewable energies in transportation fuels (see above), or putting an obligation on electricity suppliers for providing renewable electricity to transport, etc.

An additionality framework for renewable electricity would define rules for counting electricity as renewable based on RED II[311], and detailed provisions are currently under development by the European Commission. This aims at fostering additional renewable

311 See RED II Art. 27(3)

power capacities for transport not compromising the achievement of renewables electricity targets in conventional electricity consumption.

In parallel, existing policies for increasing renewable electricity production should be adjusted by increasing renewable targets for 2030 that would include additional renewable electricity demand from transport. Fostering dedicated renewable capacities for transport could be a new element introduced into existing legislation, covering rail, public transport and road.

Increasing the number of electric vehicles in road, rail and public transport is a major lever for increasing the consumption of electricity in transport, and reducing conventional fuel consumption. Elements for such policies include providing direct financial support for purchasing electric vehicles, and adjusting the tax and import duty structures to incentivize purchases of electric vehicles. The vehicle charging infrastructure is the second major lever. Policies to coordinate and incentivize the build-up of a public network of charging stations include elements of financial incentives through grants, subsidies and loans, clear permitting rules, and coordination to ensure an appropriate nationwide network structure. In addition, financial support to charging infrastructures for public transport and fleet operators is an effective and efficient instrument for rapid growth.

The appropriate administrative structures must be established including enhanced inter-ministerial co-operation, and related responsibilities assigned in government.

Further complementary policies supporting electric transport include communication and information campaigns, lighthouse projects at local/ municipal level, the establishment of zero or low emission zones in urban areas for reduced air pollution, professional and academic training, technical inspections of vehicles (both electric and conventional), etc.

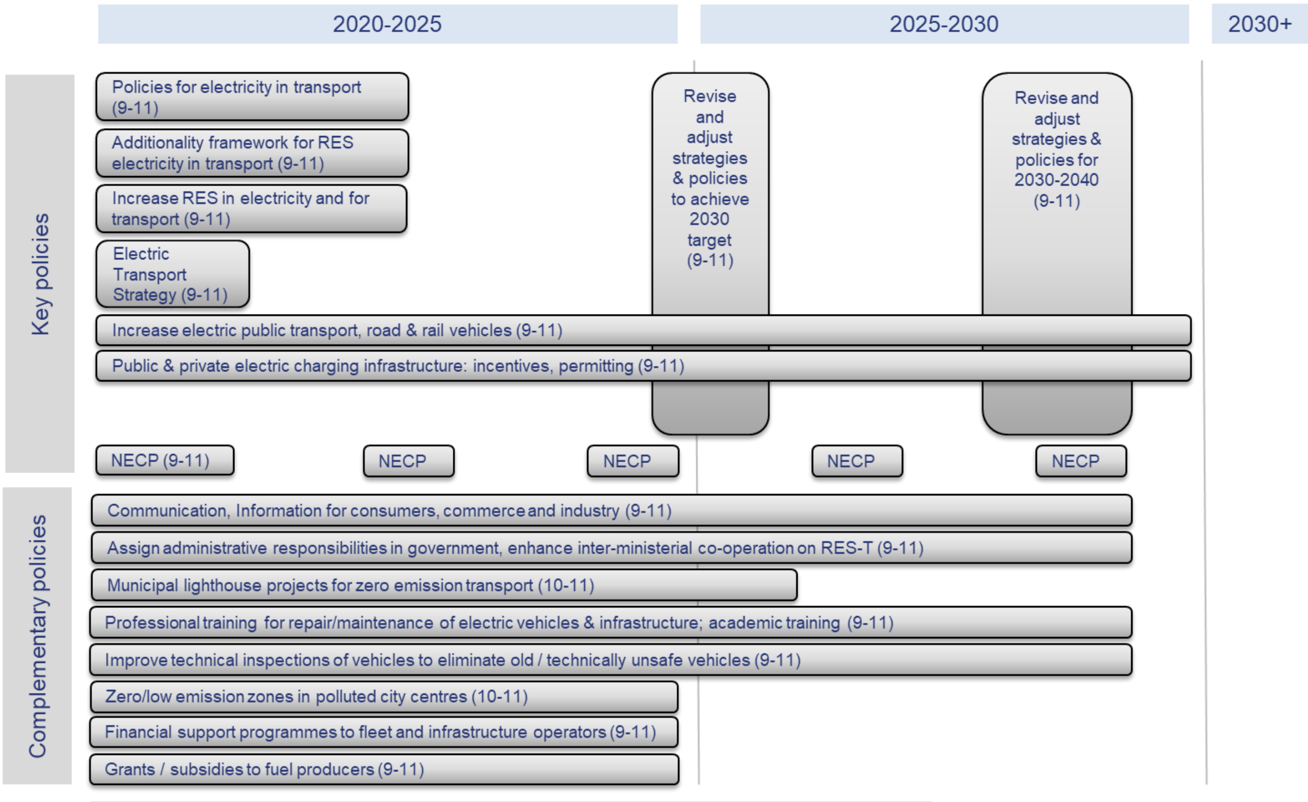

Figure 130: Roadmap for Moldova – Electricity in Transport

Hydrogen in transport using fuel cell-electric vehicles is in early phases of commercialization world-wide, and shows major potential for decarbonizing transport in a complementary fashion to battery-electric vehicles. On non-electrified rail lines, first commercial hydrogen trains are in operation, and fuel cell vehicles are coming onto the market. A focus will be on vehicles for longer distances and for duty purposes such as trucks and buses.

Hydrogen can be included in the obligation on fuel suppliers as an option, as provided for in RED II. Further key policy elements are rather similar to electricity in transport: developing a national strategy, defining an additionality framework, increasing renewable electricity capacities for hydrogen production, supporting the market uptake of fuel-cell electric vehicles, and supporting the establishment of hydrogen refuelling stations.

Also, the complementary policies are similar to electricity.

The related policies should be established together with those for biofuels and electricity, while the market may take up a few years later based on an earlier status in commercialization.

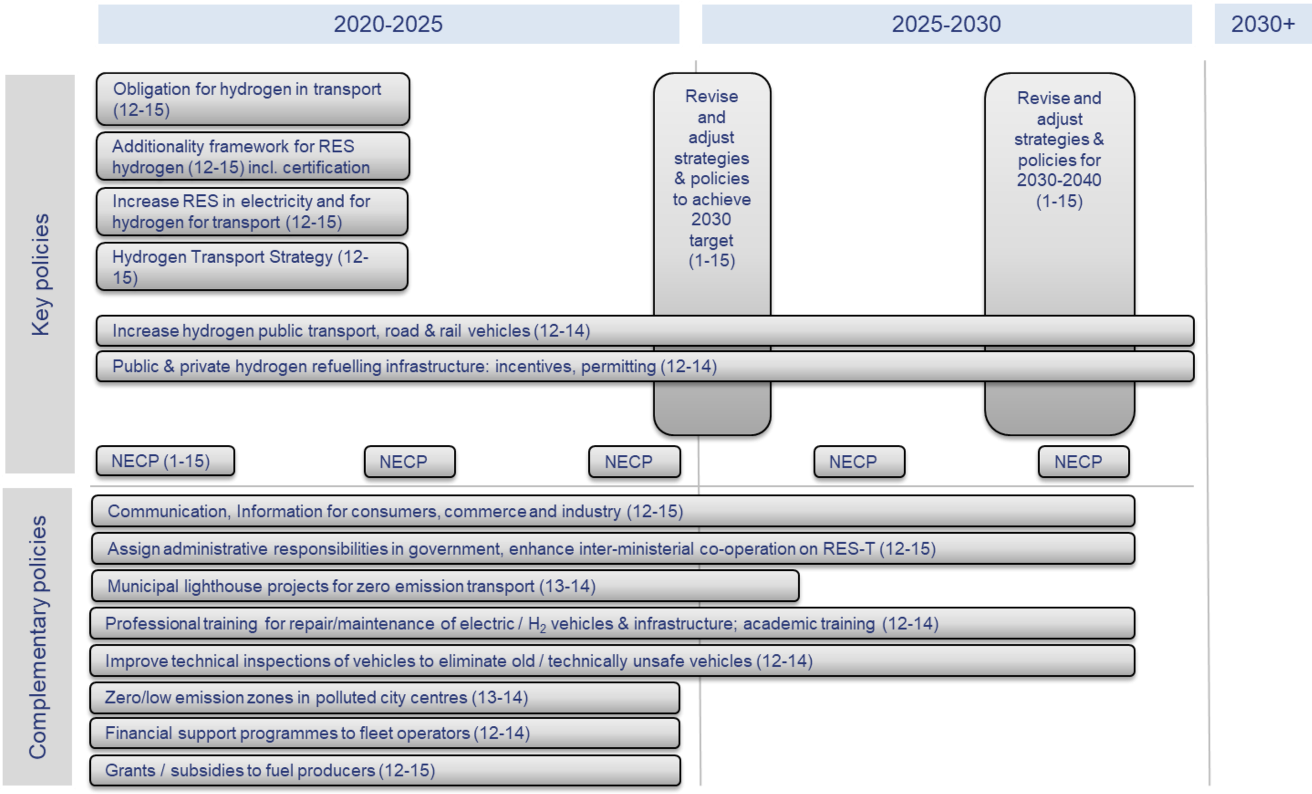

Figure 131: Roadmap for Moldova – Hydrogen in Transport

10.6 Conclusions and recommendations

10.6.1 Conclusions

Moldova can achieve the 2030 RES-T target of 9%.

Of the 9%, crop-based biofuels are capped at 2%, while 7% need to be achieved by other renewable fuels. Biofuels, and to a lesser extent biogas, are anticipated to contribute most to the target.

Electricity use in rail, road vehicles and public transport can also contribute; however, the limited renewable electricity share of 14% targeted for 2030 does not support major contributions to the transport target. Higher ambitions for cost-competitive renewables in the national mix or dedicated renewable capacities for electricity or hydrogen in transport would allow for relevant target contributions.

With this in mind, electric road vehicles have notable potential, which is anticipated to be used towards 2030 with a dynamic growth potential beyond 2030 to allow for a major RES-T share by 2050.

Hydrogen and battery-electric vehicles are complementary as hydrogen fuel cell vehicles enable longer driving distances, and are suitable for cars and heavy-duty transport alike; dynamic growth beyond 2030 is anticipated.

Additional benefits of achieving the 2030 RES-T target include the reduction of fossil energy import dependence and related financial flows out of the territory, additional national value creation, new or enhanced national value chains with related economic benefits and possible job creation as well as additional contributions to the national climate targets, etc.

10.6.2 Recommendations

As a proven policy tool, Moldova should adopt a 2030 target for renewable energies in transport based on RED II.

The Ministry of Economy and Infrastructure is currently developing a Regulation on biofuels sustainability criteria that will set the sustainability criteria a biofuel shall meet in order to be produced, imported and used, i.e. blended with conventional fuels. This regulation should take up the provisions of RED and RED II, and should provide for a certification scheme or the applicability of voluntary schemes as foreseen by RED II. Only biofuels fulfilling the sustainability requirements are RED II compliant, and make contributions to climate protection while ensuring biodiversity and other elements of a sustainable development.

The existing obligation on fuel suppliers to put renewable fuels on the market needs to be adjusted to RED II provisions, and it needs to be enforced.

Targets for renewable electricity production for 2030 should be increased based on the already low and further decreasing costs of solar PV and wind energy. This will benefit both the electricity sector and the transport sector.

Rail electrification through catenaries or through hydrogen for fuel cell trains should be developed through concrete projects.

All elements of the regulatory framework should be in place by the end of 2022.

Further key policy elements need to be established in order achieve the 2030 RES-T target:

- strategy and support mechanisms for electricity in transport;
- strategy and support mechanisms for hydrogen in transport.

Complementary policies are recommended to be established in order to ensure target achievement and maximum benefits to the Moldovan economy. For direct electricity use in road vehicles and public transport, fiscal and other incentives for increasing the number of battery vehicles in the registered vehicle fleet as well as the build-up of a public charging infrastructure are essential. Similarly, hydrogen vehicle uptake requires incentives, and a hydrogen refuelling station network needs to be built up.

Co-benefits with other policy areas should be actively developed. This includes air quality improvements in urban areas and other environmental and health issues as well as economic benefits such as reduced fossil fuel imports, job creation, national value creation, etc.

Furthermore, co-operation with other Contracting Parties, and more generally with other countries, allows synergies and should thus be pursued.

Policies should be revised and possibly adjusted in around 2025 based on a policy and results evaluation.

The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target.

11 Montenegro

11.1 Executive Summary

The implementation of the revised Renewable Energy Directive (EU) 2018/2001 (RED II) on the promotion of the use of energy from renewable sources has started to be discussed within the Energy Community. Currently, RED II is not a part of the Energy Community acquis; but the adaptation and transposition by the Contracting Parties could be envisaged. Assuming for this study that the provisions of RED II are transposed into Montenegrin law without changes, we develop a roadmap for Montenegro to achieve the 2030 target for renewables in transport of 9%[312].

Montenegro has a share of renewable energy in transport of around 0.8% through electricity consumption in rail. Biofuels consumption in Montenegro is very low so far. Adopted key policy elements fostering biofuels uptake and sustainability should be put in force in the short-term in order to increase biofuel consumption to a level compatible with 2030 targets assumed here.

Montenegro can choose from a number of options to achieve the 2030 RES-T target of 9%. In fact, significant over-achievement beyond 13% is possible. It should be noted that even with achievement of the 2030 target of 9%, the anticipated consumption growth over the coming decade is expected to result in increased fossil fuel imports relative to 2018. Therefore, higher ambitions could be beneficial in economic and environmental terms for Montenegro. Options for renewable fuels production beyond the 2030 target may open up opportunities for export of e.g. waste-based biofuels or renewable electricity-based liquid fuels in a mid-term perspective[313].

Of the 9%, crop-based biofuels are capped at 2%, while 7% need to be achieved by other renewable fuels. While biofuels are anticipated to contribute most to the 2030 target, electricity use in rail can also contribute significantly if the renewable electricity share reaches the 2030 value of 89% as assumed for this study.

Electric road vehicles have notable potential, which is anticipated to grow dynamically after 2030 to allow for major RES-T shares by 2050.

Hydrogen and battery-electric vehicles are complementary with hydrogen enabling long driving distances, and being suitable for cars and heavy-duty transport alike; dynamic growth beyond 2030 is anticipated.

Additional benefits of achieving the 2030 RES-T target include the reduction of the fossil energy import dependence, additional national value creation, new or enhanced national

[312] The overall target for RES-T of 14% can be reduced as far as the cap on crop-based biofuels is lower than 7%. As the cap on crop-based biofuels for Montenegro is 2% based on the 2020 biofuels consumption, the overall target is reduced to 9%.

[313] RFNBO – renewable fuels of non-biological origin

value chains with related economic benefits and possible job creation as well as additional contributions to the national climate targets, etc.[314]

As a proven policy tool, Montenegro should adopt a 2030 target for renewable energies in transport based on RED II.

The use of renewable energies in transport should be continued and enhanced. The adopted Regulations including a biofuels obligation and a sustainability framework should be put in force in the short-term, and should be adapted to include all provisions of RED II including for electricity and for hydrogen and RFNBOs.

Electric road mobility should be developed to become the second pillar of renewable energies in transport in Montenegro. A national electric transport strategy should be developed including policies covering the two elements of fostering market uptake of battery vehicles and of developing a nationwide public charging network including fast-chargers. Electricity use in public transport should be started by policies for the establishment of trolleybuses, tramways, or battery-electric buses.

Hydrogen fuel-cell electric transport should be developed to become the third pillar of renewable energies in transport in Montenegro. This should be defined in a national hydrogen strategy including policies fostering the market uptake of hydrogen vehicles in road, rail and public transport and aiming at the establishment of a national hydrogen refuelling infrastructure.

In parallel, existing policies for increasing renewable electricity production should be adjusted by increasing renewable targets for 2030 that would include additional renewable electricity demand from transport (for direct use or for hydrogen production) benefitting both the electricity sector and transport covering rail, public transport and road.

Complementary policies for battery-electric and hydrogen fuel cell-electric transport are recommended to be established in order to ensure target achievement and maximum benefits to the Montenegrin economy, including communication and information campaigns, lighthouse projects at local/ municipal level, the establishment of zero or low emission zones in urban areas for reduced air pollution, professional and academic training, etc.

Without prejudice to any possible legal, political or contractual obligations, all elements of the regulatory framework should be in place at the latest by the end of 2022 in order to give industry as much time as possible to plan, invest, implement and operate.

Co-benefits with other policy areas should be actively developed. This includes air quality improvements in urban areas and other environmental and health issues as well as economic benefits such as reduced fossil fuel imports, job creation, national value creation, etc.

---

[314] Such benefits are not analysed in this study, but have been assessed in various studies, e.g. for hydrogen in Fuel Cells and Hydrogen Joint Undertaking (2019): Hydrogen Roadmap Europe – a sustainable pathway for the European energy transition; and in
Fuel Cells and Hydrogen Joint Undertaking (2020): Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans.

Furthermore, co-operation with other Contracting Parties, and more generally with other countries, allows synergies and should thus be pursued.

Policies should be revised and possibly adjusted in around 2025 based on a policy and results evaluation.

The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target.

11.2 Introduction

The Energy Community Contracting Parties including Montenegro have the obligation to reach binding targets for renewable energy in gross final energy consumption by 2020. For the transport sector, the binding target is a minimum 10% of renewable energy (RES-T) by 2020. Montenegro will not achieve this target.

The implementation of the revised Renewable Energy Directive (EU) 2018/2001 (RED II) on the promotion of the use of energy from renewable sources has started to be discussed within the Energy Community. Currently, RED II is not a part of the Energy Community acquis; but the adaptation and transposition by the Contracting Parties could be envisaged.

It is assumed here that the provisions of RED II are transposed into the laws of Montenegro without changes. On this basis, we develop a roadmap for Montenegro to achieve the 2030 target for renewables in transport of 9%.

As a starting point, this study analyses the status quo of energy consumption in transport in Montenegro, and provides 2030 projections including a business as usual scenario, and a scenario for compliance with the 2030 target for renewable energies in transport according to RED II.

In the second section, we assess the potential of national renewable energy sources suitable for use in transport, or for the production of transportation fuels together with the status of fuel pathway deployment in Montenegro.

The third section describes the regulatory status quo related to renewable energies in transport. On this basis, we develop a roadmap for Montenegro to achieve the 2030 target for renewables in transport on the three pillars of biofuels, electricity and hydrogen covering all transport sectors.

The final section provides conclusions and recommendations.

11.3 Status quo and 2030 projections of renewable energy consumption in transport

The objective of this chapter is to review the current status of renewable energies in transport (RES-T) in Montenegro, and to develop scenarios of the development of renewable energy shares in transport by 2030.

The following data includes neither international aviation nor international navigation.

11.3.1 Status Quo

The following data includes neither international aviation nor international navigation as these two segments are generally excluded from statistics such as the Eurostat energy balances.

11.3.1.1 Transport Indicators

The vast majority of passenger transport is done by car with only very small shares of transport by train and bus. Navigation and aviation are negligible. Transport by car has increased moderately since 2011. Use of other means of transport has remained constant in the past years. Data on passenger transport by car is only available since 2010; latest available data are for 2017.

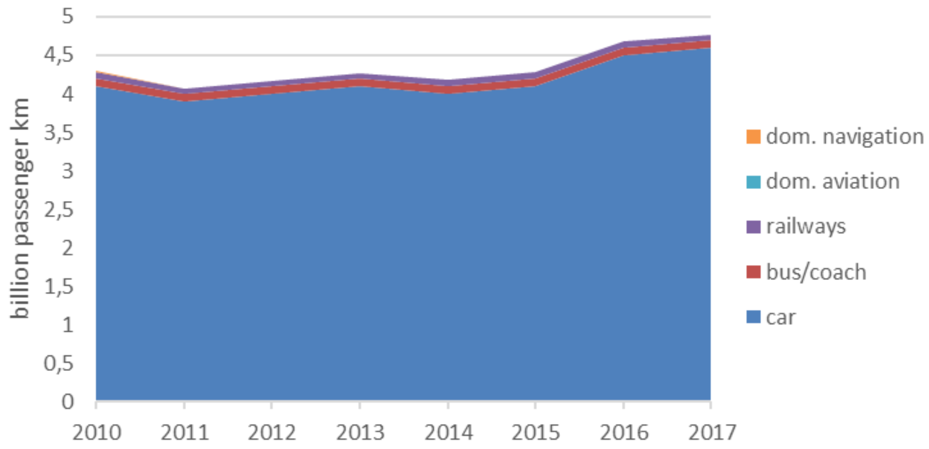

Figure 132: Passenger transport by transport mode[315 316 317 318]

Passenger kilometres by car are counted as private while all other modes of transport (bus/coach, railways) are counted as public transport. The volume of public transport is small and has slightly increased over the past years.

[315] Statistical Office of Montenegro (MONSTAT): Statistical Yearbook. Podgorica 2019: http://www.monstat.org/userfiles/file/publikacije/godisnjak%202019/GODISNJAK%202019f.pdf

[316] Statistical Office of Montenegro (MONSTAT): Annual Statistic of transport storage and communications 2018. Podgorcia 2019: https://www.monstat.org/userfiles/file/saobracaj/2018/PUBLIKACIJA-%20GODISNJA%20STATISTIKA%20SAOBRACAJA%202018-eng.pdf

[317] Statistical Office of Montenegro (MONSTAT): Annual Statistic of transport storage and communications 2016. Podgorcia 2017: https://www.monstat.org/userfiles/file/saobracaj/2016/PUBLIKACIJA-%20GODISNJA%20STATISTIKA%20SAOBRACAJA%202016-en.pdf

[318] Statistical Office of Montenegro (MONSTAT): Annual Statistic of transport storage and communications 2014. Podgorcia 2015: https://www.monstat.org/userfiles/file/saobracaj/PUBLIKACIJA-%20GODISNJA%20STATISTIKA%20SAOBRACAJA%20I%20VEZA%202014-en-bd.pdf

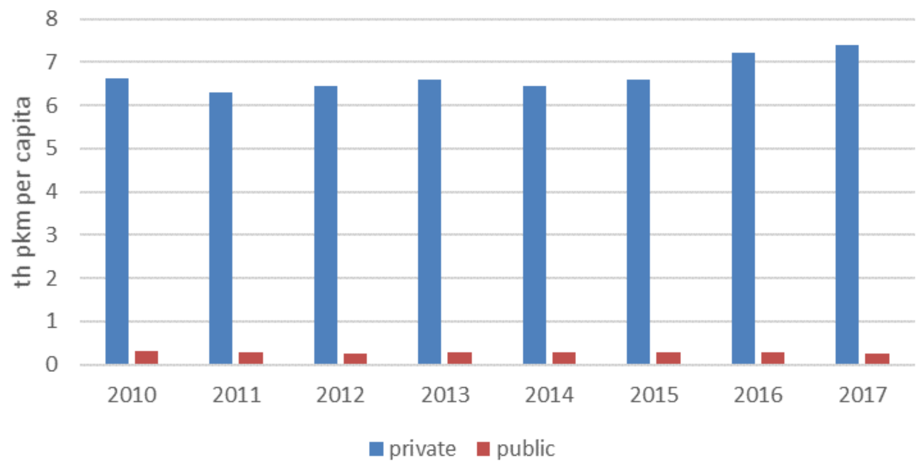

Figure 133: Comparison of public and private transport per capita

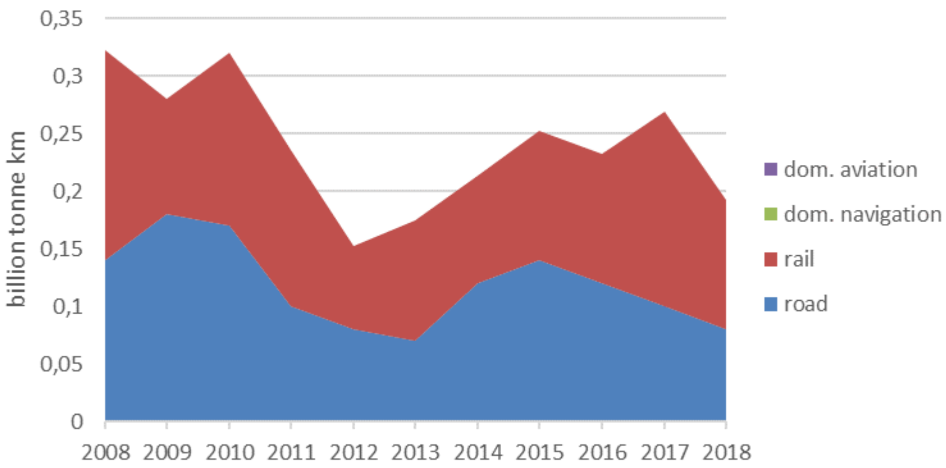

Figure 134: Freight transport by transport mode[319] [320] [321] [322]

[319] Statistical Office of Montenegro (MONSTAT): Statistical Yearbook. Podgorica, 2019: http://www.monstat.org/userfiles/file/publikacije/godisnjak%202019/GODISNJAK%202019f.pdf

[320] Statistical Office of Montenegro (MONSTAT): Annual survey on maritime transport - 2012. Release no. 71. Podgorica 2013: https://www.monstat.org/userfiles/file/saobracaj/izv%20pomoskog%20saobracaja/2012/godisnji-Maritime%20transport%202012-2.pdf

[321] Statistical Office of Montenegro (MONSTAT): Annual survey on maritime transport - 2013. Release no. 68. Podgorica 2014: https://www.monstat.org/userfiles/file/saobracaj/izv%20pomoskog%20saobracaja/20-3-14/Godisnji%20izvjestaj%20o%20pomorskom%20saobracaju%202013-eng.pdf

[322] Statistical Office of Montenegro (MONSTAT): Transport and Communications 2005-2010. Podgorica, AUG 2011: https://www.monstat.org/userfiles/file/publikacije/saobracaj%20finalno.pdf

Freight transport by rail and road has strongly fluctuated over the past decade. The volume of transport by road has decreased since 2015. Transport by rail saw a spike in 2017 but in the subsequent year the volume of transport returned to the value of 2015 and 2016. In 2018, road and rail freight transport have roughly equal shares.

11.3.1.2 Registered Road Vehicles

The number of registered cars has increased moderately in Montenegro since 2011 with a certain acceleration since 2015. The stock of commercial vehicles as well as the small stock of buses have increased moderately since 2014. There are no trolleybuses or trams in Montenegro. Data for commercial vehicles is available only from 2011 onwards.

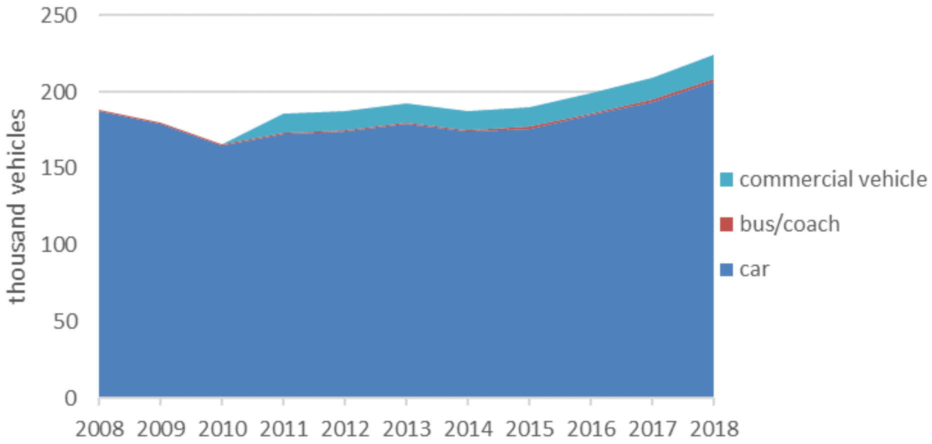

Figure 135: Registered road vehicles by type of vehicle[323] [324] [325] [326]

The number of vehicles per capita of both categories has increased since 2015. Data for commercial vehicles is available only from 2011 onwards.

[323] European Comission 2019 European Commission (EC), Directorate-General for Mobility and Transport: EU Transport in Figures - Statistical Pocketbook. Luxembourg 2019

[324] Statistical Office of Montenegro (MONSTAT): Statistical Yearbook. Podgorica 2019: http://www.monstat.org/userfiles/file/publikacije/godisnjak%202019/GODISNJAK%202019f.pdf

[325] Statistical Office of Montenegro (MONSTAT): Statistical Yearbook. Podgorica 2016: http://monstat.org/userfiles/file/publikacije/GODISNJAK%202016%20(1).pdf

[326] Statistical Office of Montenegro (MONSTAT): Transport and Communications 2005-2010. Podgorica 2011: https://www.monstat.org/userfiles/file/publikacije/saobracaj%20finalno.pdf

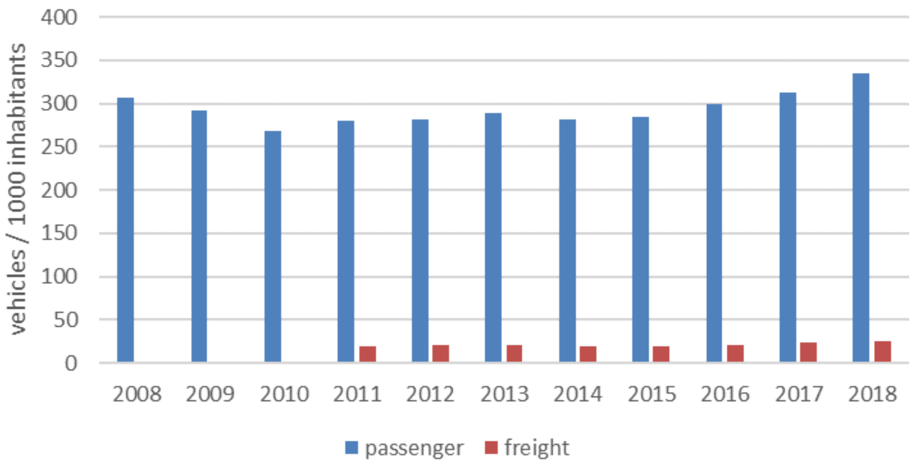

Figure 136: Comparison of passenger and freight vehicles per capita

11.3.1.3 Energy Consumption in Transport

Energy consumption in transport decreased significantly from 2010 to 2014; since then, there has been a rapid increase. The share of transport in final energy consumption is between 25% and 35% and has been increasing in recent years.

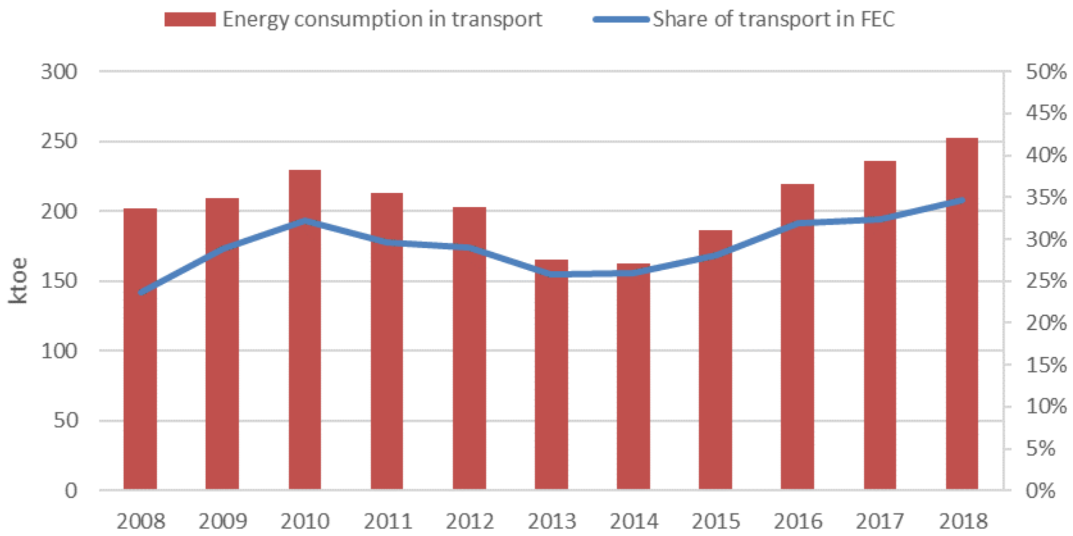

Figure 137: Energy consumption in transport[327]

The vast majority of energy is used in road transport with very small shares of consumption in rail and navigation. Consumption in road transport has increased rapidly since 2014.

[327] European Commission Energy Balances: ME-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

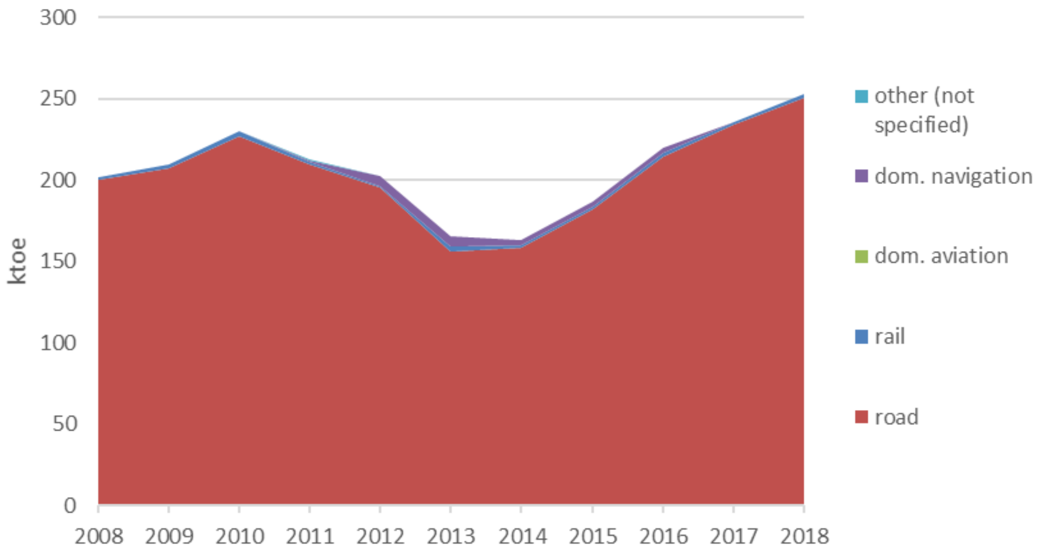

Figure 138: Energy consumption in transport by sub-sector[328]

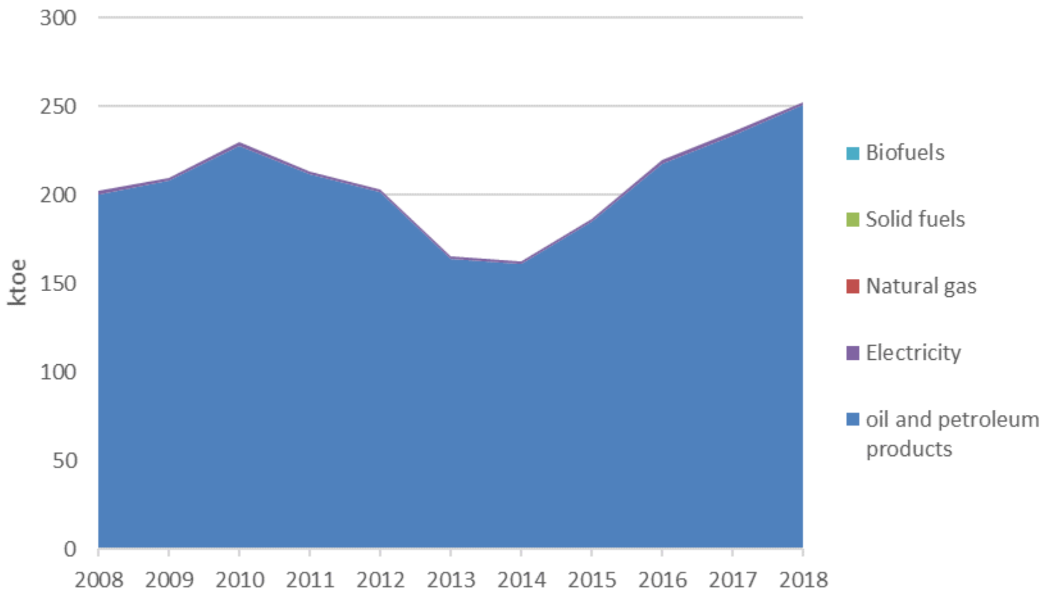

Figure 139: Energy consumption in transport by type of fuel[329]

[328] European Commission Energy Balances: ME-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

[329] European Commission Energy Balances: ME-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

Almost all energy is provided by oil and petroleum products. Additionally, a very small amount of electricity is used.

Consumption of renewable energy has fluctuated in the past years with an overall increasing tendency. Renewable energy in transport is only consumed as electricity in rail transport. After a peak in 2015, the total RES-T share has decreased since 2016 as fossil consumption in road has increased.

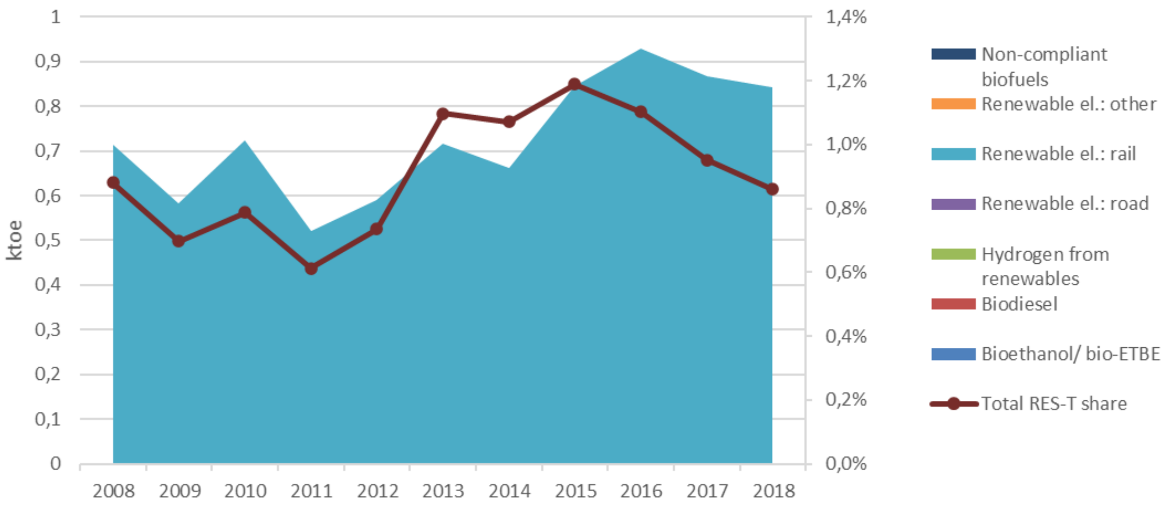

Figure 140: Renewable energy consumption in transport[330] [331]

11.3.2 2030 Projections

The 2030 projections used here rely on the Energy Development Strategy of Montenegro to 2030 of 2014[332]. In that study, a scenario for energy consumption in transport is made, which is not broken down by transport sector or fuel. Here, we have scaled the transport consumption of 2010 from that study to the actual values as reported in the energy balances[333]. For the business as usual scenario (middle column in Figure 141) we have then assumed that the individual shares of the fuels in total consumption do not change between 2015 and 2030.

---

[330] European Commission Energy Balances: ME-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

[331] Eurostat (2019) *SHARES detailed results 2018.* Available at: https://ec.europa.eu/eurostat/web/energy/data/shares

[332] Crna Gora, Ministarstvo ekonomije: Strategija Razvoja Energetike Crne Gore do 2030. Godine (Bijela knjiga), 2014, http://www.mek.gov.me/ResourceManager/FileDownload.aspx?rid=199663&rType=2&file=Strategija razvoja energetike CG do 2030. godine.pdf, last accessed 12 AUG 2020

[333] European Commission Energy Balances: ME-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

In 2030, the total energy consumption in transport in the business as usual scenario is 283 ktoe, up 12% from 253 ktoe in 2018.

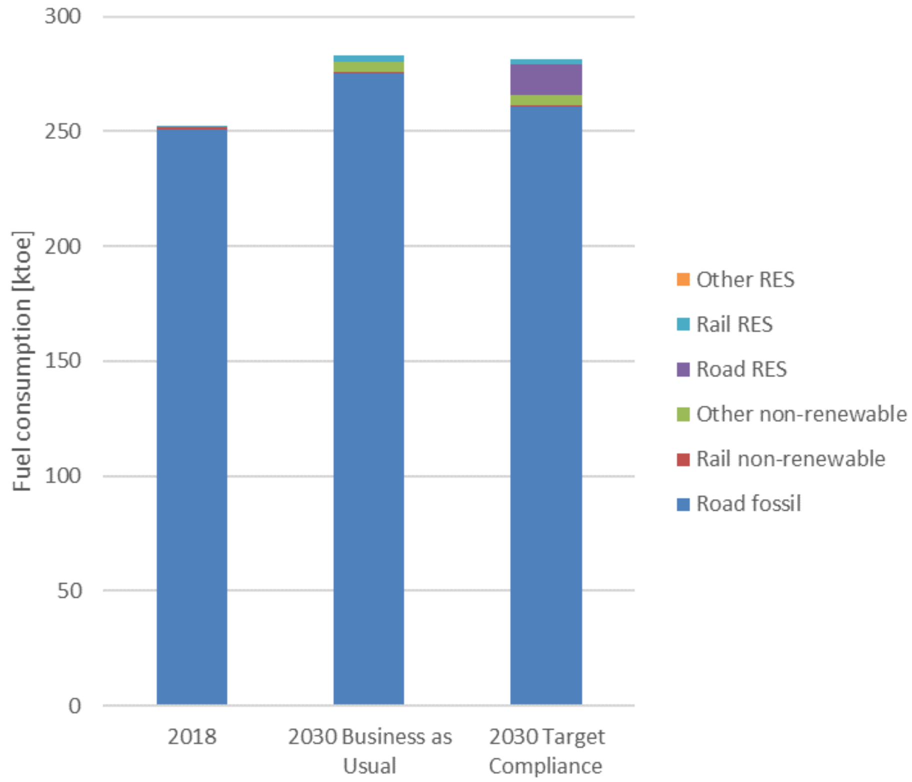

Figure 141: Energy consumption in transport in two scenarios for 2030

In a target compliance scenario achieving the 9% renewables in transport target for 2030, the roadmap as described in section 11.5.2 has been assumed to be implemented. This is represented by the right-hand column in Figure 141. The 9% renewable energies are broken down by options as described in section 0, and are shown in detail in Figure 142. It should be noted that for target compliance, multipliers are used for certain options; however, the energy quantities shown in Figure 141 show the physical energies, i.e. without multipliers. Therefore, the actual renewable energies in 2030 are less than 9% of total consumption in transport.

The total energy consumption in transport in the target compliance scenario is very slightly lower than in the business as usual scenario as battery-electric vehicles and hydrogen fuel cell-electric vehicles are more energy efficient than internal combustion engine vehicles.

The growth of fuel consumption leads to a higher fossil fuel consumption in 2030 even in the target compliance scenario. In order to reduce fossil fuel imports and CO_2 emissions from transport, either the growth in transport energy consumption needs to be reduced, or the target for renewables in transport needs to be more ambitious.

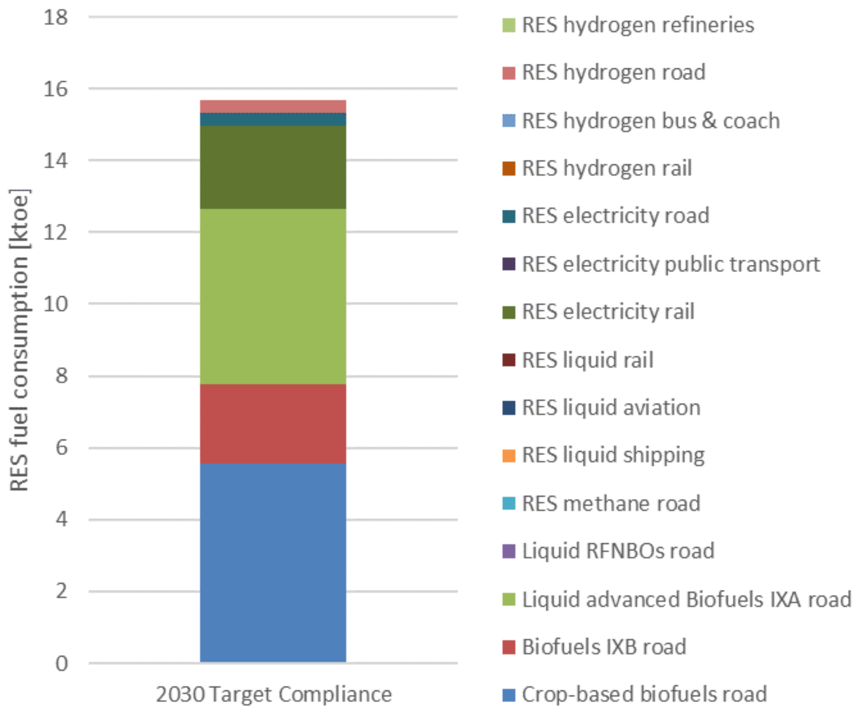

Figure 142: Renewable energy consumption in transport in 2030 by option

11.4 National renewable energy sources to meet the 2030 renewables in transport target

11.4.1 Potential of national renewable energy sources

The potential renewable fuel that could be produced from each of the feedstocks considered, is presented in Figure 143. Note these estimates relate to total feedstock potential and do not take into account competing uses, see section 3.2.1 for detailed description of sources and data used. Compared to the current energy use in road and rail transport, Montenegro has a significant existing production of sugar and starch crops, and oil-crops. However, it should be noted that the values presented in Figure 143 correspond to total current production of these crops, therefore use of this resource for biofuel production would compete with existing uses of these crops.

Current transport energy use (road and rail) in Montenegro is 63% of the potential renewable fuel that could be produced from all feedstocks apart from renewable power. When renewable power is included, current transport energy use (road and rail) in Montenegro is 22% of the potential renewable fuel produced from all feedstocks.

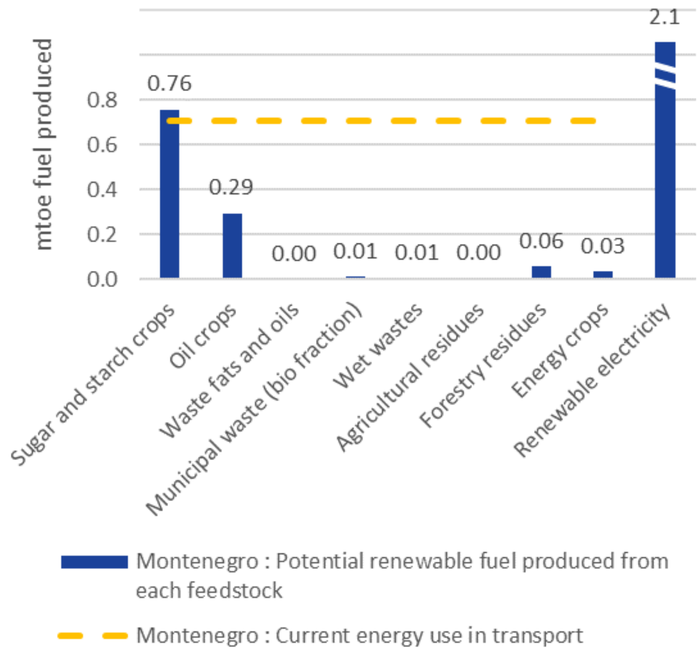

Figure 143: Montenegro: Potential renewable fuel production, compared to current energy use in road and rail transport

11.4.2 Current status of national transportation fuel pathway deployments

There are no reported biofuel production plants in Montenegro.

11.5 Roadmap for achieving the renewable energy in transport target for 2030

11.5.1 Regulatory status quo

11.5.1.1 General data

With respect to the legislative procedure Montenegro is making progress regarding the transposition of the provisions of Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009on the promotion of the use of energy from renewable sources (RED) into its national regulatory framework.

In May 2014, the Ministry of Economy published Montenegro's Energy Development Strategy, which defines that in quantitative terms, in 2020, the basis for calculating the target in the transport sector is 3.147 GWh and 10% of RES energy is 315 GWh. This obligation was to be fulfilled by biofuels (285 GWh), which represents about 90% of the target, while the rest would be covered by electricity used in electric vehicles and electric rail traction (30 GWh, or about 10%).

As well, the Montenegrin National Renewable Energy Action Plan (NREAP) until 2020 set out an ambition to achieve a stepwise introduction of biofuels (biodiesel and bioethanol) in road transport, beginning with 3% of supply (by volume) from the end of 2014, rising to 10% in

2020. A 'reference scenario' estimate indicated that around 34 million litres of biofuel (primarily biodiesel) would be required to meet the 2020 target, and around 30 million litres to meet the target in 2030. The remaining share of the transport target would be met through renewable electricity in passenger vehicles and railways. However, current use of renewable energies in transport is still very low (see section 11.3.1.3), and target achievement in 2020 is not anticipated.

Table 44: 2020 and 2030 biofuel forecast consumption (according to NREAP)

	2020		2030	
	GWh	Mil.litres	GWh	Mil.litres
Biodiesel	245	27.0	218	23.9
Ethanol	39.7	6.7	34.3	5.8
Total	285	**33.7**	252	**29.7**

In 2019, the Energy Community started the process of setting 2030 targets in line with the Policy Guidelines on the development of integrated National Energy and Climate Plans (NECP) under Recommendation 2018/01/MC-EnC. Renewable energy targets as well as policies and measures will be addressed under the 'Decarbonisation of the economy' dimension of the NECP in an integrated way, which recognizes the interactions between the different dimensions.

Renewable energy targets, policies and measures for 2030 will thus be included in the NECP.

The body competent for monitoring the implementation of the NREAP is the Ministry of Economy, comprising two directorates - Directorate of Energy and Directorate of Energy Efficiency. Furthermore, the Energy Regulatory Agency of Montenegro has the task to conduct an independent annual analysis of the contribution of renewable energy sources to the gross generation and consumption of electricity and to publish its results.

Although in Montenegro competent bodies for monitoring have been designated, they are not authorised to impose penalties in the case of non-compliance with renewable energy targets.

Montenegro does not have any provision for support measures available to purchasers of alternative-fuelled vehicles. In this respect, the Regulation on the quality and methods for the control of biofuels in relation to the compatibility of vehicles with various alternative fuel types should be mentioned. However, this Regulation only defines which quality requirements in accordance with prescribed standards biodiesel and bioethanol used as propellant in internal combustion engines need to comply with.

In January 2020 the Law on Protection from the Negative Impacts of Climate Change came into force, on the basis of which in February 2020 the government adopted the Decree on the activities producing greenhouse gases for which the state issues permits. Through these acts, Montenegro has introduced a carbon tax, which could have implications on the transport sector up to 2030.

11.5.1.2 Energy efficiency in transport

Several laws and by-laws regulating energy efficiency in transport have been passed during the past years. The National Assembly of Montenegro in 2014 has passed the Law on Efficient Use of Energy, on which basis the Ministry of Economy in 2017 has adopted the Rulebook on the labelling of energy efficiency of vehicle tyres and other parameters. Scope of this by-law is labelling of energy efficiency of tires with respect to fuel consumption, wet grip and external rolling noise.

In the period of realization of 3rd National Energy Efficiency Action Plan (NEEAP) the Action plan for implementation of renewable energy sources and energy efficiency measures in the transport sector was developed. In accordance with the recommendations of the Action Plan, activities regarding improvement of energy efficiency in future periods is needed in two directions: realization of projects that contribute to the development of sustainable transport and realization of infrastructure measures in the transport sector with the effects of energy savings.

Furthermore, in June 2019, Montenegro has adopted 4th NEEAP for period 2019-2021. In accordance with the NEEAP measures which should be realized are:

- implementation of activities on the development of Sustainable Urban Mobility Plan for the capital city of Podgorica and support to other local-self-government units in Montenegro in development of solutions regarding urban mobility and intensive promotion activities during European Mobility Week;
- realization of demonstration projects in the capital city of Podgorica and selected local self-government units in the field of sustainable urban mobility;
- development of a comprehensive study for introduction of the concept of E-mobility in Montenegro;
- undertaking the necessary activities to develop a methodology for planning and review of energy savings and environmental impacts and its application in construction of traffic infrastructure facilities;
- educational activities of relevant subjects for the application of mentioned methodology.

It should be mentioned that the measures for 2030 regarding energy efficiency shall be included in the NECP.

11.5.1.3 Production and supply of fuel

One of the significant steps in fulfilment of the obligations defined in RED was made in June 2018, when three secondary acts regarding sustainability of biofuels and bioliquids were adopted:

- Regulation on the quality and methods for the control of biofuels (Official Gazette of Montenegro no. 43/18).

- Regulation on mandatory shares of biofuels in the transport sector (Official Gazette of Montenegro no. 51/18),
- Regulation on closer sustainability criteria for biofuels and bioliquids for achieving the required share of energy in total final energy consumption (Official Gazette of Montenegro no. 51/18),

However, it is defined that the Regulation on mandatory shares of biofuels in the transport sector and the Regulation on closer sustainability criteria for biofuels and bioliquids for achieving the required share of energy in total final energy consumption will apply from the day of Montenegro's entry to the EU, which does not seem to be in line with the obligations of Montenegro in the framework of the Energy Community.

It is still not known which institution will be in charge of monitoring the fulfilment of the sustainability criteria, but in the Regulation on closer sustainability criteria for biofuels and bioliquids for achieving the required share of energy in total final energy consumption is defined that it has to be an authorized accredited legal entity.

The Regulation on mandatory shares of biofuels in the transport sector defines minimum shares of biofuels consumed in transport. Article 2 defines that the mandatory share of renewable energy sources in the transport sector is the lowest percentage of the renewable energy sources which energy entities, engaged in the trade of petroleum derivatives used in the transport sector, are required to place on the market in the transport sector on an annual basis. Thus, minimum shares are defined, not absolute quantities per fuel supplier. Article 6 of that Regulation requires that in order to determine the obligations of the energy entity that places biofuels on the market, in the transport sector, the following elements are included in the calculation:

1) biofuel energy that meets the requirements regarding sustainability criteria, which are determined in accordance with a special regulation;
2) energy of biofuels produced from waste and residues (except residues from agriculture, aquaculture, fisheries and forestry) which fulfils the requirement to reduce greenhouse gas emissions, in relation to the emissions generated by the use of petroleum products;
3) double energy value of biofuels produced from waste, residues, non-food cellulosic and lignocellulosic materials in relation to the energy value of other materials from which biofuels are produced.

Furthermore, the regulation defines exemptions to the abovementioned requirements. Quantities of petroleum products which some energy entities provide as strategic reserves of petroleum products in accordance with the Energy Law, and the quantities of petroleum products placed on the market for needs of military vehicles of Montenegro are excluded from the calculation of the mandatory share of biofuels in the transport sector.

The Regulation on mandatory shares of biofuels in the transport sector stipulates that energy entities engaged in the wholesale and retail trade of petroleum products are obliged to place biofuels on the market in order to achieve the mandatory share of renewable energy sources in the transport sector subject to a specific system as follows:

- if biofuel quantities put on the market by an obligated entity are too low, the entity has to increase in the current year the amount of biofuels by the quantity it failed to place on the market in the previous year,
- if biofuel quantities exceed the required minimum, the respective entity, with the prior approval of the Ministry of Economy, may reduce in the following year the quantity of biofuels accordingly.

Montenegro has defined sustainability criteria for biofuels and bioliquids which are placed on the market in the Regulation on closer sustainability criteria for biofuels and bioliquids for achieving the required share of energy in total final energy consumption, as follows:

1) Savings in greenhouse gas emissions;
2) The manner of use of land important for the conservation of biological diversity;
3) The manner of use of high carbon land;
4) Definition of biofuels and bioliquids calculated to save GHG emissions;
5) Defined sustainability criteria for imported biofuels and bioliquids.

Biofuels and bioliquids produced from waste and residues other than residues from agriculture, forestry, fisheries and aquaculture only have to fulfil the sustainability criteria defined in item 1) above - savings in greenhouse gas emissions.

The Regulation on closer sustainability criteria for biofuels and bioliquids for achieving the required share of energy in total final energy consumption requires that GHG emission savings from the use of biofuels and bioliquids must be at least:

1) 50% from January 1 of the following year from the date of accession to the European Union;
2) 60% from January 1 of the year following the year referred to in item 1) for biofuels and bioliquids produced in installation which started operation in the year of accession to the European Union.

The minimum GHG emission savings defined here are not in line with the provisions of RED as adopted for the Energy Community.

GHG emission savings from the use of biofuels and bioliquid shall be determined in accordance with a regulation governing the methodology for calculating the impact of biofuels on GHG emissions, as a special regulation.

The Regulation on closer sustainability criteria for biofuels and bioliquids for achieving the required share of energy in total final energy consumption excludes certain origins of biofuels and bioliquids. Biofuels and bioliquids must not be produced from materials:

- grown on land for the conservation of biodiversity, or

- grown on high carbon land;
- grown on land that had peatland status in January 2008, unless there is evidence that cultivation and harvesting of the material does not cause the land drainage.

Besides that, it is determined that agricultural materials imported into Montenegro, which are produced in a Member State of the European Union and the Energy Community, and which are used for the production of biofuels and bioliquids, and are included in the calculation of GHG emission savings, must be manufactured in accordance with the requirements and technical regulations applicable to those materials in Member States of the European Union and the Energy Community.

The competent body that monitors the fulfilment of the abovementioned obligations regarding the placement of renewable energy sources share in the transport sector is the Ministry of Economy. The Ministry passes a decision on fulfilment of the obligation of placing the share of renewable energy sources in the transport sector for the previous year, by the end of April of the current year.

The Energy Law determines measures that may be imposed to the energy entity in case of non-compliance to the prescribed provisions of the Energy Law in two cases:

The first case refers to the situation where an entity which performs trading of petroleum products and/or biofuels, which are not of the prescribed quality. In this case it shall be punished for an offense:

- with a fine in the amount of 3.000 € to 20.000 €;
- together with a fine, the energy entity may be excluded trading petroleum products and biofuels for two to six months.

The second case refers to the situation when the energy entity performs trading of petroleum products and/or biofuels at a price higher than the maximum retail prices determined in accordance with Government regulation. In this case it shall be punished for an offense with a fine in the amount of 2.000 € to 10.000 €.

With respect to reporting obligations in Montenegro, two Regulations should be mentioned: The Regulation on mandatory shares of biofuels in the transport sector, and the Regulation on closer sustainability criteria for biofuels and bioliquids for achieving the required share of energy in total final energy consumption. Despite the fact that both of the regulations contain provisions regarding reporting obligations, they do not define the consequences of non-compliance with those obligations.

The Energy Law governs the production of electricity from renewable sources in Montenegro. In accordance with the Energy Law, the subject that intends to perform this energy activity must have a license, which is issued by the Energy Regulatory Agency of Montenegro. As well, in the field of renewable energy sources, the Energy Regulatory Agency is competent for the issuance of guarantees of origin and for approving the privileged producer status.

Table 45: Reporting obligations in Montenegro

	Reporting by	Reporting to	Frequency	Monitoring	Exemptions
Regulation on mandatory share of biofuels in the transport sector	Energy entities engaged in the wholesale and retail trade of petroleum derivatives, which are obliged to place biofuels on the market in order to achieve mandatory share of renewable energy sources in the transport sector	Ministry of Economy	Once a year	Publicly available	Energy entities are not obliged to include in their report the data regarding the quantities of petroleum derivatives which are provided as strategic reserves of petroleum derivatives, in accordance with the Energy Law, and the quantities of petroleum derivatives placed on the market for needs of military vehicles of Montenegro.
Regulation on closer sustainability criteria for biofuels and bioliquids for achieving the required share of energy in total final energy consumption	Producer of biofuels and bioliquids; Distributors of biofuels and bioliquids	Ministry of Economy	Once a year	Publicly available	None

It should be noted that the Energy Law or relevant by-laws do not contain provisions with required criteria related to electricity used directly in transport.

There are several gaps in the Montenegrin legislation which may be filled in the future. This refers to renewable fuels of non-biological origin – RFNBO defined in RED II. For the production of RFNBOs no criteria related to electricity used to produce RFNBOs are defined.

Furthermore, Montenegro does not have any law specifically regulating the market of E-Mobility. The laws in the field of transport do not specifically regulate the issue of stations for charging e-vehicles, except in the section relating to the placement of power lines. That means that certain subjects, such as public garages or public parkings, are not obliged to have electric vehicle charging stations. However, it should be mentioned that a draft of a new Law on Roads has been developed.

Another Law which may be significant in the area of E-Mobility is the Law on Spatial Planning and Construction of Structures. But this Law, as well, does not have specific provisions for e-vehicle charging stations in terms of identifying the charging stations for electric motor vehicles, the obligation to incorporate them into spatial planning acts, or possibly to facilitate the conditions for their construction.

As well, in Montenegro the tariff system is not used to promote E-Mobility, i.e. there is no tariff model that relates specifically to an infrastructure for charging e-vehicles. The fee for engaging network capacity (power) is high and is certainly a barrier to the development of e-mobility in terms of fast charging (high-power) stations.

Thus, it may be concluded that there are no incentives or simplified procedures for the construction/licensing of electricity charging stations for road vehicles, or for the construction/licensing of hydrogen refuelling stations.

Another potentially field where Montenegrin legislation may be improved is introducing certain incentives for renewable fuels production/sale or differences between production/sale of renewable fuels compared to diesel/gasoline, such as defining of lower level of excise duties for renewable compared to diesel/gasoline per type of fuel, since at the present these duties are identical.

11.5.1.4 Passenger transport sector

The Law on Tax for Use of Passenger Motor Vehicles, Vessels, Aircraft and Spacecraft regulates taxation of passenger motor vehicles which are registered in Montenegro. The law stipulates annual duties for various types of passenger motor vehicles and motorcycles based on their engine capacity class.

Table 46: Annual taxes for the transport sector in Montenegro

Cat.	Motor vehicle Engine capacity, cm^3	Annual tax, €	Motorcycle Engine capacity, cm^3	Annual tax, €
1.	up to 1300	25	up to 125	10
2.	1300 – 1600	40	125 – 500	30
3.	1600 – 2000	75	500 – 1100	150
4.	2000 – 2500	220	over 1100	300
5.	2500 – 3000	500		
6.	3000 – 4000	750		
7.	4000 – 5000	1000		
8.	over 5000	1500		

The Law determines the type of vehicles which are exempted from tax duties including electric motor vehicles. This tax exemption is the only financial incentive for e-vehicles and e-mobility that currently exists in Montenegro.

The Law stipulates that the annual tax be reduced by 5% for each year of age for the vehicle, though the total reduction may not exceed 50% of the total amount of tax defined.

In addition to the abovementioned law, attention should be paid to the Law on Sales Tax on Used Passenger Motor Vehicles, Vessels, Airplanes and Aircraft, which defines that the buyer, i.e. any purchaser of used passenger and other motor vehicles, vessels, airplanes and aircraft is obliged to pay a tax at a rate of 5%.

The Law on Sales Tax on Used Passenger Motor Vehicles, Vessels, Airplanes and Aircraft determines as an exception from this requirement where a motor vehicle, vessel, airplane or aircraft is inherited or given as a gift to a person in the first order of succession. Therefore, there are no exemptions for e-vehicles.

Montenegro imposes on vehicle owners, i.e. users of vehicles, a fee on use of roads based on the Decision on determining the amount of the annual fee for the use of roads upon the registration of road motor vehicles, tractors and trailers. The fee for passenger vehicles depends on the engine displacement, and the amount varies from 2.50 € (up to 900 cm^3) up to 30 € (over 3150 cm^3) and over for passenger vehicles with 6 up to 9 seats.

Persons with 80% of bodily injury or more, i.e. persons with determined incapacity of the lower extremities of 60% or more, are exempted from the obligation to pay the fee for one passenger vehicle they own, i.e. that they use on the basis of a leasing contract.

Certain limitations for vehicles in Montenegro are imposed regarding vehicle registration. Based on the Law on Road Traffic Safety, the Ministry of Transport and Maritime Affairs has adopted the Rulebook on technical requirements for vehicles imported or first placed on the market in Montenegro in 2015. In 2018, changes to this rulebook have been adopted. The rulebook concerns passenger as well as freight vehicles imported or placed on the market in Montenegro for the first time. The updated rulebook defines minimum toxic emission standards and noise levels as follows:

- for new vehicles, including freight vehicles, when imported to Montenegro to meet at least the EURO 6 engine standard, and
- for used vehicles, including freight vehicles, to meet at least the EURO 4 engine standard.

Custom taxes for vehicles which are imported into Montenegro are defined by the Customs Tariff. The customs rate is 0% for imported vehicles originating from the European Union, and the same customs rate applies to vehicles originating from countries which are signatories of CEFTA and EFTA agreements and for vehicles originating from Turkey, Ukraine and least developed countries. If the vehicle is originating from Russia, the customs rate differs between 1% and 5%, but for the vehicles operated on electricity only customs rate of 1% shall apply. Besides the payment of the customs rate, vehicle owners, i.e. users, are obligated to pay VAT of 21%.

The sector of public transport is not regulated in Montenegro. That means there are no incentives for the use of electricity or renewable fuel in public transport, nor certain restrictions, limitations, or obligations regarding that.

11.5.1.5 Freight transport sector

The following aspects are not regulated by the Montenegrin legislation for the freight transport sector:

- incentives or burdens (related to tax, other levies and public revenues, excises etc.) for vehicle owners, i.e. users;
- determination of the authority which shall perform control over the persons who obtained the right of incentives or who have additional burdens;
- defining the consequences of non-compliance with defined burdens, i.e. limitations.

The owners, i.e. users, of freight vehicles are obligated to pay the fee on use of roads based on the Decision on determining the amount of the annual fee for the use of roads upon the registration of road motor vehicles, tractors and trailers. The fee for freight vehicles depends on the carrying capacity and varies from 3.40 € (up to 1 t) up to 68 € (from 14.1 t up to 15 t) and higher for freight vehicles over 15 t.

Rules related to exhaust emissions of vehicles imported or first placed on the market in Montenegro are listed in section 11.5.1.4 above.

11.5.1.6 Railway sector

The Law on the Safety, Organization and Efficiency of Rail Transport imposes different kinds of permissions related to use and registration of locomotives, which may be significant in the railway sector. Furthermore, technical inspection of the rail vehicles must be carried out before putting them into operation.

The following types of permissions are imposed by the Law on the Safety, Organization and Efficiency of Rail Transport as listed in Table 47.

There are no provisions which stipulate incentives or some kind of obligations for use of electric locomotives, however, it should be mentioned that 225 km of a total of 250 km of railways in Montenegro are electrified.

Also, there is no act which imposes the use of electricity from renewable energy for railway transport.

Table 47: Permissions related to the railway sector in Montenegro

Type of permission	Subjects	Competent authority for issuance
Use permission of structural subsystem	Structural subsystems of interoperability constituents and parts of structural Subsystems	Administrative body competent for railway transport operations
Vehicle type permission	Vehicles registered in Montenegro, regardless of producer	Administrative body competent for railway transport operations
Permission to use vehicles compliant with technical specifications of interoperability (TSOI)	Vehicles intended for international traffic Vehicles registered in Montenegro, compliant with TSOI	Administrative body competent for railway transport operations
Additional permission to use vehicles compliant with technical specifications of interoperability (TSOI)	Vehicles registered in other countries that are fully compliant with all TSOI, if they are not used on TSOI compliant network, or under conditions specified in the relevant TSOI	Administrative body competent for railway transport operations

11.5.2 Roadmap to achieve the 2030 target

The roadmap developed here for Montenegro to achieve the 2030 target of 9% renewable energies in transport builds on the provisions of RED II as described in section 3.1.1. It is assumed that these provisions will be transposed into Montenegrin law without changes including the calculation of renewables in transport, the caps and minimum values for various types of renewable energies, the multipliers, the provisions related to electricity and RFNBOs etc. Also, sustainability criteria need to be transposed into national law in order to fully comply with RED II, and it must be ensured that certification schemes are in place (national or voluntary) compliant with RED II requirements.

For this study, we apply the renewable share in the national electricity mix anticipated for 2030. On the one hand, this tends to overestimate the renewable share as values for the year 2028 that should be applied are not available, but should in general be lower than the 2030 values. On the other hand, dedicated renewable power plants may be erected that are counted as 100% renewable for transport.

For Montenegro, an 89% renewable electricity mix is anticipated for 2030 based on literature values.[334] This is without prejudice to 2030 targets to be defined and included in the NECP.

It should be noted that the high renewables share in the national mix may open up opportunities for RFNBO production for export, notably to European Union Member States applying the RED II provisions. Should Montenegro, however, not achieve the 89% renewable electricity target, the contributions of fuel options based on electricity will be reduced accordingly.

11.5.2.1 Potential contributions from all options

Based on the assessment of all options for Montenegro, a total RES-T share of 13.1% in 2030 can be achieved as a combination of all options (see Table 48). Further very limited potentials exist in renewable liquid fuels in aviation, which are assumed to be zero here.

Biofuels and electric rail potentially contribute most in 2030.

Liquid RFNBOs can make a contribution in Montenegro. One plant of typical size and a high renewable share in power generation of 89% would contribute 2.3% to Montenegro's renewable energy in transport target for 2030.

Electric and hydrogen vehicles can already make contributions by 2030, and have a strong growth potential thereafter.

[334] TU Wien/Energy Economics Group, Joanneum Research, REKK: Study on 2030 overall targets (energy efficiency, RES, GHG emissions reduction) for the Energy Community. Vienna 2019

Table 48: Potential RES-T contributions from all options in Montenegro

Option		Contribution to RES-T target (%) incl. multiple counting	Amount of renewable fuel used (ktoe)
Biofuels and liquid RFNBOs	1. Crop-based biofuels in road transport	2.0%	5.6
	2. Liquid fuels produced from Annex IX B feedstocks in road transport	3.4%	4.7
	3. Liquid advanced Biofuels (based on Annex IX A feedstocks) in road transport	3.5%	4.9
	4. Liquid RFNBOs in road transport	2.3%	6.44
	5. Renewable methane in road transport	0.0%	0.00
	6. Renewable liquid fuels in shipping	0.0%	0.00
	7. Renewable liquid fuels in aviation	0.0%	0.00
	8. Renewable liquid fuels in rail	0.0%	0.00
Electricity	9. Rail electrification	1.2%	2.3
	10. Electric public transport (bus, trolleybus, tram, metro)	0.003%	0.00
	11. Electric road vehicles (passenger cars and trucks)	0.52%	0.36
Hydrogen	12. Hydrogen in rail	0.0%	0.00
	13. Hydrogen bus and coach (urban bus, long distance coaches)	0.001%	0.00
	14. Hydrogen road vehicles (passenger cars and trucks)	0.13%	0.36
	15. Hydrogen in refineries	0.0%	0.00
Total		13.1%	24.6

As the possible contributions of battery-electric vehicles depend on many factors, the following considerations are intended to provide some insight into the dynamics and opportunities (see Figure 144). The graph is based on a number of approximate assumptions, and should thus be understood as rough indication showing the general trends.

Battery-electric cars contribute to the RES-T target by applying the renewable share in the national electricity mix[335].

Electricity provided through public charging stations is covered in statistics as energy consumed in transport, and thus counted accordingly; charging through private charging units is not covered in statistics. Therefore, RED II foresees a multiplier of four for electricity consumed in road transport (based on data from statistics).

The RES-T contribution of battery cars depends on:

- The number of battery cars (horizontal axis in Figure 144);
- The share of public charging (green/ blue line in Figure 144 assuming 25% and 100% public charging, respectively);

[335] However, if certain criteria are met (see RED II), renewable electricity can be counted as 100% renewable. This is not assumed in this study for option 11.

- The renewable share in the national electricity mix in 2028 (89% for Montenegro); doubling the RES share would double the contribution.

Assuming 25% public charging, 50 thousand battery cars would approximately contribute 3% RES-T by 2030 (see Figure 144).

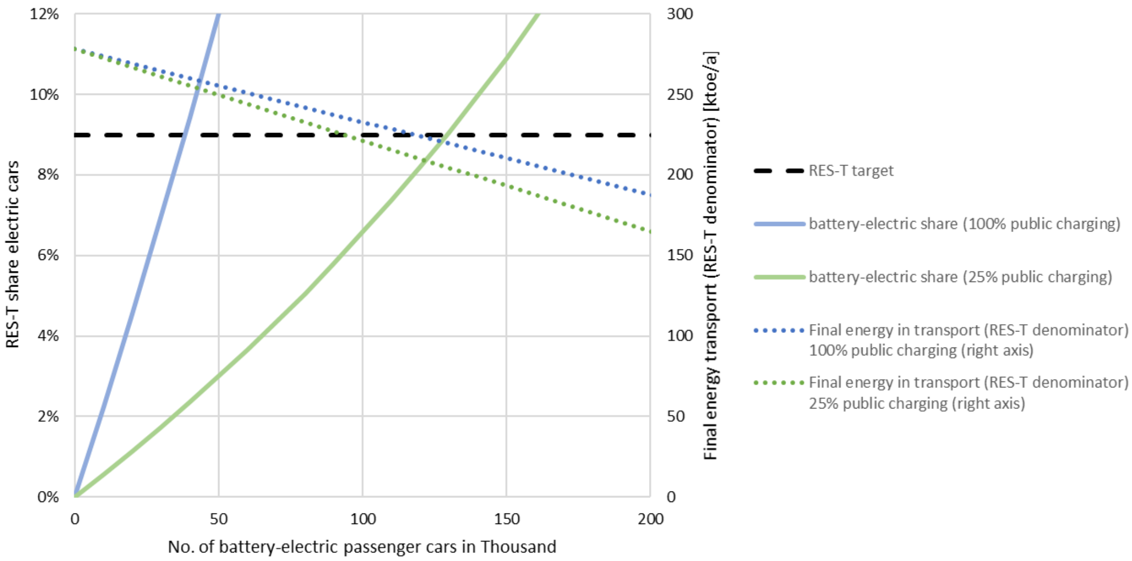

Figure 144: Possible contributions of battery cars to Montenegro's 2030 RES-T

As battery cars are more energy efficient than conventional cars and the electricity is only partly covered in statistics energy consumption in transport decreases with increasing battery cars (dotted lines in Figure 144).

11.5.2.2 Choice of options to meet RES-T target

The rather high potential contribution of all options allows the contributions from several options to be reduced. The reductions are based on the general considerations described in section 5.1, and on the specific circumstances in Montenegro as described in the following:

1. Crop-based biofuels are used up to the 2% cap
2. Biofuels based on Annex IXB biofuels can be reduced by around half from the maximum capped level. 68% of this supply could be met from domestic collectable UCO and tallow resources;
3. Liquid biofuels based on Annex IXA feedstocks ("advanced biofuels") are developed to meet the minimum targets defined in RED II. For context, this is equivalent to 15% of the output of an advanced ethanol plant at typical scale of 63 million l fuel/year;
4. Relatively expensive RFNBOs are not required in road transport to meet the 2030 target;
5. Montenegro has no use of methane in transport currently; therefore, it is assumed this is not introduced;

6. There is minimal domestic navigation in Montenegro;
7. No renewable fuels in aviation are required to meet Montenegro's RED II target;
8. No liquid fuels are consumed in rail today, so no renewable liquid fuels for rail are assumed here;
9. Increasing the national renewable share in electricity; maintaining and installing catenaries at non-electrified rail lines (only 25 km out of 250 km are not electrified) or closing non-electrified rail gaps as well as keeping the share of rail electricity in overall transport energy consumption by extending rail transport accordingly are assumed;
10. The introduction of battery buses and the establishment of trolley bus systems or trams in cities is assumed here;
11. The market uptake of battery-electric road vehicles (cars and light/ medium duty trucks) leads to electricity consumption in transport;
12. On existing and new rail lines not suitable for electrification zero emission hydrogen fuel cell trains can be operated; However, given the high electrification rate of Montenegrin rail lines, this cannot make a significant contribution and is thus assumed to be zero for this study;
13. Introduce hydrogen fuel cell buses in urban areas, and (long-distance) coaches in applications not suitable for battery-electric vehicles (high daily driving range, long-distance);
14. Start of market uptake of hydrogen fuel cell-electric road vehicles (cars and light to heavy duty trucks) for long-distance, high driving ranges;
15. There is no refining sector in Montenegro.

This results in the following contributions by 2030 assumed to be realistic and reducing the most challenging or expensive[336] options to meet the defined 2030 RES-T target:

[336] Detailed cost assessments have not been carried out in this study. Rough cost judgements are made here based on costs information provided in chapter 3.

Table 49: Contribution to Montenegro's RES-T target from options chosen

	Option	Multiplier	2030 Contribution to RES-T target incl. Multipliers	2030 Amount of renewable fuel used (ktoe)
Biofuels and liquid RFNBOs	1. Liquid crop-based biofuels in road transport	1	2.0%	5.6
	2. Liquid fuels produced from Annex IX B feedstocks in road transport	2	1.6%	2.2
	3. Advanced liquid biofuels (based on Annex IX A feedstocks) in road transport	2	3.5%	4.9
	4. Liquid RFNBOs in road transport	1	0%	0%
	5. Renewable methane in road transport	2	0%	0%
	6. Renewable liquid fuels in shipping	2	0%	0%
	7. Renewable liquid fuels in aviation	2	0%	0%
	8. Renewable liquid fuels in rail	2	0%	0%
Electricity	9. Rail electrification	1.5	1.2%	2.3
	10. Electric public transport (bus, trolleybus, tram, metro)	4 (road) 1 (tram, metro)	0.0032%	0.004
	11. Electric road vehicles (passenger cars and trucks)	4	0.52%	0.4
Hydrogen	12. Hydrogen in rail	1	0%	0
	13. Hydrogen bus and coach (urban bus, long distance coaches)	1	0.0013%	0.0040
	14. Hydrogen road vehicles (passenger cars and trucks)	1	0.13%	0.4
	15. Hydrogen in refineries	1	0%	0
Total			9.0%	16

Strong contributions are made by crop-based biofuels, liquid fuels produced from Annex IXB feedstocks (used cooking oil, tallow), and advanced biofuels (Annex IXA); moderate contributions are made by rail electrification and electric road vehicles; limited contributions are made by electric public transport, and by hydrogen in buses and coaches as well as in road vehicles.

The high proportion of Annex IXA (advanced) biofuels is driven by the sub-target in RED II and relies on a large scale-up in production of liquid Annex IXA biofuels. Should this prove not to be feasible, crop-based biofuels or biofuels based on Annex IXB could be increased, which would, however, not allow the sub-target for advanced biofuels in RED II to be fulfilled.

These contributions lead to a breakdown of fuel consumption in 2030 as shown in section 11.3.2.

11.5.2.3 Roadmap for Montenegro

The roadmap for Montenegro to achieve the 2030 target for renewable energies in transport (see Figure 145) involves key policies to be developed and adopted in the coming few years building on the existing policy elements already adopted, but not in force (see section 11.5.1). The development of the regulatory framework so far focuses on biomass-based fuels; direct electricity use and hydrogen use in road transport has received less emphasis so far, but should be taken up as two additional central pillars for renewables in transport.

The roadmap foresees that the last elements of the regulatory framework should be in place by the end of 2022.

The appropriateness, effectiveness and efficiency of this policy framework should be evaluated in around 2025, and should be adjusted where necessary to ensure target compliance by 2030. The European Union is currently developing the details of the European Green Deal, which aims to make the European Union climate neutral by 2050 by turning climate and environmental challenges into opportunities, and making the transition just and inclusive for all. Based on a set of policy initiatives by the European Commission, climate ambitions by 2030 are anticipated to be increased, which includes adjustments to RED II. A revision of the policy framework in Montenegro around the middle of the decade would be timely for taking up decisions to be taken at European Union level by then.

Around 2028 would be a suitable point in time to set targets for the 2040 timeframe, and to revise and adjust the strategies and policies accordingly.

Currently, Montenegro is developing its first National Energy and Climate Plan (NECP), which has a planning and a monitoring function. The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target, and will be helpful for the 2025 revision of the policy framework.

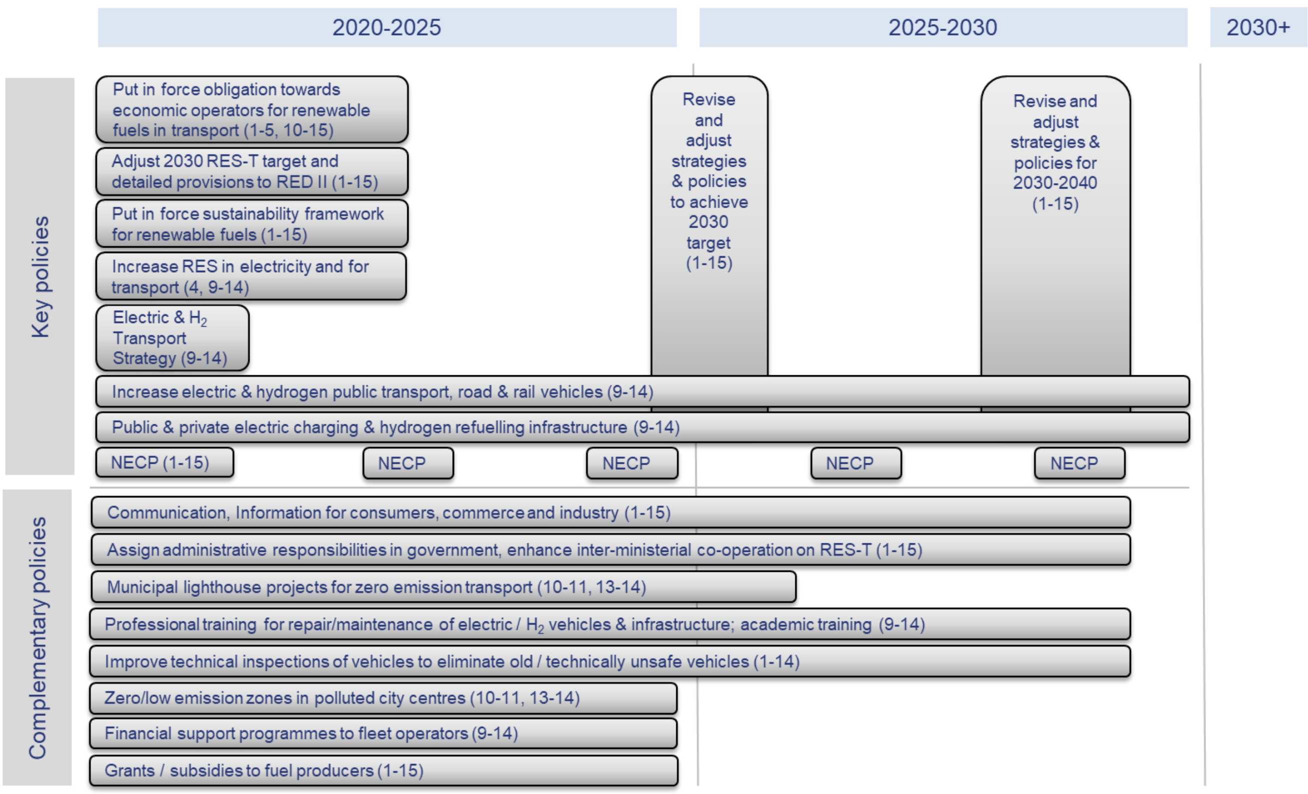

Figure 145: Overview roadmap for Montenegro

The priority in the roadmap for biofuels is to implement policy to drive uptake of these fuels, matching RED II requirements. Implementation of this policy mechanism, elements of which have been adopted in late 2019 coming into force at the beginning of 2021, including the correct targets, sub targets, caps, rules, etc. should be started as soon as possible, to allow industry as much time as possible to adjust and prepare to meet them. This obligation needs to be supported through a number of other policy elements such as rules for certification and compliance of biofuels, sustainability criteria for biofuels, and rules for calculating the impact of biofuels on the greenhouse gas emissions. As described above, whilst there is not yet an obligation enforced in Montenegro, several of these supporting policy elements are in place, although it must be ensured that all requirements of RED II are included, which is not currently the case. Additional attention also needs to be given to criteria on production of liquid RFNBOs, alongside the rules on hydrogen (below). A unit within the relevant government ministry must be designated responsible for implementing, reviewing and updating the policy as a whole, ensuring sustainability certification of fuels, administering the scheme, data collection and reporting.

Several other measures that are complementary to this demand-side policy have also been important in other countries, namely support for domestic fuel production, such as capital grants for plants and information provision for consumers on fuel switching and vehicle compatibility.

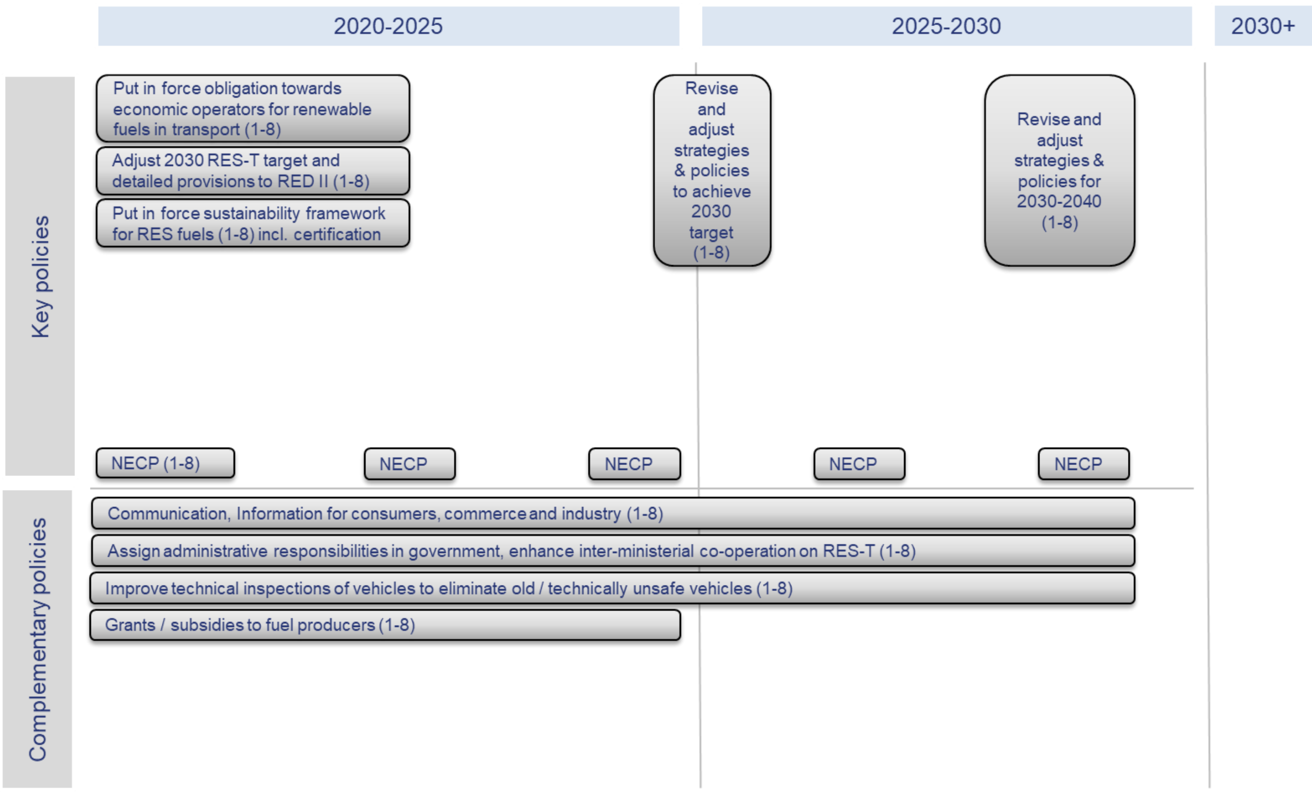

Figure 146: Roadmap for Montenegro – Biofuels and liquid RFNBOs

Some direct electricity use in transport is established in Montenegro in the rail sector, which benefits from the fact that the rail lines are almost fully electrified. Policies supporting renewables in transport should include maintaining and further strengthening renewable electricity use in rail, and extend this to public transport and road vehicles.

Battery-electric road transport including passenger cars, public transport and delivery vehicles is in an early stage of development in Montenegro, and has a significant growth potential. Developing a national electric transport strategy would be an appropriate starting point for a coherent and effective policy framework in this area. Various policies for fostering electric transport could be envisioned, such as including renewable electricity in the obligation on fuel suppliers for increasing the share of renewable energies in transportation fuels (see above), or putting an obligation on electricity suppliers for providing renewable electricity to transport, etc.

An additionality framework for renewable electricity would define rules for counting electricity as renewable based on RED II[337], and detailed provisions are currently under development by the European Commission. This aims at fostering additional renewable power capacities for transport not compromising the achievement of renewables electricity targets in conventional electricity consumption.

In parallel, existing policies for increasing renewable electricity production should be adjusted by increasing renewable targets for 2030 that would include additional renewable electricity demand from transport. Fostering dedicated renewable capacities for transport could be a new element introduced into existing legislation, covering rail, public transport and road.

Increasing the number of electric vehicles in road, rail and public transport is a major lever for increasing the consumption of electricity in transport, and reducing conventional fuel consumption. Elements for such policies include providing direct financial support for purchasing electric vehicles as already established, and adjusting the tax structures to incentivize purchases of electric vehicles. The vehicle charging infrastructure is the second major lever. Policies to coordinate and incentivize the build-up of a public network of charging stations include elements of financial incentives through grants, subsidies and loans, clear permitting rules, and coordination to ensure an appropriate nationwide network structure. In addition, financial support to charging infrastructures for public transport and fleet operators is an effective and efficient instrument for rapid growth.

The appropriate administrative structures must be established including enhanced inter-ministerial co-operation, and related responsibilities assigned in government.

Further complementary policies supporting electric transport include communication and information campaigns, lighthouse projects at local/ municipal level, the establishment of zero or low emission zones in urban areas for reduced air pollution, professional and academic training, technical inspections of vehicles (both electric and conventional), etc.

[337] See RED II Art. 27(3)

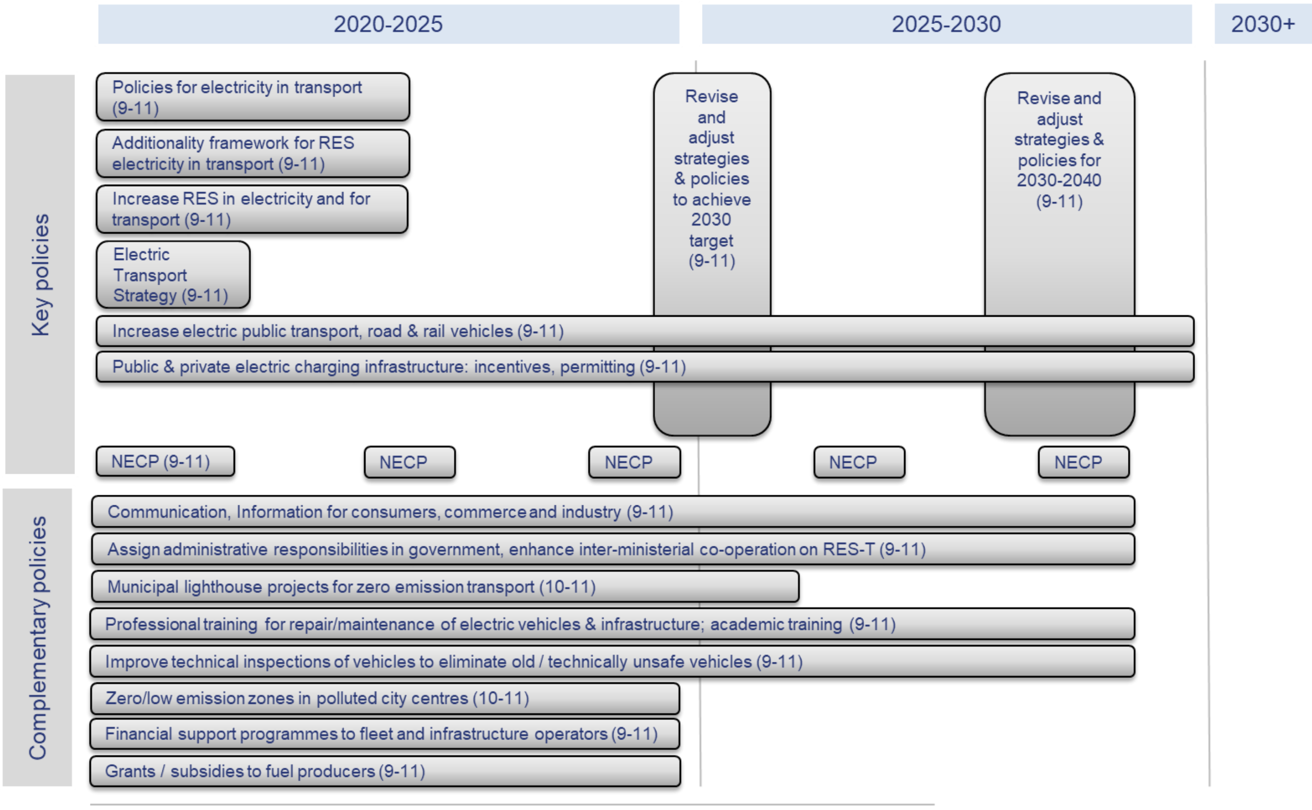

Figure 147: Roadmap for Montenegro – Electricity in Transport

Hydrogen in transport using fuel cell-electric vehicles is in early phases of commercialization world-wide, and shows major potential for decarbonizing transport in a complementary fashion to battery-electric vehicles. On non-electrified rail lines, first commercial hydrogen trains are in operation, and fuel cell vehicles are coming onto the market. A focus will be on vehicles for longer distances and for duty purposes such as trucks and buses.

Hydrogen can be included in the obligation on fuel suppliers as an option, as provided for in RED II. Further key policy elements are rather similar to electricity in transport: developing a national strategy, defining an additionality framework, increasing renewable electricity capacities for hydrogen production, supporting the market uptake of fuel-cell electric vehicles, and supporting the establishment of hydrogen refuelling stations.

Also, the complementary policies are similar to electricity.

The related policies should be established together with those for biofuels and electricity, while the market may take up a few years later based on an earlier status in commercialization.

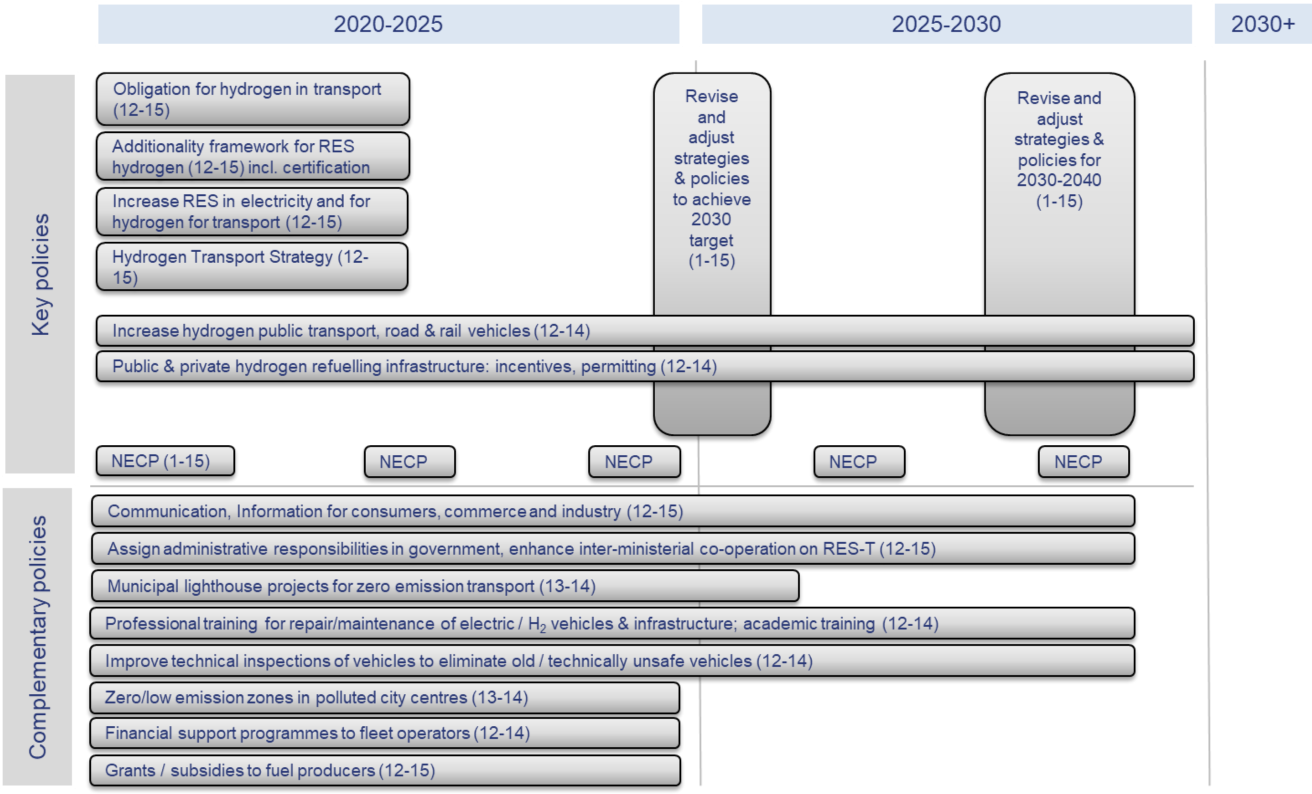

Figure 148: Roadmap for Montenegro – Hydrogen in Transport

11.6 Conclusions and recommendations

11.6.1 Conclusions

Montenegro can choose from a number of options to achieve the 2030 RES-T target of 9%. In fact, significant over-achievement beyond 13% is possible. It should be noted that even with achievement of the 2030 target of 9%, the anticipated consumption growth over the coming decade is expected to result in increased fossil fuel imports relative to 2018. Therefore, higher ambitions could be beneficial in economic and environmental terms for Montenegro. Options for renewable fuels production beyond the 2030 target may open up opportunities for exports e.g. by producing and exporting biofuels based on used cooking oil and tallow, or RFNBOs – economics of liquid RFNBOs are anticipated to become favourable in the medium-term.

Of the 9%, crop-based biofuels are capped at 2%, while 7% need to be achieved by other renewable fuels.

While biofuels are anticipated to contribute most to the target, electricity use in rail can also contribute significantly if the renewable electricity share reaches the 2030 value of 89% as assumed for this study.

Electric road vehicles have notable potential, which is anticipated to grow dynamically after 2030 to allow for major RES-T shares by 2050.

Hydrogen and battery-electric vehicles are complementary as hydrogen fuel cell vehicles enable longer driving distances, and are suitable for cars and heavy-duty transport alike; dynamic growth beyond 2030 is anticipated.

Additional benefits of achieving the 2030 RES-T target include the reduction of fossil energy import dependence and related financial flows out of the territory, additional national value creation, new or enhanced national value chains with related economic benefits and possible job creation as well as additional contributions to the national climate targets, etc.

11.6.2 Recommendations

As a proven policy tool, Montenegro should adopt a 2030 target for renewable energies in transport based on RED II.

The use of renewable energies in transport should be continued and enhanced. The adopted Regulations including a biofuels obligation and a sustainability framework should be put in force in the short-term, and should be adapted to include all provisions of RED II. Monitoring and enforcing the implementation of the provisions of these regulations including independent certification will be key to their success.

All elements of the regulatory framework should be in place by the end of 2022.

Electric road mobility should be developed to become the second pillar of renewable energies in transport in Montenegro. A national electric transport strategy should be developed including policies covering the two elements of fostering market uptake of battery vehicles and of developing a nationwide public charging network including fast-chargers.

Electricity use in public transport should be started by policies for the establishment of trolleybuses, tramways, or battery-electric buses.

Hydrogen fuel-cell electric transport should be developed to become the third pillar of renewable energies in transport in Montenegro. This should be defined in a national hydrogen strategy including policies fostering the market uptake of hydrogen vehicles in road, rail and public transport and aiming at the establishment of a national hydrogen refuelling infrastructure. The biofuels obligation Regulation should be extended to cover hydrogen for transport as the provisions of RED II are taken up.

In parallel, existing policies for increasing renewable electricity production should be adjusted by increasing renewable targets for 2030 that would include additional renewable electricity demand from transport (for direct use or for hydrogen production) benefitting both the electricity sector and transport covering rail, public transport and road.

Complementary policies for battery-electric and hydrogen fuel cell-electric transport are recommended to be established in order to ensure target achievement and maximum benefits to the Montenegrin economy, including communication and information campaigns, lighthouse projects at local/ municipal level, the establishment of zero or low emission zones in urban areas for reduced air pollution, professional and academic training, etc.

Co-benefits with other policy areas should be actively developed. This includes air quality improvements in urban areas and other environmental and health issues as well as economic benefits such as reduced fossil fuel imports, job creation, national value creation, etc.

Furthermore, co-operation with other Contracting Parties, and more generally with other countries, allows synergies and should thus be pursued.

Policies should be revised and possibly adjusted in around 2025 based on a policy and results evaluation.

The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target.

12 NORTH MACEDONIA

12.1 Executive Summary

The implementation of the revised Renewable Energy Directive (EU) 2018/2001 (RED II) on the promotion of the use of energy from renewable sources has started to be discussed within the Energy Community. Currently, RED II is not a part of the Energy Community acquis; but the adaptation and transposition by the Contracting Parties could be envisaged. Assuming for this study that the provisions of RED II are transposed into the law of North Macedonia without changes, we develop a roadmap for North Macedonia to achieve the 2030 target for renewables in transport of 9%[338].

North Macedonia has a share of renewable energy in transport of 0.12%, mainly from electricity consumption in rail. Biofuels consumption in North Macedonia is very low, and has even gone down in recent years; biofuels do not comply with RED requirements.

North Macedonia has a number of options to achieve the 2030 RES-T target of 9%. It should be noted that even with target achievement, the anticipated consumption growth will result in increased fossil fuel imports relative to 2018. Therefore, even higher ambitions could be beneficial in economic and environmental terms.

Of the 9% overall renewables target in transport, crop-based biofuels are capped at 2%, while 7% need to be achieved by other renewable fuels. Biofuels are anticipated to contribute most to the 2030 target, while renewable electricity in rail can make growing contributions.

Electric road vehicles can contribute to the 2030 target, with a strong growth potential beyond 2030. Hydrogen and battery-electric vehicles are complementary where hydrogen enables long driving distances, and heavy-duty operation alike; a small contribution by 2030 and dynamic growth thereafter is anticipated.

Additional benefits of achieving the 2030 RES-T target include the reduction of fossil energy import dependence, additional national value creation, new or enhanced national value chains with related economic benefits and possible job creation as well as additional contributions to the national climate targets, etc.[339] .

As a proven policy tool, North Macedonia should adopt a 2030 target for renewable energies in transport based on RED II.

[338] The overall target for RES-T of 14% can be reduced as far as the cap on crop-based biofuels is lower than 7%. As the cap on crop-based biofuels for North Macedonia is 2% based on the 2020 biofuels consumption, the overall target is reduced to 9%.

[339] Such benefits are not analysed in this study, but have been assessed in various studies, e.g. for hydrogen in Fuel Cells and Hydrogen Joint Undertaking (2019): Hydrogen Roadmap Europe – a sustainable pathway for the European energy transition; and in
Fuel Cells and Hydrogen Joint Undertaking (2020): Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans.

North Macedonia should develop and adopt a legal framework that includes all major elements required for establishing renewable energies in transport. It is recommended to base such legislation on RED II in order to have a legislative framework based on the latest relevant policies as well as technological and commercial developments.

A major success factor for achieving a 2030 target for renewable energy in transport is to establish legal obligations towards economic operators including their enforcement. Certification ensuring the compliance of economic operators with the sustainability requirements is another.

Without prejudice to any possible legal, political or contractual obligations, all elements of the regulatory framework should be in place at the latest by the end of 2022 in order to give industry as much time as possible to plan, invest, implement and operate.

Further key policy elements need to be established in order achieve the 2030 RES-T target:

- strategy and support mechanisms for electricity in transport
- strategy and support mechanisms for hydrogen in transport.

Complementary policies are recommended to be established in order to ensure target achievement and maximum benefits to the Georgian economy.

Co-benefits with other policy areas should be actively developed. This includes air quality improvements in urban areas and other environmental and health issues as well as economic benefits such as reduced fossil fuel imports, job creation, national value creation, etc.

Furthermore, co-operation with other Contracting Parties, and more generally with other countries, allows synergies and should thus be pursued.

Policies should be revised and possibly adjusted in around 2025 based on a policy and results evaluation.

The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target.

12.2 Introduction

The Energy Community Contracting Parties including North Macedonia have the obligation to reach binding targets for renewable energy in gross final energy consumption by 2020. For the transport sector, the binding target is a minimum 10% of renewable energy (RES-T) by 2020. North Macedonia will not achieve this target.

The implementation of the revised Renewable Energy Directive (EU) 2018/2001 (RED II) on the promotion of the use of energy from renewable sources has started to be discussed within the Energy Community. Currently, RED II is not a part of the Energy Community acquis; but the adaptation and transposition by the Contracting Parties could be envisaged.

It is assumed here that the provisions of RED II are transposed into the North Macedonian law without changes. On this basis, we develop a roadmap for North Macedonia to achieve the 2030 target for renewables in transport of 9%.

As a starting point, this study analyses the status quo of energy consumption in transport in North Macedonia, and provides 2030 projections including a business as usual scenario, and a scenario for compliance with the 2030 target for renewable energies in transport according to RED II.

In the second section, we assess the potential of national renewable energy sources suitable for use in transport, or for the production of transportation fuels together with the status of fuel pathway deployment in North Macedonia.

The third section describes the regulatory status quo related to renewable energies in transport. On this basis, we develop a roadmap for North Macedonia to achieve the 2030 target for renewables in transport on the three pillars of biofuels, electricity and hydrogen covering all transport sectors.

The final section provides conclusions and recommendations.

12.3 Status quo and 2030 projections of renewable energy consumption in transport

The objective of this chapter is to review the current status of renewable energies in transport (RES-T) in North Macedonia, and to develop scenarios of the development of renewable energy shares in transport by 2030.

The following data includes neither international aviation nor international navigation.

12.3.1 Status Quo

The following data includes neither international aviation nor international navigation as these two segments are generally excluded from statistics such as the Eurostat energy balances. Moreover, international navigation is not applicable for North Macedonia.

12.3.1.1 Transport Indicators

The use of cars has increased rapidly in the past years. Since 2008, the passenger kilometres by car have more than doubled[340]. The use of buses and coaches was roughly constant from 2012 to 2018. The use of railways for passenger transport is very small.

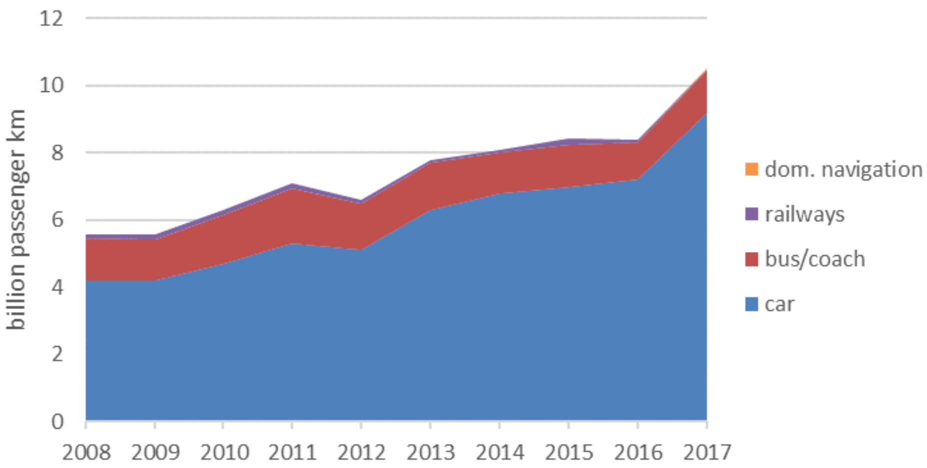

Figure 149: Passenger transport by transport mode[341]

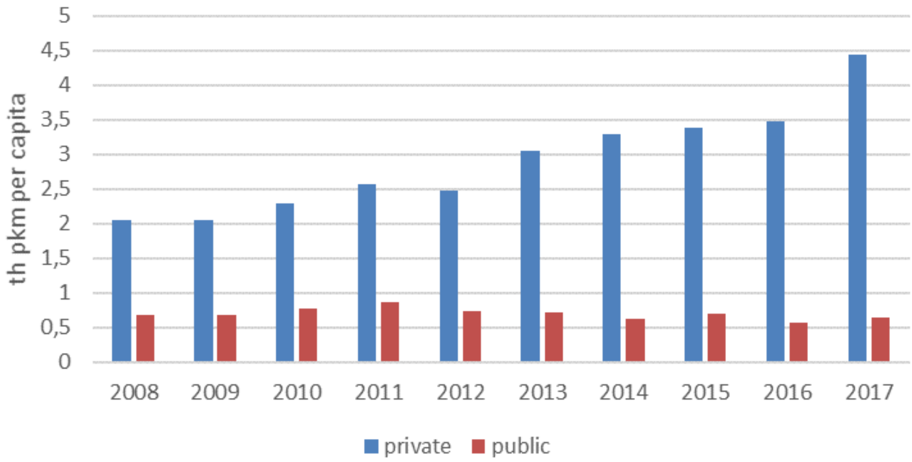

Figure 150: Comparison of public and private transport per capita

Passenger kilometres by car are counted as private while all other modes of transport (bus/coach, railways, domestic navigation) are counted as public transport. Since 2011, there

[340] 2018 data are not available

[341] State Statistical office of the Republic of North Macedonia (MAKSTAT): Statistical Yearbook of the Republic of North Macedonia. Skopje 2019

is a decreasing tendency in the use of public transport, however, it was stable from 2017 to 2018. Private transport by car, on the other hand, is rapidly increasing.

Road-based freight transport has seen a significant increase over the years, with decreases between 2012 and 2013, and between 2014 and 2015. The figures exclude transit and cabotage, which represent some 28% of total road freight in 2018; including the latter leads to rather constant road freight figures over the 2014 to 2019 period[342].

The use of rail for freight transport has seen a decrease by over 50% since 2008, with a slight increase in 2018 compared to 2017.

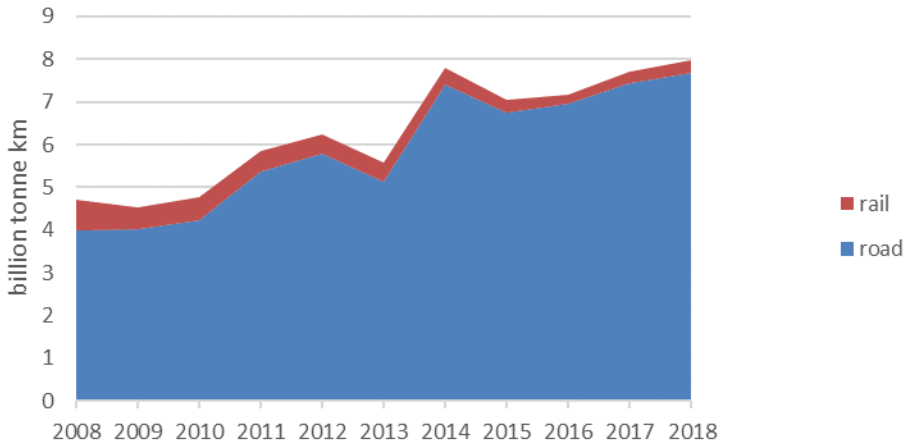

Figure 151: Freight transport by transport mode[343] [344]

12.3.1.2 Registered Road Vehicles

The number of cars has increased continuously since 2012. After a rapid increase until 2014 the growth has been moderate since then. The small number of buses has remained constant since 2014. The number of commercial vehicles has increased slowly but steadily in the past years. Data on commercial vehicles is available only from 2012 onwards.

342 See MAKSTAT online database at http://makstat.stat.gov.mk/PXWeb/pxweb/en/MakStat/MakStat__Transport__PatenTransport

343 State Statistical office of the Republic of North Macedonia (MAKSTAT): Statistical Yearbook of the Republic of North Macedonia. Skopje 2019: http://www.stat.gov.mk/PrikaziPublikacija_en.aspx?id=34&rbr=770

344 MAKSTAT online database at http://makstat.stat.gov.mk/PXWeb/pxweb/en/MakStat/MakStat__Transport__PatenTransport

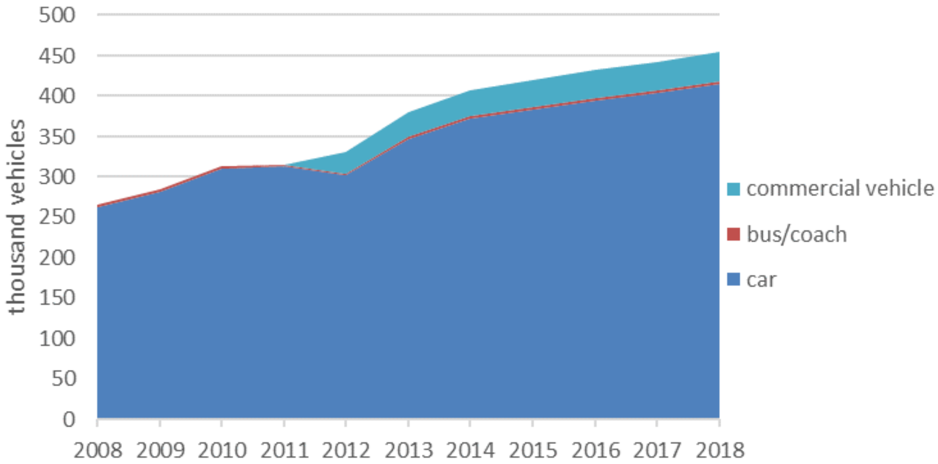

Figure 152: Registered road vehicles by type of vehicle[345] [346]

Figure 153: Comparison of passenger and freight vehicles per capita

The number of passenger vehicles per capita has increased since 2012. The number of freight vehicles per capita also shows a continuous growth.

12.3.1.3 Energy Consumption in Transport

After a rapid increase from 2012 to 2016, the energy consumption has remained roughly constant since then. The share of transport in final energy consumption has followed the

[345] European Commission (EC), Directorate-General for Mobility and Transport: EU Transport in Figures - Statistical Pocketbook. Luxembourg 2019

[346] UNECE statistical database - Transport (n.d.). Available at https://w3.unece.org/PXWeb2015/pxweb/en/STAT/STAT__40-TRTRANS/, last accessed 02. APR 2020

absolute consumption qualitatively and has increased from 25% in 2012 to almost 40% in 2018.

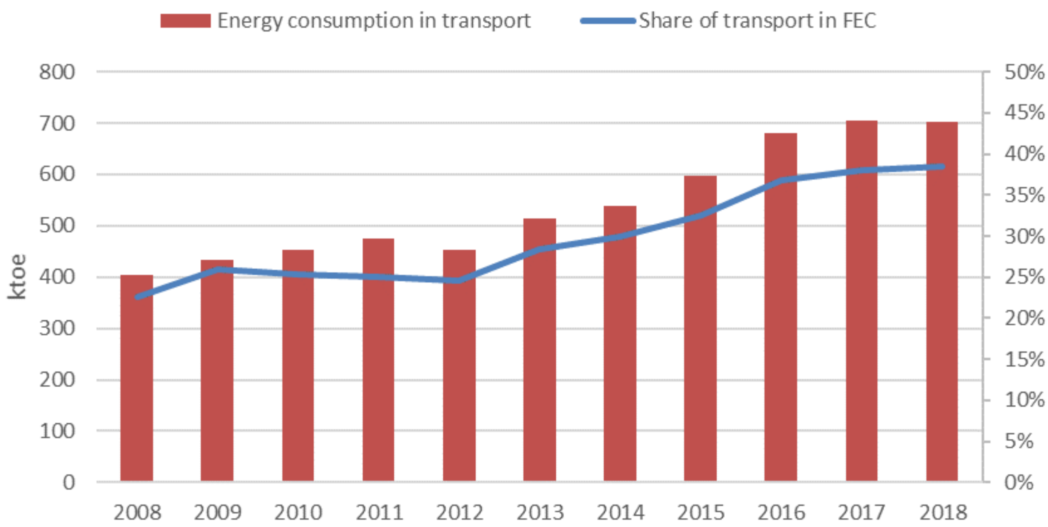

Figure 154: Energy consumption in transport[347]

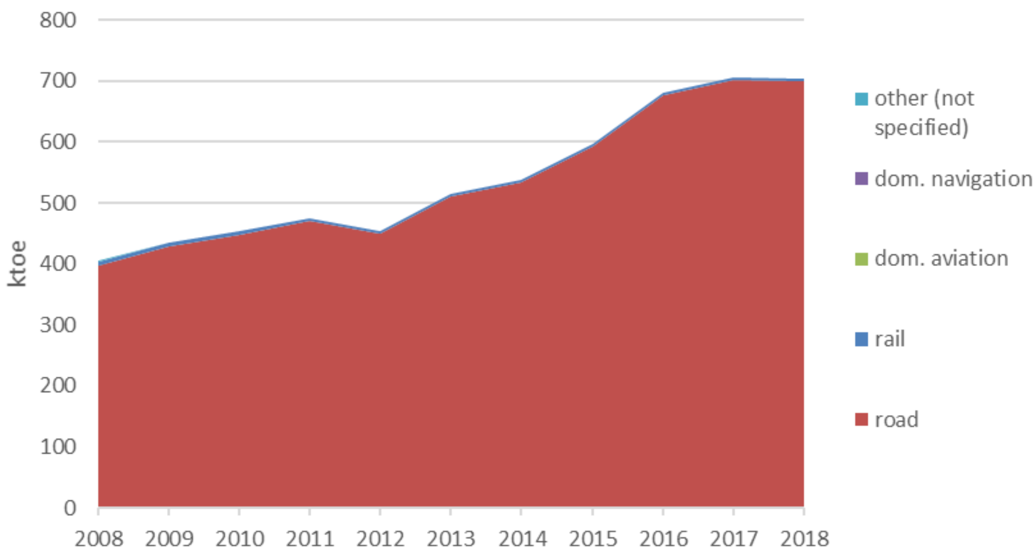

Figure 155: Energy consumption in transport by sub-sector[348]

347 European Commission Energy Balances: MK-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

348 European Commission Energy Balances: MK-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

Road transport is consuming practically all energy in the sector. Additionally, there has been a very small and decreasing share of energy consumption by trains in the past years.

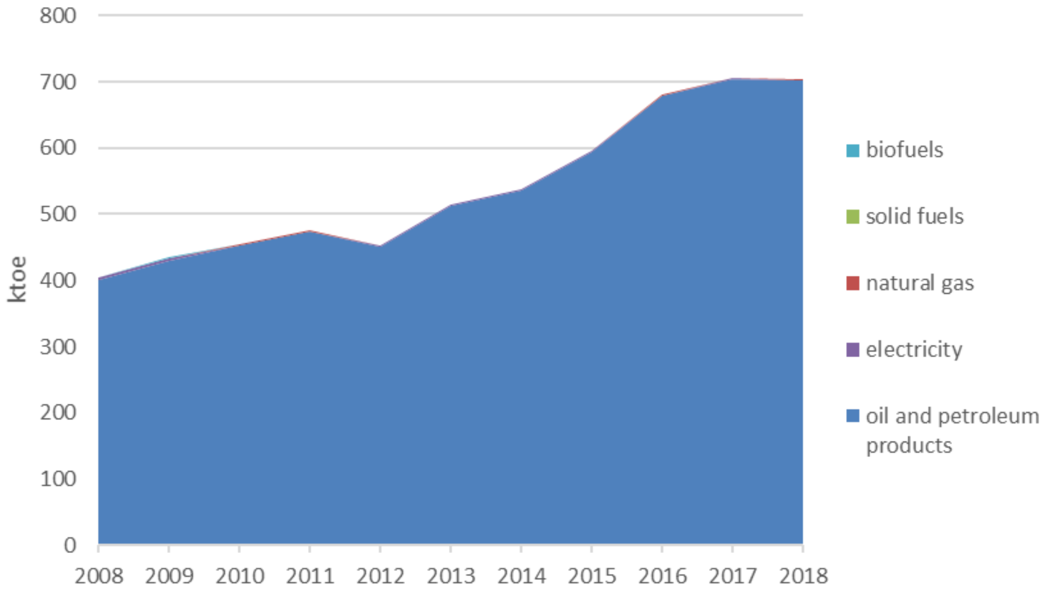

Figure 156: Energy consumption in transport by type of fuel[349]

The energy is almost exclusively provided by oil and petroleum products (including LPG). There has been a very small and decreasing share of electricity and negligible amounts of natural gas and biofuels.

The consumption of renewable electricity by trains has remained roughly constant in the past years with a peak in 2014. Since then, the consumption has been slowly decreasing. The total RES-T share has been decreasing since 2015 as well based on the overall increase of energy consumption in transport. In 2008 and 2009 there has been a small consumption of electricity by means of transport other than rail and road.[350]

349 European Commission Energy Balances: MK-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

350 The source (Eurostat SHARES does not include information as to the nature of this “other” transport; it is conceivable that the logic of assignment to transport sectors has changed after 2009.

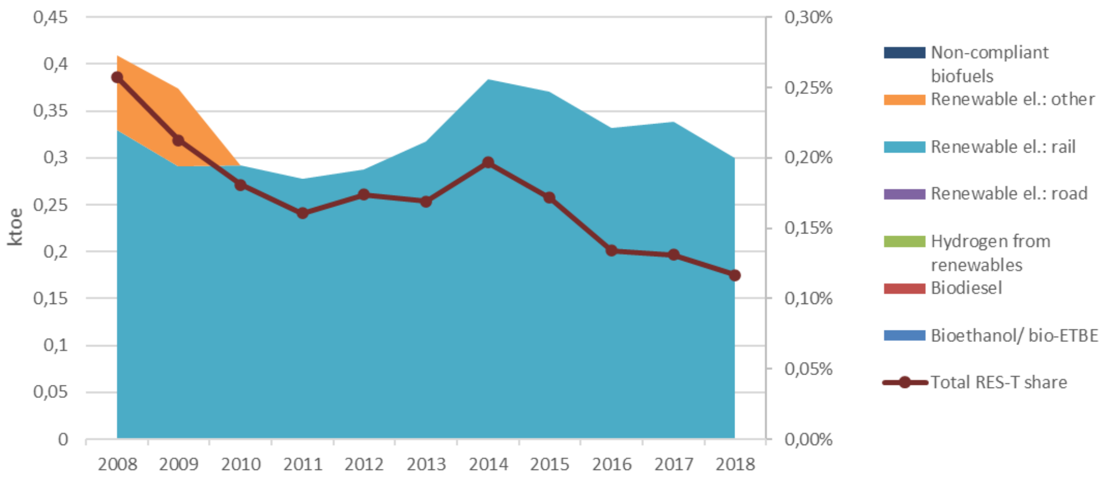

Figure 157: Renewable energy consumption in transport[351]

12.3.2 2030 Projections

The 2030 projections used here rely on The Strategy for Energy Development of the Republic of North Macedonia until 2040 of 2019[352]. In that study, a reference scenario for energy consumption in transport is made, which is broken down by fuel. Here, we have scaled the transport consumption of 2017 from that document to the actual values as reported in the energy balances[353].

In 2030, the total energy consumption in transport in the business as usual scenario is 780 ktoe, up 10% from 708 ktoe in 2018 (middle column in Figure 158).

351 Eurostat (2019) *SHARES detailed results 2018.* Available at: https://ec.europa.eu/eurostat/web/energy/data/shares

352 PricewaterhouseCoopers et al.: The Strategy for Energy Development of the Republic of North Macedonia until 2040. Final Draft – for public consultation, October 2019

353 European Commission Energy Balances: MK-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

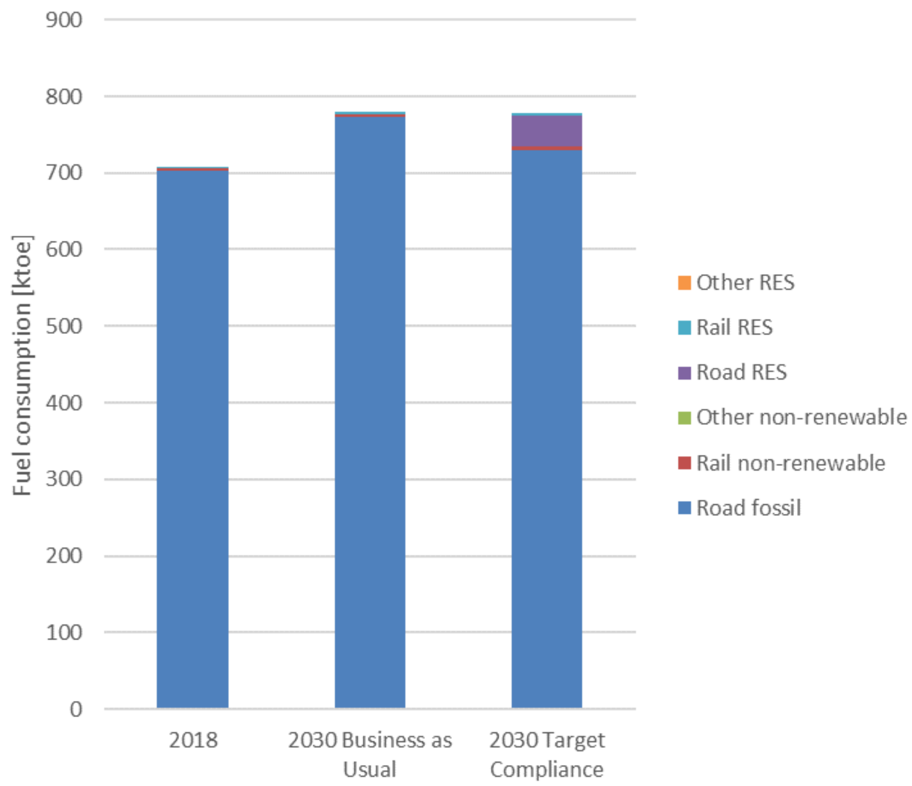

Figure 158: Energy consumption in transport in two scenarios for 2030

In a target compliance scenario achieving the 9% renewables in transport target for 2030, the roadmap as described in section 12.5.2 has been assumed to be implemented. This is represented by the right-hand column in Figure 158. The 9% renewable energies are broken down by options as described in section 0, and are shown in detail in Figure 159. It should be noted that for target compliance, multipliers are used for certain options; however, the energy quantities shown in Figure 158 show the physical energies, i.e. without multipliers. Therefore, the actual renewable energies in 2030 are less than 9% of total consumption in transport.

The total energy consumption in transport in the target compliance scenario is very slightly lower than in the business as usual scenario as battery-electric vehicles and hydrogen fuel cell-electric vehicles are more energy efficient than internal combustion engine vehicles.

The growth of fuel consumption leads to a higher fossil fuel consumption in 2030 even in the target compliance scenario. In order to reduce fossil fuel imports and CO_2 emissions from transport, either the growth in transport energy consumption needs to be reduced, or the target for renewables in transport needs to be more ambitious.

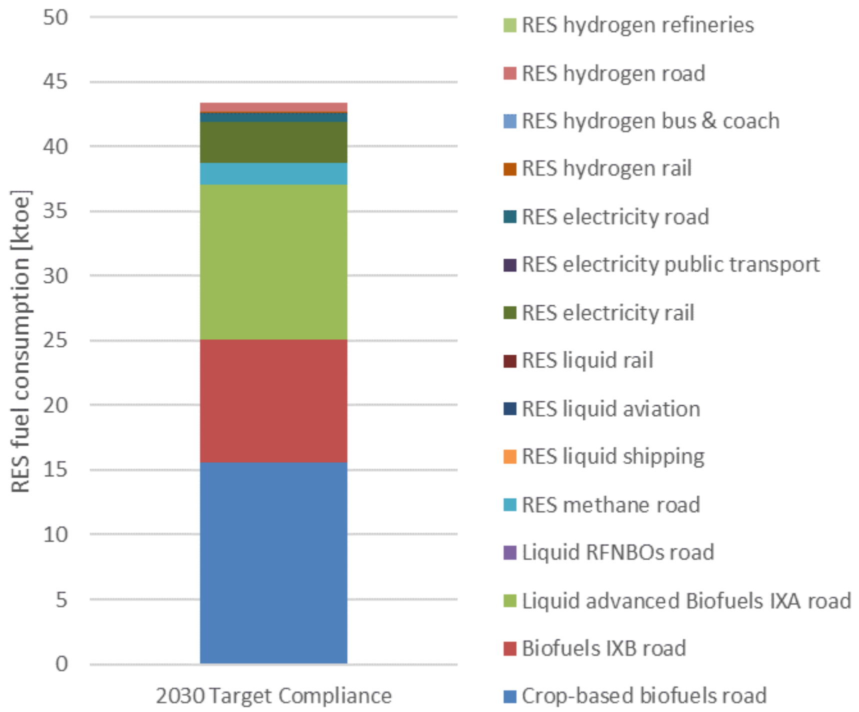

Figure 159: Renewable energy consumption in transport in 2030 by option

12.4 National renewable energy sources to meet the 2030 renewables in transport target

12.4.1 Potential of national renewable energy sources

The potential renewable fuel that could be produced from each of the feedstocks considered, is presented in Figure 160. Note these estimates relate to total feedstock potential and do not take into account competing uses, see section 3.2.1 for detailed description of sources and data used. Compared to the current energy use in road and rail transport, North Macedonia has a relatively small potential from biogenic feedstocks, but significant renewable power potential.

Current transport energy use (road and rail) in North Macedonia is larger than the potential renewable fuel that could be produced from all feedstocks apart from renewable power, at 143% of the potential. When renewable power is included, the current transport energy use (road and rail) in North Macedonia is 25% of the potential renewable fuel produced from all feedstocks.

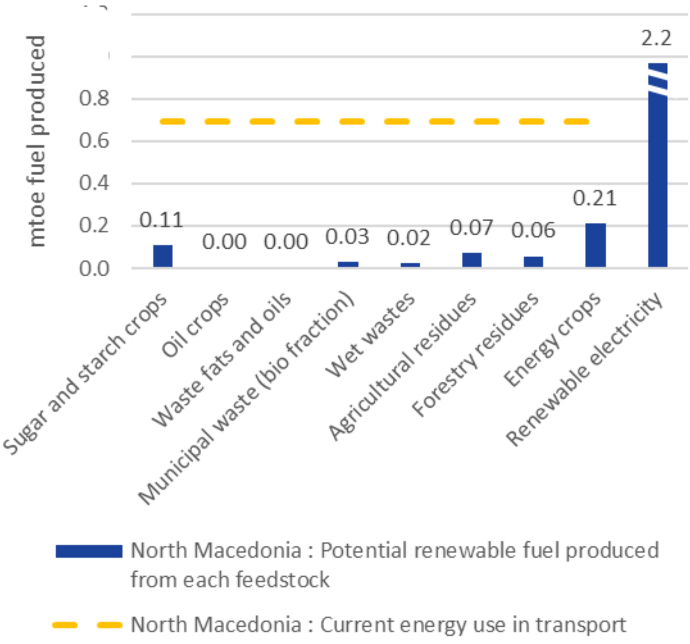

Figure 160: North Macedonia: Potential renewable fuel production, compared to current energy use in road and rail transport

12.4.2 Current status of national transportation fuel pathway deployments

North Macedonia has four operational biodiesel plants, all producing FAME biodiesel. They all use vegetable oils, such as sunflower and rapeseed, and one plant also uses used cooking oil. Their total combined annual capacity is 31 ktonnes. The breakdown of feedstock use is unknown. An additional two plants, operated by Blagoj Gorev, are planned and will produce biodiesel via the esterification of sunflower, rapeseed and soya oils. Their combined capacity is expected to be 13 ktonnes/annum.

12.5 Roadmap for achieving the renewable energy in transport target for 2030

12.5.1 Regulatory status quo

12.5.1.1 General data

North Macedonia is not compliant with RED in the transport sector, since the provisions of RED are not transposed into the national regulatory framework. However, national progress reports show that North Macedonia is not on track of achieving the RES-T target of 10% by 2020, determined by the Action Plan for Renewable Energy Sources of the Republic of Macedonia until 2025 with a vision up to 2030 (NREAP).

According to the information from the NREAP, the RES-T target of 10% is set for 2025 and 2030. In 2017 the NREAP was amended, so in accordance with the amended NREAP, the RES-T target by 2020 remains at 10%, while the expected absolute renewable energy consumption in transport is set lower than originally anticipated, so for 2020 it is 53.9 ktoe, instead of 57 ktoe, and for 2025 it is 62.3 ktoe, instead of 67 ktoe.

Additionally, in October 2019 the final draft of the Strategy for Energy Development of the Republic of North Macedonia up to 2040 was prepared according to which biofuels in transport increase from 1.25% in 2020 up to 10% in 2030 and 2040. It is stipulated by the Strategy that electric vehicles will also play an important role as environmentally friendly technologies for the transport sector.

Furthermore, the Decision on the national mandatory targets for the share of energy produced from renewable sources in gross final energy consumption and for the share of energy produced from renewable sources in the final energy consumption in transport is important. This Decision defines the national mandatory target to be achieved by 2020 for the contribution of energy produced from renewable sources in final energy consumption in transport to be 10%.

In 2019, the Energy Community started the process of setting 2030 targets in line with the Policy Guidelines on the development of integrated National Energy and Climate Plans (NECP) under Recommendation 2018/01/MC-EnC. Renewable energy targets as well as policies and measures will be addressed under the 'Decarbonisation of the economy' dimension of the NECP in an integrated way, which recognizes the interactions between the different dimensions.

Renewable energy targets, policies and measures for 2030 will thus be included in the NECP. As the first Contracting Party to do so, North Macedonia has submitted the official draft NECP to the Energy Community Secretariat, which will issue its recommendations to the draft.

The body competent for monitoring the implementation of the NREAP is the Ministry of Economy, and it is obligated to prepare a report every two years on the realization in the previous two calendar years, and to submit it to the Government no later than November 30.

Although in North Macedonia a competent body for monitoring has been designated, non-compliance with renewable targets is not regulated as an offense, so no penalties are imposed.

North Macedonia does not have any provisions in respect of the compatibility of vehicles with biofuels and biofuel blends. However, support measures available to purchasers of alternative-fueled vehicles are defined in the legislation.

The support measures are defined by the Law on Amending the Law on Vehicles adopted in 2019. This law defines environmental vehicle categories for environmental labelling, as well as subsidies for vehicles.

According to the environmental categorization, the vehicles are divided into three categories:

- the first category includes vehicles with the level of exhaust gas emission of EURO 5 and higher, as well as vehicles with the level of exhaust gases emission of EURO 4 and EURO 3 which have a device for use of liquefied petroleum gas or compressed natural gas, hybrid vehicles and electric vehicles, as well as vehicles that have installed equipment that reduces the emission of pollutant gases into the atmosphere and reaches the standards of EURO 4 and EURO 5 and higher;

- the second category includes vehicles with the level of exhaust gas emission of EURO 4 and EURO 3;
- the third category includes vehicles with the level of exhaust gas emission of EURO 2 and lower, as well as vehicles for which the manufacturer has not defined exhaust gas emission.

Also, the law defines certain exemptions. Namely, vehicles designed and manufactured exclusively for the needs of the Army of the Republic North Macedonia, police, ambulance, the fire services do not have environmental categorization of the vehicles, as well as the vehicles of completely deaf persons with a certificate for membership of the National Union of the Deaf People, persons with dystrophy, multiple sclerosis, cerebral paralysis, paraplegia, hemiplegia, quadriplegia, polio (poliomyelitis), blind persons with visual impairment over 90%, persons on dialysis and persons with amputation of the arm or leg with determined 80% of body injury.

Vehicles carry environmental labels in green, yellow and red, depending on the category, as follows:

- vehicles from the first category are marked with green label;
- vehicles from the second category are marked with yellow label;
- vehicles from the third category are marked with red label.
- The law also defines that in order to increase road traffic safety, reduce vehicle maintenance costs, reduce air pollution and increase the import of new vehicles, the Ministry of Economy for the current fiscal year in accordance with the planned funds of the national budget, prepares:
  - Programme for subsidizing part of the costs for installation of LPG vehicle devices or other type of alternative fuels;
  - Programme for subsidizing part of the costs for purchasing a new vehicle by deregistration of the old vehicle.

It should be mentioned that the draft law included one additional programme regarding purchase of electrical and hybrid vehicles; however, this was not included in the final version of the law which was adopted.

In October 2019, the Programme for subsidization of part of the costs for purchase and installation of devices for operation on LPG, CNG or other alternative fuels for vehicles was adopted, which stipulates subsidies of 50% of costs up to 18,000 denars (approx. 291,62€) in case of purchase and installation of devices for liquefied petroleum gas (LPG), methane or other type of alternative fuel. Natural persons, owners of vehicles manufactured from 2005 onwards, are eligible to apply for these subsidies. A total amount of 15,000,000 denars (approx. 243,016€) were allocated to this programme.

The programme for subsidizing part of the costs for purchasing a new vehicle by deregistration of the old vehicle is not implemented since the necessary funds in the national budget have not been allocated.

12.5.1.2 Energy efficiency in transport

In February 2020, the new Law on Energy Efficiency was adopted, which stipulates that one of its main objectives are to increase energy efficiency in the transport sector.

Article 43, which governs the obligations of the suppliers and the dealers of energy-related products regarding energy labelling of energy-related products, defines that these obligations shall not apply to the products intended for the transport of persons and goods.

Also, the law defines that, based on the proposal of the mayor, and upon the prior positive opinion obtained from the Energy Agency, the council of a municipality or the City of Skopje adopts an Energy Efficiency Programme every three years which includes inter alia: data on the energy consumption aggregated and per sector, energy efficiency targets per sector as well as measures and activities for energy efficiency improvement per sector.

Based on the provisions of the previous Law on Energy Efficiency, North Macedonia adopted the Second Energy Efficiency Action Plan (NEEAP) containing measures and activities for the period 2013-2015, while the first NEEAP was prepared and submitted for the period 2010-2012. The third NEEAP has not been adopted yet.

The first NEEAP provided measures for the most important final energy demand sectors, including the transport sector. The first NEEAP defined several measures aimed at reducing energy consumption growth in the transport sector, with a special emphasis on road transport. The measures provided in the first NEEAP were partially implemented, and the greatest success was achieved with the measure “Renewal of Public Transport Bus Fleet” and “Renewal of the National Road Vehicle Fleet”. With regulation measures and financial instruments, the public and private bus companies renewed their fleet, as well as the national road vehicles.

The second NEEAP mainly continues the started activities from the first NEEAP and sets measures, such as:

- renewal of the national road vehicle fleet;
- promotion of sustainable urban transport systems;
- car free days;
- promotion of greater use of railway for intercity travel and transport.

Additionally, the Strategy for Improvement of the Energy Efficiency in the Republic of Macedonia until 2020 defines the target savings in the transport sector for 2020, including the potential measures with estimated investments, such as:

- renewal of the national road vehicle fleet;

- promotion of sustainable urban transport systems (introduction of tramway in Skopje, renewal of public transport bus fleet, parking policy);
- fuel quality and fuel economy standards;
- car free days;
- promotion of greater use of railway for intercity travel.

It should be mentioned that the measures for 2030 regarding energy efficiency shall be included in the NECP.

12.5.1.3 Production and supply of fuel

The Strategy for utilization of renewable energy sources in North Macedonia by 2020 considers the possibilities to promote the use of biofuels for transport in pure and processed form, having in mind the potentials for securing sufficient quantity of biomass of domestic origin and from import. The consumption of biofuels by 2020 is targeted to represent 10% of total fuel consumption in transport, i.e., around 48 - 56 ktoe per year, which is within the range of planned production facilities.

These quantities of biofuels would replace the appropriate quantities of diesel and gasoline fuel consumption in transport.

In addition, the 2019 final draft of the Strategy for Energy Development of the Republic of North Macedonia up to 2040 determines that, in terms of transport energy efficiency savings, replacement of old vehicles with energy-efficient ones, electrification of road transport (EVs), as well as modal shift from road to rail for freight transport and from car to bus for passenger transport, and more biking/walking in urban areas are seen as the most important measures.

No obligation is imposed on fuel suppliers related to the share of renewable energy in the final consumption of energy in the transport sector, nor any obligation on fuel suppliers to meet certain greenhouse gas emissions standards.

Also, in North Macedonia there is no regulation which contain provisions defining minimum GHG reduction requirements for gasoline and diesel.

North Macedonia has not adopted specific legislation on sustainability criteria for biofuels, bioliquids or biomass fuels.

North Macedonia has not adopted any reporting obligations on fuel suppliers regarding the share of renewable fuel or greenhouse gas reductions are imposed.

The rules concerning production of electricity from renewable sources are set by the Energy Law. In accordance with the law, the subject that intends to perform this energy activity must have a license issued by the Energy Regulatory Commission. However, the license is not required for generation of electricity from renewable energy sources intended for own consumption, whereby the surplus of the produced energy shall be transferred to the power distribution network under conditions and in a manner determined in accordance with the regulations and rules adopted on the basis of the law. Furthermore, in the field of renewable energy sources, the Energy Regulatory Commission is the competent body for approving the preferential producer status, while the Energy Agency is the competent body for issuance of guarantees of origin.

It should be noted that there are no regulations which contain provisions with required criteria related to electricity used directly in transport.

There are several gaps in the legislation relative to RED II, which may be filled in the future. This refers among others to renewable fuels of non-biological origin – RFNBO defined in RED II, for the production of which no criteria related to electricity for their production are defined.

With respect to E-mobility, there are no provisions which refer to obligations of certain subjects such as public parkings or public garages to have electric vehicle charging stations. Furthermore, there are no incentives or simplified procedures for construction/licensing of electricity charging stations for road vehicles, or for construction/licensing of hydrogen refueling stations.

Excise duties are defined by the Law on Excise Duty. As per the last adopted Decision for determining the highest retail prices of oil derivatives and transport fuels adopted by the Energy and Water Services Regulatory Commission of the Republic of North Macedonia in August 2020, the excise duties on certain oil derivatives are as follows:

- Motor gasoline EUROSUPER BS 95 24.692 denars (approx. 0.40€)/l
- Motor gasoline EUROSUPER BS 98 24.692 denars (approx. 0.40€)/l
- Diesel fuel EURODIESEL BS (D-E V) 18.121 denars (approx. 0.29€)/l
- Burning oil 18.121 denars (approx. 0.29€)/l
- Extra light 1 (EL-1)
- Mazut M-1 NS 0.100 denars (approx. 0.0016€)/kg

Abovementioned amounts of excise duties apply as of 5th August 2020.

Furthermore, the Law on Excise Duty defines excise duty levels for other fuels as follows:

- liquefied petroleum gas; 4.900 denars (approx. 0.079€)/kg
- methane; 4.900 denars (approx. 0.079€)/kg
- kerosene as propellant; 11.000 denars (approx. 0.18€)/l
- kerosene as heating fuel; 2.200 denars (approx. 0.036€)/l
- natural gas as propellant; 0.00 denars
- natural gas as heating fuel; 0.00 denars
- biofuels 0.00 denars

It should be mentioned that in accordance with the Law on Excise Duty, biodiesel and mixtures of biodiesel, intended for use as propellant or to improve propulsion fuel or as heating fuel are subject to monitoring and control of the movement in the procedure of excise delay.

12.5.1.4 Passenger transport sector

The Law on Public Roads stipulates that the owners of motor vehicles and motorcycles are obligated to pay annually the fee for use of public roads, upon the registration of the vehicle. The fee is determined by the Decision on the amount and manner of payment of the fee for use of public roads for motor vehicles and trailers (road tax), which was amended in 2014 in respect of the fee amount. The fee for use of public roads is determined based on the engine displacement.

Table 50: Fee for use of public roads in North Macedonia

Cat.	Motor vehicle Engine capacity, cm^3	Annual tax, MKD/€	Motorcycle Engine capacity, cm^3	Annual tax, MKD/€
1.	up to 900	1,040/16.85	up to 125	180/2.92
2.	over 900 up to 1350	1,520/24.63	over 125 up to 250	330/5.35
3.	over 1350 up to 1800	2,180/35.32	over 250 up to 500	430/6.97
4.	over 1800 up to 2500	2,910/47.15	over 500 up to 1000	610/9.88
5.	over 2500 up to 3150	4,350/70.47	over 1000	750/12.15
6.	over 3150	5,780/93.64		

The Law on Public Roads determines exemptions from the obligation of payment of the fee for use of public roads: the persons suffering from dystrophy, multiple sclerosis, cerebral palsy, paraplegia, hemiplegia, quadriplegia, polio, persons on dialysis, persons with amputation of arm or leg with determined body injury over 80% are exempted. As well, the owners of motor vehicles and trailers by which international traffic is performed have the right to request a refund of the amount paid, in proportion to the time the motor vehicle and trailer has spent outside the Republic of Northern Macedonia.

In addition, owners of passenger vehicles and motorcycles have to pay the fee for street use based on the Law on Communal Taxes, which is determined based on the engine displacement. This fee is paid upon the registration of the vehicle.

Also, the Law on Administrative Fees determines fees imposed on the owners of vehicles, which refer to the different kinds of permissions, certificates, as well as to the license to perform transport of passengers and goods.

In December 2019, the Law on Motor Vehicle Tax was adopted, which defines that new and used motor vehicles that are imported and/or put into free circulation for the first time are subjects to taxation. Based on the law, the Regulation on the method of calculating the tax on motor vehicles and the amounts required for the calculation of the tax on motor vehicles provisions was adopted, which regulates the law provisions in detail.

Table 51: Fee for street use in North Macedonia

Cat.	Motor vehicle Engine capacity, cm³	Annual tax, MKD/approx. €	Motorcycle Engine capacity, cm³	Annual tax, MKD/approx. €
1.	up to 1000	from 30/0.49 up to 70/1.13	for all types of motorcycles	from 30/0.49 up to 70/1.13
2.	from 1000 up to 1300	from 50/0.81 up to 100/1.62		
3.	from 1300 up to 1500	from 70/1.13 up to 130/2.11		
4.	from 1500 up to 1800	from 200/3.24 up to 400/6.48		
5.	over 1800	from 300/4.86 up to 600/9.72		

Tax base for motor vehicle tax calculation is the amount of average carbon dioxide (CO_2) emissions expressed in grams per kilometre, depending on the type of propulsion fuel and the sales value of the vehicle or import value of the vehicle, if the vehicle is imported. The motor vehicle tax is calculated as the sum of a value component and a specific component:

Motor Vehicle Tax = Value Component + Specific Component

The Value Component represents the value of the motor vehicle multiplied by the percentage of the value of the vehicle for the appropriate value category, as follows:

- for vehicles up to 10,000 € - 0%
- for vehicles over 10,000 to 12,000 € - 1.0%
- for vehicles over 12,000 to 14,000 € - 2.0%
- for vehicles over 14,000 to 16,000 € - 4.0%
- for vehicles over 16,000 to 18,000 € - 6.0%
- for vehicles over 18,000 to 20,000 € - 8.0%
- for vehicles over 20,000 to 23,000 € - 10.0%
- for vehicles over 23,000 to 26,000 € - 12.0%
- for vehicles over 26,000 to 29,000 € - 14.0%
- for vehicles over 29,000 to 32,000 € - 16.0%
- for vehicles over 32,000 to 35,000 € - 17.0%
- for vehicles over 35,000 to 40,000 € - 18.0%
- for vehicles over 40,000 to 50,000 € - 19.0%
- for vehicles over 50,000 € - 20.0%

The Specific component represents the amount of average CO_2 emissions multiplied by the value of 1 gram of carbon dioxide for a given category, depending on the fuel type of the vehicle, as follows:

- for vehicles that emit 0 g/km CO_2 - 0 denars per gram;
- for vehicles that emit more than 1 to 50 g/km CO_2 - 5 denars (approx. 0.081€) for gasoline, LPG and CNG, 10 denars (approx. 0.16€) for diesel per gram;
- for vehicles emitting more than 51 to 75 g/km CO_2 - 10 denars (approx. 0.16€) for gasoline, LPG and CNG and 20 denars (approx. 0.32€) for diesel per gram;
- for vehicles emitting more than 76 to 90 g/km CO_2 - 20 denars (approx. 0.32€) for gasoline, LPG and CNG, 40 denars (approx. 0.65€) for diesel per gram;
- for vehicles emitting more than 91 to 100 g/km CO_2 - 30 denars (approx. 0.49€) for gasoline, LPG and CNG, 60 denars (approx. 0.97€) for diesel per gram
- for vehicles emitting more than 101 to 110 g/km CO_2 - 40 denars (approx. 0.65€) for gasoline, LPG and CNG, 80 denars (approx. 1.30€) for diesel per gram;
- for vehicles emitting more than 111 to 130 g/km CO_2 - 50 denars (approx. 0.81€) for gasoline, LPG and CNG, 100 denars (approx. 1.62€) for diesel per gram;
- for vehicles emitting more than 131 to 140 g/km CO_2 - 70 denars (approx. 1.13€) for gasoline, LPG and CNG, 130 denars (approx. 2.11€) for diesel per gram;
- for vehicles emitting more than 141 to 150 g/km CO_2 - 100 denars (approx. 1.62€) for gasoline, LPG and CNG, 160 denars (approx. 2.59€) for diesel per gram;
- for vehicles emitting more than 151 to 170 g/km CO_2 - 130 denars (approx. 2.11€) for gasoline, LPG and CNG, 190 denars (approx. 3.08€) for diesel per gram;
- for vehicles emitting more than 171 to 190 g/km CO_2 - 160 denars (approx. 2.59€) for gasoline, LPG and CNG, 220 denars (approx. 3.56€) for diesel per gram;
- for vehicles emitting more than 191 to 225 g/km CO_2 - 190 denars (approx. 3.08€) for gasoline, LPG and CNG, 250 denars (approx. 4.05€) for diesel per gram;
- for vehicles emitting more than 226 to 255 g/km CO_2 - 220 denars (approx. 3.56€) for gasoline, LPG and CNG, 280 denars (approx. 4.54€) for diesel per gram;
- for vehicles emitting more than 256 g/km CO_2 - 250 denars (approx. 4.05€) for gasoline, LPG and CNG, 320 denars (approx. 5.18€) for diesel per gram.

These coefficients are valid from the 1st January 2020 until 31st December 2020, while for 2021 they shall be increased by 25%, and for 2022 by 50%.

The law defines an exemption of paying this tax for fully battery-electric vehicles, and specific rules for:

- plug-in hybrid vehicles, in which case the amount of motor vehicle tax is reduced by 50%;
- pickup vehicles, in which case the tax is calculated on the basis of the amount of engine power expressed in kW and the value per kW, depending on the level of exhaust emissions;

- motorcycles, tricycles and quadricycles, in which case the tax is calculated on the basis of engine displacement expressed in cm^3, motor vehicle tax amount per cm^3 expressed in MKD for the relevant category and emission level;
- history cars (vehicles older than 35 years), in which case the tax is calculated and paid as a lump sum of 5,000 MKD (approx. 81 €).

Also, in order to stimulate replacement of old vehicles in the business sector, van-type vehicles that belong in the category of cargo vehicles and which are intended for transport of goods are also exempted from motor vehicle tax. Passenger vans for transport of 8 or 9 passengers, ambulance vehicles, vehicles for transport of deceased and camping motor vehicles will also be exempted from the tax, or their owners may be refunded with a part of the tax.

Custom taxes for vehicles are defined by the Customs Tariff. The customs rate is 0% for imported vehicles originating from the European Union and the same customs rate applies to the vehicles originating from countries which are signatories of CEFTA and EFTA agreements, and for vehicles originating from Turkey and Ukraine. In other cases, the customs rate is 5%. Beside the payment of the customs rate, vehicle owners are obliged to pay VAT of 18%.

In North Macedonia, limitations regarding the import of vehicles exist: from 1st July 2016 onwards, only vehicles which meet EURO 4 engine standard or higher are allowed to be imported.

The public transport sector is not regulated in North Macedonia in terms of renewable fuels. That means there are no incentives for the use of electricity or renewable fuels in public transport, nor any restrictions, limitations or obligations.

However, it should be noted that the municipalities and the City of Skopje may adopt special decisions in the days when the threshold of pollution in urban areas is exceeded, so limited movement of vehicles could be introduced in protected ecological zones. In accordance with the Law on amending the Law on Vehicles, vehicles of the first ecological category are marked with a green ecological label, and they will be able to move freely in the protected ecological zones.

12.5.1.5 Freight transport sector

The following annual fees apply to freight vehicles:

- fee for use of public roads, and
- fee for street use.

The Fee for use of public roads is defined by the Law on Public Roads, and its amount by the Decision on the amount and manner of payment of the fee for use of public roads for motor vehicles and trailers (road tax), which was amended in 2014 in respect of the fee amount. The fee for use of public roads is determined based on the weight of the freight vehicle. The amount of the fee varies from 1,330 denars (approx. 21.55€) for freight vehicles up to 1 t, while for freight vehicles from 14,1 t up to 15 t the fee amounts to 31,660 denars (approx. 513€), and higher for freight vehicles over 15 t.

The Fee for street use is defined by the Law on Communal Taxes and its amount is determined for each ton of vehicle carrying capacity to be from 70 denars (approx. 1.13€) up to 130 denars (approx. 2.11€).

It should be mentioned that the Law on Motor Vehicle Tax, which determines the motor vehicle tax, does not mention freight vehicles. However, this tax applies nonetheless to vans and pick-up vehicles.

In addition, the rules regarding limitations for import of freight vehicles are the same as for the passenger vehicles; so from 1st July 2016 onwards, only freight vehicles which meet EURO 4 engine standard or higher are allowed to be imported.

12.5.1.6 Railway sector

The Law on the Railway System defines certain authorizations related to the railway sector. The Law for safety of the railway system defines that rail vehicles, before being put into operation should be maintained by an entity in charge of maintaining rail vehicles which issues the certificate of technical conformity.

Before being put into service, the rail vehicle should obtain a certificate of commissioning by the Railway Safety Administration, in accordance with the Law on Interoperability in the Railway System.

Permission to perform public rail transport is a public document issued by a competent authority, which recognizes the legal entity's status of railway undertaking, which may be limited to providing special types of services.

The Safety certificate for public rail transport is a public document issued to a railway undertaking by the Railway Safety Administration.

The Permission for railway infrastructure management is a public document issued by a competent authority entrusting the management of railway infrastructure to the legal entity.

Safety approvals for railway infrastructure management are documents issued to the Infrastructure Manager by the Railway Safety Administration.

There are no incentives or obligations for use of electric locomotives, and there is no act which imposes the use of electricity from renewable energy for railway transport.

Table 52: Authorizations related to the railway sector in North Macedonia

Type	Subjects	Competent authority for issuance
Permission to perform public rail transport	Every public or private, domestic or foreign legal entity, if it is registered for such activity	Railway Sector Regulatory Agency
Safety certificate for public rail transport	Railway undertaking – every public or private, domestic or foreign legal entity	Railway Safety Administration
Permission for railway infrastructure management	Infrastructure manager	Railway Sector Regulatory Agency
Safety approvals for railway infrastructure management	Infrastructure manager	Railway Safety Administration

12.5.2 Roadmap to achieve the 2030 target

The roadmap developed here for North Macedonia to achieve the 2030 target of 9% renewable energies in transport builds on the provisions of RED II as described in section 3.1.1. It is assumed that these provisions are transposed into North Macedonian law without changes including the calculation method for renewables in transport, the caps and minimum values for various types of renewable energies, the multipliers, the provisions related to electricity and RFNBOs etc. Also, sustainability criteria need to be transposed into national law in order to fully comply with RED II, and it must be ensured that certification schemes are in place (national or voluntary) that are compliant with RED II requirements.

For this study, we apply the renewable share in the national electricity mix anticipated for 2030. On the one hand, this tends to overestimate the renewable share as values for the year 2028 that should be applied are not available, but should in general be lower than the 2030 values. On the other hand, dedicated renewable power plants may be erected that are counted as 100% renewable for transport.

For North Macedonia, a 62% renewable electricity mix is anticipated for 2030 based on literature values.[354] This is without prejudice to 2030 targets to be defined and included in the NECP.

It should be noted that the high renewables share in the national mix may open up opportunities for RFNBO production for export, notably to European Union Member States

[354] TU Wien/Energy Economics Group, Joanneum Research, REKK: Study on 2030 overall targets (energy efficiency, RES, GHG emissions reduction) for the Energy Community. Vienna 2019

applying the RED II provisions. Should North Macedonia, however, not achieve the 62% renewable electricity target, the contributions of fuel options based on electricity will be reduced accordingly.

12.5.2.1 Potential contributions from all options

Based on the assessment of all options for North Macedonia, a total RES-T share of 10.5% in 2030 can be achieved as a combination of all options (see Table 53). Further limited potentials exist in renewable liquid fuels in aviation and rail, which are assumed to be zero here.

Biofuels potentially contribute most in 2030. Renewable electricity in rail represents the only renewable energy consumption in transport today, and can be expanded through increasing the renewable share in the national electricity mix, and by expanding electrified rail transport.

Electric and hydrogen vehicles can already make small contributions by 2030, and have a strong growth potential thereafter.

Table 53: Potential RES-T contributions from all options in North Macedonia

Option		Contribution to RES-T target (%) incl. multiple counting	Amount of renewable fuel used (ktoe)
Biofuels and liquid RFNBOs	1. Crop-based biofuels in road transport	2.0%	15.6
	2. Liquid fuels produced from Annex IX B feedstocks in road transport	3.4%	13.3
	3. Liquid advanced Biofuels (based on Annex IX A feedstocks) in road transport	3.1%	11.9
	4. Liquid RFNBOs in road transport	0.58%	4.49
	5. Renewable methane in road transport	0.44%	1.7
	6. Renewable liquid fuels in shipping	0.0%	0.00
	7. Renewable liquid fuels in aviation	0.0%	0.00
	8. Renewable liquid fuels in rail	0.0%	0.00
Electricity	9. Rail electrification	0.608%	3.2
	10. Electric public transport (bus, trolleybus, tram, metro)	0.010%	0.03
	11. Electric road vehicles (passenger cars and trucks)	0.352%	0.69
Hydrogen	12. Hydrogen in rail	0.003%	0.02
	13. Hydrogen bus and coach (urban bus, long distance coaches)	0.004%	0.03
	14. Hydrogen road vehicles (passenger cars and trucks)	0.088%	0.69
	15. Hydrogen in refineries	0.0%	0.00
Total		10.5%	51.6

As the possible contributions of battery-electric vehicles depend on many factors, the following considerations are intended to provide some insight into the dynamics and opportunities (see Figure 161). The graph is based on a number of approximate assumptions, and should thus be understood as rough indication showing the general trends.

Battery-electric cars' contribution to the RES-T target is calculated by applying the renewable share in the national electricity mix to the use of electricity in BEVSs[355].

Electricity provided through public charging stations is covered in statistics as energy consumed in transport, and thus counted accordingly; charging through private charging units is not covered in statistics. Therefore, RED II foresees a multiplier of four for electricity consumed in road transport (based on data from statistics).

The RES-T contribution of battery cars depends on:

- The number of battery cars (horizontal axis in Figure 161);
- The share of public charging (green/ blue line in Figure 161 assuming 25% and 100% public charging, respectively);
- The renewable share in the national electricity mix in 2028 (62% for North Macedonia); lower RES shares would reduce the contribution accordingly.

Assuming 25% public charging, 200 thousand battery cars would approximately contribute 3.1% RES-T by 2030 (see Figure 161).

As battery cars are more energy efficient than conventional cars and the electricity is only partly covered in statistics energy consumption in transport decreases with increasing battery cars (dotted lines in Figure 161).

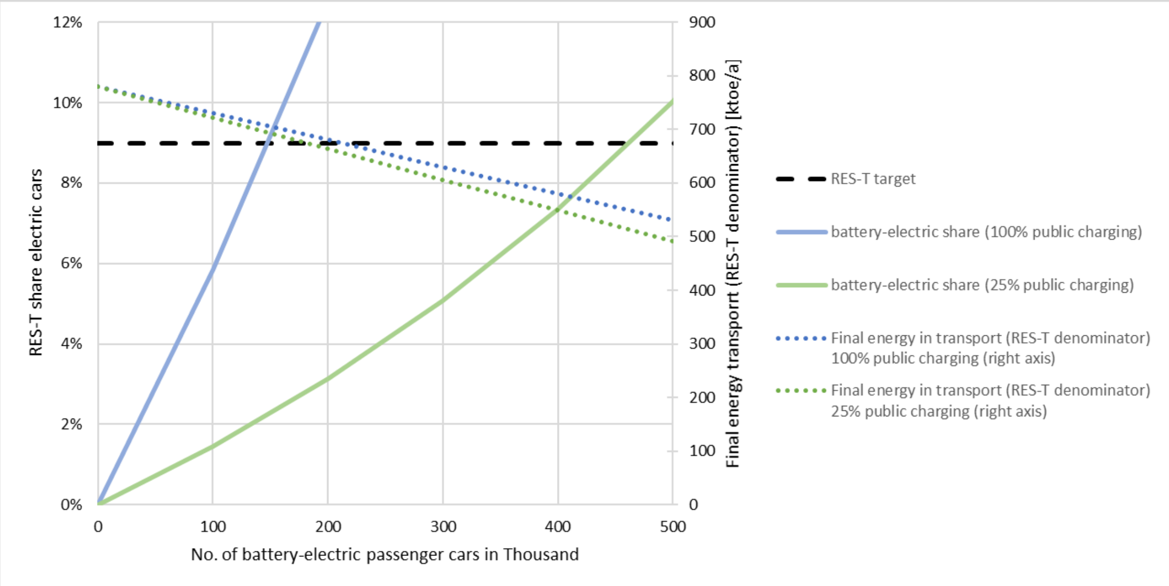

Figure 161: Possible contributions of battery cars to North Macedonia's 2030 RES-T target

355 However, if certain criteria are met (see RED II), renewable electricity can be counted as 100% renewable. This is not assumed in this study for option 11.

12.5.2.2 Choice of options to meet RES-T target

The potential contribution of all options exceeds the target, and thus allows reducing the contributions from some options. The reductions are based on the general considerations described in section 5.1, and on the specific circumstances in North Macedonia as described in the following:

1. Crop-based biofuels are used up to the 2% cap, amounting to 16ktoe. For comparison, assuming that all of North Macedonia's biofuel plants were to use crop-based feedstocks, these plants could produce 40ktoe of biofuel;
2. Biofuels based on Annex IXB biofuels can be reduced to 2.4%, or 9.5ktoe. This is equal to 24% of North Macedonia's existing plant capacity, if Annex IXB feedstocks were used. 50% of this supply could be met from domestic collectable UCO and tallow resources;
3. Liquid biofuels and biomethane based on Annex IXA feedstocks ("advanced biofuels") are developed to meet the minimum targets defined in RED II. For context, this about one third of the output of an advanced ethanol plant at typical scale of 63 million l fuel/year;
4. Relatively expensive RFNBOs are not required in road transport to meet the 2030 target;
5. A small quantity of biomethane is assumed based on North Macedonia's projections, up to a level equivalent to the current amount of biomethane used in electricity production, to contribute to the advanced biofuels target (see No. 3 above);
6. There is no significant energy consumption for domestic navigation;
7. No renewable fuels in aviation are required to meet North Macedonia's RED II target;
8. No renewable fuels in rail are required to meet North Macedonia's RED II target; expansion of electricity consumption in rail is seen as more promising (see next point)
9. Increasing the national renewable share in electricity, maintaining and installing catenaries at non-electrified rail lines or closing non-electrified rail gaps as well as keeping the share of rail electricity in overall transport energy consumption by extending rail transport accordingly are assumed;
10. The introduction of battery buses and the expansion or establishment of trolley bus systems or trams in cities is assumed here;
11. The market uptake of battery-electric road vehicles (cars and light/ medium duty trucks) leads to electricity consumption in transport;
12. Existing and new rail lines not suitable for electrification allow establishing zero emission hydrogen fuel cell trains;

13. Introduce hydrogen fuel cell buses in urban areas, and (long-distance) coaches in applications not suitable for battery-electric vehicles (high daily driving range, long-distance);
14. Start of market uptake of hydrogen fuel cell-electric road vehicles (cars and light to heavy duty trucks) for long-distance, high driving ranges;
15. There is no refining sector in North Macedonia, as the OKTA refinery is currently not operational.

This results in the following contributions by 2030 assumed to be realistic and reducing the most challenging or expensive[356] options to meet the defined 2030 RES-T target:

Table 54: Contribution to North Macedonia's RES-T target from options chosen

	Option	Multiplier	2030 Contribution to RES-T target incl. Multipliers	2030 Amount of renewable fuel used (ktoe)
Biofuels and liquid RFNBOs	1. Crop-based biofuels in road transport	1	2.0%	16
	2. Liquid fuels produced from Annex IX B feedstocks in road transport	2	2.4%	9.5
	3. Advanced liquid biofuels (based on Annex IX A feedstocks) in road transport	2	3.1%	12
	4. Liquid RFNBOs in road transport	1	0%	0%
	5. Renewable methane in road transport	2	0.4%	1.7
	6. Renewable liquid fuels in shipping	2	0%	0%
	7. Renewable liquid fuels in aviation	2	0%	0%
	8. Renewable liquid fuels in rail	2	0%	0%
Electricity	9. Rail electrification	1.5	0.61%	3.2
	10. Electric public transport (bus, trolleybus, tram, metro)	4 (road) 1 (tram, metro)	0.01%	0.03
	11. Electric road vehicles (passenger cars and trucks)	4	0.35%	0.7
Hydrogen	12. Hydrogen in rail	1	0.003%	0.02
	13. Hydrogen bus and coach (urban bus, long distance coaches)	1	0.004%	0.03
	14. Hydrogen road vehicles (passenger cars and trucks)	1	0.088%	0.7
	15. Hydrogen in refineries	1	0%	0
Total			9.0%	43

Strong contributions are made by all three types of biofuels; moderate contributions are made by electricity in rail and electric road vehicles as well as by renewable methane; limited contributions are made by electric public transport and by hydrogen in buses and coaches, road vehicles and rail.

The contribution from electricity in rail and all other forms of transport assumes a 62% share of renewable electricity in power by 2030. If this was lower, all options using electricity directly or hydrogen would make a smaller contribution to the 2030 target. A higher renewable share in the national electricity mix or dedicated renewable capacities would increase the renewable contribution of rail and all other forms of transport, which are based on electricity or hydrogen.

356 Detailed cost assessments have not been carried out in this study. Rough cost judgements are made here based on costs information provided in chapter 3.

The high proportion of Annex IXA (advanced) biofuels is driven by the sub-target in RED II and relies on successful scale-up in production of liquid Annex IXA biofuels globally. Should this prove not to be feasible, crop-based biofuels or biofuels based on Annex IXB could be increased, which would, however, not allow the sub-target for advanced biofuels in RED II to be met.

These contributions lead to a breakdown of fuel consumption in 2030 as shown in section 12.3.2.

12.5.2.3 Roadmap for North Macedonia

The roadmap for North Macedonia to achieve the 2030 target for renewable energies in transport (see Figure 162) involves key policies to be developed and adopted in the coming few years, building on the existing regulatory framework and policy elements already under development (see section 12.5.1). The regulatory framework for renewable energies in transport needs to be expanded substantially, and should include the three pillars for renewables in transport: biofuels, direct electricity use and hydrogen.

The roadmap foresees that the last elements of the regulatory framework should be in place by the end of 2022.

The appropriateness, effectiveness and efficiency of this policy framework should be evaluated in around 2025, and should be adjusted where necessary to ensure target compliance by 2030. The European Union is currently developing the details of the European Green Deal, which aims to make the European Union climate neutral by 2050 by turning climate and environmental challenges into opportunities, and making the transition just and inclusive for all. Based on a set of policy initiatives by the European Commission, climate ambitions by 2030 are anticipated to be increased, which includes adjustments to RED II. A revision of the policy framework in North Macedonia around the middle of the decade would be timely for taking up decisions to be taken at European Union level by then.

Around 2028 would be a suitable point in time to set targets for the 2040 timeframe, and to revise and adjust the strategies and policies accordingly.

Currently, North Macedonia is developing its first National Energy and Climate Plan (NECP), which has a planning and a monitoring function. North Macedonia, as the first Contracting Party to do so, has submitted its official draft to the Energy Community Secretariat for review. The biannual progress reports and the regular revisions of the National Energy and Climate Plans are the appropriate instrument for monitoring successful implementation and development towards the 2030 target, and will be helpful for the 2025 revision of the policy framework.

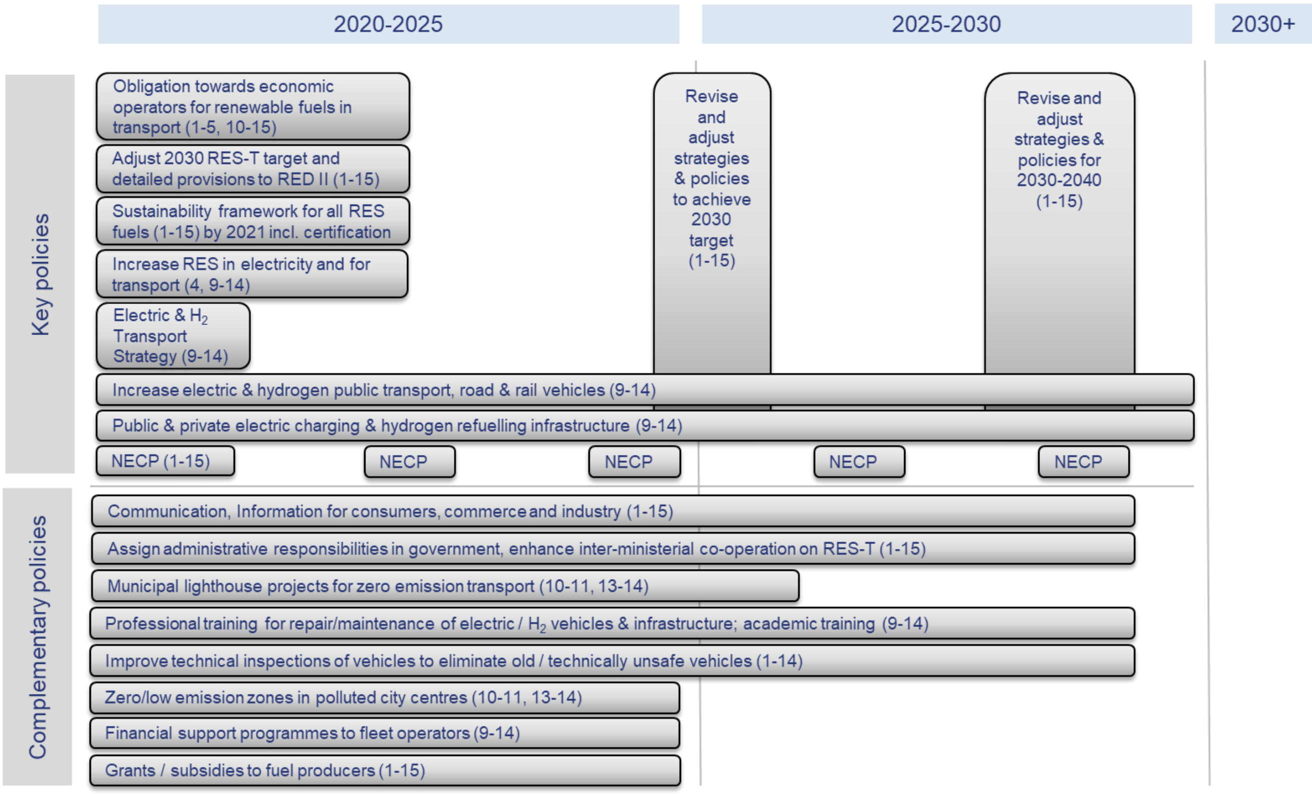

Figure 162: Overview roadmap for North Macedonia

The priority in the roadmap for biofuels is to establish policy to drive uptake of these fuels through an obligation on fuel suppliers to supply a minimum proportion of these fuels, which does not currently exist in North Macedonia. Development and introduction of this policy mechanism should be started as soon as possible, to allow industry as much time as possible to adjust and prepare to meet 2030 targets. This obligation needs to be supported through a number of other policy elements such as rules for certification and compliance of biofuels, sustainability criteria for biofuels, and rules for calculating the impact of biofuels on the greenhouse gas emissions. These should be developed based on the provisions of RED II. Additional attention may need to be given to criteria on production of liquid RFNBOs, alongside the rules on hydrogen (below). A unit within the relevant government ministry must be designated responsible for implementing, reviewing and updating the policy as a whole, ensuring sustainability certification of fuels, administering the scheme, data collection and reporting.

Several other measures that are complementary to this demand-side policy have also been important in other countries, namely support for domestic fuel production, such as capital grants for plants, and information provision for consumers on fuel switching and vehicle compatibility.

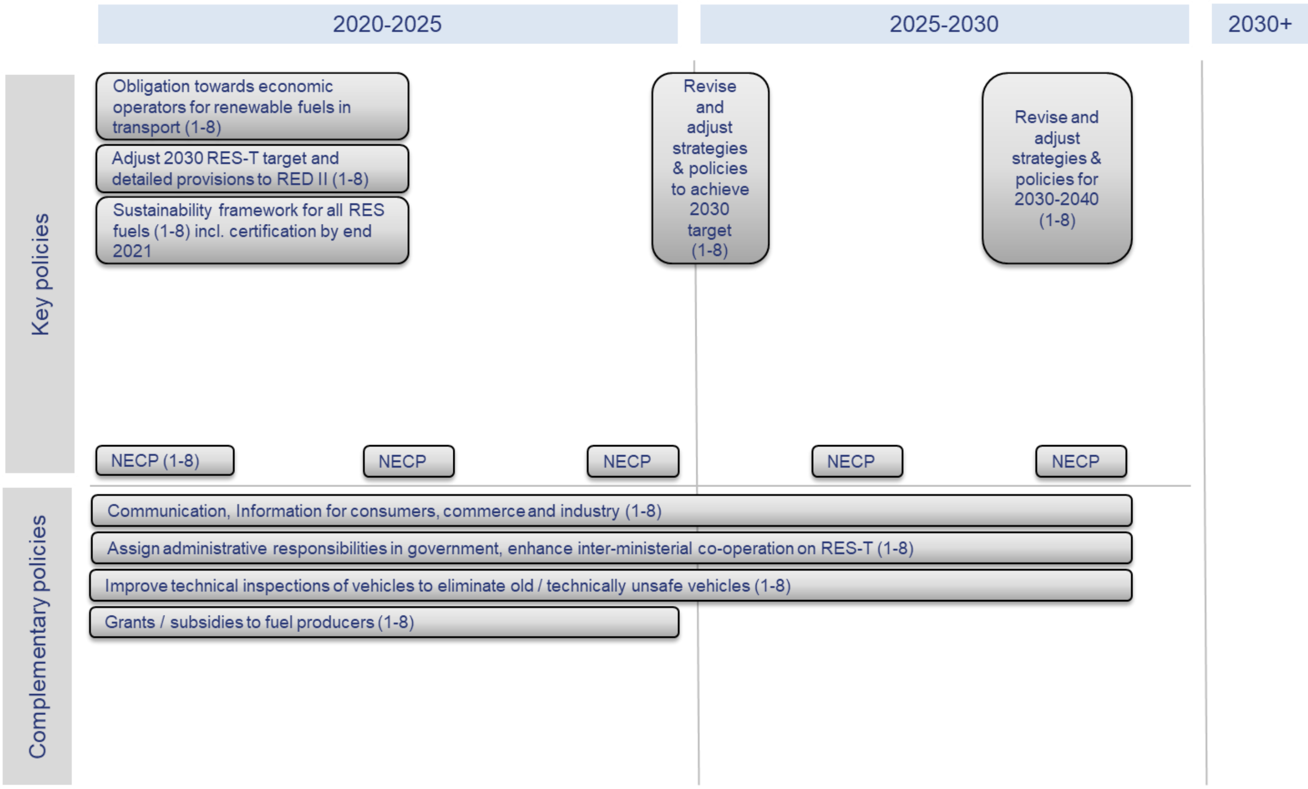

Figure 163: Roadmap for North Macedonia – Biofuels and liquid RFNBOs

Direct electricity use in transport is already established in North Macedonia in the rail sector, but only represents a small share of transport energy consumption. Policies supporting renewables in transport should include maintaining and further strengthening electricity use in this sector.

Battery-electric road transport including passenger cars, public transport and delivery vehicles is in an early stage of development in North Macedonia, and has a significant growth potential. Developing a national electric transport strategy would be an appropriate starting point for a coherent and effective policy framework in this area. Various policies for fostering electric transport could be envisioned, such as including renewable electricity in the obligation on fuel suppliers for increasing the share of renewable energies in transportation fuels (see above), or putting an obligation on electricity suppliers for providing renewable electricity to transport, etc.

An additionality framework for renewable electricity would define rules for counting electricity as renewable based on RED II[357], and detailed provisions are currently under development by the European Commission. This aims at fostering additional renewable power capacities for transport not compromising the achievement of renewables electricity targets in conventional electricity consumption.

[357] See RED II Art. 27(3)

In parallel, existing policies for increasing renewable electricity production should be adjusted by increasing renewable targets for 2030 that would include additional renewable electricity demand from transport. Fostering dedicated renewable capacities for transport could be a new element introduced into existing legislation, covering rail, public transport and road.

Increasing the number of electric vehicles in road, rail and public transport is a major lever for increasing the consumption of electricity in transport, and reducing conventional fuel consumption. Elements for such policies include providing direct financial support for purchasing electric vehicles, and adjusting the tax and import duty structures to incentivize purchases of electric vehicles. The vehicle charging infrastructure is the second major lever. Policies to coordinate and incentivize the build-up of a public network of charging stations include elements of financial incentives through grants, subsidies and loans, clear permitting rules, and coordination to ensure an appropriate nationwide network structure. In addition, financial support to charging infrastructures for public transport and fleet operators is an effective and efficient instrument for rapid growth.

The appropriate administrative structures must be established including enhanced inter-ministerial co-operation, and related responsibilities assigned in government. Further complementary policies supporting electric transport include communication and information campaigns, lighthouse projects at local/ municipal level, the establishment of zero or low emission zones in urban areas for reduced air pollution, professional and academic training, technical inspections of vehicles (both electric and conventional), etc.

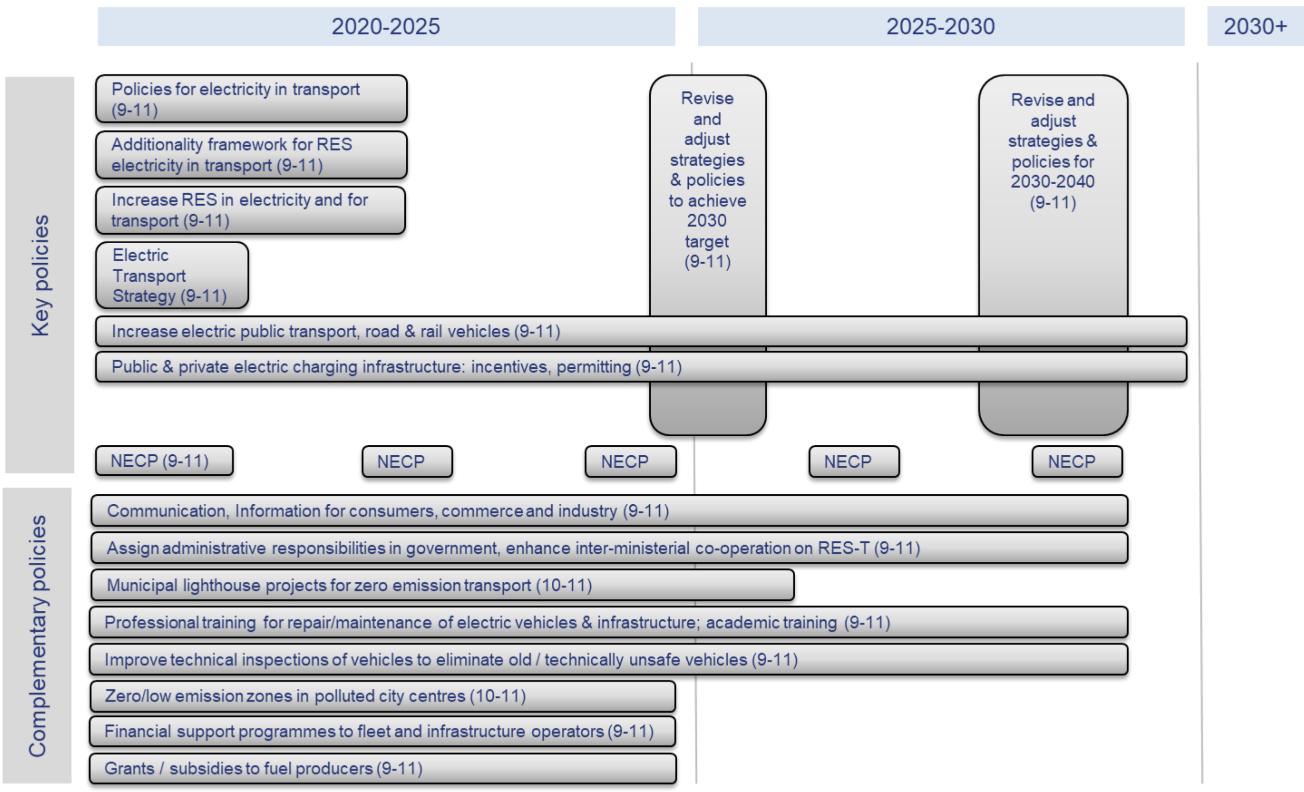

Figure 164: Roadmap for North Macedonia – Electricity in Transport

Hydrogen in transport using fuel cell-electric vehicles is in early phases of commercialization world-wide, and shows major potential for decarbonizing transport in a complementary fashion to battery-electric vehicles. On non-electrified rail lines, first commercial hydrogen trains are in operation, and fuel cell vehicles are coming onto the market. A focus will be on vehicles for longer distances and for duty purposes such as trucks and buses.

Hydrogen can be included in the obligation on fuel suppliers as an option, as provided for in RED II. Further key policy elements are rather similar to electricity in transport: developing a national strategy, defining an additionality framework, increasing renewable electricity capacities for hydrogen production, supporting the market uptake of vehicles, and supporting the establishment of hydrogen refuelling stations.

Also, the complementary policies are similar to electricity.

The related policies should be established together with those for biofuels and electricity, while the market may take up a few years later based on an earlier status in commercialization.

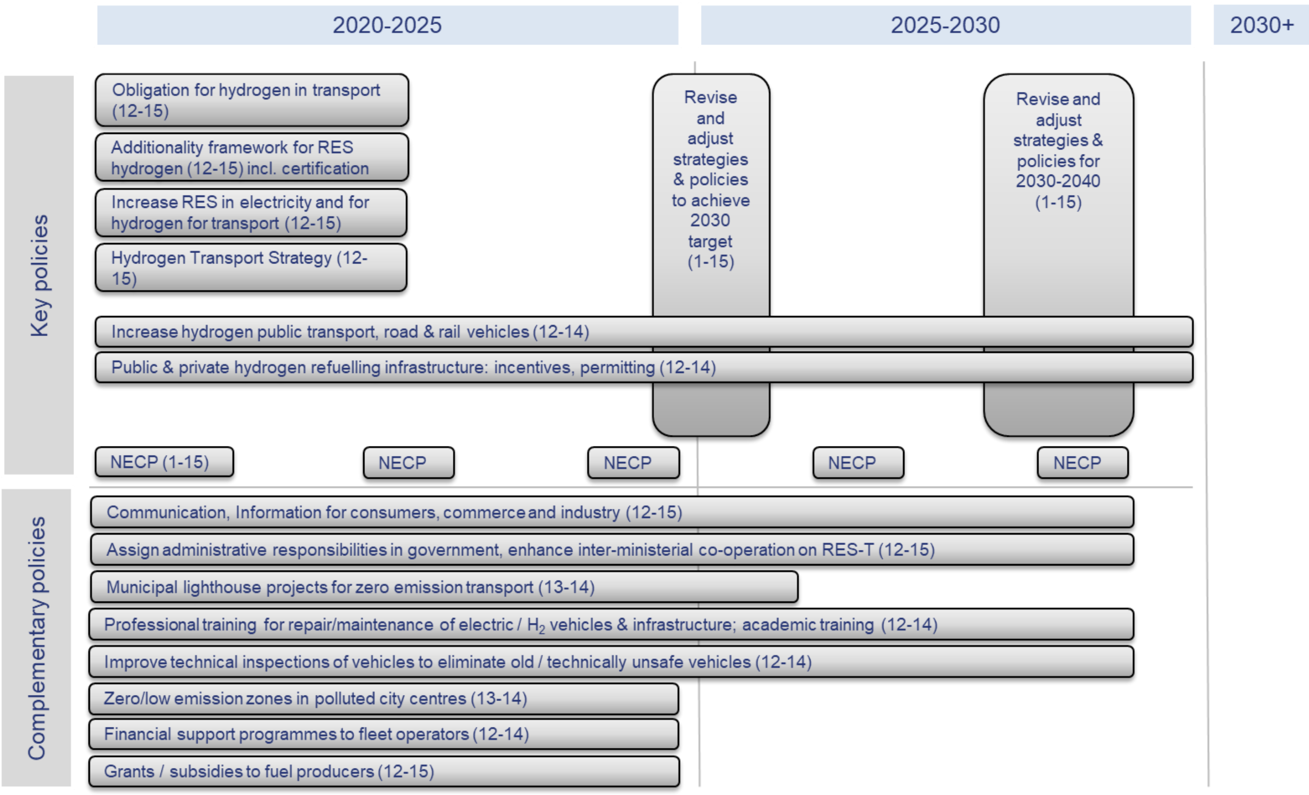

Figure 165: **Roadmap for North Macedonia – Hydrogen in Transport**

12.6 Conclusions and recommendations

12.6.1 Conclusions

North Macedonia can choose from a number of options to achieve the 2030 RES-T target of 9%. In fact, significant over-achievement of 10.5% is possible. It should be noted that even with more than 10% renewable energies in transport in 2030, the anticipated consumption growth over the coming decade is expected to result in increased fossil fuel imports relative to 2018. Therefore, even higher ambitions could be beneficial in economic and environmental terms for North Macedonia.

Of the 9% overall renewables target in transport, crop-based biofuels are capped at 2%, while 7% need to be achieved by other renewable fuels.

Biofuels are anticipated to contribute most to the target.

Expansion of electrified rail and increased renewables in the national electricity mix allow for a notable contribution of renewable electricity in rail.

Electric road vehicles have notable potential, which is anticipated to be used towards 2030 with a dynamic growth potential beyond 2030 to allow for a major RES-T share by 2050.

Hydrogen and battery-electric vehicles are complementary as hydrogen fuel cell vehicles enable longer driving distances, and are suitable for cars and heavy-duty transport alike; dynamic growth beyond 2030 is anticipated.

Additional benefits of achieving the 2030 RES-T target include the reduction of fossil energy import dependence and related financial flows out of the territory, additional national value creation, new or enhanced national value chains with related economic benefits and possible job creation as well as additional contributions to the national climate targets, etc.

12.6.2 Recommendations

As a proven policy tool, North Macedonia should adopt a 2030 target for renewable energies in transport based on RED II.

North Macedonia should develop and adopt a legal framework that includes all major elements required for establishing renewable energies in transport. It is recommended to base such legislation on RED II in order to have a legislative framework based on the latest relevant policies as well as technological and commercial developments. The existing Programme for subsidization of part of the costs for purchase and installation of devices for operation on LPG, CNG or other alternative fuels for vehicles should be continued and focused on vehicles that operate on renewable fuels, notably biomethane, electricity or hydrogen.

A major success factor for achieving a 2030 target for renewable energy in transport is to establish legal obligations towards economic operators including their enforcement. Certification ensuring the compliance of economic operators with the sustainability requirements is another.

All elements of the regulatory framework should be in place by the end of 2022.

Further key policy elements need to be established in order achieve the 2030 RES-T target:

- strategy and support mechanisms for electricity in transport
- strategy and support mechanisms for hydrogen in transport.

Complementary policies are recommended to be established in order to ensure target achievement and maximum benefits to the North Macedonian economy.

Co-benefits with other policy areas should be actively developed. This includes air quality improvements in urban areas and other environmental and health issues as well as economic benefits such as reduced fossil fuel imports, job creation, national value creation, etc.

Furthermore, co-operation with other Contracting Parties, and more generally with other countries, allows synergies and should thus be pursued.

Policies should be revised and possibly adjusted in around 2025 based on a policy and results evaluation.

The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target.

13 SERBIA

13.1 Executive Summary

The implementation of the revised Renewable Energy Directive (EU) 2018/2001 (RED II) on the promotion of the use of energy from renewable sources has started to be discussed within the Energy Community. Currently, RED II is not a part of the Energy Community acquis; but the adaptation and transposition by the Contracting Parties could be envisaged. Assuming for this study that the provisions of RED II are transposed into Serbian law without changes, we develop a roadmap for Serbia to achieve the 2030 target for renewables in transport of 9%[358].

Serbia has a share of renewable energy in transport of around 1% through electricity consumption in rail. Biofuels consumption in Serbia is very low so far, but legislation has been adopted lately that is set to establish the instruments to increase biofuel consumption to a level compatible with 2030 targets assumed here.

Serbia can choose from a number of options to achieve the 2030 RES-T target of 9%. In fact, over-achievement beyond 11% is possible. The anticipated constant energy consumption in transport until 2030 would lead to a reduction of fossil fuel imports, and so higher ambitions than the 9% target could provide additional benefits in economic and environmental terms. Alternatively, options for renewable fuels production beyond the 2030 target may open opportunities for exports.

Of the 9%, crop-based biofuels are capped at 2%, while 7% need to be achieved by other renewable fuels. While biofuels are anticipated to contribute most to the target, electricity use in rail can also make significant contributions if the renewable electricity share reaches the 2030 value of 68% as assumed for this study.

Electric road vehicles supported by the existing and additional future support measures and measures related to charging infrastructure bear notable potential, which is anticipated to grow dynamically after 2030 to allow for major RES-T shares by 2050.

Hydrogen and battery-electric vehicles are complementary with hydrogen enabling long driving distances, and being suitable for cars and heavy-duty transport alike; dynamic growth beyond 2030 is anticipated.

Additional benefits of achieving the 2030 RES-T target include the reduction of the fossil energy import dependence, additional national value creation, new or enhanced national

[358] The overall target for RES-T of 14% can be reduced as far as the cap on crop-based biofuels is lower than 7%. As the cap on crop-based biofuels for Serbia is 2% based on the 2020 biofuels consumption, the overall target is reduced to 9%.

value chains with related economic benefits and possible job creation as well as additional contributions to the national climate targets, etc.[359] .

As a proven policy tool, Serbia should adopt a 2030 target for renewable energies in transport based on RED II.

The use of renewable energies in transport should be continued and further enhanced. The recently adopted Regulations on the share of biofuels and on biofuel sustainability coming into force at the beginning of 2021 have the potential to foster the market introduction of relevant amounts of biofuels on the market making related contributions to a 2030 target for renewable energies in transport. Monitoring and enforcing the implementation of the provisions of these regulations including independent certification will be key to their success. These regulations should be adjusted to take up provisions of RED II not included yet such as caps and minimum contributions by different biofuels (crop-based, advanced, Annex IXB type), or indirect land-use change provisions.

Without prejudice to any possible legal, political or contractual obligations, all elements of the regulatory framework should be in place at the latest by the end of 2022 in order to give industry as much time as possible to plan, invest, implement and operate.

Electric road mobility should be developed to become the second pillar of renewable energies in transport in Serbia. First established measures to foster renewable electricity in road transport should be a starting element in a national electric transport strategy to be developed covering market uptake of battery vehicles and the development of a nationwide public charging network including fast-chargers. Electricity use in public transport should be enhanced by policies for the extension of trolleybuses, tramways and metro, and should be extended to battery-electric buses.

Hydrogen fuel-cell electric transport should be developed to become the third pillar of renewable energies in transport in Serbia. This should be defined in a national hydrogen strategy including policies fostering the market uptake of hydrogen vehicles in road, rail and public transport and aiming at the establishment of a national hydrogen refuelling infrastructure. Hydrogen for transport should be integrated into the transposition of RED II as an option for fuel suppliers for fulfilling their renewable obligation. The option provided by RED II of renewable hydrogen consumption in refineries for conventional fuel production should be assessed for implementation in the short-term.

In parallel, existing policies for increasing renewable electricity production should be adjusted by increasing renewable targets for 2030 that would include additional renewable

[359] Such benefits are not analysed in this study, but have been assessed in various studies, e.g. for hydrogen in
Fuel Cells and Hydrogen Joint Undertaking (2019): Hydrogen Roadmap Europe – a sustainable pathway for the European energy transition; and in
Fuel Cells and Hydrogen Joint Undertaking (2020): Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans.

electricity demand from transport (for direct use or for hydrogen production) benefitting both the electricity sector and transport covering rail, public transport and road.

Complementary policies for battery-electric and hydrogen fuel cell-electric transport are recommended to be established in order to ensure target achievement and maximum benefits to the Serbian economy, including communication and information campaigns, lighthouse projects at local/ municipal level, the establishment of zero or low emission zones in urban areas for reduced air pollution, professional and academic training, etc.

Research and innovation based on government funding for basic and applied research and development in the field of electric transport and hydrogen energy should be fostered.

Co-benefits with other policy areas should be actively developed. This includes air quality improvements in urban areas and other environmental and health issues as well as economic benefits such as reduced fossil fuel imports, job creation, national value creation, etc.

Furthermore, co-operation with other Contracting Parties, and more generally with other countries, allows synergies and should thus be pursued.

Policies should be revised and possibly adjusted in around 2025 based on a policy and results evaluation.

The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target.

13.2 Introduction

The Energy Community Contracting Parties including Serbia have the obligation to reach binding targets for renewable energy in gross final energy consumption by 2020. For the transport sector, the binding target is a minimum 10% of renewable energy (RES-T) by 2020. Serbia will not achieve this target.

The implementation of the revised Renewable Energy Directive (EU) 2018/2001 (RED II) on the promotion of the use of energy from renewable sources has started to be discussed within the Energy Community. Currently, RED II is not a part of the Energy Community acquis; but the adaptation and transposition by the Contracting Parties could be envisaged.

It is assumed here that the provisions of RED II are transposed into Serbian law without changes. On this basis, we develop a roadmap for Serbia to achieve the 2030 target for renewables in transport of 9%.

As a starting point, this study analyses the status quo of energy consumption in transport in Serbia, and provides 2030 projections including a business as usual scenario, and a scenario for compliance with the 2030 target for renewable energies in transport according to RED II.

In the second section, we assess the potential of national renewable energy sources suitable for use in transport, or for the production of transportation fuels together with the status of fuel pathway deployment in Serbia.

The third section describes the regulatory status quo related to renewable energies in transport. On this basis, we develop a roadmap for Serbia to achieve the 2030 target for renewables in transport on the three pillars of biofuels, electricity and hydrogen covering all transport sectors.

The final section provides conclusions and recommendations.

13.3 Status quo and 2030 projections of renewable energy consumption in transport

The objective of this chapter is to review the current status of renewable energies in transport (RES-T) in Serbia, and to develop scenarios of the development of renewable energy shares in transport by 2030.

The following data includes neither international aviation nor international navigation.

13.3.1 Status Quo

The following data includes neither international aviation nor international navigation as these two segments are generally excluded from statistics such as the Eurostat energy balances.

13.3.1.1 Transport Indicators

Passenger transport in Serbia is dominated by cars representing roughly three quarters, followed by bus representing one quarter.

After a drop in 2011, the use of cars has been slowly increasing continuously. Data for domestic navigation in the passenger sector is not available. The use of buses and coaches as well as the use of railways has remained roughly constant in the past years. There is also a small and constant share of transport by tram, trolleybuses and commuter rail (Beovoz).

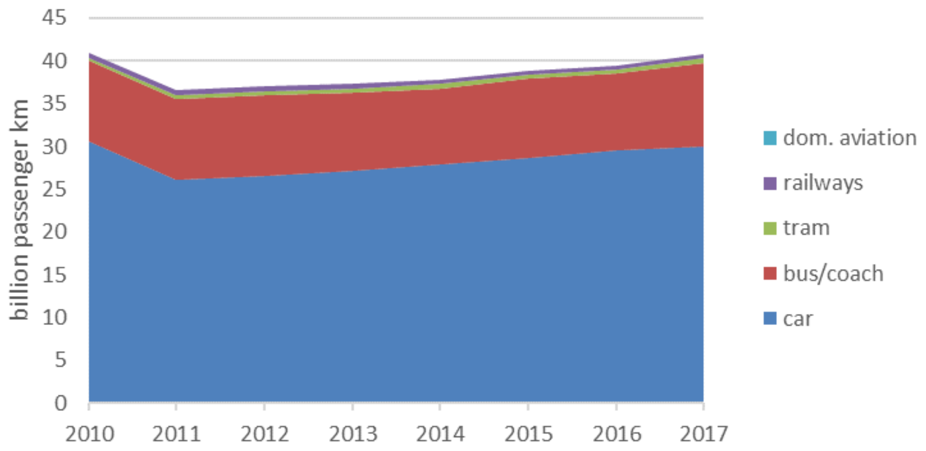

Figure 166: Passenger transport by transport mode[360] [361] [362] [363] [364]

Passenger kilometres by car are counted as private while all other modes of transport (bus/coach including trolleybus, tram/metro, railways, domestic aviation) are counted as public transport. Public transport has remained roughly constant, while private transport has been slowly increasing since 2011.

---

[360] European Commission (EC), Directorate-General for Mobility and Transport: EU Transport in Figures - Statistical Pocketbook. Luxembourg 2019: https://ec.europa.eu/transport/facts-fundings/statistics/pocketbook-2019_en

[361] Statistical Office of the Republic of Serbia (SORS): Total transport of passengers and goods, 2017 and 2018. In Statistics of Transport and Communications, 28 JUN 2019: https://publikacije.stat.gov.rs/G2019/PdfE/G20191169.pdf

[362] Statistical Office of the Republic of Serbia (SORS): Statistical Yearbook of the Republic of Serbia. Belgrade 2019: https://publikacije.stat.gov.rs/G2019/PdfE/G20192052.pdf

[363] Statistical Office of the Republic of Serbia (SORS): Statistical Yearbook of the Republic of Serbia. Belgrade 2011 https://publikacije.stat.gov.rs/G2011/PdfE/G20112004.pdf

[364] Statistical Office of the Republic of Serbia (SORS): Statistical Yearbook of the Republic of Serbia. Belgrade 2014: https://publikacije.stat.gov.rs/G2014/PdfE/G20142013.pdf

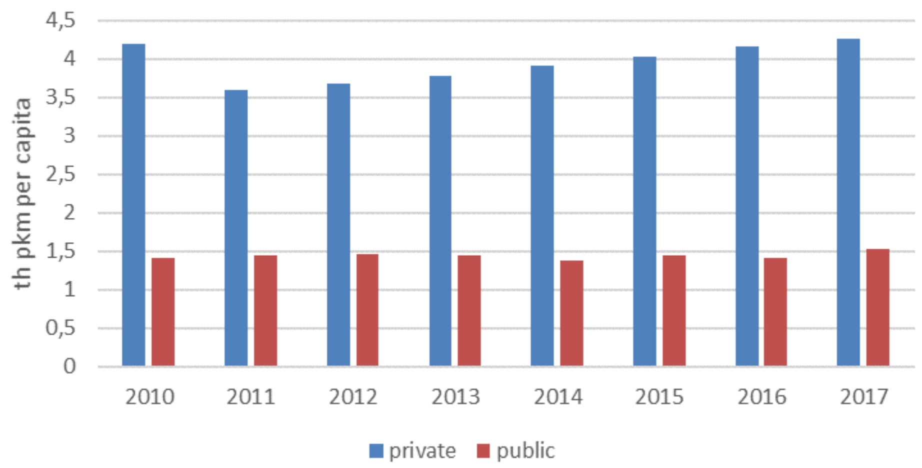

Figure 167: Comparison of public and private transport per capita

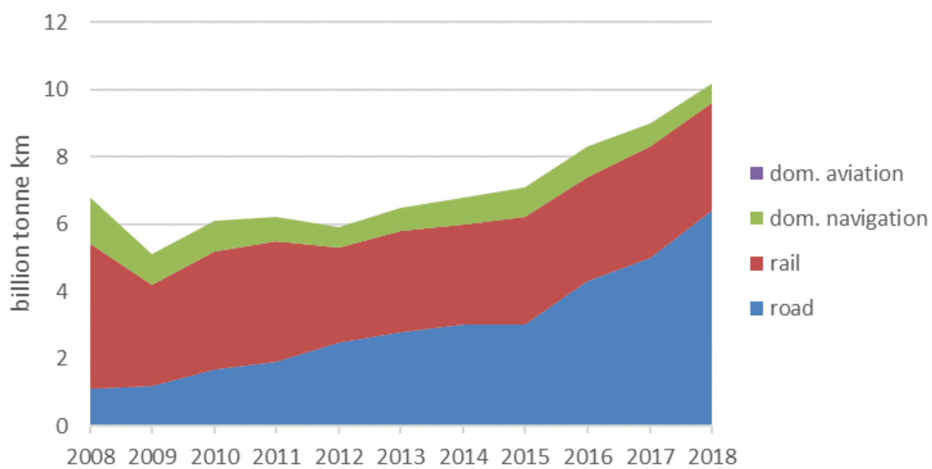

Figure 168: Freight transport by mode of transport[365] [366] [367] [368] [369]

[365] European Commission (EC), Directorate-General for Mobility and Transport: EU Transport in Figures - Statistical Pocketbook. Luxembourg 2019: https://ec.europa.eu/transport/facts-fundings/statistics/pocketbook-2019_en

[366] Statistical Office of the Republic of Serbia (SORS): Total transport of passengers and goods, 2017 and 2018. In Statistics of Transport and Communications, 28 JUN 2019: https://publikacije.stat.gov.rs/G2019/PdfE/G20191169.pdf

[367] Statistical Office of the Republic of Serbia (SORS): Statistical Yearbook of the Republic of Serbia. Belgrade 2019: https://publikacije.stat.gov.rs/G2019/PdfE/G20192052.pdf

[368] Statistical Office of the Republic of Serbia (SORS): Statistical Yearbook of the Republic of Serbia. Belgrade 2011 https://publikacije.stat.gov.rs/G2011/PdfE/G20112004.pdf

[369] Statistical Office of the Republic of Serbia (SORS): Statistical Yearbook of the Republic of Serbia. Belgrade 2014: https://publikacije.stat.gov.rs/G2014/PdfE/G20142013.pdf

Freight transport has doubled since 2009. The sole driver of this growth was a rapid increase in transport by road to almost five times the transport volume of 2009. The growth has been especially fast in recent years since 2015. Transport by rail has remained roughly constant since 2013 after a decrease between 2008 and 2012. The share of domestic navigation in freight sector fluctuated around a roughly constant value over the past years.

13.3.1.2 Registered Road Vehicles

The number of cars has increased slowly but continuously since 2010. After many years of being roughly constant, the number of commercial vehicles has increased by more than 50% in 2017. The number of buses and coaches as well as the number of trolleybuses have remained roughly constant since 2012.

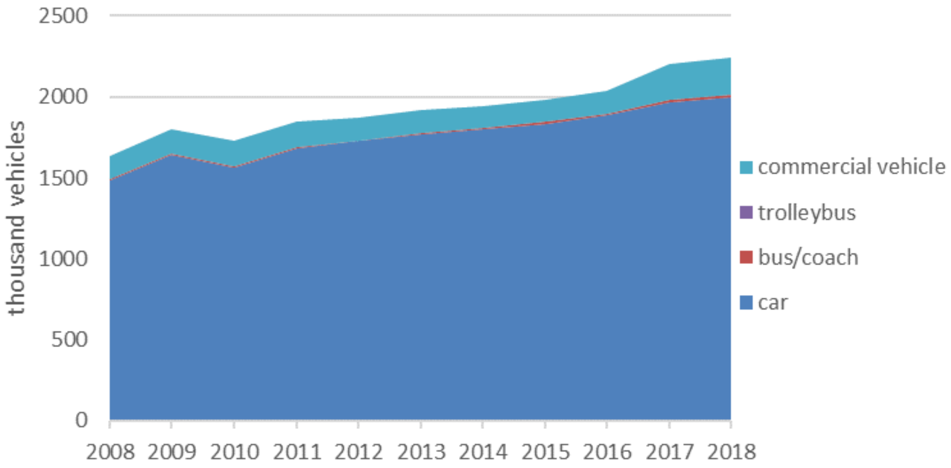

Figure 169: Registered road vehicles by type of vehicle[370 371 372 373]

[370] European Commission 2019 European Commission (EC), Directorate-General for Mobility and Transport: EU Transport in Figures - Statistical Pocketbook. Luxembourg, 11 OKT 2019: https://ec.europa.eu/transport/facts-fundings/statistics/pocketbook-2019_en

[371] Statistical Office of the Republic of Serbia (SORS): Statistical Pocketbook of the Republic of Serbia. Belgrade 2020: https://publikacije.stat.gov.rs/G2020/PdfE/G202017013.pdf

[372] Statistical Office of the Republic of Serbia (SORS): Statistical Pocketbook of the Republic of Serbia. Belgrade 2016: https://publikacije.stat.gov.rs/G2016/PdfE/G20162018.pdf

[373] Statistical Office of the Republic of Serbia (SORS): Statistical Pocketbook of the Republic of Serbia. Belgrade 2014 https://publikacije.stat.gov.rs/G2014/PdfE/G20142012.pdf

Figure 170: **Comparison of passenger and freight vehicles per capita**

The number of passenger vehicles per capita has continuously increased since 2010. After remaining constant for several years, the number of freight vehicles per capita increased significantly in 2017.

13.3.1.3 Energy Consumption in Transport

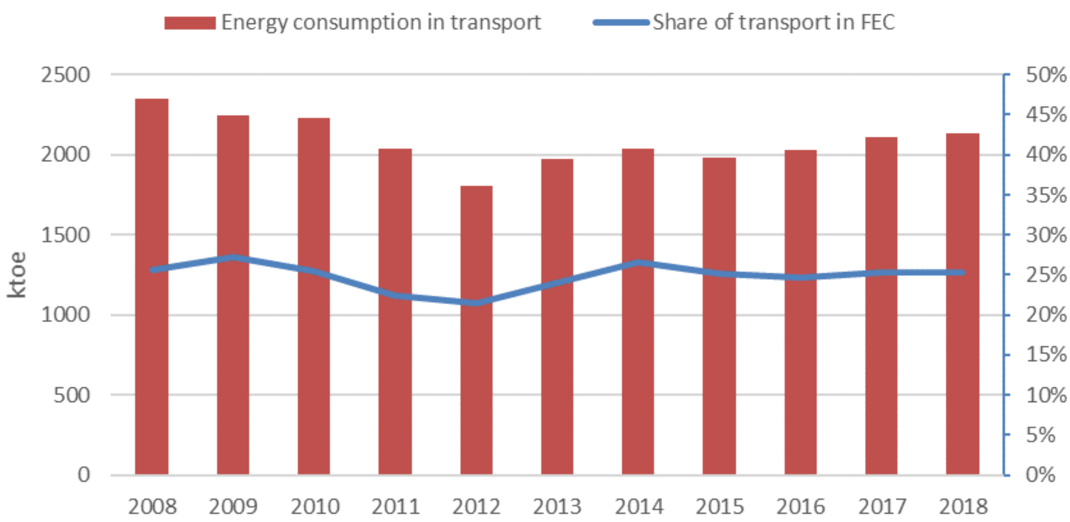

Figure 171: **Energy consumption in transport**[374]

After a decrease from 2008 to 2012 with an acceleration in 2011 and 2012, the energy consumption in transport has increased again, but remaining below the level of 2010 and before. The increase in energy consumption in transport of 18% between 2012 and 2018 is

[374] Eurostat - RS-Energy-Balances-January-2020-edition

lower than the increase in transport indicators: 10% increase of passenger-kilometres, 53% increase in tonne-kilometres. This indicates efficiency gains combined with increased freight vehicle sizes.

In recent years, the share of transport in final energy consumption has been rather constant at 25%.

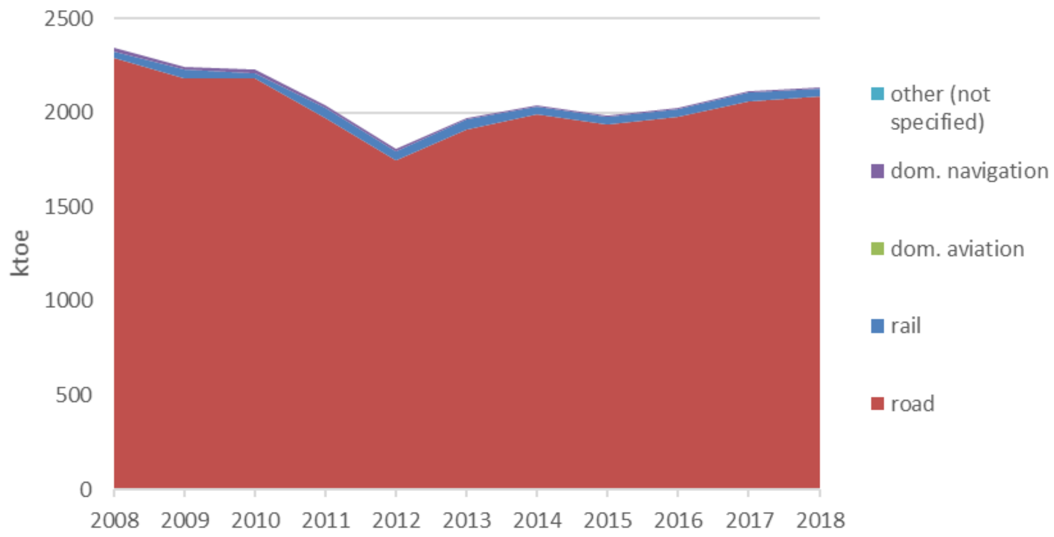

Figure 172: Energy consumption in transport by sub-sector[375]

The vast majority of energy is used for road transport. The small amount of energy used in rail transport has been slowly increasing again in recent years. There is also an even smaller amount used for domestic navigation, which has a decreasing tendency.

Almost all energy for transport is provided by oil and petroleum products. There is only a small amount of electricity used by trains. In recent years, there has been a very small, but increasing share of natural gas.

375 European Commission Energy Balances: Serbia-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

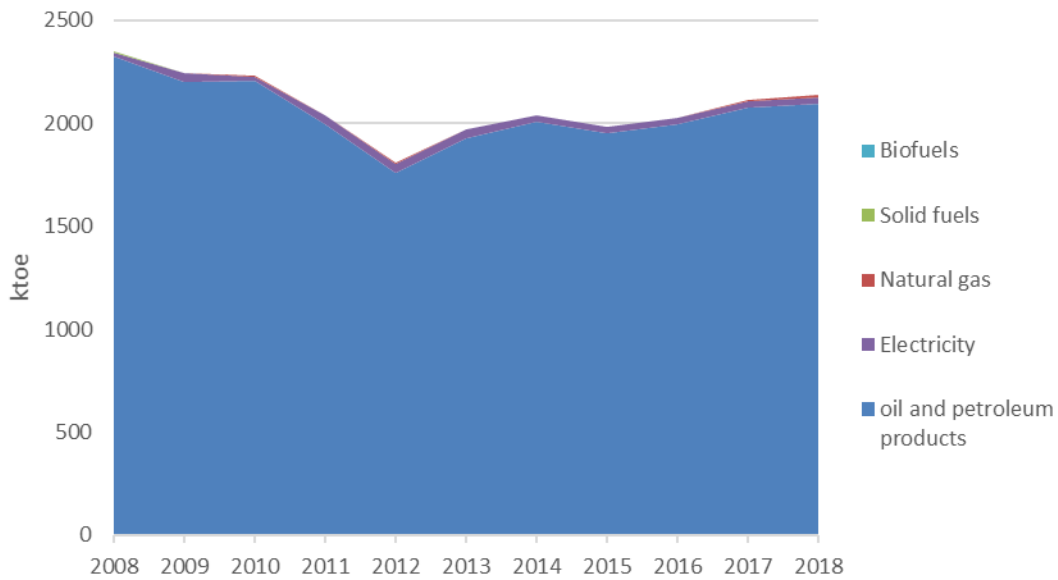

Figure 173: Energy consumption in transport by type of fuel[376]

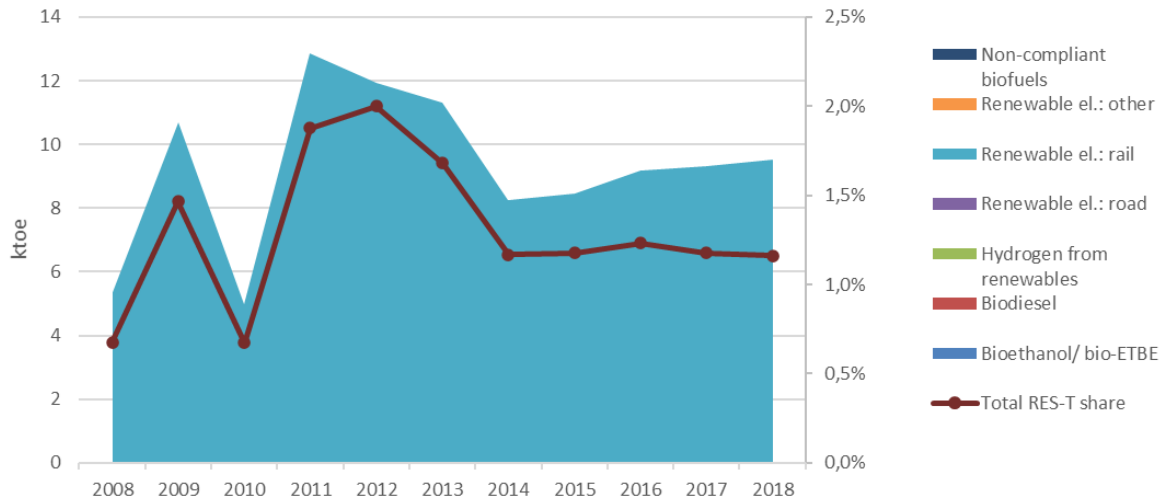

Figure 174: Renewable energy consumption in transport[377]

After strong fluctuations until 2011, the consumption of renewable energy in transport decreased until 2014 and has remained roughly constant since then. Renewable energy in

376 European Commission Energy Balances: Serbia-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

377 Eurostat (2019) *SHARES detailed results 2018.* Available at: https://ec.europa.eu/eurostat/web/energy/data/shares

transport is consumed only as electricity in rail transport. Biofuels are not consumed. The total RES-T share shows the same qualitative behaviour as total renewable consumption.

13.3.2 2030 Projections

The 2030 projections used here rely on the Energy Sector Development Strategy of the Republic of Serbia of 2016[378]. In that study, a forecast for energy consumption in transport is made, which is not broken down by transport sector or fuel. Here, we have scaled the transport consumption of 2015 from that study to the actual values as reported in the energy balances[379]. For the business as usual scenario (middle column in Figure 175) we have then assumed that the individual shares of the fuels in total consumption do not change between 2015 and 2030.

Overall, transport energy consumption in 2030 is at the same level as in 2018 at 2135 ktoe (see Figure 175).

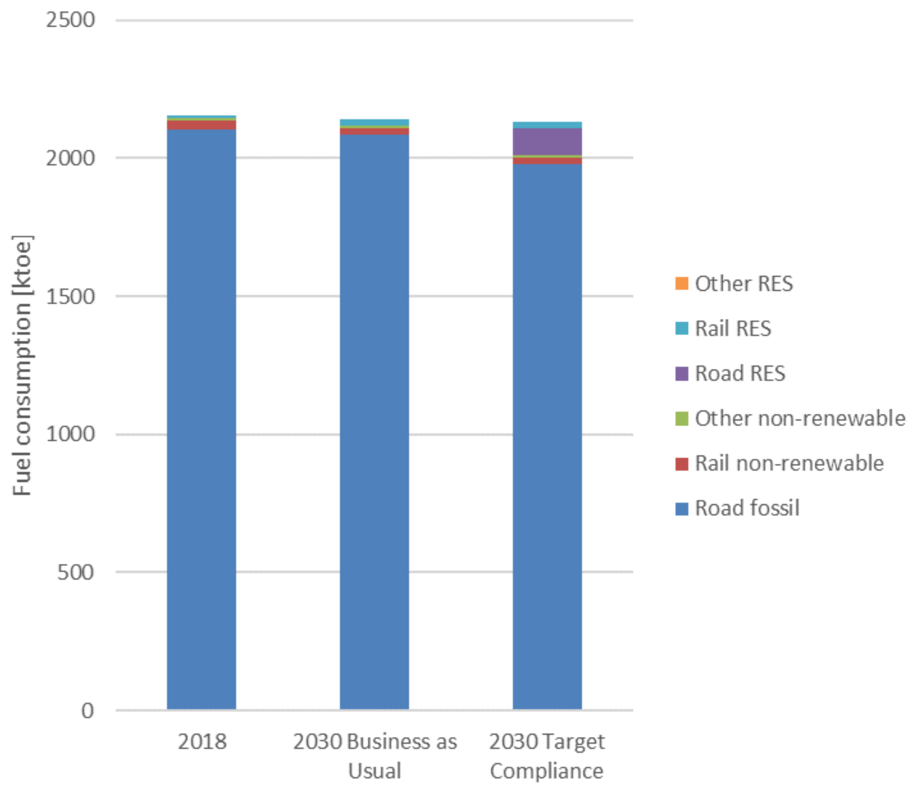

Figure 175: Energy consumption in transport in two scenarios for 2030

378 Republic of Serbia, Ministry of Mining and Energy: Energy Sector Development Strategy of the Republic of Serbia for the period by 2025 with projections by 2030. 2016

379 European Commission Energy Balances: Serbia-Energy-Balances-January-2020-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

In a target compliance scenario achieving the 9% renewables in transport target for 2030, the roadmap as described in section 13.5.2 has been assumed to be implemented. This is represented by the right-hand column in Figure 175. The 9% renewable energies are broken down by options as described in section 0, and are shown in detail in Figure 176. It should be noted that for target compliance, multipliers are used for certain options; however, the energy quantities shown in Figure 175 show the physical energies, i.e. without multipliers. Therefore, the actual renewable energy contribution in 2030 is less than 9% of total consumption in transport.

The total energy consumption in transport in the target compliance scenario is slightly lower than in the business as usual scenario as battery-electric vehicles and hydrogen fuel cell-electric vehicles are more energy efficient than internal combustion engine vehicles.

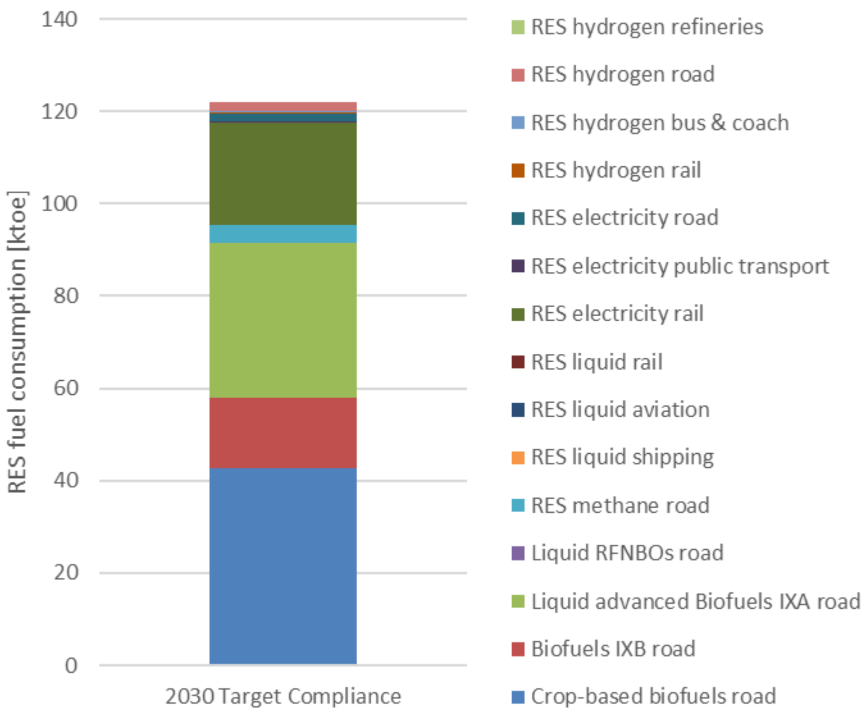

Figure 176: **Renewable energy consumption in transport in 2030 by option**

Given the increasing trends in transport indicators and to a lesser extent in transport energy consumption (see sections 13.3.1.1 and 13.3.1.3) it will be a challenge to keep energy consumption at current levels in transport. However, if this is achieved, renewable energies in transport will reduce the fossil fuel imports with associated economic benefits.

13.4 National renewable energy sources to meet the 2030 renewables in transport target

13.4.1 Potential of national renewable energy sources

The potential renewable fuel that could be produced from each of the feedstocks considered, is presented in Figure 177. Note these estimates relate to total feedstock potential and do not take into account competing uses: see section 3.2.1 for detailed description of sources and data used. In particular, note that Figure 177 shows data corresponding to the total current production of sugar and starch crops for all purposes. The use of this resource for biofuel production would compete with existing uses of these crops.

For comparison, the current transport energy use (road and rail) in Serbia is equivalent to 40% of the total potential shown in Figure 177 excluding that from renewable power. When renewable power is included, the current transport energy use is 16% of the renewable fuel that could be produced from all feedstocks.

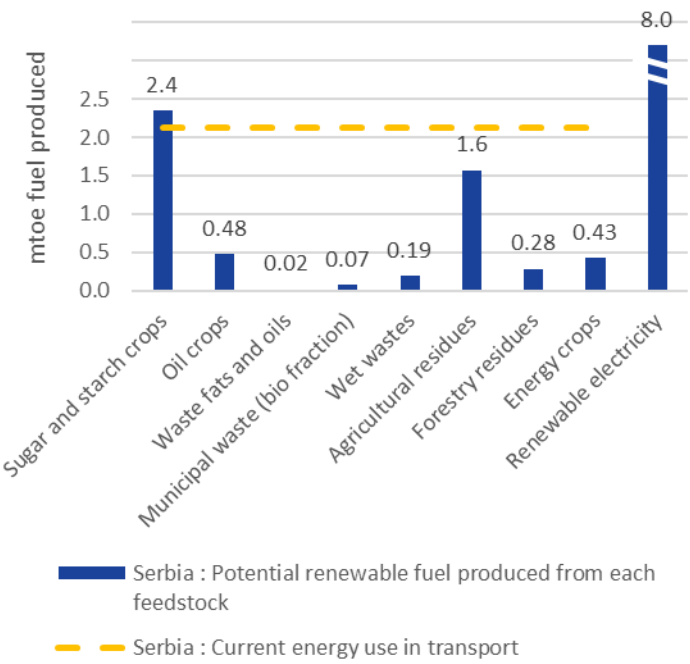

Figure 177: Serbia: Potential renewable fuel production, compared to current energy use in road and rail transport

13.4.2 Current status of national transportation fuel pathway deployments

Serbia no longer has any operational biofuel plants. It used to have four FAME biodiesel plants, with a total production capacity of 145 ktonnes/annum. While these plants are not operational, they could potentially produce biodiesel again if it becomes economically feasible. A HVO plant was initially planned by NIS j.s.c. Novi Sad, to be implemented at their refinery. However, after a deeper analysis of the vegetable oil market in Serbia and the region, NIS abandoned this project. There are reports of a potential FAME biodiesel plant in Pirot, operated by BIOGOR OIL, but no further information could be sourced.

13.5 Roadmap for achieving the renewable energy in transport target for 2030

13.5.1 Regulatory status quo

13.5.1.1 General data

Recently, Serbia has made significant steps regarding the transposition of the provisions of RED into its national regulatory framework. However, national progress reports show that Serbia is not on track to achieve the 2020 target.

In 2015, Serbia adopted the Energy Development Strategy to 2025 with projections until 2030. Projections of energy balances, which are an integral part of the Strategy, show that a reference scenario estimates for the transport sector a total consumption of 2,448 ktoe for 2025 and 2,509 ktoe for 2030[380]. A scenario with the application of energy efficiency measures estimates a total consumption of 2,073 ktoe for 2025 and 2,022 ktoe for 2030. Furthermore, the Strategy envisages that the change of structure within the transport sector shall refer primarily to the higher use of biofuels.

In 2013, Serbia has adopted a National Renewable Energy Action Plan (NREAP) including renewable energy targets until 2020.

In 2019, the Energy Community started the process of setting 2030 targets in line with the Policy Guidelines on the development of integrated National Energy and Climate Plans (NECP) under Recommendation 2018/01/MC-EnC. Renewable energy targets as well as policies and measures will be addressed under the 'Decarbonisation of the economy' dimension of the NECP in an integrated way, which recognizes the interactions between the different dimensions.

Renewable energy targets, policies and measures for 2030 will thus be included in the NECP.

The Ministry competent for energy activities is the competent body for monitoring the implementation of NREAP and renewable energy targets, about which it is obligated to submit a report to the Government every other year. The Ministry competent for energy activities is not authorize to impose penalties in case of non-compliance with renewable energy targets.

Serbia does not have any provisions for support measures available to purchasers of alternative-fuelled vehicles. In relation to the compatibility of vehicles with various alternative fuel types, the Regulation on monitoring the quality of petroleum derivatives and biofuels should be mentioned. However, this Regulation only defines that petroleum derivatives and biofuels which are placed on the market or delivered to the market must be

[380] The values of the Energy Development Strategy for the year 2015 are approximately 15% higher than the corresponding values in the Eurostat energy balances statistics. For this study we base our 2030 projections on the Serbian strategy with a downward correction of 15% based on the Eurostat energy balances values.

subject to quality monitoring and they must meet the requirements set by the regulations governing the quality of petroleum derivatives and biofuels, without deviations of quality parameters. The part of the Regulation which refers to biofuels shall apply starting from 1st January 2021.

13.5.1.2 Energy efficiency in transport

Energy efficiency is regulated by the Law on Efficient Use of Energy which is setting goals and main principles on which the efficient use of energy is based. This law applies to the energy users, including road and rail transport.

In respect of energy efficiency in the transport sector, the law imposes obligations for the local self-government units. Namely, the competent body of the local self-government unit with more than 20 000 inhabitants is obligated to adopt a programme for improving energy efficiency in the transport sector for a period of three years.

Based on the provisions of the Law on Efficient Use of Energy, Serbia has adopted the Third Energy Efficiency Action Plan (NEEAP) in 2016, containing a report on the results of final energy savings and the status of implementation of certain measures defined within the Second NEEAP, which have been achieved until adoption of the Third NEEAP, as well as targets for final energy savings in 2018 and measures for achieving them. According to the Third NEEAP, the target for the transport sector in 2018 amounts 0,2107 Mtoe. New measures for the transport sector, introduced by the Third NEEAP, are following:

- measure for mobility management which combines activities aimed at promotion of public transport, non-motorized traffic, parking system management and car sharing;
- measure for improving energy efficiency in public transport;
- measure for improving energy efficiency in freight transport;
- new regulation on emission levels according to EURO standards for imported-used vehicles. This measure has a special significance because the share of imported-used cars, in relation to the share of new cars, is increased each year;
- switching to energy efficient tires in passenger vehicles;
- improvement of the quality of annual technical inspections of vehicles;
- measures regarding fuel quality marking and monitoring;
- measure of mandatory replacement of summer tires.

It should be mentioned that the measures for 2030 regarding energy efficiency shall be included in the NECP.

13.5.1.3 Production and supply of fuel

In 2019, Serbia has adopted several by-laws which include measures covered by RED regarding biofuels:

- Regulation on the share of biofuels on the market (Official Gazette of RS no. 71/2019);
- Rulebook on technical and other requirements for biofuels and bioliquids (Official Gazette of RS no. 73/2019);
- Regulation on biofuel sustainability criteria (Official Gazette of RS no. 89/2019).

However, it is defined that the Regulation on the share of biofuels on the market and the Regulation on biofuel sustainability criteria shall apply from 1st January 2021, while the Rulebook on technical and other requirements for biofuels and bioliquids already started to apply from 1st January 2020.

In accordance with the Regulation on biofuel sustainability criteria, entities responsible for verifying the fulfilment of sustainability criteria are third party independent verifiers.

The Regulation on the share of biofuels on the market defines minimum shares of biofuels consumed in transport: the share of biofuels on the market is defined as the percentage of energy from biofuels in the total energy of fuels which is placed on the market in Serbia.

In addition, the Regulation on the share of biofuels on the market defines that materials for obtaining biofuels whose energy value should be double counted in relation to biofuels obtained from other materials are listed in Annex 4 of the Regulation - List of materials for the production of biofuels whose energy value is double counted. This Annex 4 contains the list of materials in accordance with RED II.

Biofuels are placed on the market mixed with petroleum-based fuels and they must meet prescribed sustainability criteria and technical and other requirements for biofuels. The Rulebook on technical and other requirements for biofuels and bioliquids defines technical and other requirements regarding prescribed standards that biofuels and bioliquids have to meet.

The Government passes the decision on the mandatory share of biofuels which has to be placed on the market in Serbia. Obligation of placing defined shares of biofuels is imposed on the energy entities that perform the energy activity of production of petroleum products and / or energy activity of trade of petroleum, petroleum products, biofuels and compressed natural gas, and which import petroleum products.

The amount of energy from biofuels that the abovementioned energy entities are obligated to place on the market is calculated based on the formula prescribed in the Methodology for calculating the share of biofuels on the market. Thus, the minimum share is defined, not absolute quantities per fuel supplier.

It should be mentioned that the mandatory share of biofuels in the transport sector is determined no later than October of the current year for the period of the next three calendar years.

The Regulation on the share of biofuels on the market defines exemptions to the abovementioned requirements. Namely, this Regulation does not apply to the fuels placed on the market for the purposes of establishing mandatory commodity reserves and military reserves.

Furthermore, the Regulation on the share of biofuels on the market stipulates that if mentioned energy entity does not place a mandatory share of biofuels on the market, it is obliged to pay a penalty. The penalty is determined as the amount of money per unit of energy depending on the amount of biofuel which the energy entity failed to place on the market, in relation to the prescribed mandatory share of biofuels on the market. Detailed calculation of the penalty amount is prescribed by the formula defined in the methodology on penalty calculation.

Sustainability criteria for biofuels are prescribed by the Regulation on biofuel sustainability criteria as follows:

1. Savings in greenhouse gas emissions in the production of the biofuels;
2. The manner of use of land important for the conservation of biological diversity;
3. The manner of use of high carbon land;
4. The manner of use of peat land.

The Regulation stipulates that rules regarding sustainability criteria apply to bioliquids[381] as well. Legislation in respect of sustainability criteria for biomass does not exist in Serbia.

Biofuels produced from wastes and residues, other than residues from agriculture, fisheries, forestry and aquaculture only have to fulfil the sustainability criteria defined in item 1) above – savings in greenhouse gas emissions.

The Regulation on biofuel sustainability criteria requires that greenhouse gas emission savings from the use of biofuels must be at least 60% for biofuels produced in plants that started operation after 5th October 2015. Biofuels from plants that started operation at the latest on 5th October 2015, may be placed on the market only if they are produced after 1st January 2018 and if their savings in greenhouse gas emissions are at least 50%.

The savings in greenhouse gas emissions achieved through the use of biofuels are calculated in accordance with the formula prescribed by the methodology for calculating greenhouse gas emission savings in the Regulation.

The Regulation on biofuel sustainability criteria excludes certain origins of biofuels. Namely, biofuels must not be produced from materials:

- grown on land for the conservation of biological diversity;
- grown on high carbon land;
- grown on land that had peatland status in January 2008, unless there is evidence that cultivation and harvesting of the material does not cause the drainage of the previously undried land.

[381] For other purposes than transport.

It should be mentioned that the Regulation stipulates additional criteria, besides sustainability criteria, that biofuels must meet if they are imported from the European Union or produced from agricultural materials originating from the European Union:

- biofuels must be produced in accordance with EU rules related to support measures for agricultural producers, and
- in accordance with minimum requirements for good agricultural and environmental conditions, which are used in the European Union.
- If biofuels are imported from countries that are not members of the European Union or produced from agricultural materials originating from countries that are not members of the European Union, in addition to the sustainability criteria, such biofuels must meet the following criteria:
- minimum environmental and social conditions, which are prescribed in the attachment of the Regulation on biofuel sustainability criteria.

Furthermore, the Regulation prescribes if biofuel traders import biofuels which are produced in a country that is not member of the European Union and such biofuels can be used in the European Union as biofuel meeting the sustainability criteria without providing additional evidence, the biofuel trader is only obligated to prove that he imported such biofuels, but he is not obligated to provide additional evidence in respect of fulfilment of the sustainability criteria.

The Rulebook on the calculation of the share of renewable energy sources (Official Gazette of RS no. 37/20) of March 2020 defines the method of calculating the share of energy from renewable sources in total final energy consumption, including in transport. It also defines the energy content of fuels in transport, the method of calculating the impact of biofuels and bioliquids and their comparable fossil fuels on greenhouse gas emissions. Besides transport, the Rulebook also covers renewable shares calculations for total energy, and for electricity produced from hydro and wind power plants, and for energy from heat pumps.

Reporting obligations in Serbia are defined by two Regulations: The Regulation on biofuel sustainability criteria and the Regulation on the share of biofuels on the market.

Both Regulations define the consequences of non-compliance with reporting obligations.

In accordance with the Regulation on biofuel sustainability criteria if a biofuel producer, i.e. a participant in biofuel trade, does not submit the annual report within the prescribed period, or submits an annual report that is incomplete, unclear, contradictory, unsigned, or contains some other flaw, the Ministry competent for energy activities shall notify that biofuel producer, i.e. participant in the biofuel trade, to edit the report within a period of no less than 8 days and no more than 30 days.

Biofuel producers, i.e. participants in biofuel trade, that do not submit the report, shall be punished for an offense:

- with a fine in the amount of 1.500.000,00 RSD (approx. 12.759 €) up to 3.000.000,00 RSD (approx. 25.517 €);

- it may be excluded from performing of certain economic activity for six months to three years, if the legal entity has been punished for the same offense for the last two years.

The Regulation on the share of biofuels on the market prescribes if system subject does not submit the report on the biofuel quantities put on the market within the prescribed period, i.e. if report is incomplete, unclear, contradictory, unsigned, or contains some other flaw, the Ministry competent for energy activities shall notify system subject to edit report in the period not less than 8 days and not more than 30 days.

Table 55: Reporting obligations in Serbia

	Reporting by	Reporting to	Frequency	Monitoring	Exemptions
Regulation on biofuel sustainability criteria	Biofuel producer, i.e. participant in the biofuel trade	Ministry competent for energy activities	Once a year	Publicly available	None
Regulation on the share of biofuels on the market	Energy entities that perform the energy activity of production of petroleum derivatives and / or energy activity of petroleum trade, trade of petroleum derivatives, biofuels and compressed natural gas, and which import petroleum derivatives	Ministry competent for energy activities	Once a year	Business secret of the energy entity	The Regulation does not apply to fuels placed on the market for the purposes of establishing mandatory, commodity and military reserves

If a biofuel producer, i.e. participants in biofuel trade, does not eliminate the flaws in the report, it is considered that it did not achieve the share of biofuels on the market in the year for which the report is made. As well, if in the procedure of inspection, it is determined that the report was made on the basis of untrue data and records, the inspector shall determine the actual quantity of biofuels the biofuel producer, i.e. participants in biofuel trade, placed on the market in the reporting period, and in this case it is obliged to pay penalty for non-fulfilment of the obligation to place the mandatory share of biofuels on the market.

Biofuel producers, i.e. participants in biofuel trade, that do not submit the report, or do not eliminate flaws in the period from 8 up to 30 days may be punished for an offense:

- with a fine in the amount of 1.500.000,00 RSD (approx. 12.759 €) up to 3.000.000,00 RSD (approx. 25.517 €);
- it may be excluded from performing of certain economic activity for six months to three years, if the legal entity has been punished for the same offense for the last two years.

National rules concerning production of electricity from renewable sources are defined in the Energy Law. In accordance with the Energy Law, the subject that intends to perform this energy activity must have a license issued by the Energy Agency of the Republic of Serbia. Furthermore, the energy subject that produces electricity from renewable energy sources may acquire the status of privileged producer, and it is entitled to incentive measures. In addition, producers of electricity from renewable energy sources are entitled to acquire the right for guarantees of origin, issued by the transmission system operator.

It should be noted that the relevant laws or by-laws do not contain provisions with required criteria related to electricity in transport.

There are several gaps in Serbian legislation which may be filled in the future. This refers to renewable fuels of non-biological origin – RFNBO defined in RED II. For the production of RFNBOs, no criteria related to electricity used to produce RFNBOs are defined.

In connection with the excise duties in Serbia, they are defined in the Excise Law, which prescribes that excise is paid for biofuels, bioliquids and for petroleum products. The excise tax applies as of 1st July 2020, as follows:

- leaded gasoline: 60,71 RSD (approx. 0,52€[382])/lit.
- unleaded gasoline: 57,10 RSD (approx. 0,48€)/lit.
- gas oils: 58,72 RSD (approx. 0,50€)/lit.
- kerosene: 68,45 RSD (approx. 0,58€)/kg
- liquefied petroleum gas: 44,59 RSD (approx. 0,38€)/kg
- biofuels and bioliquids: 57,37 RSD (approx. 0,49€)/lit.
- other petroleum products obtained from petroleum fractions having a distillation range of up to 380° C: 68,45 RSD (approx. 0,58€)/kg

In connection with the area of E-mobility in Serbia it should be mentioned that the legislation still does not clearly define the manner of obtaining permits and the necessary conditions that need to be met in order to install chargers for electric vehicles. Given the tendency of Serbia to harmonize its regulations with the regulations of the European Union, it is expected that in the near future this aspect will be clearly defined by law.

382 At an exchange rate of 1 EUR=117.6 RSD

Thus, the regulation does not contain provisions regarding incentives or simplified procedures for construction/licensing of electricity charging stations for road vehicles, or for construction/licensing of hydrogen refuelling stations. As well, it may be concluded that certain subjects such as public parking or garages are not obligated to have electric vehicle charging stations.

However, as part of road modernization in Serbia, at key points on highways as well as in public garages and parking, within certain exclusive hotels, restaurants, retail stores a number of chargers for e-vehicles have already been installed. The Serbian manager of state roads, Public Enterprise "Roads of Serbia", in cooperation with the Ministry in charge of Transport has installed five chargers on road Corridor X (Corridor 10), in order to facilitate transport for users of electric vehicles, on the entrance from Hungary, Croatia, North Macedonia, Bulgaria and near Belgrade, with this activity is planned to continue. In addition, drafting and adoption of a new comprehensive Transport Strategy for all modes of transport is planned.

Charging of e-vehicles is free of charge on state-owned chargers, but when it comes to other mentioned facilities, the situation may be different. In most cases, this is a supplementary, exclusive offer that is free of charge, but in some objects charging of e-vehicles is charged at a defined rate.

13.5.1.4 Passenger transport sector

The Law on Taxes on the Use, Holding and Carrying of Goods regulates taxation of the motor vehicles registered in Serbia. The Law prescribes annual duties - tax on use of motor vehicles and motorcycles based on their engine capacity class.

Table 56: Annual taxes for the transport sector in Serbia

Cat.	Motor vehicle Engine capacity, cm^3	Annual tax, RSD/€	Motorcycle Engine capacity, cm^3	Annual tax, RSD/€
1.	up to 1.150	1.310 /11,14	up to 125	1.530/13,01
2.	1.150 to 1.300	2.570/21,86	over 125 up to 250	2.570/21,86
3.	1.300 to 1.600	5.650/48,06	over 250 up to 500	3.860/32,83
4.	1.600 to 2.000	11.590/98,58	over 500 up to 750	7.730/65,75
5.	2.000 to 2.500	57.280/487,22	over 750 up to 1.100	9.460/80,47
6.	2.500 to 3.000	116.070/987,28	over 1.100	13.530/115,08
7.	over 3.000	239.890/2040,5		

The prescribed amount of tax on the use of motor vehicles is reduced for motor vehicles over 5 years of age, as follows:

- 15% - for motor vehicles over 5 to 8 years of age;
- 25% - for motor vehicles over 8 to 10 years of age;
- 40% - for motor vehicles over 10 years of age;
- for motor vehicles aged 20 and over, the tax amounts to 20% of the abovementioned amounts.

The Law stipulates that the tax on the use of motor vehicles is not paid by the owners of electric vehicles and hybrid vehicles.

Another cost imposed on vehicle owners by type of vehicle is the local utility tax for holding of motor road and trailer vehicles, maximum amount of which is defined by the Law on financing of the local self-government, and it is paid when registering the vehicle.

The amount of this tax is based on the engine capacity of motor vehicles and applies since 1st January 2020, as follows.

Table 57: Local utility tax for holding of motor road vehicles in Serbia

Cat.	Motor vehicle Engine capacity, cm^3	Annual tax, RSD/€	Motorcycle Engine capacity, cm^3	Annual tax, RSD/€
1.	up to 1.150	up to 580/ 4,93	up to 125	up to 466/3,96
2.	1.150 to 1.300	up to 1.150/ 9,78	over 125 up to 250	up to 690/5,87
3.	1.300 to 1.600	up to 1.740/ 14,80	over 250 up to 500	up to 1.150/ 9,78
4.	1.600 to 2.000	up to 2.330/ 19,82	over 500 up to 1.200	up to 1.410/ 11,99
5.	2.000 to 3.000	up to 3.510/ 29,85	over 1.200	up to 1.740/ 14,80
6.	over 3.000	up to 5.800/ 49,33		

Custom taxes for vehicles in Serbia are defined by the Customs Tariff. In accordance with the Stabilization and Association Agreement, the customs rate is 0% for imported vehicles originating from the European Union and the same customs rate applies to vehicles originating from countries which are signatories of CEFTA and EFTA agreements as well as for vehicles originating from Turkey. In all other cases, the customs rate is 12.5%. Beside the payment of the customs rate, vehicle owners are obliged to pay VAT of 20%. There are no incentives for electric, i.e. hybrid vehicles in respect of customs rate and VAT.

In March 2020, Serbia has adopted the Regulation on the conditions and manner of implementation of subsidized purchase of new vehicles that have exclusively electric drive, as well as vehicles with hybrid drive. The Regulation applies to vehicles which are new and which have never been registered before, as follows:

- mopeds, motorcycles, tricycles, quadricycles;
- passenger vehicles;
- freight vehicles (light trucks).

The right on subsidized purchase may be acquired by individuals, legal entities and entrepreneurs. In accordance with the Regulation, the total available funds for the realization of subsidized purchase of vehicles in 2020, are in the amount of 120,000,000.00 RSD (approx. 1,016,949€).

The amount of subsidy for the purchase of a vehicle primarily depends on the type of vehicle, as follows:

Table 58: Subsidy amount for the purchase of e-vehicles and hybrid vehicles

Cat.	Type of vehicle	Amount of subsidy, €
1.	moped / light tricycle	250
2.	motorcycle / motorcycle with side seat / heavy tricycle / light quadricycle / heavy quadricycle	500
3.	hybrid passenger vehicle and hybrid light truck with CO_2 emissions up to a maximum of 100 g/km	2.500
4.	Plug In Hybrid Electric Vehicle (PHEV) and light truck, as well as electric vehicle and light truck with range extender with CO_2/km emissions up to a maximum of 50 g/km	3.500
5.	totally electric passenger vehicle and totally electric light truck	5.000

In addition, the Law on the Property Tax defines that seller of used motor vehicles, vessels or aircraft is obliged to pay a tax at a rate of 2,5% in case of ownership transfer. In case of inheritance or gift of the used motor vehicle, vessel or aircraft, the Law prescribes that the successor in the first order of succession, the spouse and parents, i.e. gift recipient in the first order of succession and the spouse, are not obliged to pay taxes. In case of persons in the second order of succession, the tax must be paid at the rate of 1,5%, and if persons are in the third or further order of succession, i.e. if they are not related, the tax is paid at a rate of 2,5%. The Law on the Property Tax does not stipulate exemptions for electric vehicles.

One of the significant issues in Serbia is related to the import of used vehicles, which is regulated by the Regulation on import of motor vehicles. The Regulation concerns motor vehicles intended for the transport of persons as well as vehicles intended for the transportation of goods, which are imported to Serbia. The Regulation defines that the vehicle may be imported if exhaust emissions and noise level fulfil the conditions prescribed by the EURO 3 engine standard.

The Regulation defines that its provisions shall cease to be valid on the day of the accession of Serbia to the European Union. However, the Ministry of Environmental Protection announced at the beginning of this year that the import of vehicles with EURO 3 engine standard, most likely, will be forbidden starting from 2021, so the Regulation will be amended.

The sector of public transport in Serbia is developing in the direction of its modernization. One of the incentives for the public transport sector is introduced by the adoption of the Regulation on conditions and manner of conducting subsidized purchase of passenger vehicles for the needs of renovation of the fleet of taxi transport as public transport.

This Regulation defines that legal entities and entrepreneurs which perform the activity of taxi transport as public transport may acquire the right for subsidized purchase of new vehicles that meet one of the following criteria:

- have a fully electric, hybrid or compressed natural gas drive, or
- meet at least EURO 6 engine standard in terms of exhaust emissions.

Additional criteria are related to the price of the vehicle, which cannot be less than 13.000,00 EUR and to the colour of vehicle, so it must be white, or light / dark colour tone.

The subsidized purchase of new vehicles shall be carried out by payment of the amount of 8.000,00 EUR to the legal entity or entrepreneurs who fulfils the conditions.

Moreover, the Regulation envisages that the taxi carrier is obligated to perform the activity of taxi transport as public transport with the subsidized vehicle for at least three years. The subsidized purchase of taxi vehicles is foreseen for three years for a maximum of 6000 vehicles per year.

13.5.1.5 Freight transport sector

The Law on financing of the local self-government stipulates a maximum amount of the local utility tax which is paid when registering freight vehicles.

The amount of this tax is based on the vehicle size and applies since 1st January 2020, as follows:

Table 59: Local utility tax for freight vehicles in Serbia

Cat.	Freight vehicle Vehicle size, in tons	Annual tax, RSD/€
1.	For trucks up to 2t	up to 1.750/14,88
2.	For trucks from 2t up to 5t	up to 2.330/19,82
3.	For trucks from 5t up to 12t	up to 4.060/34,53
4.	For trucks over 12t	up to 5.800/49,33

Rules related to the exhaust emissions of freight vehicles imported into Serbia are identical to passenger vehicles (see above).

Furthermore, in accordance with the Rulebook on the division of motor vehicles and trailers, freight vehicles and buses can be manufactured in Serbia with exhaust emission of level EURO 4 at least, or they can be completed on homologated bus chassis CX and homologated chassis of freight vehicles BX of exhaust emission of at least EURO 5 level, until31st December 2021.

13.5.1.6 Railway sector

The Law on the Safety of Rail Transport prescribes different kinds of safety certificates in the railway transport sector. Furthermore, technical inspection of the rail vehicles must be carried out after obtaining a use permit and before putting the rail vehicle into operation.

Another act which may be significant in the railway sector is the Law on Railway which defines that the company or other legal entity whose registered predominant activity is the rail transport of goods and / or passengers, as well the company or other legal entity that performs or will perform rail transport for its own needs and which is established in the Republic of Serbia must obtain a respective license. This license is issued by the Directorate of Railways.

There are no provisions which on incentives or obligations for use of electric locomotives, and also there is no act which imposes the use of electricity from renewable energy for railway transport.

Table 60: Certificates related to the railway sector in Serbia

Type of permission	Subjects	Competent authority for issuance
Transport safety certificate	Company, other legal entity or an entrepreneur which performs the transport of passengers and / or goods and which provides train towing or which exclusively provides the service of train towing or manoeuvring or which performs transport for its own needs	Directorate of Railways
Industrial Railway for Transport Safety Certificate	Holder of industrial railway	Directorate of Railways
Safety Certificate for Railway Infrastructure Management	Driver	Directorate of Railways
Safety Certificate for Industrial Railway Infrastructure Management	Holder of industrial railway	Directorate of Railways

13.5.2 Roadmap to achieve the 2030 target

The roadmap developed here for Serbia to achieve the 2030 target of 9% renewable energies in transport builds on the provisions of RED II as described in section 3.1.1. It is assumed that these provisions will be transposed into Serbian law without changes including the calculation of renewables in transport, the caps and minimum values for various types of renewable energies, the multipliers, the provisions related to electricity and RFNBOs etc. Also, sustainability criteria need to be transposed into national law in order to fully comply with RED II, and it must be ensured that certification schemes are in place (national or voluntary) compliant with RED II requirements.

For this study, we apply the renewable share in the national electricity mix anticipated for 2030. On the one hand, this tends to overestimate the renewable share as values for the year 2028 that should be applied are not available, but should in general be lower than the 2030 values. On the other hand, dedicated renewable power plants may be erected that are counted as 100% renewable for transport.

For Serbia, a 68% renewable electricity mix is anticipated for 2030 based on literature values.[383] This is without prejudice to 2030 targets to be defined and included in the NECP.

It should be noted that the high renewables share in the national mix may open up opportunities for RFNBO production for export, notably to European Union Member States applying the RED II provisions. Should Serbia, however, not achieve the 68% renewable electricity value, the contributions of fuel options based on electricity will be reduced accordingly.

13.5.2.1 Potential contributions from all options

Based on the assessment of all options for Serbia, a total RES-T share of 11.2% in 2030 can be achieved as a combination of all options (see Table 61). Further very limited potentials exist in renewable liquid fuels in shipping, aviation and rail, which are assumed to be zero here.

Table 61: Potential RES-T contributions from all options in Serbia

Option		Contribution to RES-T target (%) incl. multiple counting	Amount of renewable fuel used (ktoe)
Biofuels and liquid RFNBOs	1. Crop-based biofuels in road transport	2.0%	42.6
	2. Liquid fuels produced from Annex IX B feedstocks in road transport	3.4%	36.2
	3. Liquid advanced Biofuels (based on Annex IX A feedstocks) in road transport	3.1%	33.3
	4. Liquid RFNBOs in road transport	0.23%	4.92
	5. Renewable methane in road transport	0.37%	3.99
	6. Renewable liquid fuels in shipping	0.0%	0.00
	7. Renewable liquid fuels in aviation	0.0%	0.00
	8. Renewable liquid fuels in rail	0.0%	0.00
Electricity	9. Rail electrification	1.56%	22.1
	10. Electric public transport (bus, trolleybus, tram, metro)	0.03%	0.27
	11. Electric road vehicles (passenger cars and trucks)	0.35%	1.86
Hydrogen	12. Hydrogen in rail	0.01%	0.13
	13. Hydrogen bus and coach (urban bus, long distance coaches)	0.01%	0.27
	14. Hydrogen road vehicles (passenger cars and trucks)	0.09%	1.86
	15. Hydrogen in refineries	0.0%	0.00
Total		11.2%	148

Biofuels and electric rail potentially contribute most in 2030. Serbia has an established use of methane in road transport. This can be used to introduce biomethane based on Annex IXA

383 TU Wien/Energy Economics Group, Joanneum Research, REKK: Study on 2030 overall targets (energy efficiency, RES, GHG emissions reduction) for the Energy Community. Vienna 2019

feedstocks, which have a suitable potential in Serbia. Also, Serbia's contribution from Annex IXB biofuels could be supplied entirely from domestic UCO and tallow resources.

Electric and hydrogen vehicles can already make small contributions by 2030, and have a strong growth potential thereafter.

As the possible contributions of battery-electric vehicles depend on many factors, the following considerations are intended to provide some insight into the dynamics and opportunities (see Figure 178). The graph is based on a number of approximate assumptions, and should thus be understood as rough indication showing the general trends.

Battery-electric cars contribute to the RES-T target by applying the renewable share in the national electricity mix[384].

Electricity provided through public charging stations is covered in statistics as energy consumed in transport, and thus counted accordingly; charging through private charging units is not covered in statistics. Therefore, RED II foresees a multiplier of four for electricity consumed in road transport (based on data from statistics).

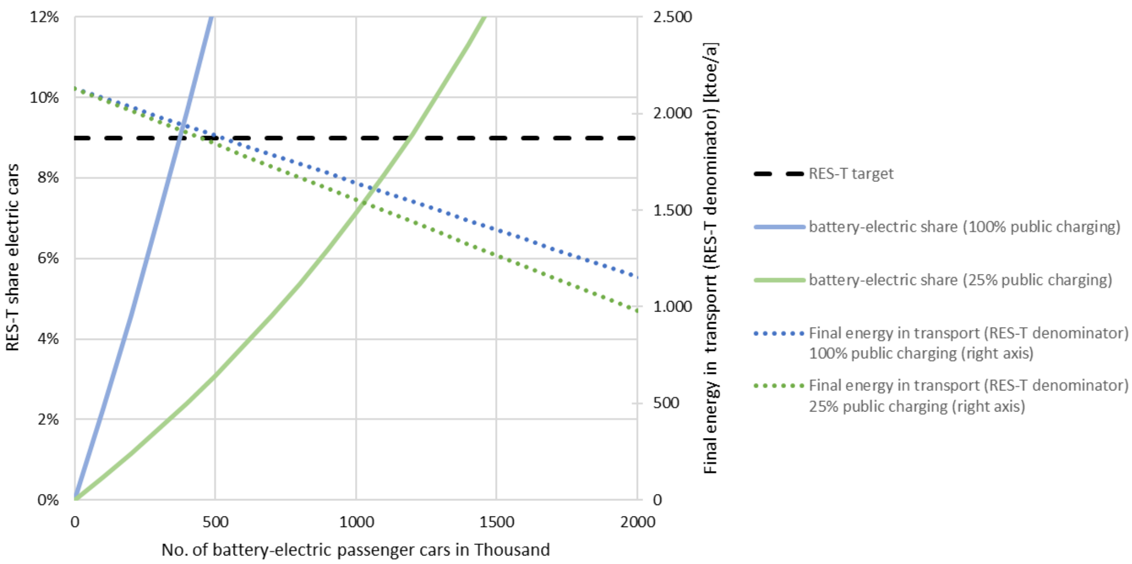

Figure 178: Possible contributions of battery cars to Serbia's 2030 RES-T target

The RES-T contribution of battery cars depends on:

- The number of battery cars (horizontal axis in Figure 178);
- The share of public charging (green/ blue line in Figure 178 assuming 25% and 100% public charging, respectively);

384 However, if certain criteria are met (see RED II), renewable electricity can be counted as 100% renewable. This is not assumed in this study for option 11.

- The renewable share in the national electricity mix in 2028 (68% for Serbia); doubling the RES share would double the contribution.

Assuming 25% public charging, 500 thousand battery cars would approximately contribute 3.1% RES-T by 2030 (see Figure 178).

As battery cars are more energy efficient than conventional cars and the electricity is only partly covered in statistics energy consumption in transport decreases with increasing battery cars (dotted lines in Figure 178).

13.5.2.2 Choice of options to meet RES-T target

The potential contribution of all options exceeds the target, and thus allows reducing the contributions from some options. The reductions are based on the general considerations described in section 5.1, and on the specific circumstances in Serbia as described in the following:

1. Crop-based biofuels are used up to the 2% cap, equal to 43ktoe. Assuming that all of Serbia's biofuel plants became operational again and were to produce crop-based fuels, this could produce 130 ktoe of biofuels per year: significantly greater than what is required for the target;
2. Biofuels based on Annex IXB biofuels can be reduced by around half from the maximum capped level, to 15 ktoe. 100% of this supply could be met from domestic collectable UCO and tallow resources;
3. Liquid biofuels and biomethane based on Annex IXA feedstocks ("advanced biofuels") are developed to meet the minimum targets defined in RED II. Reaches 2030 target for Annex IXA for ("advanced") biofuels when summed with amount of renewable methane in road transport. For context, this is equivalent to approximately the output of an advanced ethanol plant at typical scale of 63 million l fuel/year;
4. Relatively expensive RFNBOs are not required in road transport to meet the 2030 target;
5. The 2030 demand for methane in transport can be fully met using 2.1% of the total potential for biomethane production from manure in Serbia, counting as advanced biofuel (see No. 3 above);
6. No renewable fuels in shipping are required;
7. No renewable fuels in aviation are required to meet Serbia's RED II target;
8. No renewable fuels in rail are required to meet Serbia's RED II target; expansion of electricity consumption in rail is seen as more promising (see next point)
9. Increasing the national renewable share in electricity, maintaining and installing catenaries at non-electrified rail lines or closing non-electrified rail gaps as well as keeping the share of rail electricity in overall transport energy consumption by extending rail transport accordingly are assumed;

10. The introduction and expansion of battery buses and the expansion or establishment of trolley bus systems, trams, or metros in cities is assumed here;
11. The market uptake of battery-electric road vehicles (cars and light/ medium duty trucks) leads to electricity consumption in transport;
12. On existing and new rail lines not suitable for electrification zero emission hydrogen fuel cell trains can be operated;
13. Introduce hydrogen fuel cell buses in urban areas, and (long-distance) coaches in applications not suitable for battery-electric vehicles (high daily driving range, long-distance);
14. Start of market uptake of hydrogen fuel cell-electric road vehicles (cars and light to heavy duty trucks) for long-distance, high driving ranges;
15. Use of renewable hydrogen in the refineries sector in Serbia could be an option for the near-term, but is not assumed here for a contribution by 2030. A detailed assessment of the refineries would be needed to assess the opportunities. Possible hydrogen demand that would be served from renewable sources could contribute to the RES-T target.

This results in the following contributions by 2030 assumed to be realistic and reducing the most challenging or expensive[385] options to meet the defined 2030 RES-T target:

Table 62: Contribution to Serbia's RES-T target from options chosen

	Option	Multiplier	2030 Contribution to RES-T target incl. Multipliers	2030 Amount of renewable fuel used (ktoe)
Biofuels and liquid RFNBOs	1. Liquid crop-based biofuels in road transport	1	2.0%	43
	2. Liquid fuels produced from Annex IX B feedstocks in road transport	2	1.5%	15
	3. Advanced liquid biofuels (based on Annex IX A feedstocks) in road transport	2	3.1%	33
	4. Liquid RFNBOs in road transport	1	0%	0
	5. Renewable methane in road transport	2	0.37%	4.0
	6. Renewable liquid fuels in shipping	2	0%	0
	7. Renewable liquid fuels in aviation	2	0%	0
	8. Renewable liquid fuels in rail	2	0%	0
Electricity	9. Rail electrification	1.5	1.6%	22
	10. Electric public transport (bus, trolleybus, tram, metro)	4 (road) 1 (tram, metro)	0.032%	0.3
	11. Electric road vehicles (passenger cars and trucks)	4	0.35%	1.9
Hydrogen	12. Hydrogen in rail	1	0.0063%	0.1
	13. Hydrogen bus and coach (urban bus, long distance coaches)	1	0.013%	0.3
	14. Hydrogen road vehicles (passenger cars and trucks)	1	0.087%	1.9
	15. Hydrogen in refineries	1	0%	0
Total			9.0%	134

Strong contributions are made by crop-based biofuels, liquid fuels produced from Annex IXB feedstocks (used cooking oil, tallow), and advanced biofuels (Annex IXA) as well as by rail

385 Detailed cost assessments have not been carried out in this study. Rough cost judgements are made here based on costs information provided in chapter 3.

electrification; moderate contributions are made by biomethane in road transport, electric road vehicles and hydrogen road vehicles; limited contributions are made by electric public transport, hydrogen in buses and coaches as well as in rail.

The contribution from electricity in rail and all other forms of transport assumes a 68% share of renewable electricity in power by 2030. If this was lower, all options using electricity directly or hydrogen would make a smaller contribution to the 2030 target. A higher renewable share in the national electricity mix or dedicated renewable capacities would increase the renewable contribution of rail and all other forms of transport, which are based on electricity or hydrogen.

The high proportion of Annex IXA (advanced) biofuels is driven by the sub-target in RED II and relies on a large scale-up in production of liquid Annex IXA biofuels. Should this prove not to be feasible, crop-based biofuels or biofuels based on Annex IXB could be increased, which would, however, not allow the sub-target for advanced biofuels in RED II to be fulfilled.

These contributions lead to a breakdown of fuel consumption in 2030 as shown in section 13.3.2.

13.5.2.3 Roadmap for Serbia

The roadmap for Serbia to achieve the 2030 target for renewable energies in transport (see Figure 179) involves key policies to be developed and adopted in the coming few years building on the existing regulatory framework and policy elements already under development (see section 13.5.1). The development of the regulatory framework so far focuses on biomass-based fuels; direct electricity use and hydrogen use in road transport has received less emphasis so far, but should be taken up as two additional central pillars for renewables in transport.

The roadmap foresees that the last elements of the regulatory framework for RED II should be in place by the end of 2022.

The appropriateness, effectiveness and efficiency of this policy framework should be evaluated in around 2025, and should be adjusted where necessary to ensure target compliance by 2030. The European Union is currently developing the details of the European Green Deal, which aims to make the European Union climate neutral by 2050 by turning climate and environmental challenges into opportunities, and making the transition just and inclusive for all. Based on a set of policy initiatives by the European Commission, climate ambitions by 2030 are anticipated to be increased, which includes adjustments to RED II. A revision of the policy framework in Serbia around the middle of the decade would be timely for taking up decisions to be taken at European Union level by then.

Around 2028 would be a suitable point in time to set targets for the 2040 timeframe, and to revise and adjust the strategies and policies accordingly.

Currently, Serbia is developing its first National Energy and Climate Plan (NECP), which has a planning and a monitoring function. The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target, and will be helpful for the 2025 revision of the policy framework.

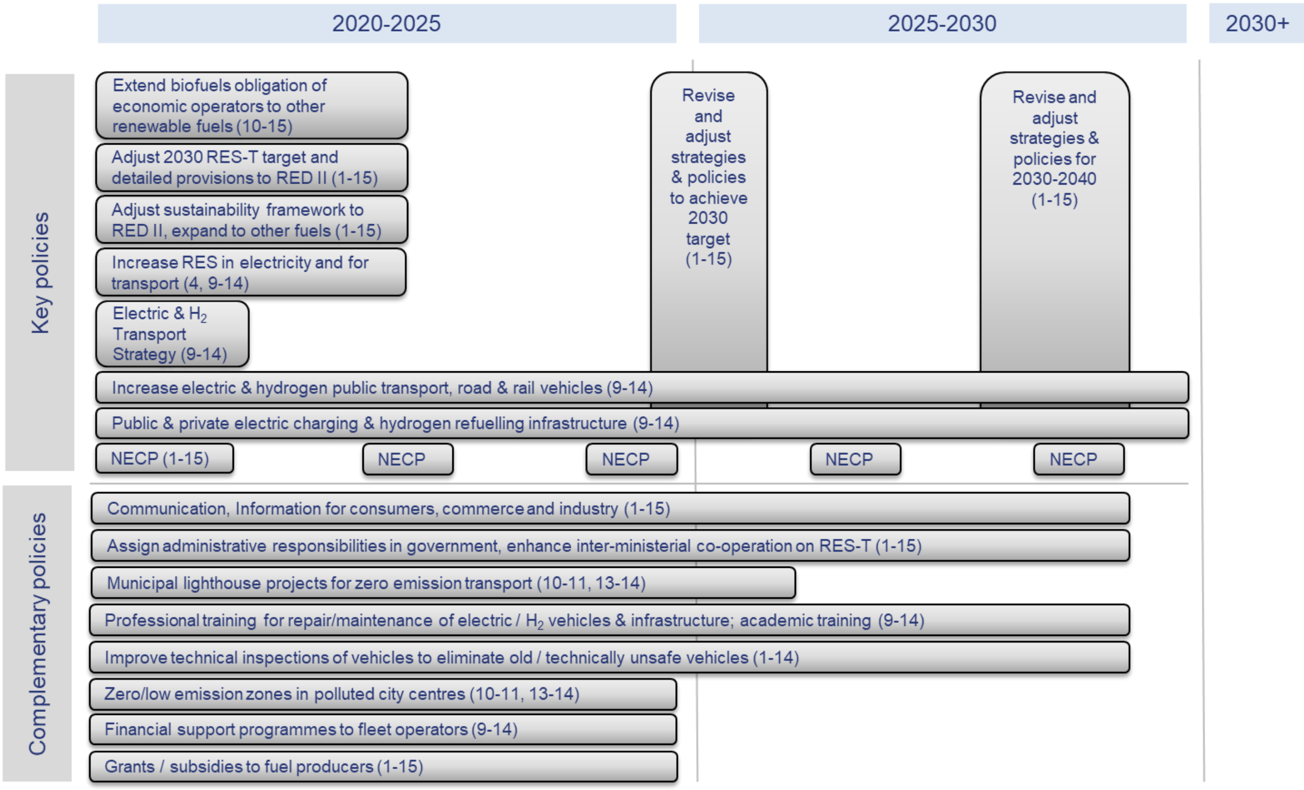

Figure 179: Overview roadmap for Serbia

The priority in the roadmap for biofuels is to implement policy to drive uptake of these fuels, matching RED II requirements. Implementation of this policy mechanism, elements of which have been adopted in late 2019 coming into force at the beginning of 2021, including the correct targets, sub targets, caps, rules, etc. should be started as soon as possible, to allow industry as much time as possible to adjust and prepare to meet them. This obligation needs to be supported through a number of other policy elements such as rules for certification and compliance of biofuels, sustainability criteria for biofuels, and rules for calculating the impact of biofuels on the greenhouse gas emissions. As described above, most of these policy elements are in place in Serbia through the “Regulation on the share of biofuels on the market” and the “Regulation on biofuel sustainability criteria”, although it must be ensured that all requirements of RED II are included. Additional attention may need to be given to criteria on production of liquid RFNBOs, alongside the rules on hydrogen (below) as these do not appear to be covered within existing activities. A unit within the relevant government ministry must be designated responsible for implementing, reviewing and updating the policy as a whole, ensuring sustainability certification of fuels, administering the scheme, data collection and reporting.

Several other measures that are complementary to this demand-side policy have also been important in other countries, namely support for domestic fuel production, such as capital grants for plants and information provision for consumers on fuel switching and vehicle compatibility.

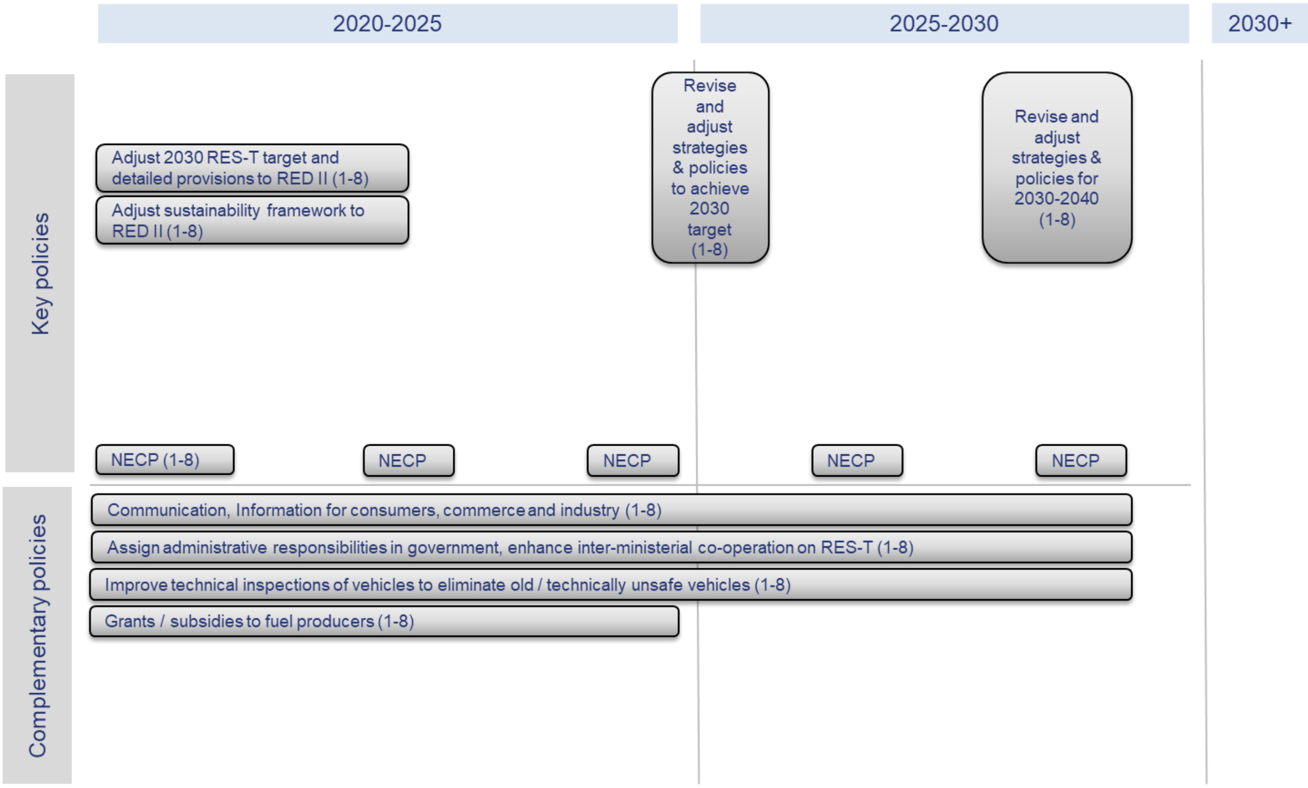

Figure 180: Roadmap for Serbia – Biofuels and liquid RFNBOs

Some direct electricity use in transport is established in Serbia using trolley buses and tramways. The rail sector also uses electricity to a significant extent, and has potential for further electrification. Policies supporting renewables in transport should include maintaining and further strengthening electricity use in these sectors.

Battery-electric road transport including passenger cars, public transport and delivery vehicles is in an early stage of development in Serbia supported by incentives to purchase battery vehicles and hybrid vehicles, and has a significant growth potential. Developing a national electric transport strategy would be an appropriate starting point for a coherent and effective policy framework in this area. Various policies for fostering electric transport could be envisioned, such as including renewable electricity in the obligation on fuel suppliers for increasing the share of renewable energies in transportation fuels (see above), or putting an obligation on electricity suppliers for providing renewable electricity to transport, etc.

An additionality framework for renewable electricity would define rules for counting electricity as renewable based on RED II[386], and detailed provisions are currently under development by the European Commission. This aims at fostering additional renewable power capacities for transport not compromising the achievement of renewables electricity targets in conventional electricity consumption.

In parallel, existing policies for increasing renewable electricity production should be adjusted by increasing renewable targets for 2030 that would include additional renewable electricity demand from transport. Fostering dedicated renewable capacities for transport could be a new element introduced into existing legislation, covering rail, public transport and road.

Increasing the number of electric vehicles in road, rail and public transport is a major lever for increasing the consumption of electricity in transport, and reducing conventional fuel consumption. Elements for such policies include providing direct financial support for purchasing electric vehicles as already established, and adjusting the tax structures to incentivize purchases of electric vehicles. The vehicle charging infrastructure is the second major lever. Policies to coordinate and incentivize the build-up of a public network of charging stations include elements of financial incentives through grants, subsidies and loans, clear permitting rules, and coordination to ensure an appropriate nationwide network structure. In addition, financial support to charging infrastructures for public transport and fleet operators is an effective and efficient instrument for rapid growth.

The appropriate administrative structures must be established including enhanced inter-ministerial co-operation, and related responsibilities assigned in government.

Further complementary policies supporting electric transport include communication and information campaigns, lighthouse projects at local/ municipal level, the establishment of zero or low emission zones in urban areas for reduced air pollution, professional and academic training, technical inspections of vehicles (both electric and conventional), etc.

[386] See RED II Art. 27(3)

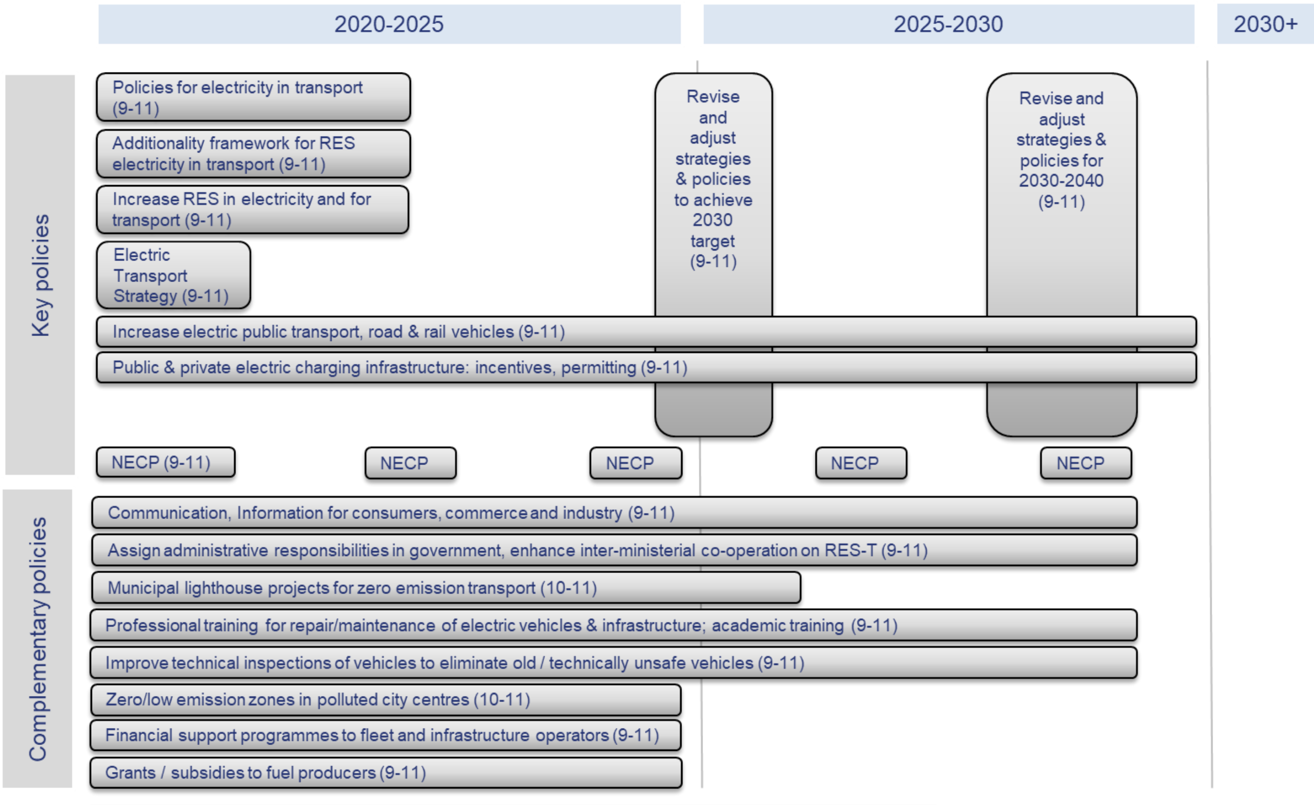

Figure 181: Roadmap for Serbia – Electricity in Transport

Hydrogen in transport using fuel cell-electric vehicles is in early phases of commercialization world-wide, and shows major potential for decarbonizing transport in a complementary fashion to battery-electric vehicles. On non-electrified rail lines, first commercial hydrogen trains are in operation, and fuel cell vehicles are coming onto the market. A focus will be on vehicles for longer distances and for duty purposes such as trucks and buses.

Hydrogen can be included in the obligation on fuel suppliers as an option, as provided for in RED II. Further key policy elements are rather similar to electricity in transport: developing a national strategy, defining an additionality framework, increasing renewable electricity capacities for hydrogen production, supporting the market uptake of fuel-cell electric vehicles, and supporting the establishment of hydrogen refuelling stations.

Also, the complementary policies are similar to electricity.

The related policies should be established together with those for biofuels and electricity, while the market may take up a few years later based on an earlier status in commercialization.

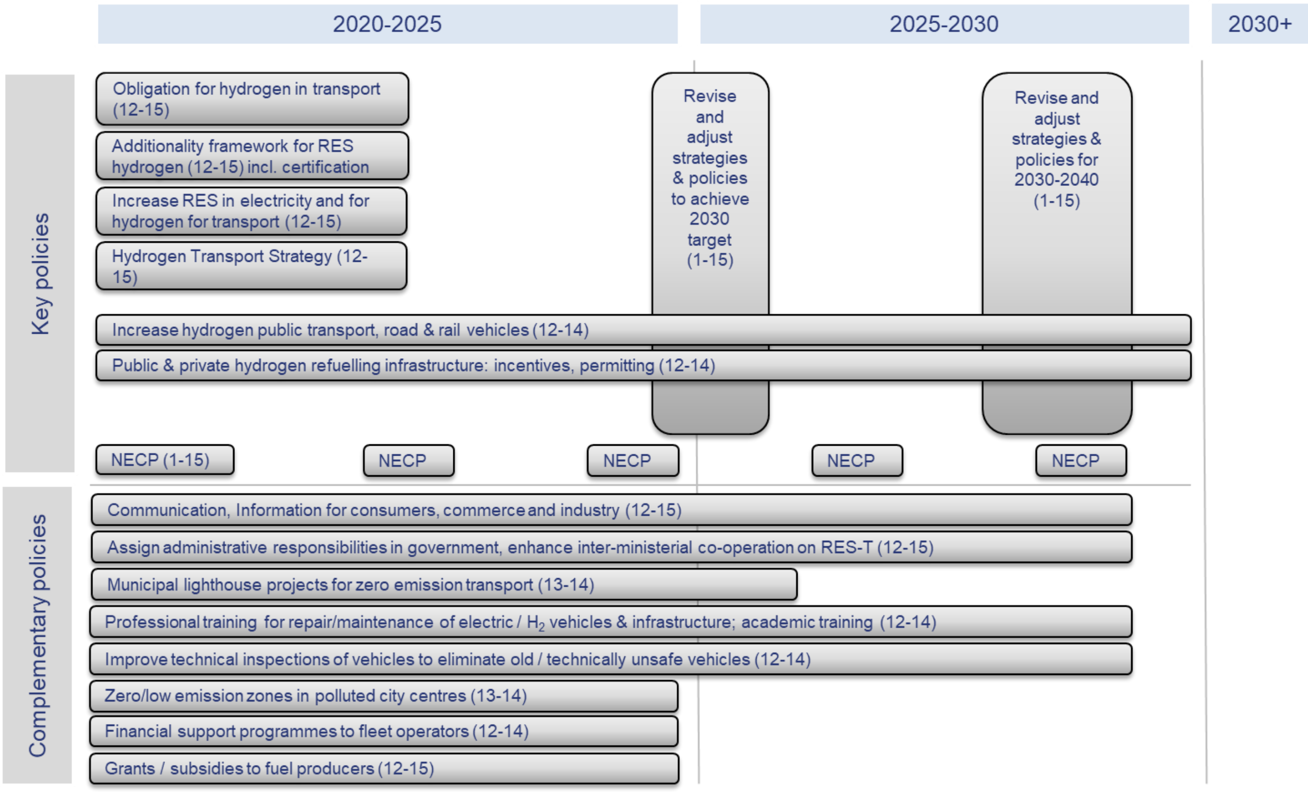

Figure 182: Roadmap for Serbia – Hydrogen in Transport

13.6 Conclusions and recommendations

13.6.1 Conclusions

Serbia can choose from a number of options to achieve the 2030 RES-T target of 9%. In fact, over-achievement beyond 11% is possible; it should be noted that the anticipated constant energy consumption in transport would lead to a reduction of fossil fuel imports equivalent to the RES-T consumption in 2030, and so higher ambitions than the 9% target could provide additional benefits in economic and environmental terms.

Options for renewable fuels production beyond the 2030 target may open opportunities for exports.

Of the 9%, crop-based biofuels are capped at 2%, while 7% need to be achieved by other renewable fuels.

While biofuels are anticipated to contribute most to the target, electricity use in rail can also make significant contributions if the renewable electricity share reaches the 2030 value of 68% as assumed for this study.

Electric road vehicles supported by the existing and further support measures and further measures related to charging infrastructure bear notable potential, which is anticipated to grow dynamically after 2030 to allow for major RES-T shares by 2050.

Hydrogen and battery-electric vehicles are complementary as hydrogen fuel cell vehicles enable longer driving distances, and are suitable for cars and heavy-duty transport alike; dynamic growth beyond 2030 is anticipated.

Additional benefits of achieving the 2030 RES-T target include the reduction of fossil energy import dependence and related financial flows out of the territory, additional national value creation, new or enhanced national value chains with related economic benefits and possible job creation as well as additional contributions to the national climate targets, etc.

13.6.2 Recommendations

As a proven policy tool, Serbia should adopt a 2030 target for renewable energies in transport based on RED II.

The use of renewable energies in transport should be continued and further enhanced. The recently adopted Regulations on the share of biofuels and on biofuel sustainability coming into force at the beginning of 2021 have the potential to foster the market introduction of relevant amounts of biofuels on the market making related contributions to a 2030 target for renewable energies in transport. Monitoring and enforcing the implementation of the provisions of these regulations including independent certification will be key to their success. These regulations should be adjusted to take up provisions of RED II not included yet such as caps and minimum contributions by different biofuels (crop-based, advanced, Annex IXB type), or indirect land-use change provisions.

All elements of the regulatory framework should be in place by the end of 2022.

Electric road mobility should be developed to become the second pillar of renewable energies in transport in Serbia. First established measures to foster renewable electricity in road transport should be a starting element in a national electric transport strategy to be developed. Policies should cover the two elements of fostering market uptake of battery vehicles and of developing a nationwide public charging network including fast-chargers. Electricity use in public transport should be enhanced by policies for the extension of trolleybuses, tramways and metro, and should be extended to battery-electric buses.

Hydrogen fuel-cell electric transport should be developed to become the third pillar of renewable energies in transport in Serbia. This should be defined in a national hydrogen strategy including policies fostering the market uptake of hydrogen vehicles in road, rail and public transport and aiming at the establishment of a national hydrogen refuelling infrastructure. Hydrogen for transport should be integrated into the transposition of RED II as an option for fuel suppliers for fulfilling their renewable obligation. The option provided by RED II of renewable hydrogen consumption in refineries for conventional fuel production should be assessed for implementation in the short-term.

In parallel, existing policies for increasing renewable electricity production should be adjusted by increasing renewable targets for 2030 that would include additional renewable electricity demand from transport (for direct use or for hydrogen production) benefitting both the electricity sector and transport covering rail, public transport and road.

Complementary policies for battery-electric and hydrogen fuel cell-electric transport are recommended to be established in order to ensure target achievement and maximum benefits to the Serbian economy, including communication and information campaigns, lighthouse projects at local/ municipal level, the establishment of zero or low emission zones in urban areas for reduced air pollution, professional and academic training, etc.

Research and innovation based on government funding for basic and applied research and development in the field of electric transport and hydrogen energy should be fostered.

Co-benefits with other policy areas should be actively developed. This includes air quality improvements in urban areas and other environmental and health issues as well as economic benefits such as reduced fossil fuel imports, job creation, national value creation, etc.

Furthermore, co-operation with other Contracting Parties, and more generally with other countries, allows synergies and should thus be pursued.

Policies should be revised and possibly adjusted in around 2025 based on a policy and results evaluation.

The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target.

14 UKRAINE

14.1 Executive Summary

The implementation of the revised Renewable Energy Directive (EU) 2018/2001 (RED II) on the promotion of the use of energy from renewable sources has started to be discussed within the Energy Community. Currently, RED II is not a part of the Energy Community acquis; but the adaptation and transposition by the Contracting Parties could be envisaged. Assuming for this study that the provisions of RED II are transposed into Ukrainian law without changes, we develop a roadmap for Ukraine to achieve the 2030 target for renewables in transport of 9%[387].

Ukraine has a share of renewable energy in transport of around 2% through electricity consumption in rail. Biofuels consumption in Ukraine is low so far, but draft legislation is in the political debate that is set to establish the instruments to increase biofuel consumption.

Ukraine can choose from a number of options to achieve the 2030 RES-T target of 9%. In fact, significant over-achievement beyond 13% is possible. It should be noted that even with achievement of the 2030 target of 9%, the anticipated consumption growth over the coming decade is expected to result in increased fossil fuel imports relative to 2018. Higher ambitions could thus be beneficial in economic and environmental terms for Ukraine.

Options for renewable fuels production including hydrogen beyond the 2030 target may open up opportunities for exports.

Of the 9%, crop-based biofuels are capped at 2%, while 7% need to be achieved by other renewable fuels. Crop-based and advanced biofuels as well as renewable electricity in rail and public transport are anticipated to contribute most to the target if the renewable electricity share is to reach the 2030 value of 40% as assumed for this study.

Electric road vehicles supported by the existing support strategy and further measures related to charging infrastructure have notable potential by 2030, which is anticipated to grow dynamically thereafter.

Hydrogen and battery-electric vehicles are complementary with hydrogen enabling long driving distances, and being suitable for cars and heavy-duty transport alike; development of the sector until 2030 would allow for dynamic growth thereafter.

Additional benefits of achieving the 2030 RES-T target include the reduction of fossil energy import dependence, additional national value creation, new or enhanced national value

[387] The overall target for RES-T of 14% can be reduced as far as the cap on crop-based biofuels is lower than 7%. As the cap on crop-based biofuels for Ukraine is 2% based on the 2020 biofuels consumption, the overall target is reduced to 9%.

chains with related economic benefits and possible job creation as well as additional contributions to the national climate targets, etc.[388] .

As a proven policy tool, Ukraine should adopt a 2030 target for renewable energies in transport based on RED II.

The "National Transport Strategy", the "Energy Development Strategy"[389], the "Ukraine 2050 – Green Energy Transition Concept – Ukraine Green Deal" and the "Roadmap for the wide introduction of hydrogen energy in Ukraine" represent a strategic basis for policies aimed at increasing the share of renewable energies in transport based on biofuels, electricity and hydrogen.

Without prejudice to any possible legal, political or contractual obligations, all elements of the regulatory framework should be in place at the latest by the end of 2022 in order to give industry as much time as possible to plan, invest, implement and operate.

The use of renewable energies in transport should be continued and enhanced. The existing strategies should be further developed to strengthen the focus on electricity and hydrogen in transport, and should be complemented by a national strategy for the development of hydrogen energy and fuel cells in Ukraine, both for domestic use and for export using synergies between the two.

The draft Law of Ukraine "On Amending Certain Legislative Acts Of Ukraine On The Development Of The Production Of Liquid Biofuels" currently in the political debate will amend laws and legislative acts relative to obligatory quotas on the biocomponent share in the volume of sold motor fuel including responsibility for non-compliance with quotas as well as sustainability criteria. Terminology in the field of liquid biofuels complying with RED II will also be introduced. This would be the perfect opportunity for taking up the provisions of RED II including certification.

Policies fostering the market uptake of battery vehicles should be further developed, notably in view of the establishment of a national charging network including fast-chargers. Electricity use in public transport should be enhanced by policies for the extension of trolleybuses, tramways and metro, and should be extended to battery-electric buses.

The current political discussions on hydrogen should be steered towards adoption of policies fostering the market uptake of hydrogen vehicles in road, rail and public transport and aiming at the establishment of a national hydrogen refuelling infrastructure. Hydrogen for transport should be integrated into the transposition of RED II as an option for fuel suppliers. The

388 Such benefits are not analysed in this study, but have been assessed in various studies, e.g. for hydrogen in Fuel Cells and Hydrogen Joint Undertaking (2019): Hydrogen Roadmap Europe – a sustainable pathway for the European energy transition; and in
Fuel Cells and Hydrogen Joint Undertaking (2020): Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans.

389 The Energy Development Strategy is currently being updated; see "Ukraine 2050 – Green Energy Transition Concept – Ukraine Green Deal", 2020

option provided by RED II of renewable hydrogen consumption in refineries for conventional fuel production should be assessed for implementation in the short-term.

2030 targets for renewable electricity production should be increased including additional renewable electricity demand from transport (for direct use or for hydrogen production).

Complementary policies for battery-electric and hydrogen fuel cell-electric transport are recommended to be established in order to ensure target achievement and maximum benefits to the Ukrainian economy, including communication and information campaigns, lighthouse projects at local/ municipal level, the establishment of zero or low emission zones in urban areas for reduced air pollution, professional and academic training, etc.

Research and innovation based on government funding for basic and applied research and development in the field of electric transport and hydrogen energy should be fostered.

Co-benefits with other policy areas should be actively developed. This includes air quality improvements in urban areas and other environmental and health issues as well as economic benefits such as reduced fossil fuel imports, job creation, national value creation, etc.

Furthermore, co-operation with other Contracting Parties, and more generally with other countries, allows synergies and should thus be pursued.

Policies should be revised and possibly adjusted in around 2025 based on a policy and results evaluation.

The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target.

14.2 Introduction

The Energy Community Contracting Parties including Ukraine have the obligation to reach binding targets for renewable energy in gross final energy consumption by 2020. For the transport sector, the binding target is a minimum 10% of renewable energy (RES-T) by 2020. Ukraine will not achieve this target.

The implementation of the revised Renewable Energy Directive (EU) 2018/2001 (RED II) on the promotion of the use of energy from renewable sources has started to be discussed within the Energy Community. Currently, RED II is not a part of the Energy Community acquis; but the adaptation and transposition by the Contracting Parties could be envisaged.

It is assumed here that the provisions of RED II are transposed into Ukrainian law without changes. On this basis, we develop a roadmap for Ukraine to achieve the 2030 target for renewables in transport of 9%.

As a starting point, this study analyses the status quo of energy consumption in transport in Ukraine, and provides 2030 projections including a business as usual scenario, and a scenario for compliance with the 2030 target for renewable energies in transport according to RED II.

In the second section, we assess the potential of national renewable energy sources suitable for use in transport, or for the production of transportation fuels together with the status of fuel pathway deployment in Ukraine.

The third section describes the regulatory status quo related to renewable energies in transport. On this basis, we develop a roadmap for Ukraine to achieve the 2030 target for renewables in transport on the three pillars of biofuels, electricity and hydrogen covering all transport sectors.

The final section provides conclusions and recommendations.

14.3 Status quo and 2030 projections of renewable energy consumption in transport

The objective of this chapter is to review the current status of renewable energies in transport (RES-T) in Ukraine, and to develop scenarios of the development of renewable energy shares in transport by 2030.

The following data includes neither international aviation nor international navigation.

14.3.1 Status Quo

The following data includes neither international aviation nor international navigation as these two segments are generally excluded from statistics such as the Eurostat energy balances.

14.3.1.1 Transport Indicators

From 2014 on, the temporarily occupied territory of the Autonomous Republic of Crimea, the city of Sevastopol and a part of temporarily occupied territories in the Donetsk and Luhansk regions are not included in the data on transport indicators.

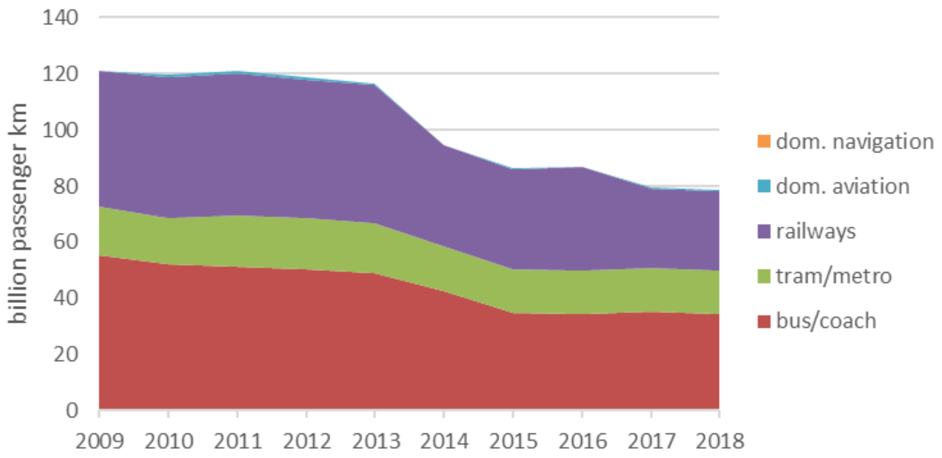

Figure 183: Passenger transport by transport mode[390] [391]

After having been roughly constant the years before, transport by train has dropped in 2017. Transport by bus and coaches as well as by tram and metro has remained roughly constant in recent years. The small volume of domestic aviation has increased since 2015. Domestic navigation is negligible in terms of energy consumption. Data for transport by car is not available.

[390] State Statistics Service of Ukraine (UkrStat): Транспорт і зв’язок України - 2013. Kiev 2014: http://www.ukrstat.gov.ua/druk/publicat/kat_u/2014/zb/09/zb_tr_13.zip

[391] State Statistics Service of Ukraine (UkrStat): Транспорт і зв’язок України - 2018. Kiev 2019: http://www.ukrstat.gov.ua/druk/publicat/kat_u/2019/zb/08/zb_tr2018pdf.pdf

Freight transport is dominated by rail, which has slightly decreased over the past decade, while road transport has slightly increased.

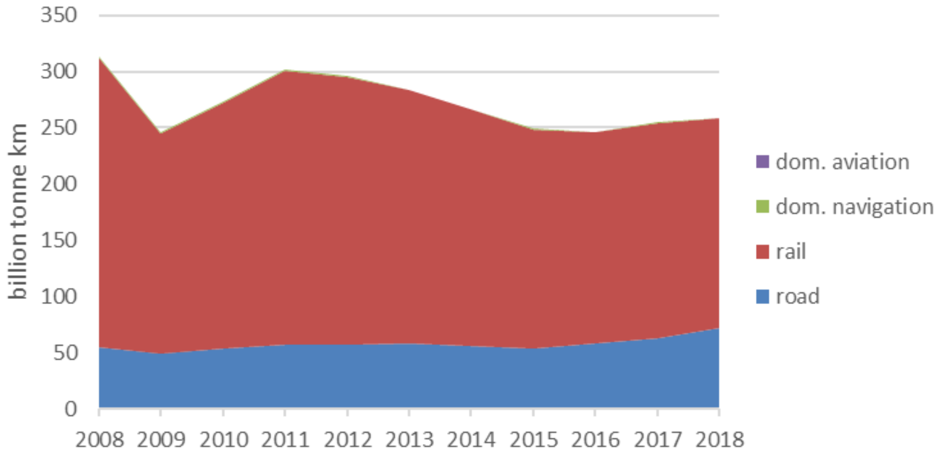

Figure 184: Freight transport by transport mode[392] [393] [394]

14.3.1.2 Registered Road Vehicles

The number of registered road vehicles is based on various sources for the different years; the values for registered passenger cars in 2016 and 2017 are interpolated between 2015 and 2018. Not all passenger cars in circulation on Ukrainian roads are registered in Ukraine. Data for commercial vehicles are only available until 2011. The limited accuracy of the data does not allow detailed conclusions to be drawn on trends.

[392] State Statistics Service of Ukraine (UkrStat): Транспорт і зв'язок України - 2013. Kiev 2014: http://www.ukrstat.gov.ua/druk/publicat/kat_u/2014/zb/09/zb_tr_13.zip

[393] State Statistics Service of Ukraine (UkrStat): Транспорт і зв'язок України - 2018. Kiev 2019: http://www.ukrstat.gov.ua/druk/publicat/kat_u/2019/zb/08/zb_tr2018pdf.pdf

[394] Zhavoronkova, G.V.; Zhavoronkov V.O.; Volvach N.N. (.(Zhavoronkova et al.):.): Development of the Market of Aviation Transportation in Ukraine: Problems and Prospects. In Trans Motauto World, Volume 3, Issue 6, 2018, pp. 116-120: https://stumejournals.com/journals/tm/2018/3/116

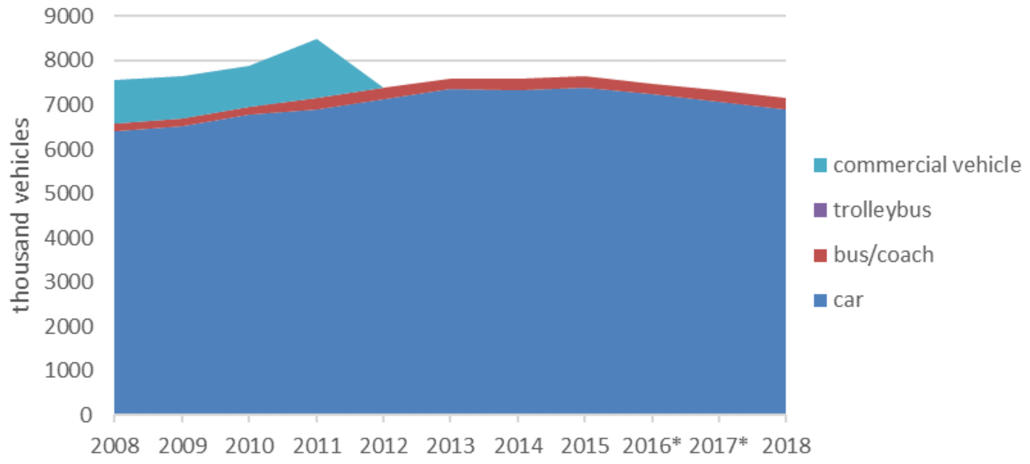

Figure 185: Registered road vehicles by type of vehicle[395 396 397 398]

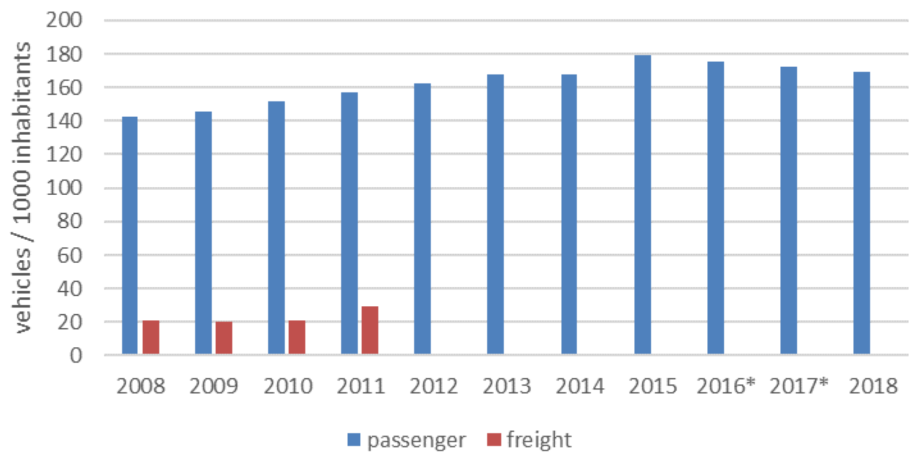

Figure 186: Comparison of passenger and freight vehicles per capita

[395] State Statistics Service of Ukraine (UkrStat): Транспорт і зв'язок України - 2013. Kiev 2014: http://www.ukrstat.gov.ua/druk/publicat/kat_u/2014/zb/09/zb_tr_13.zip

[396] Organisation Internationale des Constructeurs d'Automobiles (OICA): PC World Vehicles in Use. (n.d.). Available at www.oica.net/wp-content/uploads//PC_Vehicles-in-use.pdf, last accessed 16. APR 2020

[397] Organisation Internationale des Constructeurs d'Automobiles (OICA): New PC Registrations or Sales. (n.d.). Available at http://www.oica.net/wp-content/uploads/pc_sales_2019.pdf, last accessed 16. APR 2020: http://www.oica.net/wp-content/uploads/pc_sales_2019.pdf

[398] Ministry of Infrastructure of Ukraine (MTU): Statistics. (n.d.). Available at https://mtu.gov.ua/en/content/statistichni-dani-po-galuzi-avtomobilnogo-transportu.html, last accessed 16. APR 2020

14.3.1.3 Energy Consumption in Transport

From 2014 on, the temporarily occupied territory of the Autonomous Republic of Crimea, the city of Sevastopol and a part of temporarily occupied territories in the Donetsk and Luhansk regions are not taken into account.

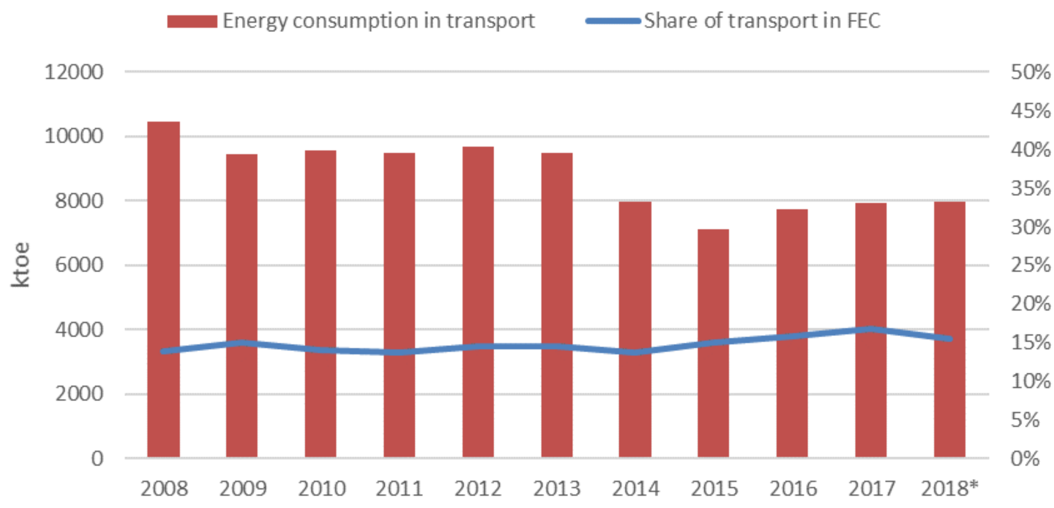

Figure 187: Energy consumption in transport[399]

The energy consumption has increased since 2015 after remaining roughly constant for several years. The share of transport in final energy consumption has fluctuated around 15% being a little higher in recent years.

The majority of energy is used for road transport. The consumption in this sector has increased since 2015 after remaining roughly constant in the years before. The share of transport by rail has been fluctuating in recent years without a clear tendency. There are small fluctuating shares of consumption in navigation and non-specified transport.

The dominant fuels in transport are oil and petroleum products, including gasoline, diesel (gasoil) and liquefied petroleum gas (LPG). The next most important fuel is electricity in rail and to a lesser extent in other transport including trolleybuses, trams, etc. Also, there have been small shares of natural gas and solid fuels which each have remained roughly constant since 2014.

[399] European Commission Energy Balances: Ukraine-Energy-Balances-September-2019-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

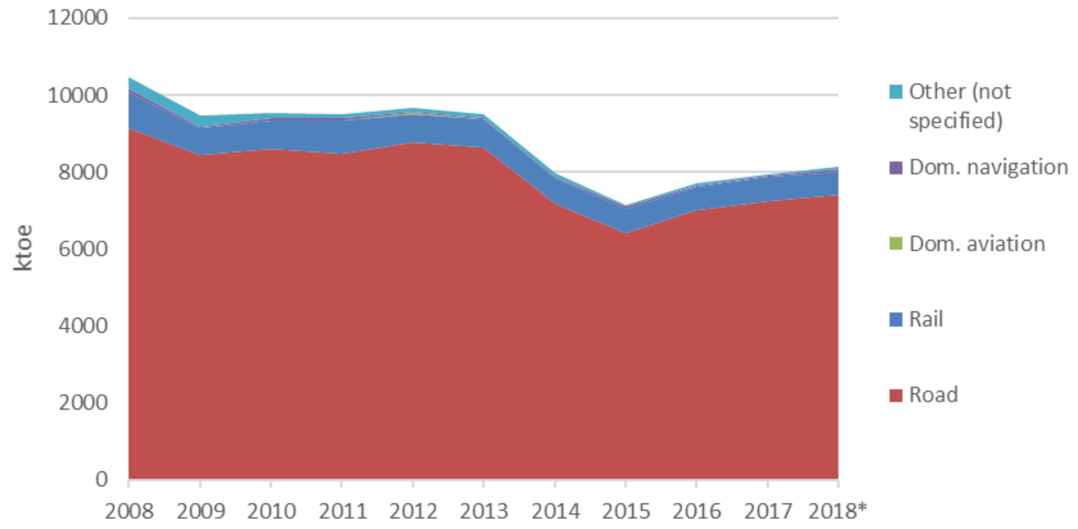

Figure 188: Energy consumption in transport by sub-sector[400]

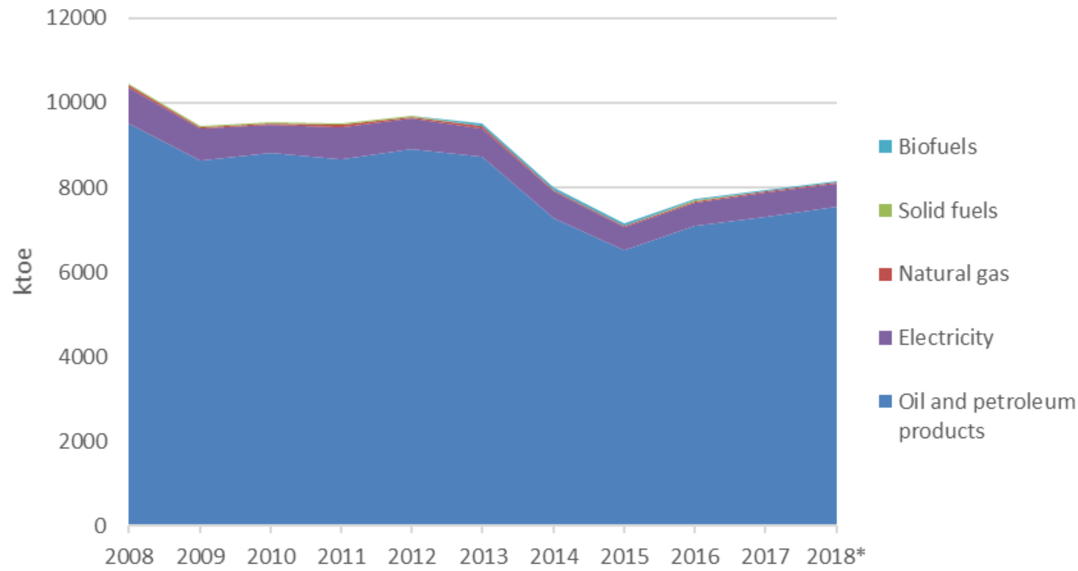

Figure 189: Energy consumption in transport by type of fuel[401]

The share of electricity consumption has remained constant since 2015. Since 2013 there has been a small consumption of biofuels. For Ukraine, bioethanol/bio-ETBE consumption is declared in the national progress reports. However, it is not compliant with RED, notably with

[400] European Commission Energy Balances: Ukraine-Energy-Balances-September-2019-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

[401] European Commission Energy Balances: Ukraine-Energy-Balances-September-2019-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

sustainability certification requirements, and is thus regrouped into "Non-compliant biofuels" here. In Figure 190, the renewable transportation fuels (left axis) and the renewable share in transport are displayed (right axis). The latter is based on renewable electricity, but does not include non-compliant biofuels, and applies multipliers both in the numerator and in the denominator according to RED. The increase in the RES-T share after 2013 is based on the decline in overall energy consumption in transport.

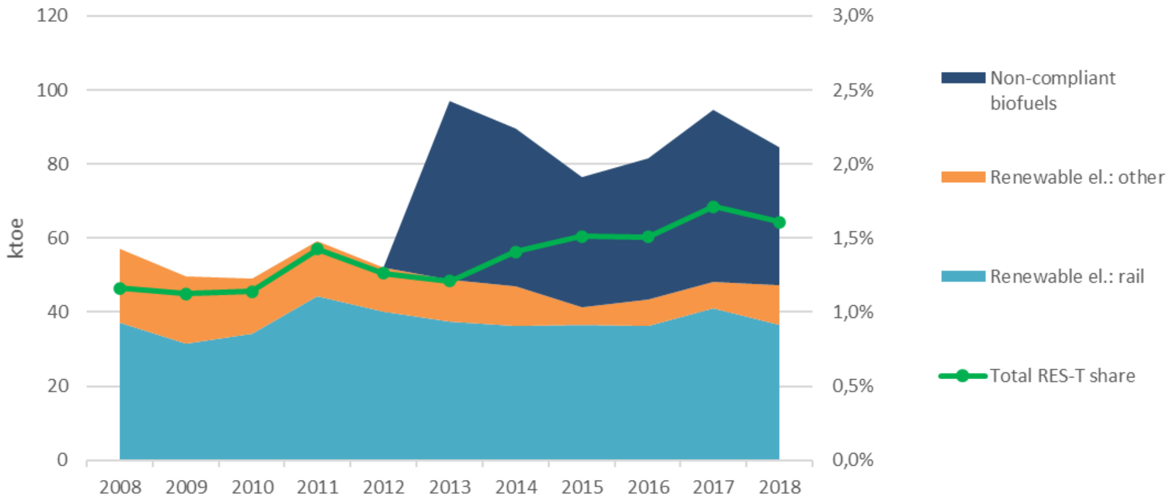

Figure 190: **Renewable energy consumption in transport**[402 403 404]

14.3.2 2030 Projections

The 2030 projections used here rely on the recent long-term energy modelling and forecasting study of the National Academy of Sciences of Ukraine[405]. In this study, forecasts for energy consumption in transport are made by fuel, but not by transport sub-sector (road, rail, etc.). Here, we have assumed for the business as usual scenario (middle column in Figure 191) that the share of rail in transport electricity consumption remains unchanged from 2018 in 2030, which implies an 18% growth of electricity consumption in rail by 2030. The same logic is applied to trolleybuses and other electricity consumption in public transport. The

402 European Commission Energy Balances: Ukraine-Energy-Balances-September-2019-edition. Available at https://ec.europa.eu/eurostat/web/energy/data/energy-balances, last accessed 02. APR 2020

403 Report on the Results of Stimulation and Use of Energy from Renewable Sources (2012-2013 values); Report on Promotion of the Use of Energy from Renewable Sources and Consumption in Ukraine in 2014-2015; Ukraine's Progress Report On The Promotion And Use Of Energy From Renewable Sources in Ukraine in the years of 2016-2017

404 Ukrainian input to the Eurostat SHARES instrument; personal communication by SAEE to LBST on 21 July 2020

405 Institute for Economics and Forecasting of the National Academy of Sciences of Ukraine, Danish Energy Agency, Technical University of Denmark: Long-term Energy Modelling and Forecasting in Ukraine: Scenarios for the Action Plan of Energy Strategy of Ukraine until 2035 - Final Report, 2019. Available at Web-page: https://timesukraine.tokni.com/tab3, last accessed 11 August 2020

remaining electricity consumption in transport according to the forecasting study is assumed to be road transport, i.e. battery cars and commercial vehicles. Overall growth in transport energy consumption from 2018 to 2030 is 23% from 7964 ktoe to 9780 ktoe (see Figure 191).

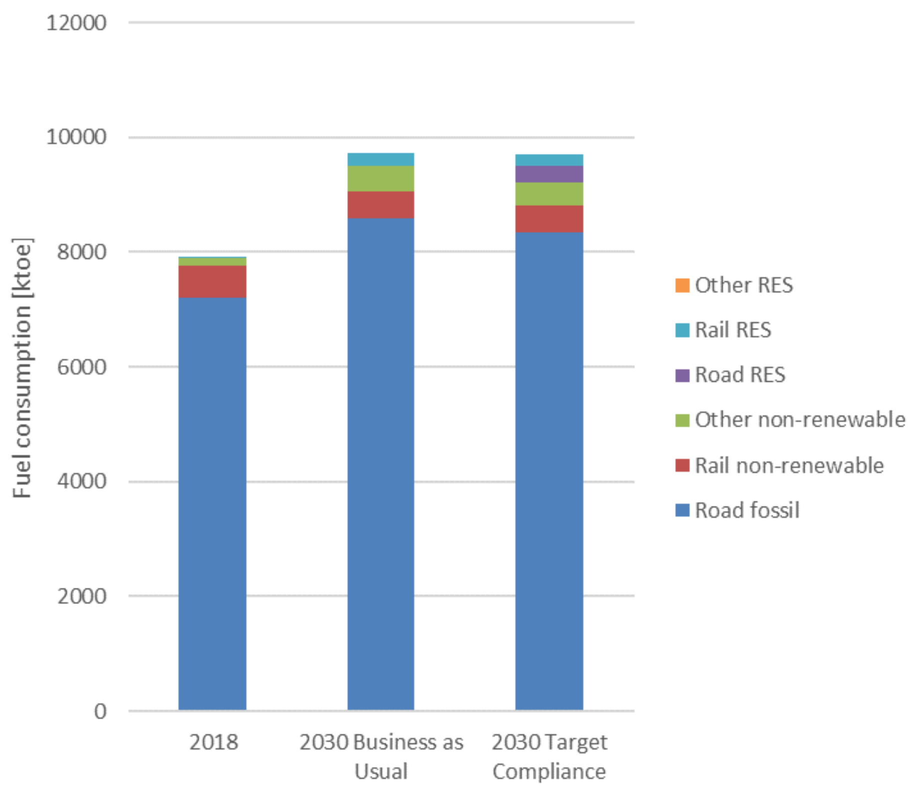

Figure 191: Energy consumption in transport in two scenarios for 2030

In a target compliance scenario achieving the 9% renewables in transport target for 2030, the roadmap as described in section 14.5.2 has been assumed to be implemented. This is represented by the right-hand column in Figure 191. The 9% renewable energies are broken down by options as described in section 0, and are shown in detail in Figure 192. It should be noted that for target compliance, multipliers are used for certain options; however, the energy quantities shown in Figure 191 show the physical energies, i.e. without multipliers. Therefore, the actual renewable energy contribution in 2030 is less than 9% of total consumption in transport.

The total energy consumption in transport in the target compliance scenario is slightly lower than in the business as usual scenario as battery-electric vehicles and hydrogen fuel cell-electric vehicles are more energy efficient than internal combustion engine vehicles.

The growth of fuel consumption leads to a higher fossil fuel consumption in 2030 even in the target compliance scenario. In order to reduce fossil fuel imports and CO_2 emissions from transport, either the growth in transport energy consumption could be reduced, or the target for renewables in transport could be more ambitious.

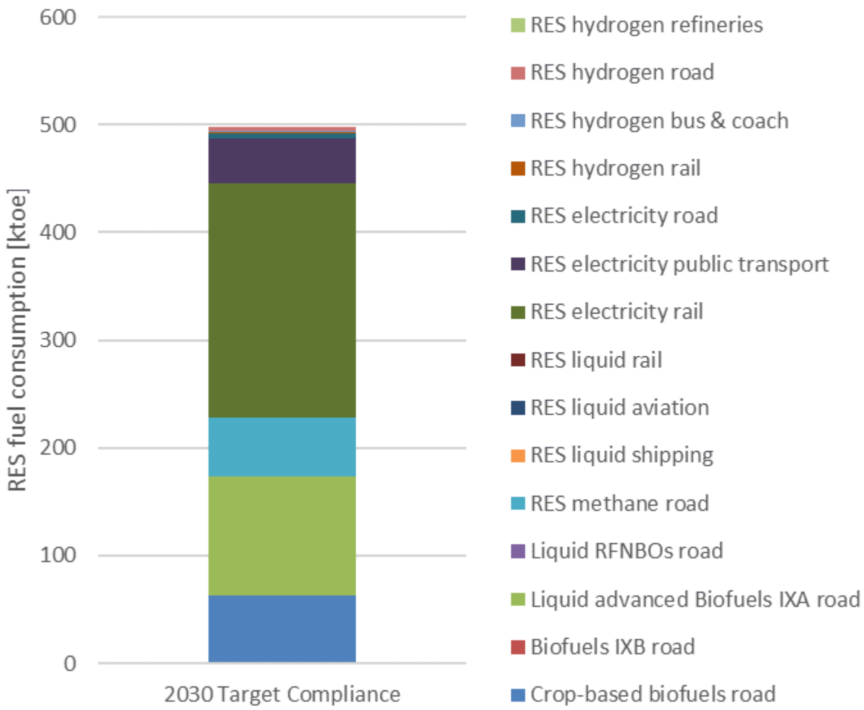

Figure 192: **Renewable energy consumption in transport in 2030 by option**

14.4 National renewable energy sources to meet the 2030 renewables in transport target

14.4.1 Potential of national renewable energy sources

The potential renewable fuel that could be produced from each of the feedstocks considered, is presented in Figure 193. Note these estimates relate to total feedstock potential and do not take into account competing uses, see section 3.2.1 for detailed description of sources and data used. Compared to the current energy use in road and rail transport, Ukraine has a significant existing production of sugar and starch crops. However, it should be noted that the values presented in Figure 193 correspond to total current production of these crops, therefore use of this resource for biofuel production would compete with existing uses of these crops. Ukraine also has a significant agricultural residues resource.

Current transport energy use (road and rail) in Ukraine is 21% of the potential renewable fuel that could be produced from all feedstocks apart from renewable power. When renewable power is included, the current transport energy use (road and rail) in Ukraine is 10% of the potential renewable fuel produced from all feedstocks.

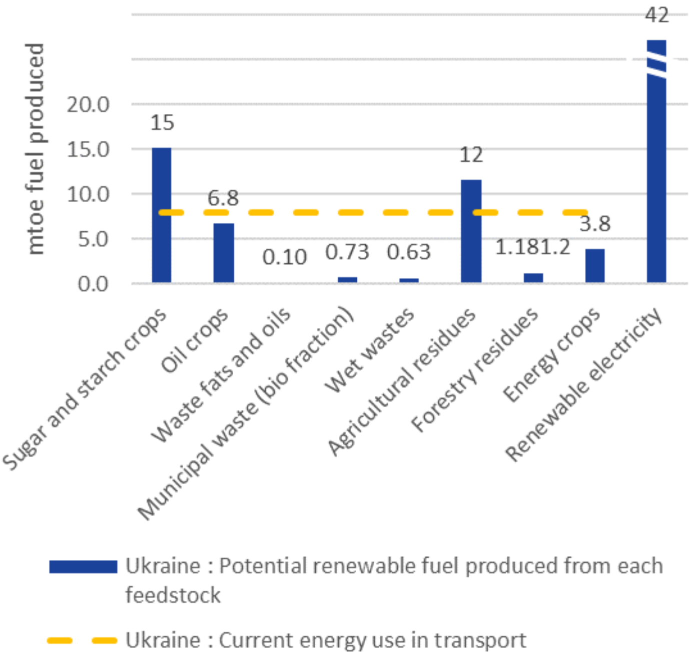

Figure 193: Ukraine: Potential renewable fuel production, compared to current energy use in road and rail transport

14.4.2 Current status of national transportation fuel pathway deployments

Ukraine has significant feedstock potential, and is a major exporter of crops, with an estimated 20 million tonnes of corn exported in 2019/20[406]. There is a large existing biofuels industry in the country. There are eight operational ethanol fermentation plants in Ukraine, with a combined production capacity of over 100 ktonnes/ annum. A further four plants are planned, which would increase the installed ethanol production capacity by 280 ktonnes/annum. There are currently eight ethanol fermentation plants which are not operating – their combined production totalled 154 ktonnes/annum. These plants could become operational again if the economics and other factors become favourable. Combined, this amounts to a potential capacity of 342 ktoe of crop-based ethanol per year.

Ukraine also has four operational FAME biodiesel plants, with a combined reported capacity of 25 ktonnes/annum. They predominantly use rapeseed and sunflower oils. There used to be an operational plant in Kalush, operated by Oriana Galev, with a production capacity of 180 ktonnes/annum. These operational plants, if operated at full capacity, could provide a further 23 ktoe of FAME per year.

[406] USDA, 2019. Feed and Grain Annual – Ukraine. Available at: https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Grain%20and%20Feed%20Annual_Kyiv_Ukraine_04-15-2020. Accessed November 2020.

14.5 Roadmap for achieving the renewable energy in transport target for 2030

14.5.1 Regulatory status quo

14.5.1.1 General data

Ukraine is making progress regarding the transposition of the provisions of RED into its national framework. However, national progress reports show that Ukraine is not on track to achieve the 2020 target set by the National Renewable Energy Action Plan up to 2020.

Ukraine has adopted the Law "On Alternative Fuels" which defines the legal, social, economic, environmental and organizational principles of production (extraction) and use of alternative fuels. As well, this law stimulates increase of the share of biofuels use to 20% of total fuel consumption in Ukraine by 2020.

In accordance with the Energy Strategy of Ukraine the share of energy from renewable energy sources used in transport should increase to 20% by 2025, which is less ambitious than the objective of the Law "On Alternative Fuels" mentioned above. Coordination and control over the implementation of the Energy Strategy is carried out by the Cabinet of Ministers of Ukraine and the National Security and Defense Council of Ukraine.

In 2018 Ukraine adopted the National Transport Strategy of Ukraine 2030. One of the priorities defined by this Transport Strategy is reduction of negative impact of transport on the environment. As well, the goals of the Transport Strategy are improvement of the transport service quality and safety, as well as improvement of transport infrastructure up to the European standards. In accordance with the National Transport Strategy the level of use of alternative fuels (bioethanol, biodiesel) is expected to increase to 50% by 2030, and the electric transport share in domestic traffic is expected to increase to 75% in 2030 through an increased use of electric vehicles including cars.

In 2019, the Energy Community started the process of setting 2030 targets in line with the Policy Guidelines on the development of integrated National Energy and Climate Plans (NECP) under Recommendation 2018/01/MC-EnC. Renewable energy targets as well as policies and measures will be addressed under the 'Decarbonisation of the economy' dimension of the NECP in an integrated way, which recognizes the interactions between the different dimensions.

Renewable energy targets, policies and measures for 2030 will thus be included in the NECP.

The competent body for monitoring of renewable energy targets is the State Agency on Energy Efficiency and Energy Saving of Ukraine (SAEE).

However, no penalties or fines are imposed in case of non-compliance with renewable energy targets.

Ukraine does not have any provision in respect of the compatibility of vehicles with various alternative fuel types. However, some support measures are available to purchasers of vehicles with electric propulsion engines.

In relation to the compatibility of vehicles with various alternative fuel types, in particular for operation on gaseous motor fuel and alternative types of liquid and gaseous fuels, the Procedure for retrofit of vehicles[407] to such fuels was adopted in 2010.

Some support measures are available to purchasers of vehicles with electric propulsion engines.

The Technical Regulation on requirements for motor gasoline, diesel, marine and boiler fuels defines that during the retail supply (sale) of fuel, designation of fuels must be placed on places accessible to the consumer (on the fuel distribution equipment), and reflected in the settlement documents, as well. Annex 1 of the Technical Regulation defines the requirements for designation of gasoline and diesel fuel. Namely, designation of motor gasoline includes the name and brand of gasoline and contains prescribed groups of signs, arranged in a certain sequence through a hyphen, while designation of diesel fuel includes prescribed groups of characters arranged in a certain sequence through a hyphen.

14.5.1.2 Energy efficiency in transport

In 2015 Ukraine has adopted National Energy Efficiency Action Plan until 2020 (NEEAP). NEEAP was developed based on the requirements of the Directive 2006/32/EC of the European Parliament and of the Council on energy end-use efficiency and energy services. The used model was recommended by the European Commission for the Member States of the European Union, and was also adapted for the Contracting Parties of the Energy Community. The reporting period of NEEAP for Ukraine to achieve the estimated goal according to the Directive is from 2012 to 2020.

The major priority tasks for improving energy efficiency in transport sector defined by NEEAP include development of a market for cleaner, more energy-efficient and safer vehicles through incentives like: easier access to city centers by public transport, creating of parking lot systems, optimizing public transport routes, development of electric transport, etc.

NEEAP for period 2019-2030 is discussed. The experts from the Energy Community Secretariat conducted a workshop on which was discussed the preliminary forecast for energy saving potential, for example measures related to buildings, industry and transport. The draft of NEEAP, including a roadmap for its implementation, will be developed in the coming months. On this basis, the Ukrainian government will make important decisions on how to enhance the energy security of its citizens. However, it should be mentioned that the measures for 2030 regarding energy efficiency shall be included in the NECP.

In addition, it should be mentioned the Law “On Energy Saving” which defines the legal, economic, social and environmental bases of energy saving for all enterprises, associations and organizations located on the territory of Ukraine, as well as for citizens. The Law “On Energy Saving” stipulates that the purpose of energy saving legislation is to regulate relations between economic entities, as well as between the public authorities and legal entities and

407 Document number in the Verkhovna Rada of Ukraine № 607-2010-п from 21.07.2010 https://zakon.rada.gov.ua/laws/show/607-2010-п?lang=en#Text

individuals in the field of energy saving related to extraction, processing, transportation, storage, production and use of fuel and energy resources.

As well, it has been prepared the Draft Law “On Energy Efficiency” which shall define the legal and organizational basis for activities in the field of energy efficiency and aims to create conditions to reduce energy consumption. This draft law is setting up the national legal framework regarding the energy efficiency in all the sectors of the national economy, inclusively the transport sector.

The Draft Law "On Energy Efficiency" will lay the foundation for reducing energy dependence and increasing the competitiveness of Ukraine. The basic Draft Law of Ukraine "On Energy Efficiency" is developed and improved in accordance with the requirements of the Directive 2012/27/EU.

The goal of the Draft Law “On Energy Efficiency” is to replace the outdated Energy Saving Law from 1994 and to increase the energy efficiency of the Ukrainian economy and its competitiveness.

National Energy and Utilities Regulatory Commission of Ukraine (NEURC) is an independent regulatory body which carries out state regulation, monitoring and control over the activities of economic entities in the fields of energy and utilities. However, NEURC does not have competences in the field of transport sector.

Another significant body is State Agency on Energy Efficiency and Energy Saving of Ukraine (SAEE). SAEE’s main responsibilities are: implementation of the national policy in the field of efficient use of fuel and energy resources, energy saving, renewable energy sources and alternative fuels, ensuring an increase in the share of renewable energy sources and alternative fuels in the energy balance of Ukraine, provision of administrative services in the relevant sphere, as well as submitting proposals to ensure development of the national policy in this area to the competent Ministry.

The Ministry of Energy and Coal Industry of Ukraine is responsible for development of the Energy Strategy, monitoring of the implementation of the Energy Strategy and making proposals to clarify the target values and mechanisms for its implementation, as well as for the formation and implementation of national policy in the fuel and energy sector.

14.5.1.3 Production and supply of fuel

The creation of an effective legislative mechanism for the development of a competitive market for the production and use of bioethanol and biocomponents is extremely important for Ukraine.

According to the Law “On Alternative Fuels”, the share of bioethanol in gasoline produced and / or sold on the territory of Ukraine shall amount at least 7% from 2016 onwards.

It should be noted that the Law of Ukraine On Alternative Types of Liquid and Gas Fuel defines that the main principles of the national policy in the field of alternative fuels are:

- promotion of the development and rational use of non-traditional sources and types of energy raw materials for the production (extraction) of alternative fuels in order to save fuel and energy resources and reduce Ukraine's dependence on their import. Non-traditional sources and types of energy raw materials are: vegetable raw materials, waste, solid combustible substances, other natural and artificial sources and types of energy raw materials, including oil, gas, gas condensate and oil and gas condensate depleted, non-industrial and man-made fields, heavy oil, natural bitumens, gas-saturated waters, gas hydrates, etc.;
- gradual increase of the normatively defined share of production and use of biofuels and mixed motor fuels. The content of bioethanol in motor gasolines produced and/or sold on the territory of Ukraine will be not less than 7 percent (volume) from 2016;

In accordance with the Law of Ukraine On the State Regulation of Production and Circulation of Ethyl Alcohol, Cognac and Fruit Alcohols, Alcoholic Beverages, Tobacco Products and Fuel, fuel production is carried out by economic entities which must have a license for such activity. The license should be obtained for retail or wholesale trading and storage of fuel, as well. Licenses for retail and storage of fuel are issued by the by the executive bodies authorized by the Cabinet of Ministers of Ukraine at the location of fuel storage for a period of five years, and the license for wholesale trading is issued by the executive bodies authorized by the Cabinet of Ministers of Ukraine in the Autonomous Republic of Crimea, oblasts, the cities of Kyiv and Sevastopol for a period of five years.

Business entities that perform retail, wholesale trading or storage of fuel exclusively in consumer packaging up to 5 liters, are not obliged to have a license.

In order to fulfil international obligations and to create a regulatory framework for the development of the sphere of production, circulation and use of liquid biofuels in transport, the Members of Parliament of Ukraine, together with the SAEE, developed a draft Law of Ukraine on Amendments to Certain Legislative Acts of Ukraine Concerning the Mandatory Use of Liquid Biofuels (Biocomponents) in the Transport Industry[408]. The draft Law amends several Laws of Ukraine and other legislative acts related to

- obligatory quotas on the biocomponent in the volume of sold motor fuel; for gasoline:
  - From 1st July 2021 after the adoption – not less than 3.4% energy (5% volume);
  - From 1st July 2022 after the adoption – not less than 4.1% energy (6% volume);
  - From 1st July 2023 after adoption – not less than 4.8% energy (7% volume);
- responsibility for non-compliance with quotas;
- fulfilment of sustainability criteria by biocomponents from 1st July 2022, after the adoption;

[408] Registration number in the Verkhovna Rada of Ukraine № 3356 17042020 from 17.04.2020; http://w1.c1.rada.gov.ua/pls/zweb2/webproc4_1?pf3511=68617

- introduction of terminology in the field of liquid biofuels, which complies with RED II.

In respect of the sustainability criteria the draft Law introduces sustainability criteria for liquid biofuels (biocomponents) and biogas in transport, and in particular it defines greenhouse gas emission savings from the use of these types of biofuels and the ban on use of certain land types to obtain raw materials for the production of biofuels. Technical requirements for the reduction of greenhouse gas emissions in the production and use of liquid biofuels (biocomponents) and biogas intended for use in the transport sector are determined in accordance with the national standard.

The sustainability criteria need to be certified by independent audits based on voluntary schemes as defined in RED II for certification.

With respect to the reporting obligations in Ukraine, the Law of Ukraine "On State Statistics" is relevant. All business entities in accordance with the Law of Ukraine "On State Statistics" provide to the State Statistics Service in the appropriate forms of statistical information in a timely manner information "On sales of light petroleum products and gas" on monthly and annual bases.

Also, in accordance with the Customs Code of Ukraine, information is provided to the State Customs Service.

The draft Law imposes reporting obligations, as well, which shall apply after its adoption. In accordance with the draft Law, business entities engaged in the production and/or import of fuel and/or wholesale trade of fuel should provide information on the actual share of liquid biofuels (biocomponents) in the sold volumes of motor gasoline for the reporting period, as well as on the compliance of liquid biofuels (biocomponents) with sustainability criteria. This obligation should be fulfilled annually starting from 2022, no later than July 1 of the year following the reporting calendar year.

In addition, the provisions of the draft Law define that information on the compliance of liquid biofuels (biocomponents) with the sustainability criteria for the previous calendar year shall be submitted to the independent auditor by February 1 of the year following the reporting calendar year. The information contains information on measures taken to protect soil, water and air, restore degraded lands, avoid excessive water consumption in scarce areas.

Once the draft Law is adopted, business entities that carry out activities regarding the production and/or import of fuel and/or carry out wholesale trade of fuel shall be liable for offense, if they fail to submit by July 1 of the year following the reporting calendar year information on the actual share of liquid biofuels (biocomponents) in the volume leaving or entering the customs territory of Ukraine.

Table 63: Reporting obligations in Ukraine

	Reporting by	Reporting to	Frequency	Exemptions
Draft Law	Business entity engaged in the production and/or import of fuel and/or wholesale trade of fuel	The central executive body, which implements the national policy in the field of efficient use of fuel and energy resources, energy saving, renewable energy sources and alternative fuels; Independent auditor	Annual	None
The Law of Ukraine "On State Statistics"	All business entities	The State Statistics Service	Monthly and annual	None
The Customs Code of Ukraine		The State Customs Service		

In respect of the production of electricity from renewable sources, the Law on Alternative Energy Sources and the Law On Electricity Market should be mentioned.

The Law on Alternative Energy Sources defines the legal, economic, environmental and organizational principles of alternative energy sources and promotes their use in the national energy mix, while the Law On Electricity Market defines the legal, economic and organizational principles of the electricity market, regulates relations related to the production, transmission, distribution, purchase and sale, supply of electricity to ensure reliable and secure supply of electricity to consumers, taking into account the interests of consumers, market development relations, minimizing the cost of electricity supply and minimizing the negative impact on the environment.

The authority which is responsible for licensing procedures for the production of electricity from renewable sources is NEURC. On the other hand, production of biofuels is not subject to licensing in Ukraine.

It is important to mention that in Ukraine does not exist regulation which contain provisions with required criteria related to electricity used directly in transport.

There are several gaps in the Ukrainian legislation which may be filled in the future. This refers to renewable fuels of non-biological origin – RFNBO defined in RED II. For the production of RFNBOs no criteria related to electricity used to produce RFNBOs is defined.

Certain subjects such as public parking or public garages are obliged to have electric vehicle charging stations. Namely, in 2019 came into force amendments to the state building codes for the design of parking lots and garages. According to them, a mandatory requirement is introduced in Ukraine – to equip at least 5% of parking spaces in parking lots under construction or reconstruction with electric cars.

Furthermore, in accordance with existing legislation, for charging electric vehicles at electric charging stations is not required a license.

One of the interesting measures in the area of E-mobility is imposed to the owners of vehicles that park a vehicle with an internal combustion engine in places directly intended for parking or charging electric vehicles. In such case, the owners shall be obliged to pay a fine in the amount of 20 to 30 tax-free minimums, which is accordingly 340-510 UAH.

In 2019 was adopted the Law of Ukraine "On Amendments to Certain Legislative Acts of Ukraine Concerning the Creation of Access to the Infrastructure of Charging Stations for Electric Vehicles". One of the amendments refer to the implementation of green license plates for electric cars, and systematization of the issues of traffic, parking and charging of electric cars by changing governmental traffic and construction regulations.

Tax Code of Ukraine imposes exemption from taxation in case of import into the customs territory of Ukraine of the equipment and materials for the production of alternative fuels, materials, raw materials, equipment and components that will be used in the production of alternative fuels or energy from renewable energy sources.

As well, the Custom Code of Ukraine determines tax benefits, i.e. exemption from customs duties for companies operating in the use of renewable energy sources and alternative fuels.

14.5.1.4 Passenger transport sector

Article 215.3.5[1] of the Tax Code of Ukraine defines tax rate for passenger vehicles in Ukraine.

Tax rate for the passenger vehicles is determined by the formula defined by the Tax Code of Ukraine, in accordance with the tax basis, engine and vehicle's age, as follows:

Tax rate = tax basis * Factor „engine" * factor "age"

Tax basis is the tax rate in EUR for 1 unit of vehicle:

- with spark-ignition internal combustion engine and crank mechanism with a cylinder capacity of up to 3.000 cm^3 (inclusive) - 50.0;
- with spark ignition internal combustion engine and crank mechanism with a cylinder capacity exceeding 3.000 cm^3 - 100.0;
- with an internal combustion engine with compression ignition (diesel or semi-diesel) with a cylinder capacity of up to 3.500 cm^3 (inclusive) - 75.0;

- with compression-ignition internal combustion engine (diesel or semi-diesel) with a cylinder capacity exceeding 3500 cm^3- 150.0;

Factor „engine” shall be determined by dividing the volume of the cylinders of the internal combustion engine of the vehicle per 1.000 cm^3.

Factor “age” is a coefficient equal to the number of full calendar years from the year following the year of production of the vehicle to the year of determining the tax rate (for new vehicles and vehicles used before one full calendar year, the coefficient is 1, and for vehicles used for more than 15 full calendar years, the coefficient is equal to 15).

Furthermore, in case of the vehicles for transport of 10 and more passengers including the driver, fixed tax rate per unit depends on:

- engine capacity;
- whether the vehicle is new or used;
- is it vehicle with compression-ignition internal combustion engine (diesel or semi-diesel), or with spark-ignition internal combustion engine.

However, the amount of tax rate is almost the same for each vehicle category, 0,003€ or 0,007€ per 1 cm^3 of volume of cylinders of the engine.

Tax rate for vehicles that have been used for more than 8 years and comply with the code 8702 according to the UKT ZED (motor vehicles intended for the carriage of 10 persons or more, including the driver) are applied with a factor 50.

The tax rate for vehicles powered only by an electric motor amount 100 € for 1 piece, for other vehicles equipped with electric motors.

The tax rate for vehicles equipped exclusively with electric motors (one or more), is set at 1€ per 1 kilowatt-hour of electric battery capacity of such vehicles.

For free circulation in the customs territory of Ukraine, in accordance with the customs and tax codes for customs clearance of goods – vehicles are subject to payment of:

- import duty – at a rate of 10% of the customs value of goods (Law of Ukraine "On Customs Tariff of Ukraine");
- excise tax – amount depends on the volume of the engine and the age of the vehicle at the rates specified in Article 215 of the Tax Code of Ukraine;
- VAT – at a rate of 20%, in accordance with the Article 193 of the Tax Code of Ukraine.

It should be mentioned that individuals and legal entities, including non-residents, who have their own vehicles registered in Ukraine are the payers of the transport tax.

The object of taxation (transport tax) are vehicles whose year of production has not exceeded five years (inclusive) and whose average market value is higher than 375 times the minimum wage, determined by the law on January 1 of the tax (reporting) year.

Limitations for registration, purchase, i.e. import of a vehicle are based on the age of a vehicle. In case when the vehicle is older, the higher is a tax, i.e. fees imposed to the owner of vehicle.

In accordance with the Law of Ukraine "On Customs Tariff of Ukraine" customs duty rate is defined based on the following criteria:

- vehicle age – new or used vehicle;
- engine capacity;
- engine type: combustion engine, or electro, or only electro.

Incentives which refer to electric vehicles are determined by the Tax Code of Ukraine, as well as by the Law of Ukraine "On Customs Tariff of Ukraine”. The Law of Ukraine "On Customs Tariff of Ukraine” imposes the abolition of import duties on electric vehicles, i.e. vehicles equipped with electric motors (battery electric vehicles and fuel cell electric vehicles). Furthermore, imported electric vehicles are exempted of payment of VAT until the end of 2022.

In addition, in June 2020 the Verkhovna Rada adopted a draft Law on Customs Tariff, which stipulates that from July 1, 2020, the classification of vehicles equipped exclusively with electric motors will not be under code 8703 90 10 10, but under codes 8703 80 10 10 (new) and 8703 80 90 10 (used).

In respect of the duties imposed to the owners of motorcycles, Article 215.3.7 of the Tax Code of Ukraine defines tax rate for motorcycles (including mopeds) and bicycles in Ukraine, depending on their engine capacity. For motorcycles (including mopeds) and bicycles with an auxiliary engine, with or without carriages, with internal combustion engine with a crank mechanism and engine capacity not exceeding 50 cm^3 up to 500 cm^3 fixed tax rate per unit is set at 0,062€ per 1 cm^3 of volume of cylinders of the engine. If the engine capacity is exceeding 500 cm^3 but not more than 800 cm^3 fixed tax rate per unit is set at 0,443 € per 1 cm^3 of volume of cylinders of the engine. In case of motorcycle with engine capacity exceeding 800 cm^3 fixed tax rate per unit is set at 0,447 € per 1 cm^3 of volume of cylinders of the engine.

However, for motorcycles (including mopeds) and bicycles, with or without electric motors, i.e. other than those with an internal combustion engine with a crank mechanism and strollers, fixed tax rate per unit is set at 22€ for 1 piece.

In the area of public transport in Ukraine, abovementioned incentives which refer to electric vehicles apply as well.

At the moment, in the public transport sector there is no obligation to use electricity, or related to the age of vehicles. However, in 2020/2022 regular technical inspections depending on vehicles (bus/taxi, passenger car etc.) are introduced.

14.5.1.5 Freight transport sector

Article 215.3.5² of the Tax Code of Ukraine defines tax rate for freight vehicles in Ukraine.

For dump trucks intended for off-road use, with a compression-ignition internal combustion engine (diesel or semi-diesel) or with a spark-ignition internal combustion engine, and a carrying capacity exceeding 75 t, fixed tax rate per unit is set at is set at 0,016€ per 1 cm³ of volume of cylinders of the engine.

For dump trucks weighing up to 5 t, fixed tax rate per unit is set at is set at 0.01€ per 1 cm³ of volume of cylinders of the engine.

For other vehicles with compression-ignition internal combustion engine (diesel or semi-diesel) fixed tax rate per unit is set depending on:

- mass of the vehicle (from 5 t up to 20 t and more);
- whether is new vehicle or used vehicle.

In case when the mass of vehicle is higher and when the vehicle is used, the tax rate is set higher, and vice versa.

Except of the criteria related to the new or used vehicle, in case the mass of the vehicle is not exceeding 5 t, condition related to the engine capacity is defined, as well (not exceeding 2,500 cm³ or exceeding 2,500 cm³), however the tax rate is set in the same amount regardless of the engine capacity, taking into account only whether the vehicle is new or used.

For other vehicles with spark-ignition internal combustion engine fixed tax rate per unit is set depending on:

- mass of the vehicle (not exceeding 5 t and exceeding 5 t);
- whether is new vehicle or used vehicle.

Except of the criteria related to the age of the vehicle, in case the mass of the vehicle is not exceeding 5t, condition related to the engine capacity is defined, as well (not exceeding 2,800 cm³ or exceeding 2,800 cm³), but the tax rate is set in the same amount regardless of the engine capacity, taking into account only whether the vehicle is new or used.

The tax rate for freight vehicles corresponding to the code 8704 according to the UKT ZED (motor vehicles for cargo transportation) applies to vehicles used from 5 up to 8 years with a factor of 40, and for vehicles used for more than 8 years with a factor 50.

In the area of freight transport, limitations for registration, purchase, or import of a vehicle are based on the age of the vehicle. Taxes or fees are higher for older vehicles.

The following aspects are not regulated by the legislation in Ukraine for the freight transport sector:

- determination of the authority which shall perform control over the persons who obtained a right of incentives or who have additional burdens;
- defining the consequences of non-compliance with the burdens.

It should be noted that in Ukraine customs checks the technical specifications of the vehicles when they are imported.

14.5.1.6 Railway sector

In Ukrainian legislation, there are no provisions which regulate the following issues:

- determination of the limitations for registration, purchase, import or use of a locomotive (diesel, steam, electric) in terms of age or emission standard or fuel;
- imposing of certain obligations for use of electric locomotives;
- use of electricity from renewable energy for railway transport.

14.5.2 Roadmap to achieve the 2030 target

The roadmap developed here for Ukraine to achieve the 2030 target of 9% renewable energies in transport builds on the provisions of RED II as described in section 3.1.1. It is assumed that these provisions are transposed into Ukrainian law without changes including the calculation method for renewables in transport, the caps and minimum values for various types of renewable energies, the multipliers, the provisions related to electricity and RFNBOs etc. Also, sustainability criteria need to be transposed into national law in order to fully comply with RED II, and it must be ensured that certification schemes are in place (national or voluntary) that are compliant with RED II requirements.

For this study, we apply the renewable share in the national electricity mix anticipated for 2030. On the one hand, this tends to overestimate the renewable share as values for the year 2028 that should be applied are not available, but should in general be lower than the 2030 values. On the other hand, dedicated renewable power plants may be erected that are counted as 100% renewable for transport.

For Ukraine, a 40% renewable electricity mix is anticipated for 2030 based on literature values.[409] This is without prejudice to 2030 targets to be defined and included in the NECP.

It should be noted that the national electricity mix is applied to electricity in transport for calculating the contribution of renewable electricity to the 20303 RES-T target. However, RED II allows electricity to be counted as 100% renewable if it is based on dedicated capacities for transport, and further criteria are met.

14.5.2.1 Potential contributions from all options

Based on the assessment of all options for Ukraine, a total RES-T share of 13.8% in 2030 can be achieved as a combination of all options (see Table 64). Further limited potentials exist in renewable liquid fuels in shipping, aviation and rail, which are assumed to be zero here.

Biofuels and electric rail potentially contribute most in 2030. In Ukraine, the rail network is electrified to a significant degree and represents a relatively high share of transport fuel consumption today, which is assumed to be maintained towards 2030. The 40% renewable share in the national electricity mix leads to proportional accounting of the electricity as renewable. The third element is the multiplier of 1.5 for electricity consumed in rail. Already

[409] TU Wien/Energy Economics Group, Joanneum Research, REKK: Study on 2030 overall targets (energy efficiency, RES, GHG emissions reduction) for the Energy Community. Vienna 2019

today, the renewable contribution of electricity in rail transport is high based on this calculation method.

Ukraine has an established use of methane in road transport. This can be used to introduce biomethane based on Annex IXA feedstocks, which have a suitable potential in Ukraine.

Electric and hydrogen vehicles can already make small contributions by 2030, and have a strong growth potential thereafter.

Table 64: Potential RES-T contributions from all options in Ukraine

Option		Contribution to RES-T target (%) incl. multiple counting	Amount of renewable fuel used (ktoe)
Biofuels and liquid RFNBOs	1. Crop-based biofuels in road transport	2.0%	188.6
	2. Liquid fuels produced from Annex IX B feedstocks in road transport	3.4%	160.3
	3. Liquid advanced Biofuels (based on Annex IX A feedstocks) in road transport	2.3%	110.4
	4. Liquid RFNBOs in road transport	0.03%	2.90
	5. Renewable methane in road transport	1.2%	54.6
	6. Renewable liquid fuels in shipping	0.0%	0.00
	7. Renewable liquid fuels in aviation	0.0%	0.00
	8. Renewable liquid fuels in rail	0.0%	0.00
Electricity	9. Rail electrification	3.45%	217.0
	10. Electric public transport (bus, trolleybus, tram, metro)	1.12%	42.23
	11. Electric road vehicles (passenger cars and trucks)	0.19%	4.55
Hydrogen	12. Hydrogen in rail	0.01%	1.11
	13. Hydrogen bus and coach (urban bus, long distance coaches)	0.006%	0.60
	14. Hydrogen road vehicles (passenger cars and trucks)	0.05%	4.55
	15. Hydrogen in refineries	0.0%	0.00
Total		13.8%	787

As the possible contributions of battery-electric vehicles depend on many factors, the following considerations are intended to provide some insight into the dynamics and opportunities (see Figure 194). The graph is based on a number of approximate assumptions, and should thus be understood as rough indication showing the general trends.

Battery-electric cars' contribution to the RES-T target is calculated by applying the renewable share in the national electricity mix to the use of electricity in BEVSs[410].

Electricity provided through public charging stations is covered in statistics as energy consumed in transport, and thus counted accordingly; charging through private charging

[410] However, if certain criteria are met (see RED II), renewable electricity can be counted as 100% renewable. This is not assumed in this study for option 11.

units is not covered in statistics. Therefore, RED II foresees a multiplier of four for electricity consumed in road transport (based on data from statistics).

The RES-T contribution of battery cars depends on:

- The number of battery cars (horizontal axis in Figure 194);
- The share of public charging (green/ blue line in Figure 194 assuming 25% and 100% public charging, respectively);
- The renewable share in the national electricity mix in 2028 (40% for Ukraine); higher/ lower RES shares would reduce the contribution accordingly.

Assuming 25% public charging, 2 million battery cars would approximately contribute 1.7% RES-T by 2030 (see Figure 194).

As battery cars are more energy efficient than conventional cars and the electricity is only partly covered in statistics energy consumption in transport decreases with increasing battery cars (dotted lines in Figure 194).

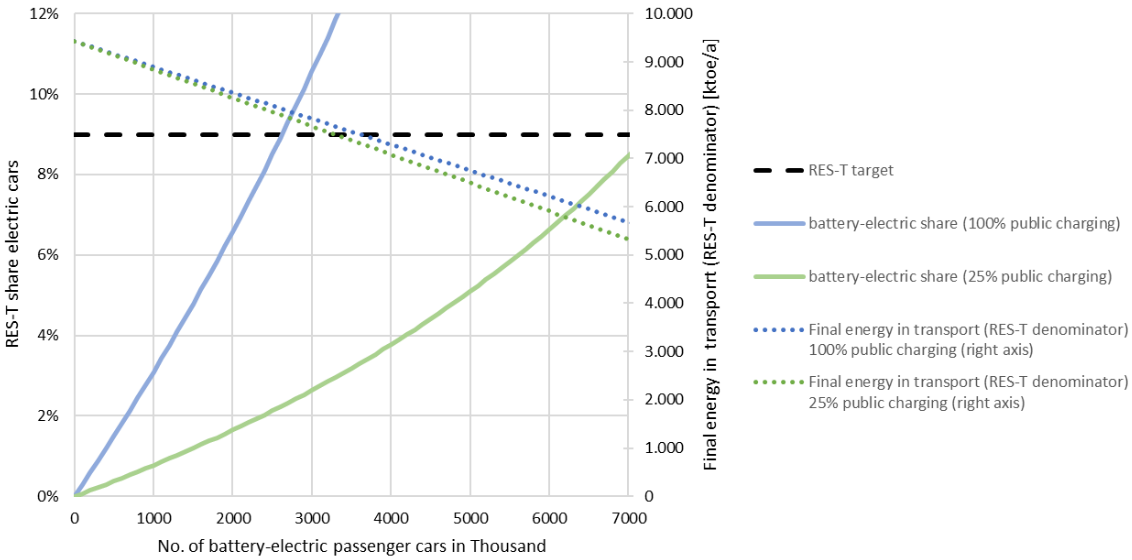

Figure 194: Possible contributions of battery cars to Ukraine's 2030 RES-T target

14.5.2.2 Choice of options to meet RES-T target

The rather high potential contribution of all options allows the contributions from several options to be reduced. The reductions are based on the general considerations described in section 5.1, and on the specific circumstances in Ukraine as described in the following:

1. In order to limit the competition with food and animal feed production, crop-based biofuels are capped at 2% by RED II; however, only 0.7% is required to achieve the 9% target, reducing the food and feed competition even further. If all of Ukraine's ethanol plants operated at full capacity, these plants could produce 342 ktoe of crop-

based ethanol per year: significantly greater than Ukraine's roadmap target of 189 ktoe per year from crop-based biofuels;

2. Biofuels based on Annex IXB biofuels are not required to meet the 2030 target;
3. Liquid biofuels based on Annex IXA feedstocks ("advanced biofuels") are developed to meet the minimum targets defined in RED II, aside from the contribution from biomethane (see point 5). For context, this is equivalent to the output of 3.5 advanced ethanol plants at typical scale of 63 million l fuel/yr;
4. Relatively expensive RFNBOs are not required in road transport to meet the 2030 target;
5. Biomethane is used in existing gas vehicles, up to a level equivalent to the current amount of biomethane used in electricity production, to contribute to the advanced biofuels target (see No. 3 above); this requires an additional 9% of Ukraine's total manure-biomethane potential;
6. No renewable fuels in shipping are required to meet Ukraine's RED II target;
7. No renewable fuels in aviation are required to meet Ukraine's RED II target;
8. No renewable fuels in rail are required to meet Ukraine's RED II target; expansion of electricity consumption in rail is seen as more promising (see next point)
9. Increasing the national renewable share in electricity, maintaining and installing catenaries at non-electrified rail lines or closing non-electrified rail gaps as well as keeping the share of rail electricity in transport electricity consumption by extending rail transport accordingly are assumed;
10. The introduction of battery buses and the expansion or establishment of trolley bus systems, trams, or metros in cities is assumed here;
11. The market uptake of battery-electric road vehicles (cars and light/ medium duty trucks) leads to electricity consumption in transport based on the existing strategy for electric mobility, and further development of it;
12. Existing and new rail lines not suitable for electrification allow establishing zero emission hydrogen fuel cell trains;
13. Introduce hydrogen fuel cell buses in urban areas, and (long-distance) coaches in applications not suitable for battery-electric vehicles (high daily driving range, long-distance);
14. Start of market uptake of hydrogen fuel cell-electric road vehicles (cars and light to heavy duty trucks) for long-distance, high driving ranges;
15. Use of renewable hydrogen in the refineries sector in Ukraine could be an option for the near-term, but is not assumed here for a contribution by 2030. A detailed assessment of the refineries would be needed to assess the opportunities. Possible

hydrogen demand that would be served from renewable sources could contribute to the RES-T target.

This results in the following contributions by 2030 assumed to be realistic and reducing the most challenging or expensive[411] options to meet the defined 2030 RES-T target:

Table 65: Contribution to Ukraine's RES-T target from options chosen

	Option	Multiplier	2030 Contribution to RES-T target incl. Multipliers	2030 Amount of renewable fuel used (ktoe)
Biofuels and liquid RFNBOs	1. Crop-based biofuels in road transport	1	0.67%	63
	2. Liquid fuels produced from Annex IX B feedstocks in road transport	2	0%	0
	3. Advanced liquid biofuels (based on Annex IX A feedstocks) in road transport	2	2.3%	110
	4. Liquid RFNBOs in road transport	1	0%	0
	5. Renewable methane in road transport	2	1.2%	55
	6. Renewable liquid fuels in shipping	2	0%	0
	7. Renewable liquid fuels in aviation	2	0%	0
	8. Renewable liquid fuels in rail	2	0%	0
Electricity	9. Rail electrification	1.5	3.5%	217
	10. Electric public transport (bus, trolleybus, tram, metro)	4	1.1%	42
	11. Electric road vehicles (passenger cars and trucks)	4	0.2%	4.6
Hydrogen	12. Hydrogen in rail	1	0.012%	1.1
	13. Hydrogen bus and coach (urban bus, long distance coaches)	1	0.0064%	0.6
	14. Hydrogen road vehicles (passenger cars and trucks)	1	0.048%	4.6
	15. Hydrogen in refineries	1	0%	0
Total			9%	498

Strong contributions are made by electricity in rail and by liquid advanced biofuels; moderate contributions are made by biomethane in road transport, electric public transport (bus, trolleybus, tram, metro), and crop-based biofuels; limited contributions are made by electric road vehicles, and hydrogen in road vehicles, buses and coaches as well as in rail.

The high contribution from electricity in rail, and to a lesser extent from all other forms of electricity or hydrogen-based transport, assumes a 40% share of renewable electricity in power by 2030. If this was lower, all options using electricity directly or hydrogen would make a smaller contribution to the 2030 target. A higher renewable share in the national electricity mix or dedicated renewable capacities would increase the renewable contribution of rail and all other forms of transport, which are based on electricity or hydrogen.

The high proportion of Annex IXA (advanced) biofuels is driven by the sub-target in RED II and relies on successful scale-up in production of liquid Annex IXA biofuels globally. Should this prove not to be feasible, crop-based biofuels or biofuels based on Annex IXB could be increased, which would, however, not allow the sub-target for advanced biofuels in RED II to be met.

These contributions lead to a breakdown of fuel consumption in 2030 as shown in section 14.3.2.

[411] Detailed cost assessments have not been carried out in this study. Rough cost judgements are made here based on costs information provided in chapter 3.

14.5.2.3 Roadmap for Ukraine

The roadmap for Ukraine to achieve the 2030 target for renewable energies in transport (see Figure 195) involves key policies to be developed and adopted in the coming few years, building on the existing regulatory framework and policy elements already under development (see section 14.5.1). The development of the regulatory framework so far focuses on biomass-based fuels and on battery-electric vehicles. In parallel, renewable hydrogen is being discussed as an opportunity for Ukraine both for domestic use and for export. The rail sector and public transport are a stronghold in Ukraine of electricity use. Increasing the share of renewable electricity in the national power mix will benefit also the transport sector. The roadmap foresees that the last elements of the regulatory framework should be in place by the end of 2022.

The appropriateness, effectiveness and efficiency of this policy framework should be evaluated in around 2025, and should be adjusted where necessary to ensure target compliance by 2030. The European Union is currently developing the details of the European Green Deal, which aims to make the European Union climate neutral by 2050 by turning climate and environmental challenges into opportunities, and making the transition just and inclusive for all. Based on a set of policy initiatives by the European Commission, climate ambitions by 2030 are anticipated to be increased, which includes adjustments to RED II. A revision of the policy framework in Ukraine around the middle of the decade would be timely for taking up decisions to be taken at European Union level by then.

Around 2028 would be a suitable point in time to set targets for the 2040 timeframe, and to revise and adjust the strategies and policies accordingly.

Currently, Ukraine is developing its first National Energy and Climate Plan (NECP), which has a planning and a monitoring function. The biannual progress reports and the regular revisions of the National Energy and Climate Plans are the appropriate instrument for monitoring successful implementation and development towards the 2030 target, and will be helpful for the 2025 revision of the policy framework.

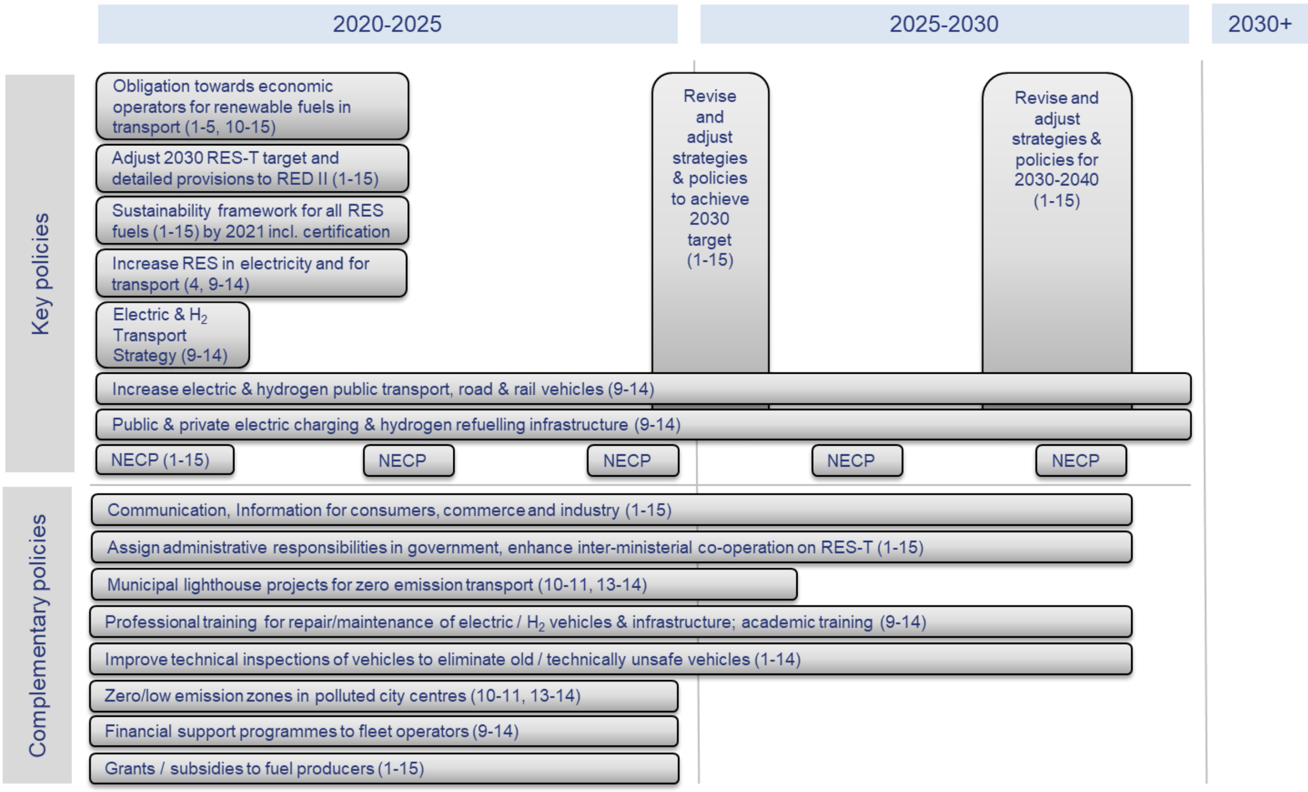

Figure 195: Overview roadmap for Ukraine

The priority in the roadmap for biofuels is to establish policy to drive uptake of these fuels through an obligation on fuel suppliers to supply a minimum proportion of these fuels. This policy mechanism should be implemented as soon as possible, to allow industry as much time as possible to adjust and prepare to meet 2030 targets. This obligation needs to be supported through a number of other policy elements such as rules for certification and compliance of biofuels, sustainability criteria for biofuels, and rules for calculating the impact of biofuels on the greenhouse gas emissions. As described above, many of these policy elements are included in the draft law “Amendments to Certain Legislative Acts of Ukraine Concerning the Mandatory Use of Liquid Biofuels (Biocomponents) in the Transport Industry”, including target levels, non-compliance rules, sustainability criteria, and terminology matching RED II. However, meeting RED II requirements will require increased target levels to 2030, implementation of caps and sub-targets, and ensuring that there is alignment with other RED II sustainability requirements.

Additional attention may need to be given to criteria on production of liquid RFNBOs, alongside the rules on hydrogen (below) as these do not appear to be covered within existing activities. A unit within the relevant government ministry must be designated responsible for implementing, reviewing and updating the policy as a whole, ensuring sustainability certification of fuels, administering the scheme, data collection and reporting.

Several other measures that are complementary to this demand-side policy have also been important in other countries, namely support for domestic fuel production, such as capital grants for plants and information provision for consumers on fuel switching and vehicle compatibility.

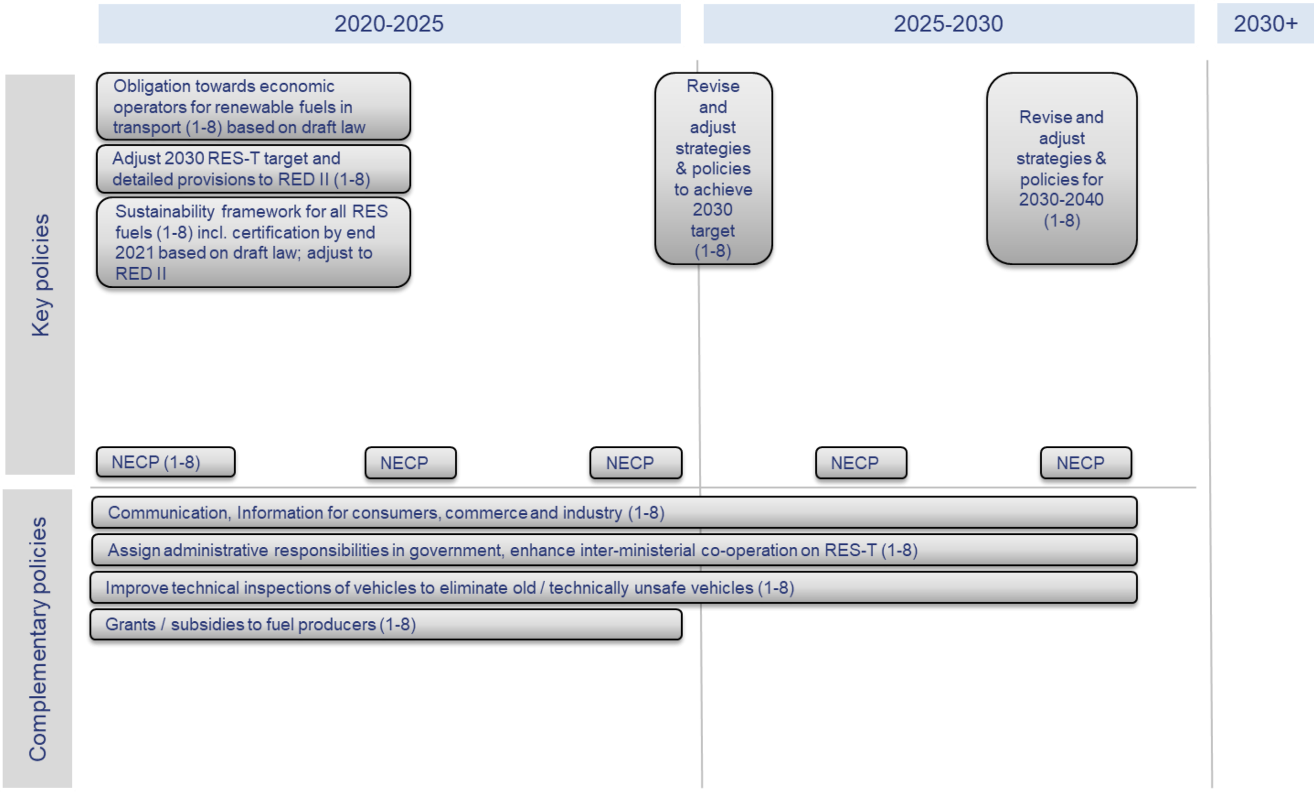

Figure 196: Roadmap for Ukraine – Biofuels and liquid RFNBOs

Direct electricity use in transport is already well-established in Ukraine in the rail sector, and also public transport based on trolleybuses, tramways, and metro. Policies supporting renewables in transport should include maintaining and further strengthening electricity use in these sectors.

Battery-electric road transport including passenger cars, public transport and delivery vehicles has been supported by policy instruments in Ukraine over several years already (see section 4.9), and has a significant further growth potential. Adjusting and further developing these policies in a national electric transport strategy would enhance the successes already visible. Most notably, the build-up of a national public charging network including fast charging stations would be a strong lever to increase electric road transport. Complementary policies could be envisioned, such as including renewable electricity in the obligation on fuel suppliers for increasing the share of renewable energies in transportation fuels (see above), or putting an obligation on electricity suppliers for providing renewable electricity to transport, etc.

An additionality framework for renewable electricity would define rules for counting electricity as renewable based on RED II[412], and detailed provisions are currently under development by the European Commission. This aims at fostering additional renewable power capacities for transport not compromising the achievement of renewables electricity targets in conventional electricity consumption.

In parallel, existing policies for increasing renewable electricity production should be adjusted by increasing renewable targets for 2030 that would include additional renewable electricity demand from transport. Fostering dedicated renewable capacities for transport could be a new element introduced into existing legislation, covering rail, public transport and road.

Increasing the number of electric vehicles in road, rail and public transport is key for increasing the consumption of electricity in transport, and reducing conventional fuel consumption. Important elements for such policies have already been established, including adjusting the tax and import duty structures to incentivize purchases of electric vehicles. These policies should be maintained and adjusted over time to ensure their effectiveness and efficiency in a dynamically developing market.

The vehicle charging infrastructure is the second major lever. Policies to coordinate and incentivize the build-up of a public network of charging stations include elements of financial incentives through grants, subsidies and loans, clear permitting rules, and coordination to ensure an appropriate nationwide network structure. In addition, financial support to charging infrastructures for public transport and fleet operators is an effective and efficient instrument for rapid growth.

The appropriate administrative structures must be established including enhanced inter-ministerial co-operation, and related responsibilities assigned in government.

Further complementary policies supporting electric transport include communication and information campaigns, lighthouse projects at local/ municipal level, the establishment of zero or low emission zones in urban areas for reduced air pollution, professional and academic training, etc. Many of these elements have already been listed in the National Transport Strategy of Ukraine 2030[413], and should be implemented.

[412] See RED II Art. 27(3)

[413] MTU (2018) *National Transport Strategy of Ukraine 2030.* Available at: https://mtu.gov.ua/files/for_investors/230118/National%20Transport%20Strategy%20of%20Ukraine.pdf

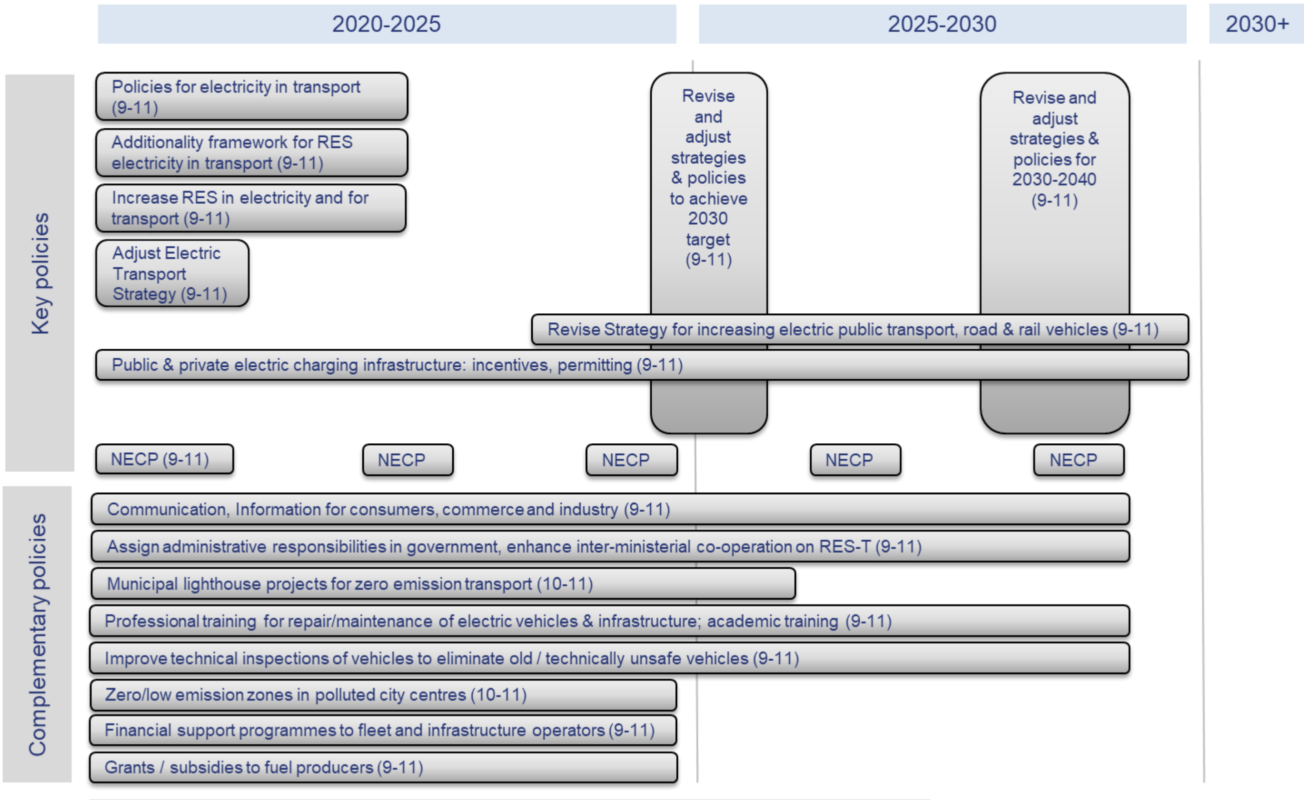

Figure 197: Roadmap for Ukraine – Electricity in Transport

Hydrogen in transport using fuel cell-electric vehicles is in early phases of commercialization world-wide, and shows major potential for decarbonizing transport in a complementary fashion to battery-electric vehicles. On non-electrified rail lines, first commercial hydrogen trains are in operation, and fuel cell vehicles are coming onto the market. A focus will be on vehicles for longer distances and for duty purposes such as trucks and buses.

In Ukraine, renewable hydrogen is currently in political discussions both for domestic use and for export. The "Ukrainian Hydrogen Council" established in 2018 developed a roadmap for the wide introduction of hydrogen energy in Ukraine together with the Institute of Renewable Energy of the National Academy of Sciences of Ukraine. It contains recommendations to governments and industry until 2035. Hydrogen for transport should be integrated into the transposition of RED II: Hydrogen can be included in the obligation on fuel suppliers as an option, as provided for in RED II, including hydrogen consumption in refineries for conventional fuel production. Further key policy elements are rather similar to electricity in transport: developing a national hydrogen strategy including applications in transport, defining an additionality framework, increasing renewable electricity capacities for hydrogen production, supporting the market uptake of vehicles, and supporting the establishment of hydrogen refuelling stations.

Also, the complementary policies are similar to electricity including incentives for vehicles uptake and refuelling infrastructure development, information campaigns, lighthouse projects, zero-emission zones, professional and academic training, technical inspections of vehicles, etc.

Research and innovation based on government funding for basic and applied research and development in the field of hydrogen energy would foster the national economy in this area.

The related policies should be established together with those for biofuels and electricity, while the market may take up a few years later based on an earlier status in commercialization.

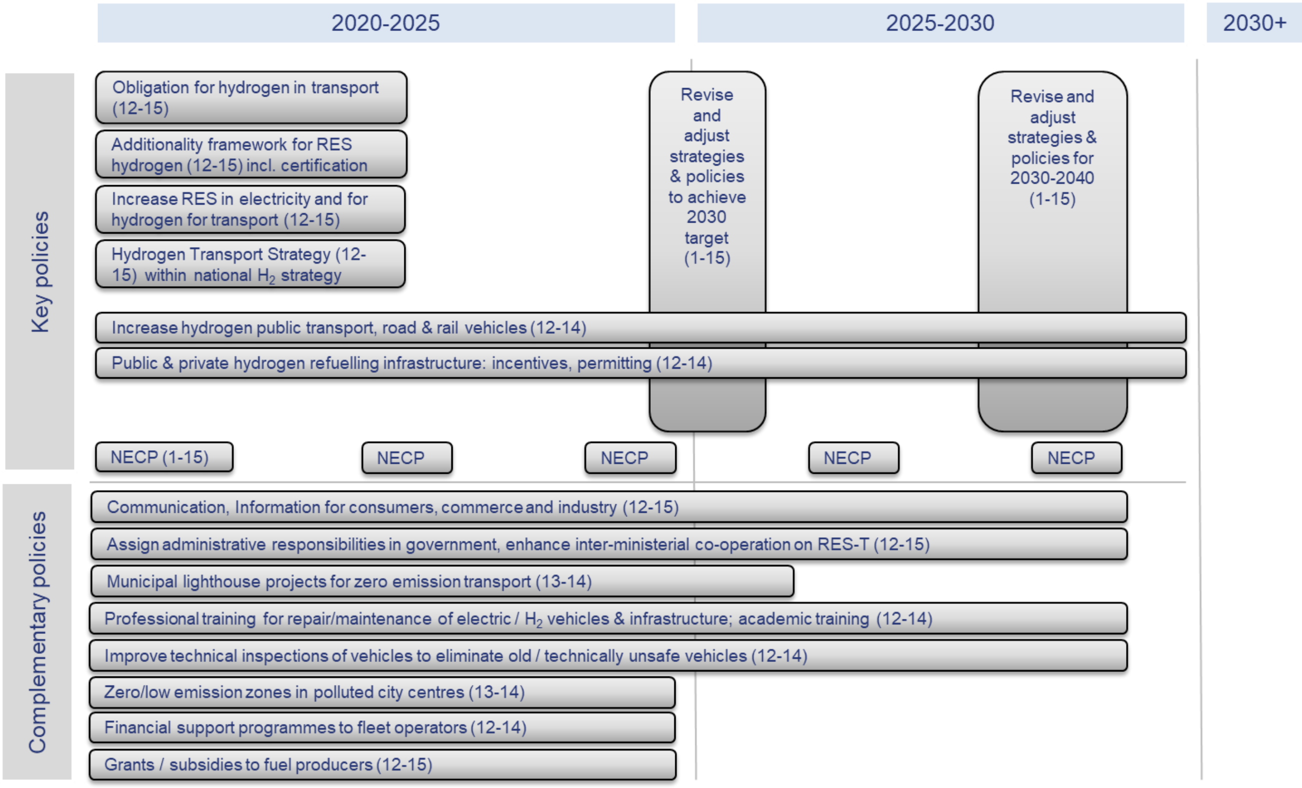

Figure 198: Roadmap for Ukraine – Hydrogen in Transport

14.6 Conclusions and recommendations

14.6.1 Conclusions

Ukraine can choose from a number of options to achieve the 2030 RES-T target of 9%. In fact, significant over-achievement beyond 13% is possible. It should be noted that even with achievement of the 2030 target of 9%, the anticipated consumption growth over the coming decade is expected to result in increased fossil fuel imports relative to 2018. Therefore, higher ambitions could be beneficial in economic and environmental terms for Ukraine. Options for renewable fuels production beyond the 2030 target may open up further opportunities for exports e.g. by producing and exporting biofuels based on used cooking oil and tallow.

Of the 9%, crop-based biofuels are capped at 2%, while 7% need to be achieved by other renewable fuels.

While biofuels are anticipated to contribute most to the target, electricity use in rail can contribute almost as much if the renewable electricity share is to reach the 2030 value of 40% as assumed for this study.

Electric road vehicles supported by the existing support strategy and further measures related to charging infrastructure have notable potential, which is anticipated to grow dynamically after 2030 to allow for major RES-T shares by 2050.

Hydrogen and battery-electric vehicles are complementary as hydrogen fuel cell vehicles enable longer driving distances, and are suitable for cars and heavy-duty transport alike; dynamic growth beyond 2030 is anticipated. Taking the current political discussions further both for domestic use of renewable hydrogen and for export allows for synergies between the two objectives.

Additional benefits of achieving the 2030 RES-T target include the reduction of fossil energy import dependence and related financial flows out of the territory, additional national value creation, new or enhanced national value chains with related economic benefits and possible job creation as well as additional contributions to the national climate targets, etc.

The “National Transport Strategy”, the “Energy Development Strategy”, and the “Roadmap for the wide introduction of hydrogen energy in Ukraine” represent a strategic basis for policies aimed at increasing the share of renewable energies in transport based on biofuels, electricity and hydrogen. Furthermore, the government concept “Ukraine 2050 – Green Energy Transition Concept – Ukraine Green Deal” of 2020 is a response to significant transformation of approaches to energy development around the globe, including the European Green Deal: “This transition is both a challenge and an opportunity for Ukraine, a country with an extremely ambitious EU Association Agreement and cooperation as part of the Energy Community. […] Ukraine’s National Security and Defence Council resolved that the country needs to revise its 2035 Energy Strategy and develop this new Concept.”[414]

[414] Ukraine 2050 – Green Energy Transition Concept – Ukraine Green Deal (2020), p. 1.

14.6.2 Recommendations

As a proven policy tool, Ukraine should adopt a 2030 target for renewable energies in transport based on RED II.

The use of renewable energies in transport should be continued and enhanced supported by policies based on the existing strategies, which should be further developed to strengthen the focus on electricity and hydrogen in transport. It would be beneficial to develop a national strategy and a national programme for the academic and industrial development of hydrogen energy and fuel cells in Ukraine.

The draft Law of Ukraine "On Amending Certain Legislative Acts Of Ukraine On The Development Of The Production Of Liquid Biofuels" currently in the political debate will amend laws and legislative acts relative to obligatory quotas on the biocomponent share in the volume of sold motor fuel including responsibility for non-compliance with quotas as well as to sustainability criteria. The terminology in the field of liquid biofuels complying with RED II will also be introduced. This would be the perfect opportunity for taking up the provisions of RED II including certification.

All elements of the regulatory framework should be in place by the end of 2022.

Policies fostering the market uptake of battery vehicles should be further developed, notably in view of the establishment of a national charging network including fast-chargers. Electricity use in public transport should be enhanced by policies for the extension of trolleybuses, tramways and metro, and should be extended to battery-electric buses.

In Ukraine, the current political discussions on hydrogen both for domestic use and for export should be continued and should lead to the adoption of policies fostering the market uptake of hydrogen vehicles in road, rail and public transport and aiming at the establishment of a national hydrogen refuelling infrastructure. Hydrogen for transport should be integrated into the transposition of RED II as an option for fuel suppliers for fulfilling their renewable obligation. Synergies between domestic use and export of renewable hydrogen should be actively developed and used. The option provided by RED II of renewable hydrogen consumption in refineries for conventional fuel production should be assessed for implementation in the short-term.

In parallel, existing policies for increasing renewable electricity production should be adjusted by increasing renewable targets for 2030 that would include additional renewable electricity demand from transport (for direct use or for hydrogen production) benefitting both the electricity sector and transport covering rail, public transport and road.

Complementary policies for battery-electric and hydrogen fuel cell-electric transport are recommended to be established in order to ensure target achievement and maximum benefits to the Ukrainian economy, including communication and information campaigns, lighthouse projects at local/ municipal level, the establishment of zero or low emission zones in urban areas for reduced air pollution, professional and academic training, etc.

Research and innovation based on government funding for basic and applied research and development in the field of electric transport and hydrogen energy should be fostered.

Co-benefits with other policy areas should be actively developed. This includes air quality improvements in urban areas and other environmental and health issues as well as economic benefits such as reduced fossil fuel imports, job creation, national value creation, etc.

Furthermore, co-operation with other Contracting Parties, and more generally with other countries, allows synergies and should thus be pursued.

Policies should be revised and possibly adjusted in around 2025 based on a policy and results evaluation.

The biannual progress reports and the regular revisions of the National Energy and Climate Plan are the appropriate instrument for monitoring successful implementation and development towards the 2030 target.