ERM - Green & Blue Hydrogen Case Studies

The business of sustainability

ERM

Who is ERM?

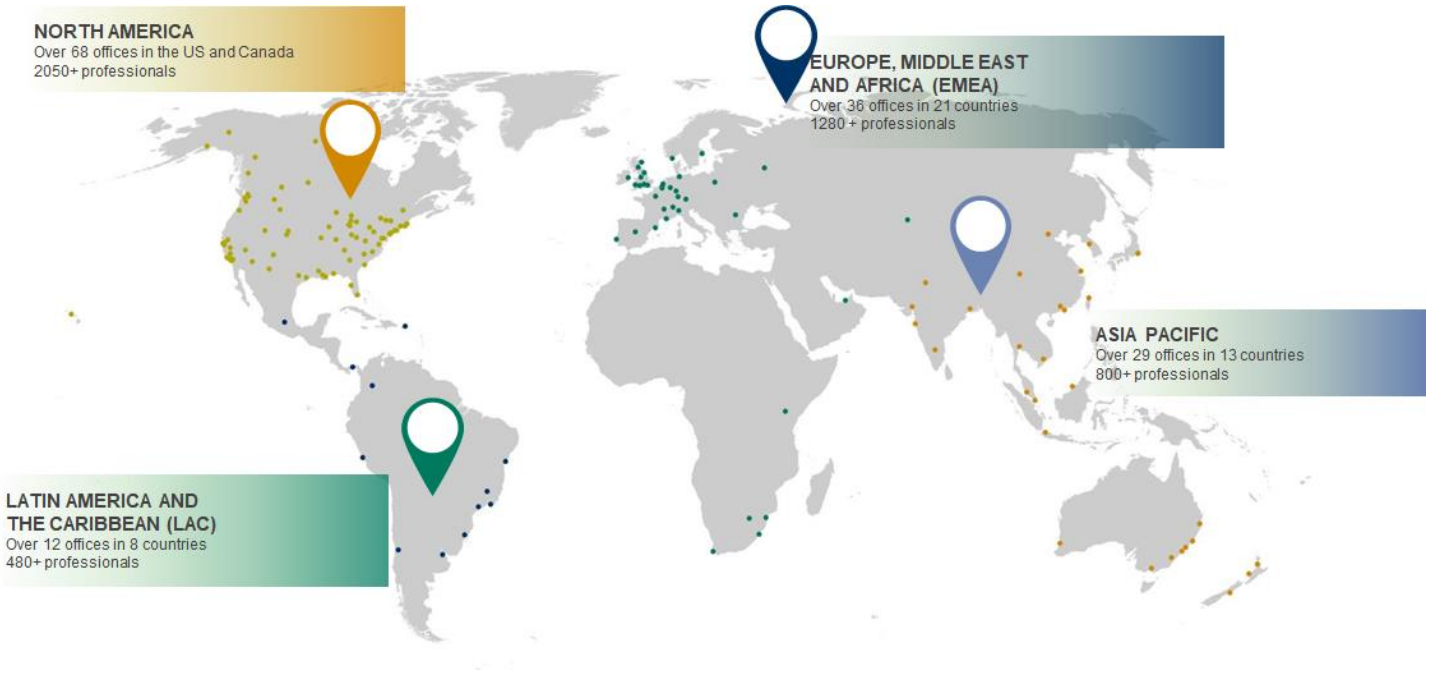
ERM is the world's largest pure play environmental, health and safety, risk and sustainability consultancy

History
Leading sustainability consultancy providing environment, social and governance services for 40+ years to global corporate clients and the financial services industry

People
Unique blend of 5,500 staff i.e. technical, strategy, commercial and financial experience, in over 160 offices in 40 countries

Sustainability Services
We understand business and provide transaction and financing environmental and social risk management support, at the assessment and implementation stages

Thought Leader
Based on over 10 years of climate change scenario analysis, we supported the Taskforce on Climate-related Financial Disclosure to develop its recommendations for applying scenarios



Our portfolio of Services

Corporate Sustainability and Climate Change

Partnering with leading organisations to address complex sustainability challenges, from climate change risk to human rights, by clarifying strategic direction, designing corporate programs, and enhancing transparency and the robustness of public disclosures.

Operational Performance

Helping global organisations mitigate risk, grow revenues, and manage costs by optimising and transforming EHS functions to connect deeply to operations, integrating data-driven approaches, and delivering managed services.

Safety Services

Encouraging clients to move beyond traditional compliance and corrective programs so that they can maximise the return on their investments in safety - to safeguard lives, protect assets and strengthen reputation.

Mergers and Acquisitions

Helping clients mitigate environmental, social and governance (ESG) and sustainability risks to maximise and protect value throughout their investment lifecycle by delivering insight-driven, commercially-focused due diligence.

EHS Management and Compliance

Working with every level in an organisation to define, design, and deploy programs that achieve and sustain compliance, effectively manage EHS issues, and also control operational costs and reduce risks.

Digital Services

Helping business leaders achieve a step-change in EHS and sustainability performance through tech-enabled innovation. We deliver these business outcomes at pace and scale through the integration of our global network, exceptional subject matter expertise and deep digital capabilities.

Capital Project Delivery

Helping clients keep capital projects on schedule and on budget by mitigating environmental, safety, and social risks from conception to final investment decision, through operational handover and ongoing management.

Liability Portfolio Management and Remediation

Managing risks through strategic approaches, digital applications and best-fit technical methods that identify, assess and manage environmental liabilities. Actively engage with clients to understand and respond to their specific and evolving needs and obligations through an end-to-end integration of site investigation, remediation, decommissioning and retirement.

Product Stewardship

Helping clients bring products to market safely, sustainably, and in compliance with global regulations, in a way that also meets their business goals and satisfies key stakeholders.

ERM's Hydrogen Expertise

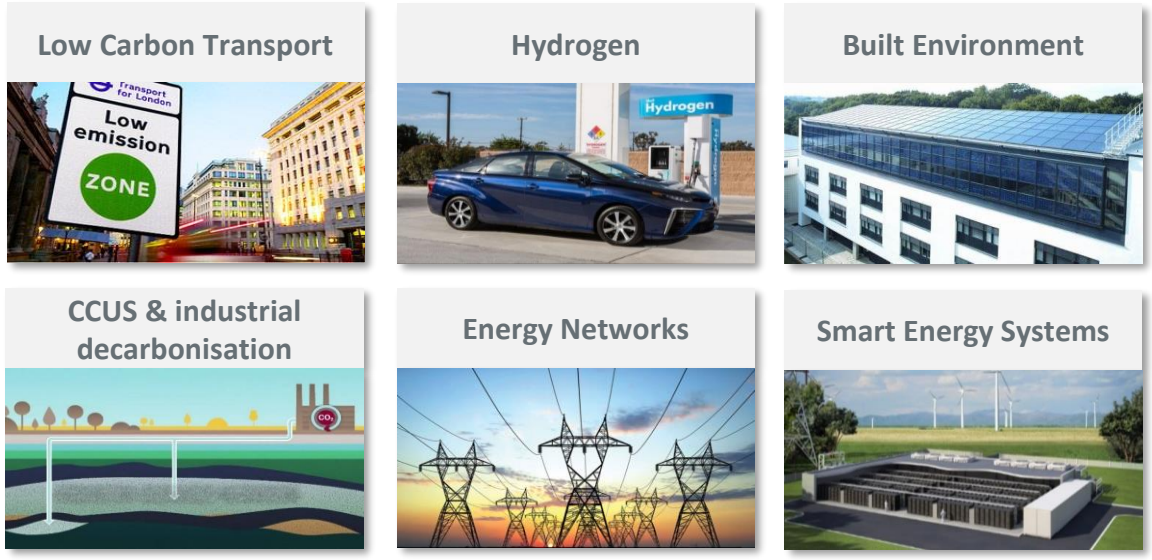
- **Concept development of hydrogen projects** including technology selection, financial modelling, hydrogen demand and off-take scenarios.
- **Strategy Advisory** including development and analysis of strategic responses to climate change and the low carbon energy transition for **industry** and **Government**.
- Hydrogen **hazard assessment and risk assessment including** hydrogen production facilities, storage and pipelines.
- **Techno-economic feasibility** including detailed cost estimates, financial modelling, and technical options evaluation for new projects.
- **Stakeholder engagement** (technical and non-technical).
- **Safety & environmental consent** delivery for projects (Planning, EIA, Seveso III, Permitting, etc).
- **Lifecycle assessment**

Element Energy – an ERM company

In July 2021, ERM announced the acquisition of Element Energy, a specialist energy consultancy, focused on low and zero carbon energy with offices in the UK, Europe and Australia. The addition of Element Energy expands the scope of services ERM offers across all low carbon energy sectors and in particular the emerging clean hydrogen industry.

Element Energy is regularly involved in projects developing net zero pathways and assessing options for emissions reductions in haulage operations and industrial applications including mining and minerals processing and spanning various low carbon options (e.g. renewable electricity generation combined with energy storage, fuel switching, carbon capture and storage, etc.).

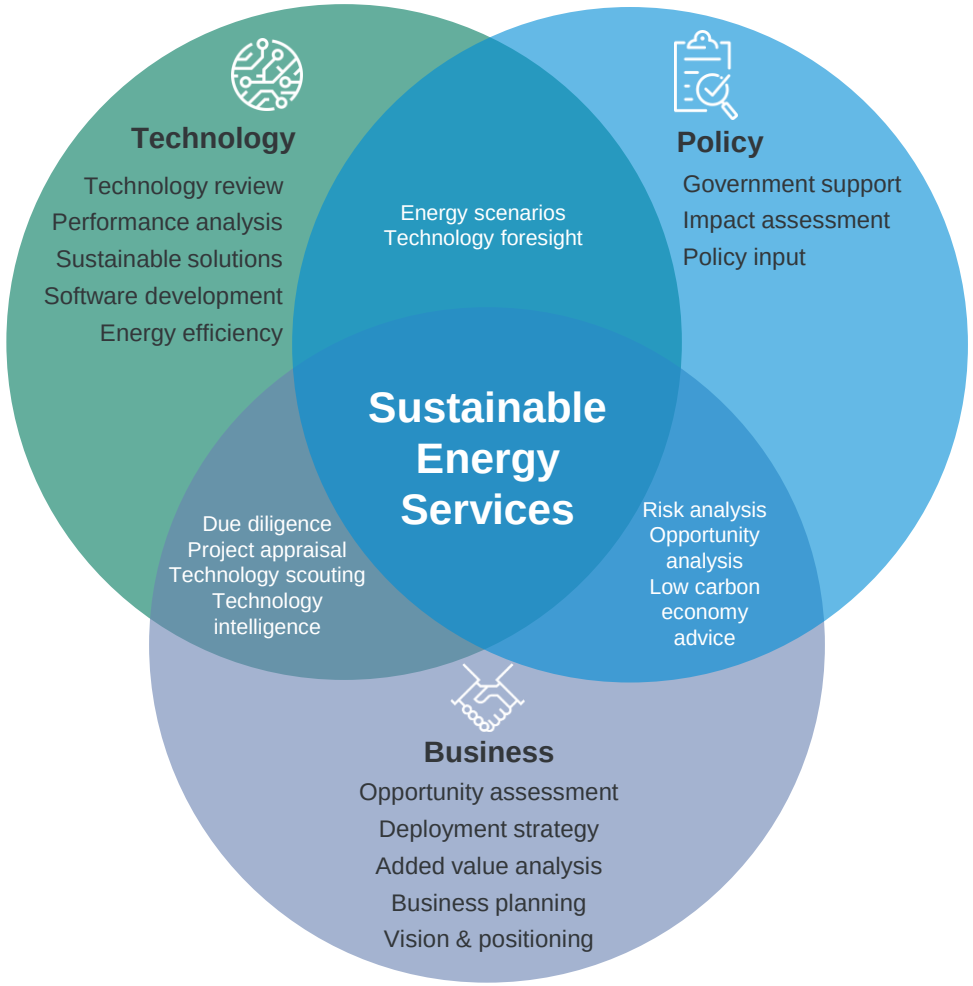
Element Energy low carbon energy sectors:



Relevant Project Experience

- Development of Pathways for Industrial Deep-Decarbonisation Technologies and Hydrogen and CCS Infrastructure for the Committee on Climate Change and UK Government (2019-2020)
- Initiated and co-ordinating H2Bus Europe initiative, aiming to deploy 600 hydrogen buses across Europe (2018 – present)
- Development of hydrogen roadmaps for UK hydrogen fuel cell sector (2016) and Hydrogen Europe Technology Roadmap (2018)
- Extensive work on UK transport policy, including for Department for Transport, the Committee on Climate Change, Transport Scotland (2012 – present) – including carbon emission modelling across all transport modes
- Several city strategies for alternative fuels HDVs uptake and refuelling needs, including London, Birmingham, Liverpool, Leeds and Manchester (2011-2020) + supported Brisbane with metro bus study (2018)
- Co-established UKH_2Mobility, H_2Mobilité France and Hydrogen Mobility Ireland to develop hydrogen refuelling infrastructure and hydrogen vehicle roll-out (2011 – present)
- Hy4Heat: Industrial hydrogen conversion study for the UK Government (2019)

E4tech – an ERM company



In July 2021, ERM announced the acquisition of E4tech, a strategic energy consulting firm working at the interface of business, sustainability, and policy. The addition of E4tech expands the scope of services ERM offers across all low carbon energy sectors and in particular the emerging clean hydrogen industry.

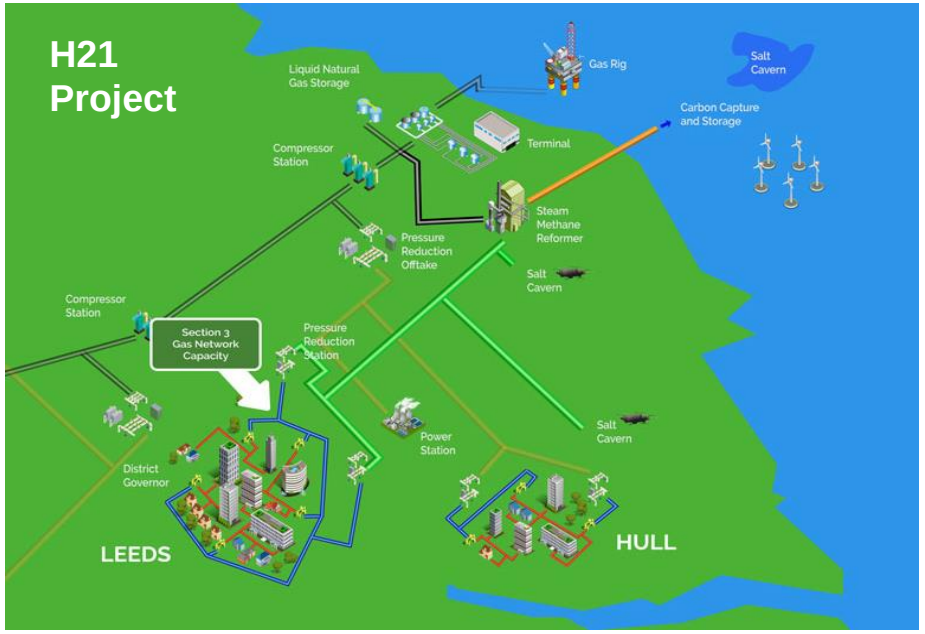
E4tech has conducted hundreds of fuel cell and hydrogen projects over 20+ years.

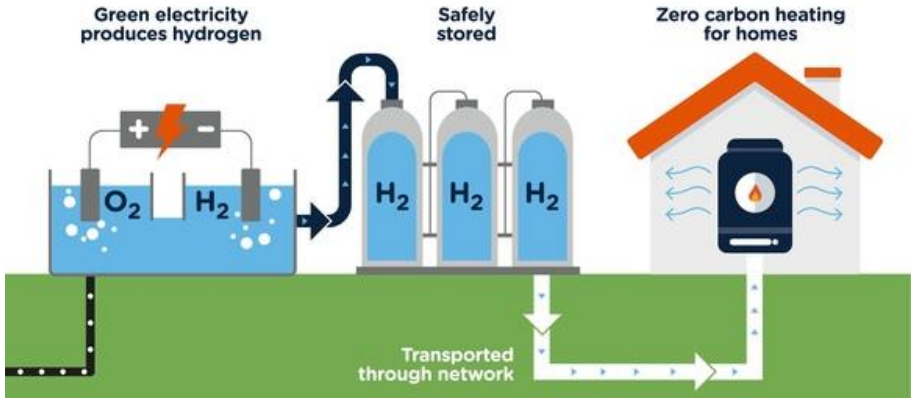
Long experience of advising public sector and institutions and specific capabilities in the design and development of hydrogen roadmaps. Identifying the right mix of technology, market and timing is essential. E4tech helps clients to navigate through the complexity.

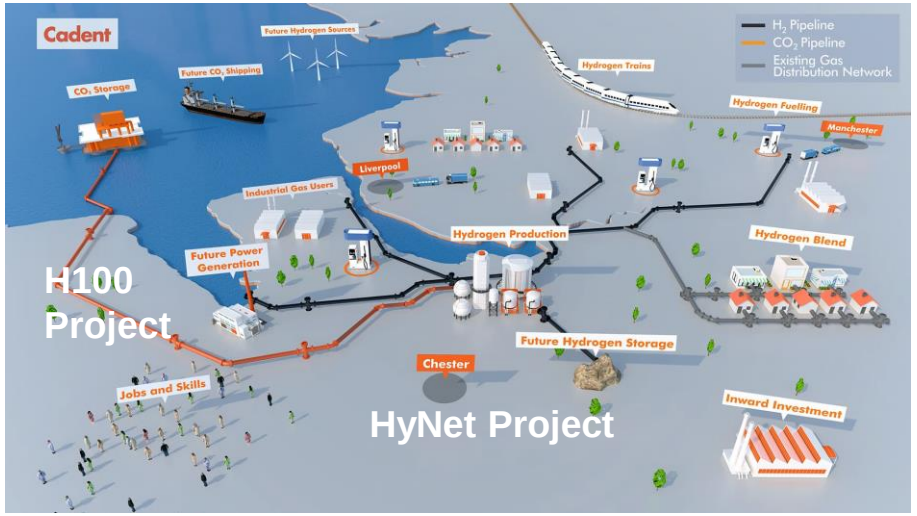
Helping multiple private sector clients understand the opportunity in the electrolytic hydrogen and ammonia in emerging applications.
E4tech's in-house industry database and modelling tools enable to tackle a range of questions for companies, investors and the public sector

1 Case study 1: Gas Network Projects

- First 100% Hydrogen Pilot Trial by 2024
- First European City converted to Hydrogen by 2032
- ERM involved in all 3 projects and safety programme (Hy4Heat)







2 Case study 2: Bulk Hydrogen Production from Offshore Wind

- Commissioned by **Offshore Wind Innovation Hub**, with **ORE Catapult** as key delivery party.
- Review of market, benefits and scenarios for implementation of bulk scale hydrogen production.
- Estimation of macroeconomic benefit including:

Job creation and GVA

Supply chain readiness

Policy requirements

- Provides a case for government investment.
- Work published in combined OWIH study, 2020.

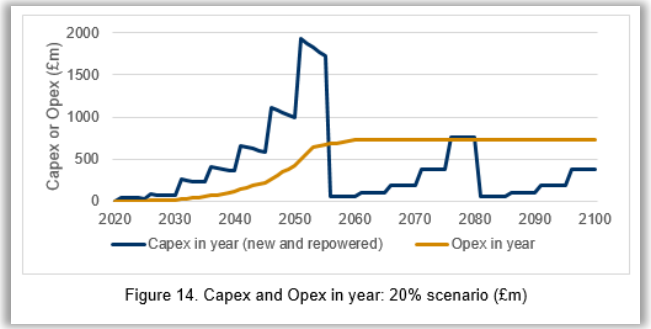


Figure 14. Capex and Opex in year: 20% scenario (£m)

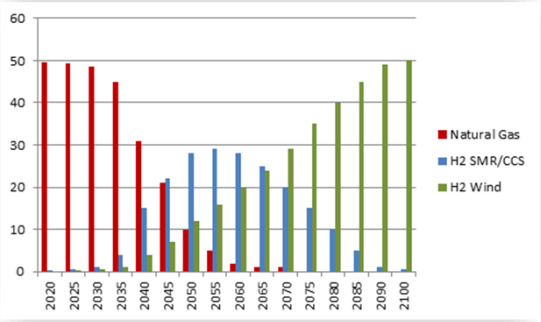


Table 5. Return on Government Investment

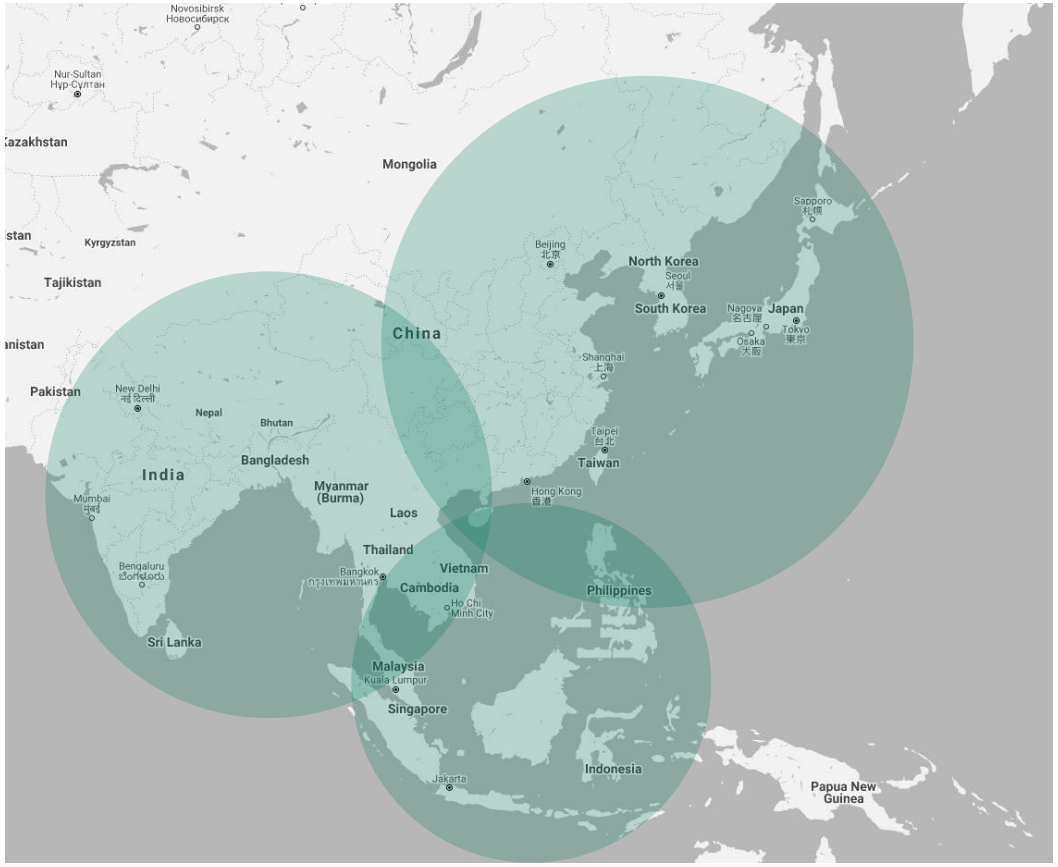
20% hydrogen blended into gas network		100% hydrogen in gas network by 2100	
Government investment required	ROI	Government investment required	ROI
£bn	£ GVA for each £1 gov investment	£bn	£ GVA for each £1 gov investment
1.4	3.6 in Year 2050	1.4	22.4 in Year 2050
	20.5 in Year 2100		180.9 in Year 2100

3 **Case study 3:** UK's First Hydrogen Trains

- Project to convert 14 Class 321 Trains to Hydrogen
- Hydrogen trains to begin replacing Diesel engines on UK routes from 2023
- ERM performing technical safety assessment and risk assessment to ensure project HSE goals are met
- Safety Case to be developed by ERM to meet all UK Regulatory Requirements

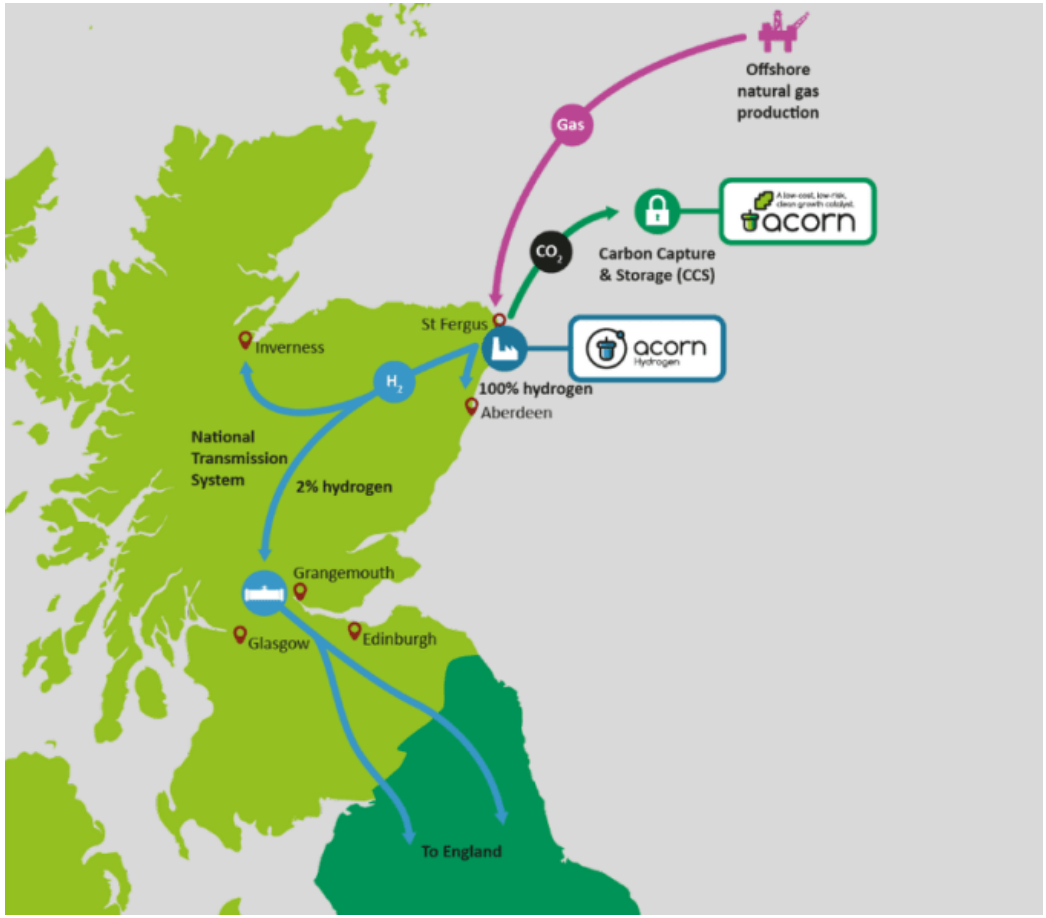
4 **Case study 4:** Hydrogen Strategy for North Asia utility (Confidential Client)

- To examine the potential for hydrogen to decarbonise heat and transport in North Asia
- Evaluation of Hydrogen Supply options, costs and timescales
- Evaluation of bulk transport of imported hydrogen in different forms (e.g. liquid hydrogen, ammonia, LOHC, Methanol)
- Techno-economic analysis of infrastructure, supply, storage, transport and usage
- Assessment of the potential to re-purpose conventional assets



5 **Case study 5:** Blue Hydrogen and CCS Project (Acorn)

- Large Scale Production of Blue Hydrogen with Carbon Capture and Offshore Storage of CO2
- ERM performing all EHS Consent Delivery Work
- Includes Environmental Impact Assessment, Permitting and COMAH Safety Case
- ERM managing interface with Regulatory Authorities to ensure project progresses to plan without any delays
- ERM working with Pale Blue Dot to identify synergies for hydrogen production, transport and use in the Aberdeen region and along Scotland East Coast



6 **Case study 6:** Hydrogen pre-feasibility for Hyundai Carbon Neutral Strategy

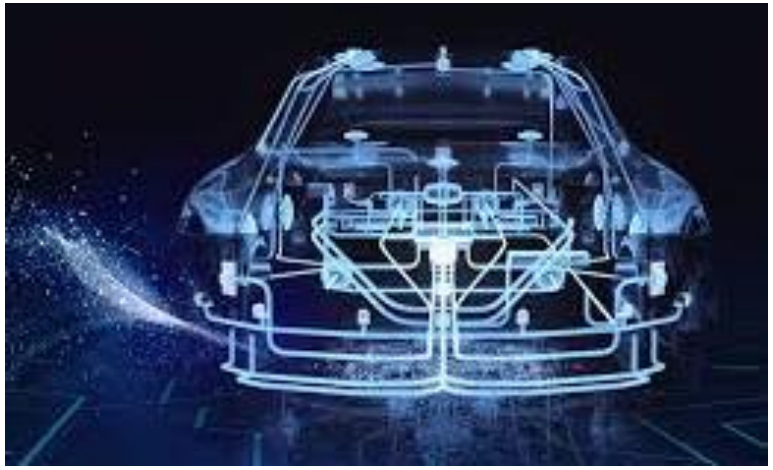
- Long-term enabler assessment for hydrogen for production fuel mix change strategy for HMC
- 3 domestic manufacturing sites pre-feasibility for hydrogen technology adoption
- Techno-economic assessment of long-term mitigation option including hydrogen:

Pre-technical feasibility and GHG abatement potential

Cost benefit assessment

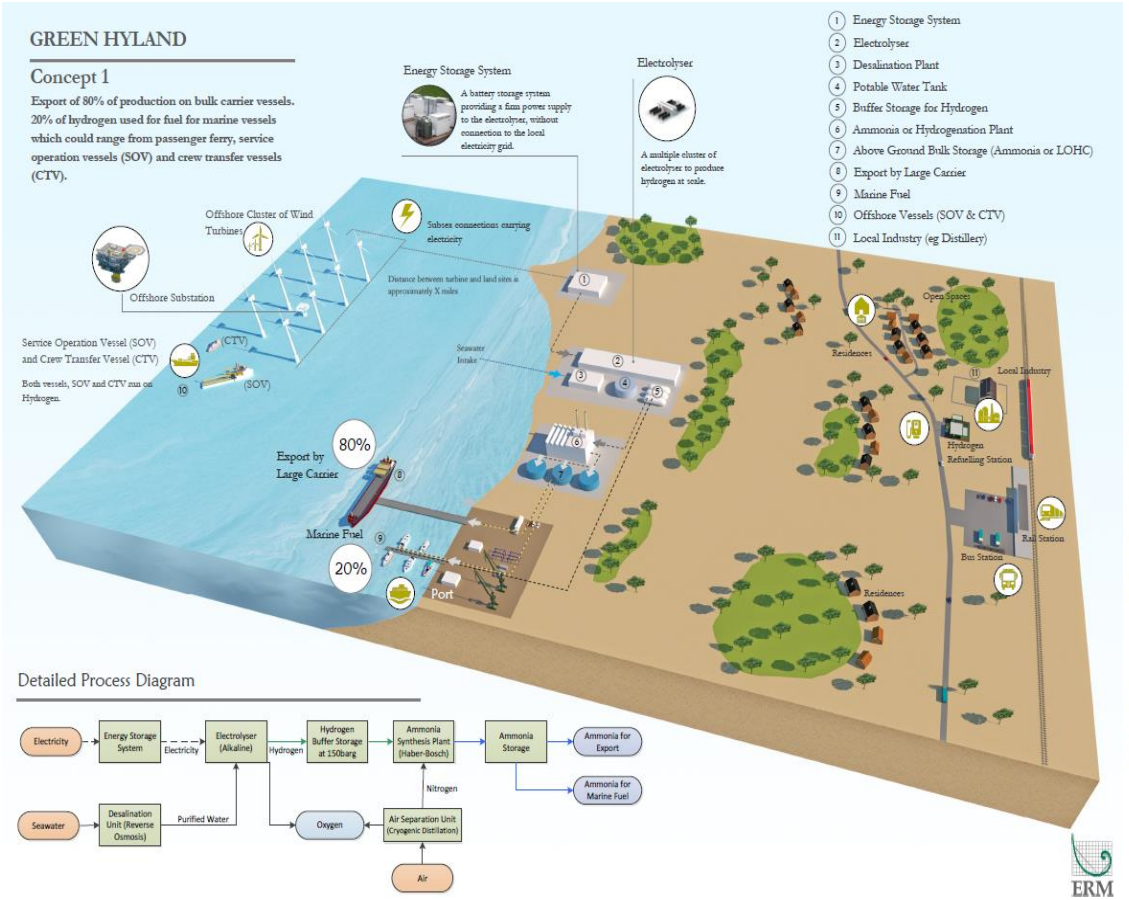
Strategic roadmap

- Policy recommendation to create enabling environment to drive hydrogen economy and technology adoption



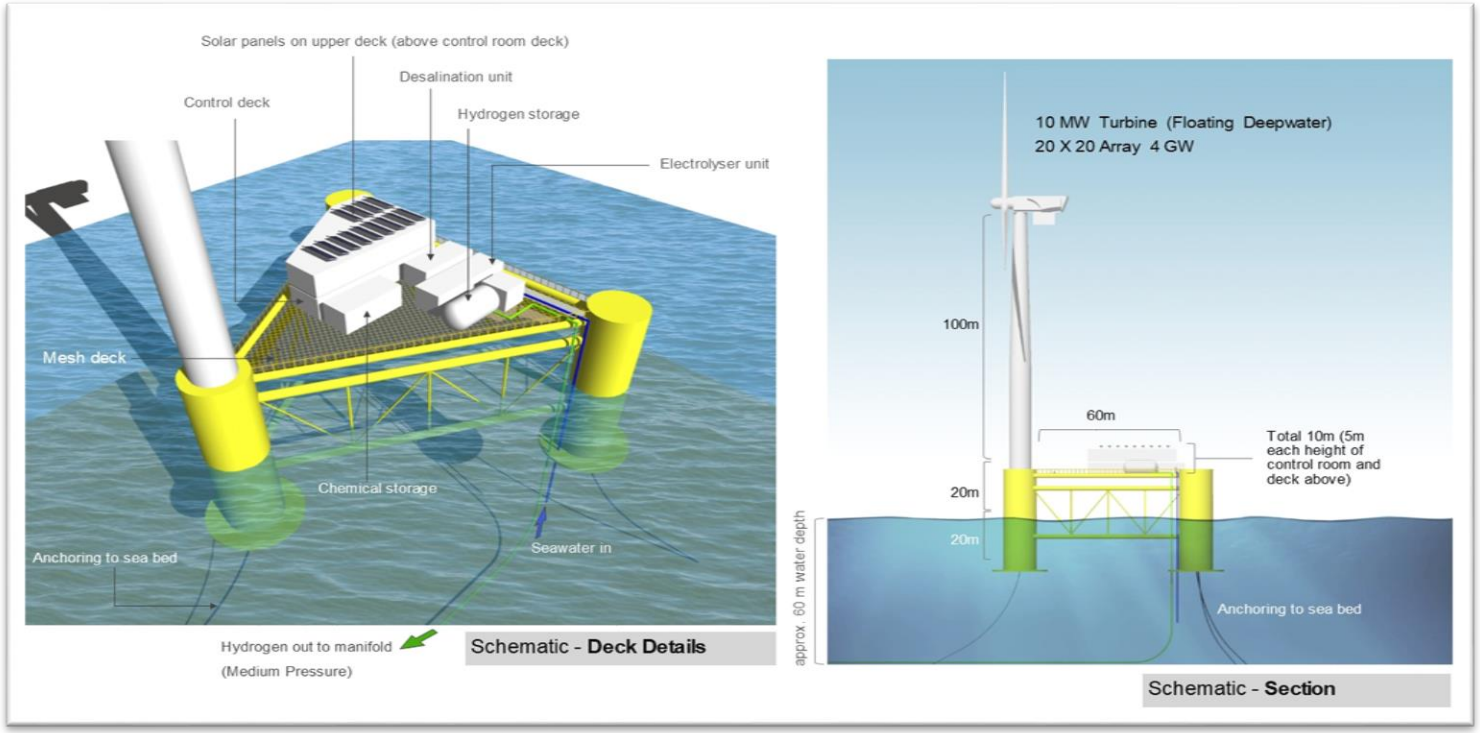
7 **Case study 7:** Green Hydrogen from Fixed Offshore Wind (Hyland Project)

- Evaluation of Options for Green Hydrogen Production and Export, UK North Sea
- Techno-economic analysis of different options including export of hydrogen in form of Ammonia and LOHC
- Large Offshore Wind (Fixed Bottom) Turbines connected to onshore electrolysis
- Evaluation of Storage Options
- Financial modelling and assessment of local offtake potential including marine applications, road transport, rail transport and local industrial heat applications



8 **Case study 8:** ERM Dolphyn – Green Hydrogen Production at Scale

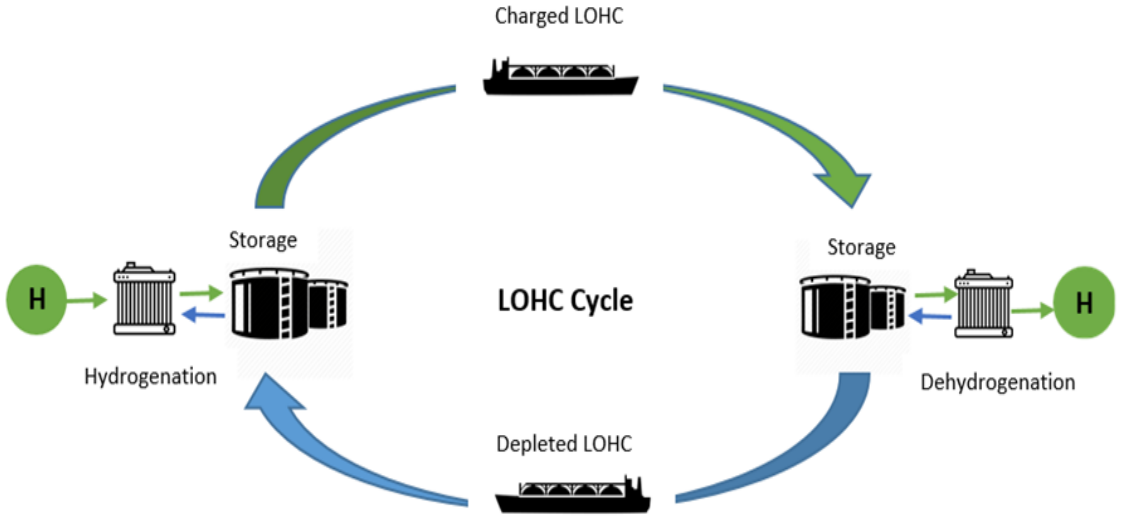
- ERM is the owner and developer of an innovative project to help roll out hydrogen at scale by the 2030s.
- Completed first phase of the Dolphyn project, a floating platform design that will provide access to offshore wind resources in deep water up to several hundred kilometers from land.
- Completed a preliminary front-end engineering design for a 2-megawatt hydrogen prototype facility to be built and installed off the United Kingdom by 2024.

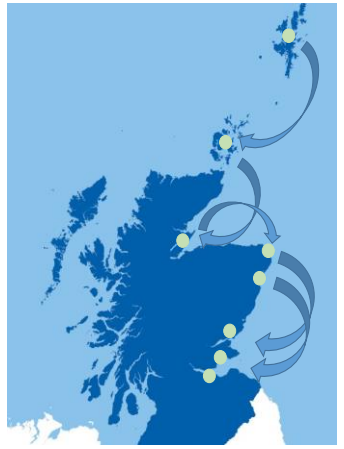


9 **Case Study 9:** Bulk Shipping of Hydrogen using LOHC

Objective: To determine the most economically advantageous solution for transporting hydrogen at bulk scale

- ERM are evaluating the techno-economic, safety and environmental aspects of LOHC vs ammonia, methanol and liquid hydrogen for the Scottish Government.
- LOHC offers the ability to transfer hydrogen like oil, enabling existing oil assets to be repurposed





The Scottish Government

PORT OF CROMARTY FIRTH

REPSOL SINOPEC Resources UK

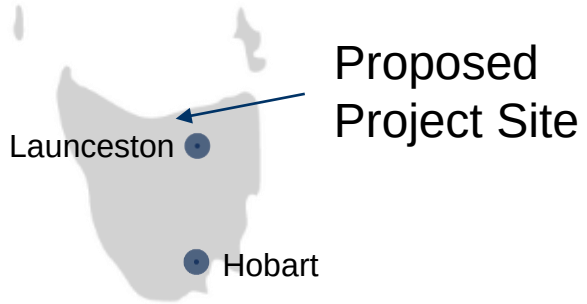
The Oil & Gas Technology Centre
Your Innovation Partner

Sullom Voe Oil Terminal

10 **Case Study 10:** Woodside H2Tas Project for Transportation

Objective: Help Woodside & CRE secure the relevant environmental approvals for Woodside's H2Tas Project

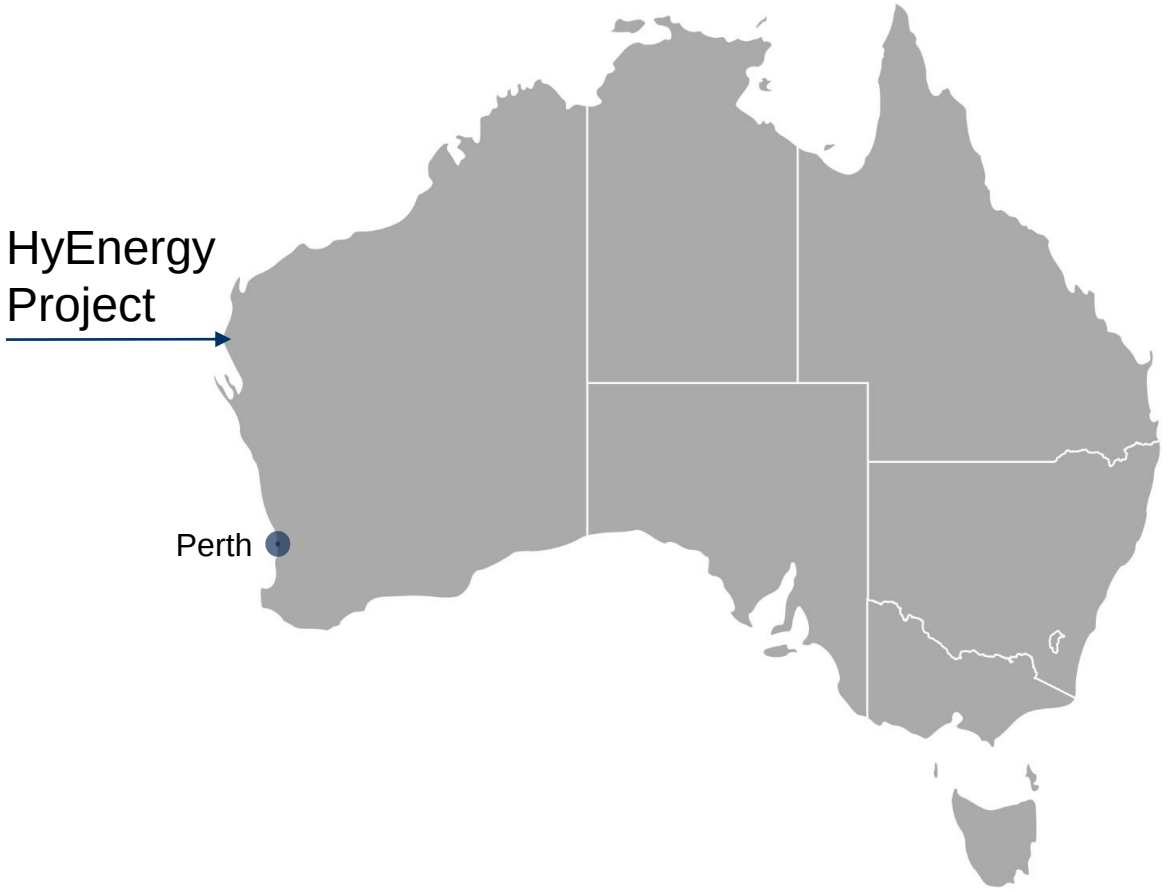
- Proposed 10MW hydrogen production project located in Tasmania's Bell Bay for 4.5 tpd of hydrogen for domestic use in the transportation sector.
- ERM is preparing the environmental approvals strategy, completion of a contaminated site assessment, and preparation of a notice of intent and subsequent environmental impact assessment and management plans



11 Case Study 11: HyEnergy Green H2

Objective: Support Province to secure the relevant environmental approvals for their HyEnergy Project in Western Australia

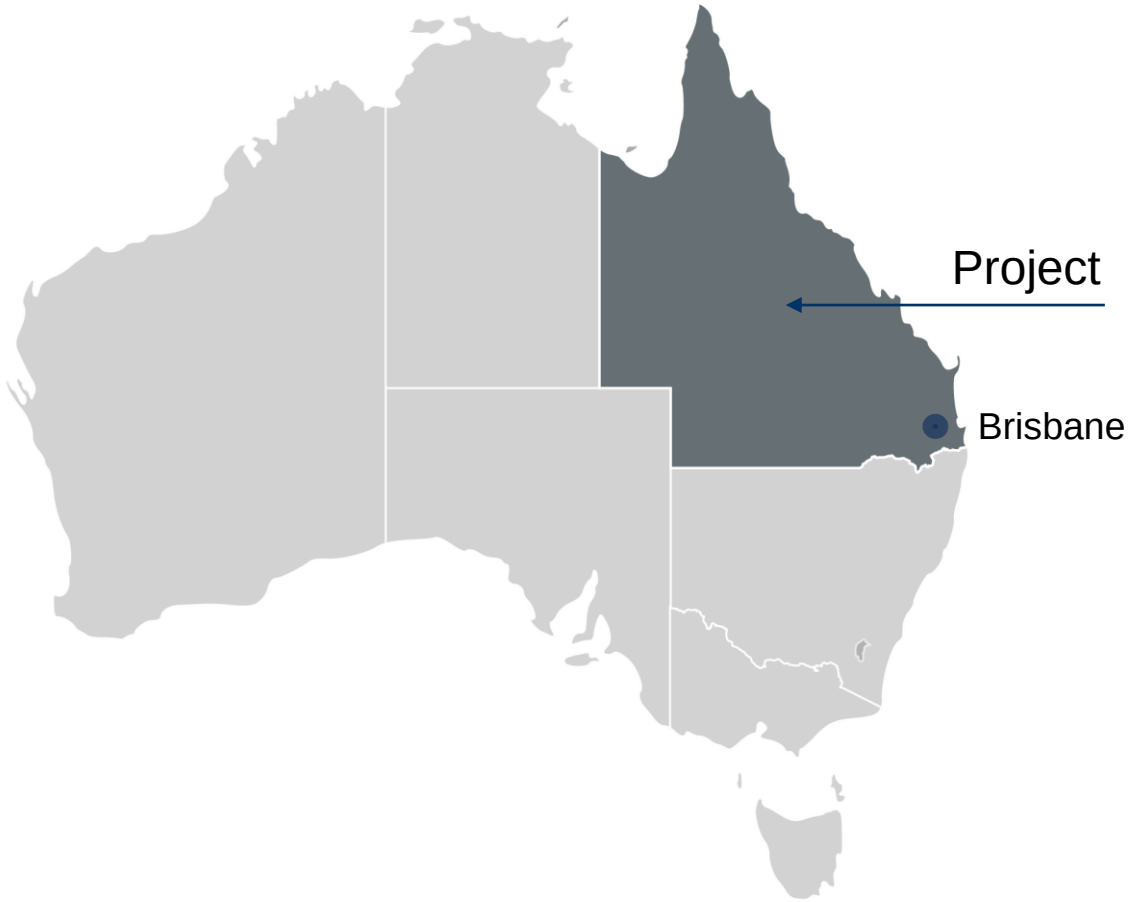
- Proposed 8,000 MW green hydrogen production project located in Western Australia's Carnarvon region for domestic and export use.
- Province recently signed and MOU with Total Eren the global IPP 30% owned by the Total SA.
- ERM is currently preparing the environmental approvals strategy for the project.



12 Case Study 12:
Solar, Wind, Green H2 Project

Objective: Carrying out environmental, approvals and social due diligence on a proposed green hydrogen project with integrated with solar and wind.

- Proposed >3000MW hydrogen production project located in Queensland for export.
- ERM delivered the environmental, approvals and social due diligence.



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