Net Zero Technology Centre

Technology Driving Transition

The Hydrogen Backbone Link

Connecting Scotland & UK and Northern Europe

Hydrogen Industry Leaders: 1st October 2025

North Sea Potential

- Scottish and UK waters host some of the largest wind power potential in Europe

- Hydrogen production cost from offshore wind potential: Imperial College London report (2023)
- North Sea LCOH = £2.5 - 4.5/kg H2
- Scotland has rich engineering heritage in the O&G sector, 50+ years offshore engineering experience
- Experienced large-scale energy exporter
- Innovation in energy & hydrogen technologies

Supporting jobs in offshore industries and creating new jobs

Driving investment throughout the UK

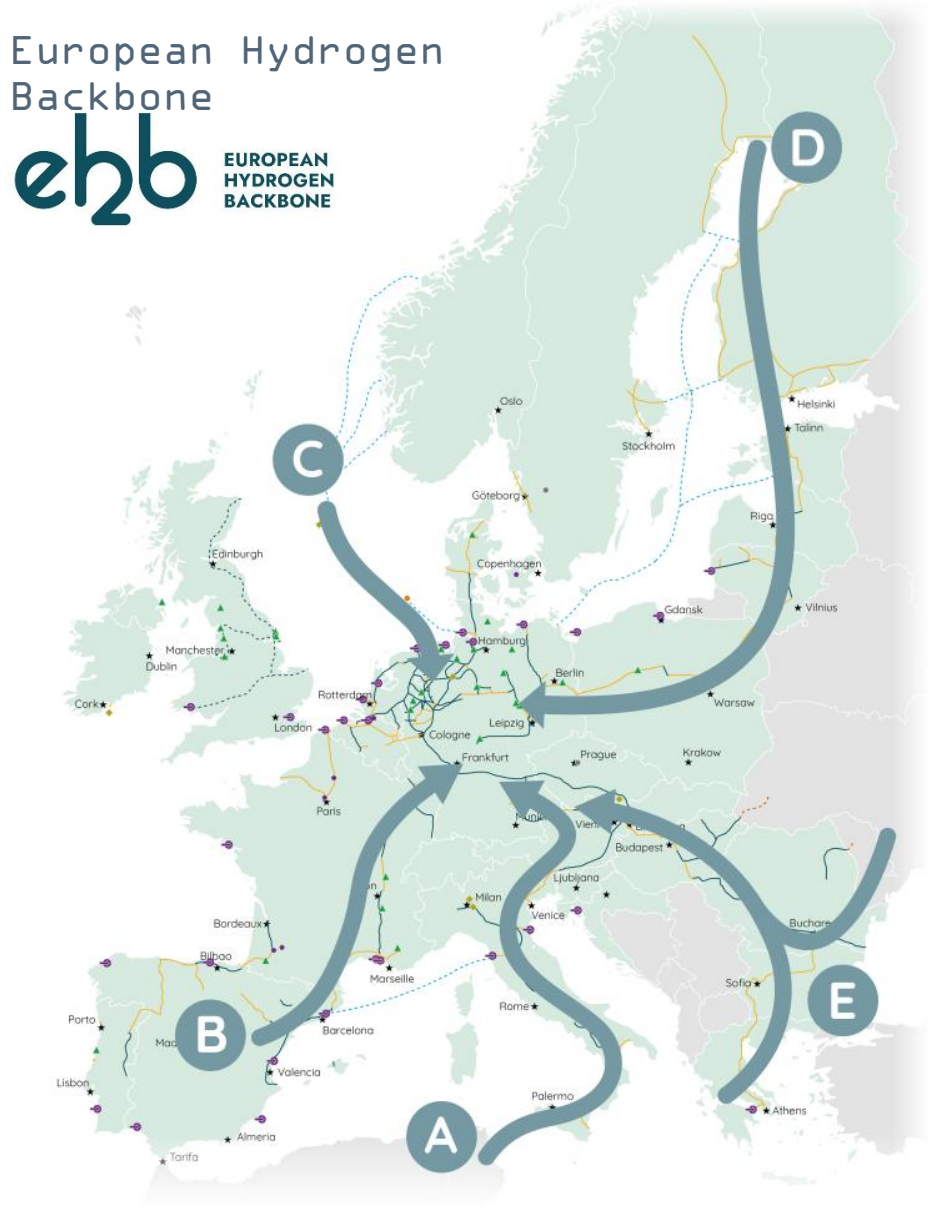
Figure 9 Heatmap showing how the levelised cost of hydrogen produced from co-located wind energy varies across the country.

Integrated North Sea Vision

- Context of the project: The HBL aims to meet Europe's hydrogen demands from the mid 2030s onwards.
- Ambition for Scotland to be a leading producer and exporter of hydrogen and hydrogen derivatives for use in UK and Europe
- Scotland has 2.5Mt (94TWh) export ambition by 2045
- European Union has set target of importing 10Mt of hydrogen by 2030
- EHB is a consortium of 33 operators aiming to enable a low-carbon hydrogen market
- HBL to be key infrastructure project in 'Corridor C' – accessing up to 28 energy markets by 2040

Strengthening mutual energy security: 'Made in Europe' approach

Meeting up to 10% of the 8-11Mtpa German hydrogen demand



Project partners

Collaboration is key – support from O&G majors and Tier 1 suppliers

- Phase 1: Feasibility studies - route assessment; pipeline reuse options; technology development; economics; and safety analysis.
- Phase 2: Concept development - expansion to tie-in with England, EIRE, West Coast of Scotland, and AquaDuctus; further technology development; large-scale storage options; and non-technical analysis including stakeholder engagement plan.

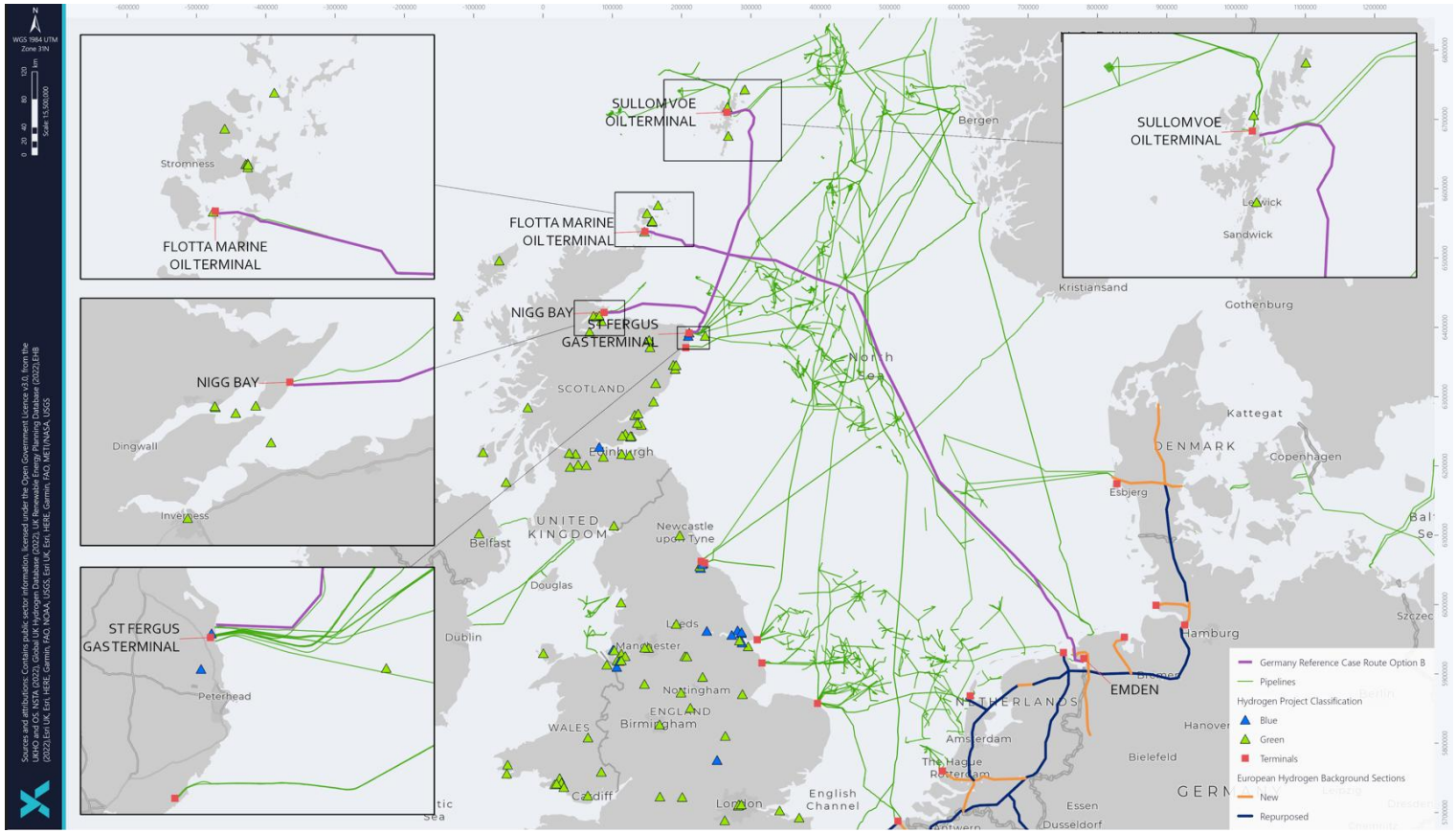
Phase 1

Feasibility studies

UK Offshore Hydrogen Pipeline: Phase 1 Preferred Option

Developing strategic infrastructure links from Scotland and Rest of the UK to Europe for the export of green hydrogen. The HBL will connect the UK with northern Europe via a 100% hydrogen pipeline.

Base case: UK – Germany (Emden)



- New-build dedicated pipeline
- Study cases:
  2GW, 5GW & 10GW pipelines transporting 100% Hydrogen
- Selection of 10GW windfarm capacity
- Routing Option 1B preferred:
  32” backbone | 1,494km | 2,400Te H2/day
- CAPEX spend ~£2.8billion
- €0.36/kg Implied Tariff

Export Economics

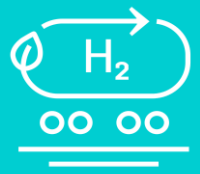
Green hydrogen transported via pipeline from Scotland could be cost comparable to other globally sourced hydrogen.

	Scotland	Middle East, North Africa, Chile, …
H2 Production	€2.6/kg	€1.7/kg
H2 Transport	€0.4/kg	€1.4/kg
H2 to EU Customer	**€3.0/kg**	€3.1/kg
Security of Supply	+	-
Shared Ownership	+	-

In the base case analysis, the implied tariff is
£0.32/kg

A 40% increase or decrease in development capex implies a tariff of
£0.44/kg or £0.21/kg
respectively

A 40% increase or decrease in the operating costs implies a tariff of
£0.35 or £0.31/kg
respectively



Adjusting the hydrogen supply build-up period from 5 years to 10 and 1 year implies a tariff of
£0.39/kg and £0.30/kg
respectively

Reducing the plateau utilisation of the pipeline from 90% to 75% and 60% increase the implied tariff to
£0.38/kg and £0.48/kg
respectively

A 2GW scale pipeline (as opposed to the 10GW modelled in the base case) increases the implied tariff to
£0.96/kg
three times the 10GW value

Technology Assessment & Development

The ancillary equipment for offshore hydrogen pipeline operation exists, but technology development is required to deliver at scale.

	Valves	Meters	Compressors	Storage	Blending/deblending
Phase 1	Identified gaps in standards, qualifications and testing for hydrogen service, and gaps in materials selection.	Coriolis and thermal mass flowmeters are most reliable for hydrogen; further validation for high-flow, high-pressure hydrogen service required.	Reciprocating compressors most viable for hydrogen, but new designs and materials needed for offshore and high-capacity applications; further pilot testing recommended.	Identified small-scale (operational) and large-scale (seasonal) storage opportunities for hydrogen export.	Blending up to 20% hydrogen is feasible with existing technology; large-scale deblending is currently only viable using PSA or cryogenic separation.
Phase 2	Valves meeting ISO 15848-1 Class BH or higher are suitable. API 6D Annex M standard recommended. **No urgent need for new valve designs, but further guidance on SLH levels and offshore valves is needed.**	**National Gas expected to undertake testing (at Future Grid facility), with learnings to be applied to HBL.**	Scale/footprint/cost of HBL compression at export terminals included in Concept Definition scope.	**Aldbrough salt caverns** and **Rough reservoir** identified as potential sites for operation with the HBL in the UK.	No further blending studies undertaken. Blending consultation is ongoing in UK Government (2025).

Phase 2

Concept development

West Coast and EIRE

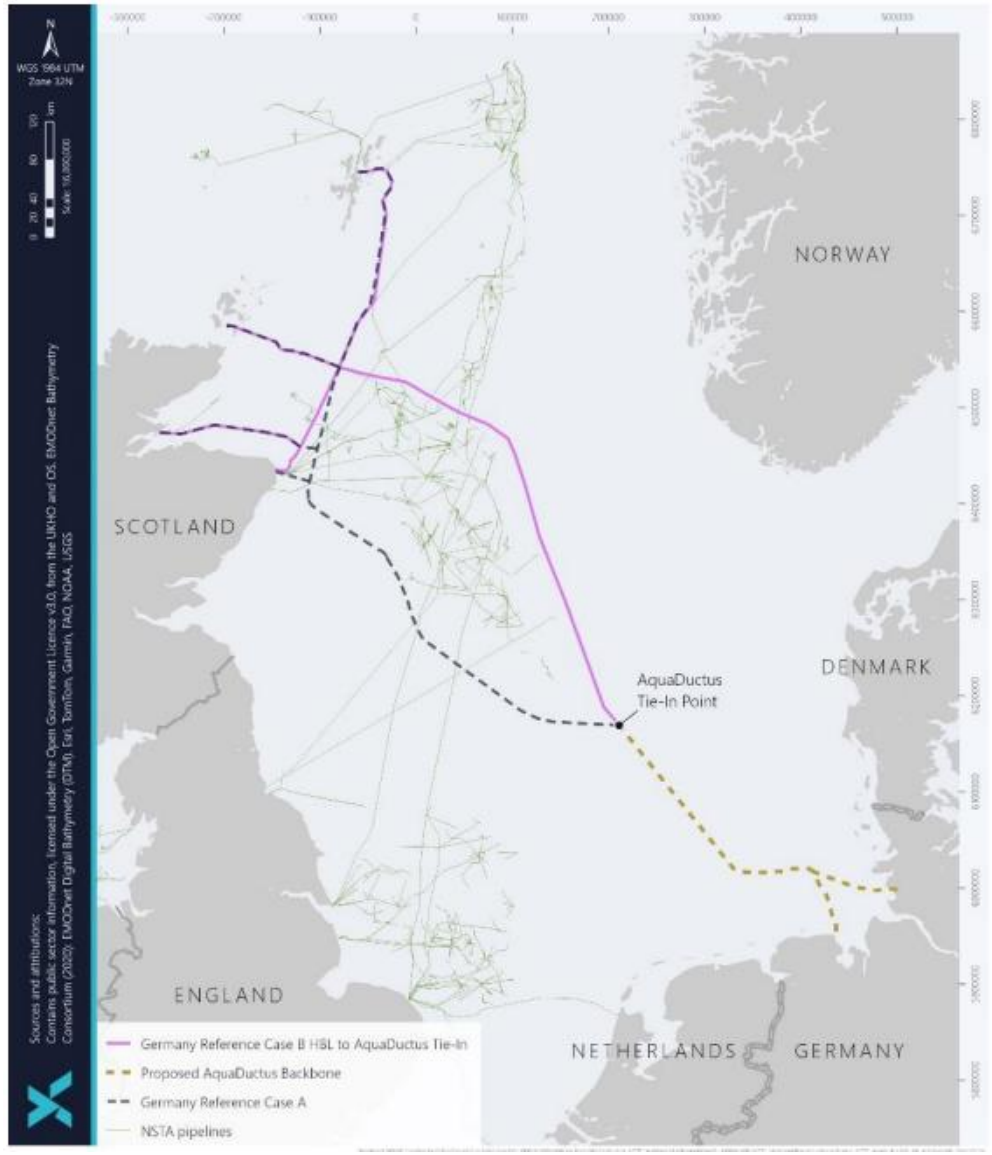
Strategic connections from hydrogen produced in Northern Ireland, Republic of Ireland, and the Outer Hebrides.

- Study considered connections from NI/RoI and the Outer Hebrides to HBL.
- Recommended to connect Outer Hebrides to HBL.
- Recommended **new-build** pipelines to link NI/RoI across the Irish Sea:
  - Onwards transport via onshore pipelines in Scotland to the HBL.

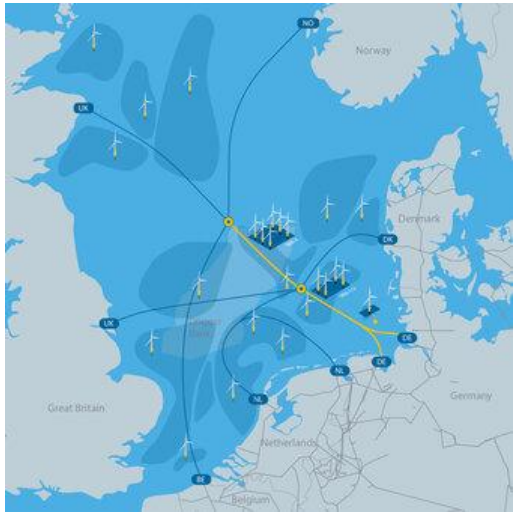
AquaDuctus (AQD)

- Technically feasible to connect the HBL to the AquaDuctus manifold, located 400km out in the German North Sea.
- Higher entry pressure compared to Phase 1, meaning 3 stages of compression are required.
- Deliverable solution that connects to an advanced PCMI project in the North Sea.

AQD tie-in cost would be ~30% (£1 billion) cheaper than the original Phase 1 Option 1B routing cost.



- AQD, part of the German AquaVentus initiative – planning a 20GW pipeline to first connect to hydrogen production 200km offshore, then another 200km into the North Sea for additional capacity.

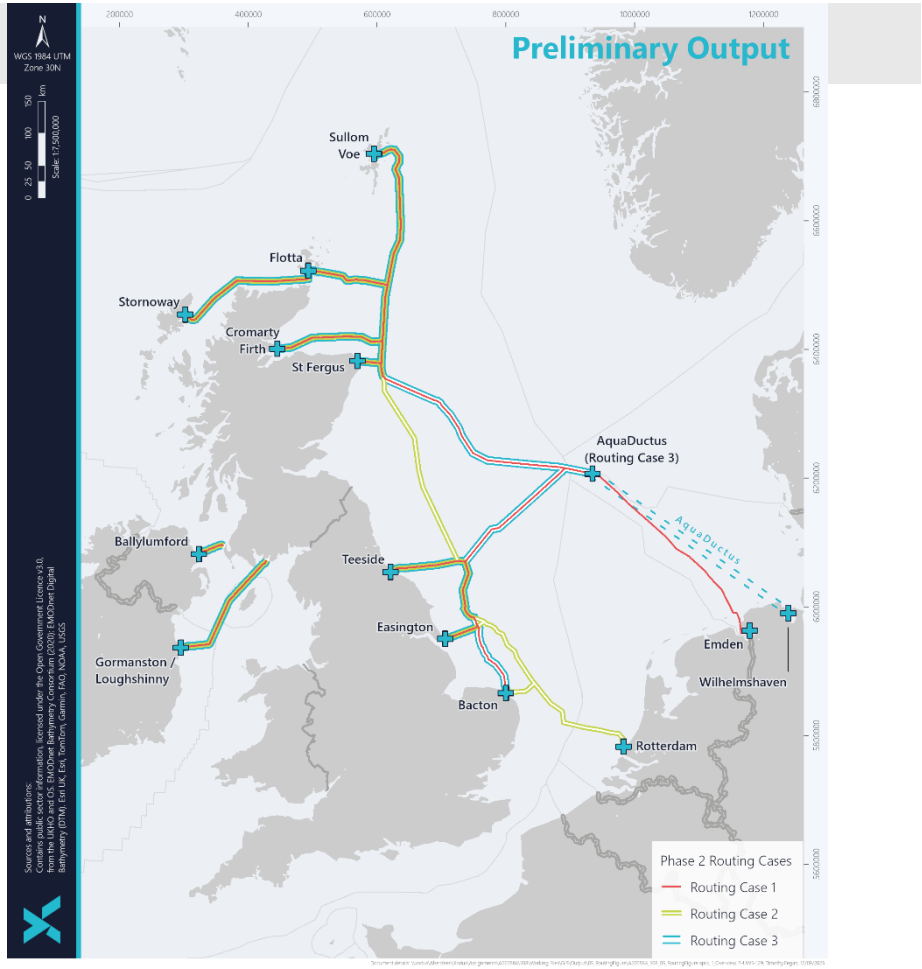


UK Offshore Hydrogen Pipeline: Phase 2 Options

Developing strategic infrastructure links from Scotland and Rest of the UK to Europe for the export of green hydrogen. The HBL will connect the UK with northern Europe via a 100% hydrogen pipeline.

Phase 2 Options: Three Routing Cases

- 10GW pipeline transporting 100% Hydrogen, 2,400 Te H2/day. Routing options currently:
  - Routing Case 1: UK – Emden
  - Routing Case 2: UK – Port of Rotterdam
  - Routing Case 3: UK – AquaDuctus
- Seasonal storage opportunities for HBL hosted in southern UK onshore salt caverns (Aldbrough), and offshore gas reservoir (Rough). Also potential to connect to German onshore salt caverns.
- Operational analysis ongoing for Routing Cases.



Where we're going next..

Developing and delivering a comprehensive stakeholder engagement plan is the most crucial next step of the HBL project.

Technical Close-out	Stakeholder Engagement	TYNDP Application
Close-out of routing and ancillary equipment analysis, to provide a handover package to industry. Concept Definition scope will provide technical information on Three Routing Cases that can be pitched to potential future investors.	Engage with key stakeholders across UK and EU industry and governments, to promote the HBL as a priority infrastructure project for mutual energy security. Meet key project milestones over the next 12 months.	Promote HBL to ENTSOG's Ten Year Network Development Plan (TYNDP) initiative to align with existing and future infrastructure projects and plans in the EU. Apply to the Project of Common or Mutual Interest (PCMI) initiative in 2026 to collaborate and enhance project credentials.

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Thank you

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