

North-East, Yorkshire & Humber

The region has ~10.8 GW of operational generation capacity, with 8.1 GW from low-carbon sources—one of the highest shares in Great Britain. Biomass dominates (59%), followed by wind and solar (19%) and other renewables (11%). Battery storage stands at ~937 MW, with major sites in the south. Planned capacity is substantial, totalling ~22.2 GW, including 6.3 GW generation and 15.8 GW storage—placing the region among the UK leaders in renewables and battery deployment. Offshore wind is also expanding rapidly, supported by major port infrastructure and flagship projects such as Hornsea 3 and Dogger Bank developments



Challenges

- **Electricity network congestion:** Growing offshore wind output exceeds existing transmission capacity, causing curtailment and delaying clean energy connections.
- **Industrial decarbonisation pressure:** The Humber is the UK's largest CO₂-emitting industrial cluster; hard-to-abate sectors (steel, refining, chemicals) require hydrogen and CCUS at pace and scale.
- **System resilience and cost:** Integrating high shares of variable offshore wind with hydrogen production, storage and industrial demand creates complex balancing challenges with significant implications for system costs and security of supply.
- **Cross-vector planning coordination:** Electricity network upgrades and hydrogen infrastructure deployment are currently planned separately, creating sequencing risks and the potential for stranded investment.



Opportunities

- **World-class offshore wind** – Hornsea, Dogger Bank & upcoming North Sea projects for large-scale green H₂
- **Strategic H₂ infrastructure** – Saltend, Immingham Green Terminal, Aldbrough/Rough + Humber H₂ Network
- **East Coast industrial cluster** – co-location of steel, refining, fertilisers and power demand centres
- **H₂-to-power flexibility** – despatchable H₂-ready stations supporting GB-wide stability and deferring network upgrades

Stakeholders

National Energy System Operator – Northern Powergrid – National Gas – Hydrogen developers (such as Equinor and/or Bp) – Humber Industrial Cluster – Net Zero Industry Innovation Centre (Teesside University)

Research Questions

- **RQ1:** How does electrolyser capacity at key Humber–North-East locations (Saltend, Immingham, Easington) affect wind curtailment and electricity network congestion under different deployment scenarios?
- **RQ2:** How can hydrogen storage facilities such as Aldbrough and Rough support the balancing of offshore wind variability and industrial hydrogen demand?
- **RQ3:** How do alternative hydrogen pipeline (e.g., Humber Hydrogen Network) and electricity network upgrade strategies compare in terms of system costs and decarbonisation outcomes under different industrial demand growth scenarios?
- **RQ4:** What role can hydrogen-to-power generation play in providing flexibility to the electricity system?

HI-ACT Research Plan

- **Electrolyser sensitivity analysis:** Vary electrolyser capacity at Saltend, Immingham and Easington in the PyPSA-Eur-UK model to quantify impacts on wind curtailment, network congestion and system costs across different scenarios.
- **Storage dispatch modelling:** Integrate Aldbrough and Rough storage with offshore wind profiles and industrial H₂ demand to quantify balancing value and optimal storage sizing across 2025–2050.
- **Infrastructure scenario comparison:** Compare three PyPSA-Eur-UK scenarios — pipeline-led, network upgrade-led and combined — on system costs, CO₂ reductions and stranded asset risk
- **H₂-to-power flexibility analysis:** Assess the capacity credit, dispatch value and system cost impacts of hydrogen-fired generation benchmarked against battery storage and interconnectors in high-wind scenarios.