HYDROGEN UK
2024 CONFERENCE AND AWARDS
Caroline Stancell
Air Products
A World-Leading Hydrogen Supplier

>60 years of hydrogen experience

100+ hydrogen plants

1,100 km of hydrogen pipeline
New York, USA  
Green H₂ Production

Texas, USA  
Green H₂ Production

California, USA  
SAF Production Plant

Louisiana, USA  
Blue H₂ Production

Edmonton, Canada  
Blue H₂ Production

Hamburg, Germany  
RE Terminal and H₂ Production

Rotterdam, Netherlands  
RE Terminal and H₂ Production

Immingham, UK  
RE Terminal and H₂ Production

NEOM, Saudi Arabia  
Green RE Production

$15 billion  
Committed in energy transition projects

>1,000 MTD  
of green hydrogen

>3,500 MTD  
of blue hydrogen
Embracing all Production Pathways

- Lowers cost of energy transition
- Enhances energy security
- Builds supply chain resilience and creates demand
- Complements domestic renewable energy production

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<td><strong>Land use</strong></td>
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<td>Production</td>
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Immingham Green Hydrogen Production Facility

- 300MW H2 production
- 1,400 jobs in the region
- £4.6 bn GVA
- 580,000 tonnes of GHG reduction

In partnership with ABP

Generating a cleaner future
Policy Landscape

- Strategic plan
- Confidence in market supply
- Policies to create level playing field
- Internationally recognised certification scheme
Thank you

GENERATING A CLEANER FUTURE
William Mezzullo
Centrica
Unlocking the value of hydrogen

Hydrogen UK Conference
March 2024
We are an integrated energy & services business

10m+ Retail customers

Power & Gas Infrastructure

Maintaining a balanced portfolio through the energy transition

Leading Optimisation capability
Hydrogen is key to our Climate Transition Plan

**Climate Transition Plan:** be a net zero business by 2045 and help our customers be net zero by 2050

**Our Business Climate Plan:**
- Reduce our property emissions in the UK by 50% by 2030
- Grow low carbon asset portfolio up to 1GW in operation (solar, batteries, gas peakers and hydrogen) by 2027
- Build a zero-emission fleet by 2025

**Our Customer Climate Plan:**
- Roll out energy efficiency management solutions
- Deliver low carbon technologies (EV charging, heat pumps and hydrogen as an alternative to natural gas heating)
- Supply energy from renewable assets, biomethane and hydrogen

**Centrica Group fuel switching demand:**
- Easington Terminal
- Barrow Terminal
- Brigg Gas Peaker
- c.1200 x CHPs
- Whitegate CCGT

**Centrica Group fuel switching capacity is c.550ktpa of hydrogen** (excluding additional demand)

550ktpa requires **c.3GW of installed low carbon hydrogen production**, driving the demand for hydrogen production.
We take a whole-system approach to hydrogen
Centrica is developing decentralised UK hydrogen projects

Our Working Solution
- Electrolyser
- Hydrogen Storage
- Pressure Reduction System & Odorisation
- PPA & Optimisation Solution
- Off-taker
- Meter & PRS

Centrica’s decentralised hydrogen projects across the UK
- North-West Project: 
  - $H_2$ production
  - Fuel switching
- Humber Project: 
  - $H_2$ production
  - Industrial fuel switching
- Humber Project 2: 
  - $H_2$ production
  - Fuel switching
- Humber Project 3: 
  - $H_2$ for industrial demand
  - Solar co-location potential
- Staffordshire: 
  - $H_2$ for industrial demand
- Wales: 
  - $H_2$ production
  - Fuel switching
- Humber Project: 
  - $H_2$ production
  - Industrial fuel switching

Humber Project 3:
- $H_2$ for industrial demand
- Solar co-location potential

Wales:
- $H_2$ production
- Fuel switching

Staffordshire:
- $H_2$ for industrial demand

North-West Project:
- $H_2$ production
- Fuel switching

Humber Project:
- $H_2$ production
- Industrial fuel switching
Enabling the Hydrogen Market

Centrica has backed one of the largest and most comprehensive UK whole-systems model integrating electricity, natural gas and hydrogen vectors.
We have backed one of the largest and most comprehensive UK whole-systems model over the past 12 months

Co-developed a new whole-systems model including H₂

1. Detailed 7-zone GB power model
2. GB gas model
3. GB hydrogen model

Power generation to drive gas demand

Cost of gas to affect merit order and prices

Cost of H₂ to affect merit order and prices

Assessment of substitutability if relevant

Cost of gas to affect blue H₂ production

Renewable generation to affect green H₂ production

Extent of electrification displacing gas / H₂

Pipeline Storage H₂ production

Cross-vector whole systems modelling

Work started in March 2023

Our objective is to understand the interplay among multiple energy vectors to assess key policy, strategy and investment questions.

✓ Inform our policy stance by assessing the overall role and value of H₂
✓ Help us understand market interactions and the development of the H₂ market
✓ Support our investment decisions including assessment of locational deployment of H₂ assets and market entry points

We have collaborated with industry partners, including National Gas Transmission, to develop our approach
Hydrogen storage will play a key role in balancing our increasingly intermittent energy supply

Curtailed electricity used for hydrogen production is projected to grow significantly by 2050 as we increase weather-driven power…

...and the need for hydrogen storage increases to support system balancing from electrolysers and hydrogen power

The British Energy Security Strategy has re-emphasised the importance of hydrogen and the need for system investment

- On networks, storage and flexibility:
  
  “On costs, building ahead of need, where good value for money, may mean paying more in the short term for an asset that isn’t efficiently utilised immediately but is the cheapest option over the long term and reduces the need for repeated disruptive works to continually upgrade the system.”

Sources: CCC Sixth Carbon Budget (Dec 2020) and National Grid ESO Future Energy Scenarios 2022
National scale hydrogen infrastructure will help drive down the cost of hydrogen production

Indicative cost breakdown from HAR1:

- **CAPEX** 34%
- **OPEX** 17%
- **Power** 49%
- **Other**

Driving down the LCOH to improve affordability:

**LEGISLATIVE & REGULATORY:**
- Enable network blending including transmission level
- Enabling Risk Taking Intermediaries under the HBM

**TRANSPORT & STORAGE INFRASTRUCTURE:**
- Scale ambition on storage to reduce net zero system costs
- Accelerate whole-system planning and decision making on critical infrastructure

**TECHNOLOGY:**
- Continue to support technology development pathways to reduce CAPEX
- The rollout of blue hydrogen can help enable the development of green hydrogen by the earlier development of common infrastructure
Snapshot of results: the flexibility provided by storage and transport 
...(1) A windy day in 2050

Excess low-cost hydrogen production is stored...

...while networks flow almost exclusively from North to South

Sources: FTI modelling, Core scenario
Note: To date, we have not accounted for compressor usage and losses but could be included in subsequent modelling runs
**Snapshot of results: the flexibility provided by storage and transport**

...(2) A low wind day in 2050

<table>
<thead>
<tr>
<th>H₂ production</th>
<th>H₂ transport</th>
<th>H₂ storage</th>
<th>H₂ usage</th>
<th>Electricity consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>105 GWh</td>
<td>1,058 GWh</td>
<td>1,411 GWh</td>
<td>837 GWh</td>
<td>254 GWh</td>
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<tr>
<td>73 GWh</td>
<td></td>
<td></td>
<td>572 GWh</td>
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<tr>
<td>281 GWh</td>
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Price £51/MWh

Price £19/MWh

Sources: FTI modelling, Core scenario

Note: To date, we have not accounted for compressor usage and losses but could be included in subsequent modelling runs

Snapshot of results: 8 November 2050

**...while some network flows reverse to move H₂ towards generators**

**End-user demand**

**Storage**

**H₂-to-power**

**H₂ flows**

Sources: FTI modelling, Core scenario
The interplay between hydrogen, power and gas is critical

1. **Green hydrogen production is likely to be economic**
   Minimal subsidy support if there is an energy system where the vast majority of primary generation is from intermittent renewables...
   ...allowing the system to take advantage of windy/sunny periods

2. **H₂ storage and transport is essential**
   to ensure the system maximises the benefits of low-cost H₂ production...
   ... H₂ transport allows H₂ to be produced where it is cheapest and to be conveyed to demand
   ... storage ensures H₂ can be used during periods where it is of greatest value...

3. **Blue H₂ production** has a stronger economic case if...
   ... H₂ storage is limited...
   ... H₂ transport is limited or delayed...
   ... and H₂ demand for home heating is high
   This points to a potential substitutability for blue H₂ relative to electrolyser and storage, depending on the factors above

4. **The role of H₂-to-power assets** is still relatively unclear and would depend on the relative cost of H₂ to gas or power.
   Larger H₂Ps may substitute gas-fired plants in earlier years...
   ... but smaller H₂Ps might be more suitable to serve more peaky electricity periods as more renewables are added to the system.
The importance of National Scale Infrastructure to unlock hydrogen

- Net Zero “will require a fundamental change in the country’s energy infrastructure”
- “Core networks of infrastructure to transmit and store H\textsubscript{2} and carbon are essential by 2035”

National Infrastructure Assessment NIC (Oct 2023)

- H\textsubscript{2} transport allows H\textsubscript{2} to be produced where it is cheapest and to be conveyed to demand…
- … and Large-scale geological storage ensures H\textsubscript{2} can be used during periods where it is of greatest value…

Project Union H\textsubscript{2} Transmission National Gas

Geological H\textsubscript{2} Storage Depleted Gas Fields + Salt Caverns

Minimum of 8TWh of H\textsubscript{2} storage needed by 2035

Potential of 10-16TWh of H\textsubscript{2} storage via Rough that could be delivered in multiple phases
Thank you for Listening!

William Mezzullo

William.Mezzullo@centrica.com
Hydrogen’s essential role in net zero future

Catherine Raw
Managing Director, SSE Thermal

12 March 2024
Strategy aligned to future energy system
Decarbonising power generation and enabling electrification

1. Creating renewable energy at home and abroad
2. Transporting electricity to power society
3. Providing flexible energy to ensure energy security
4. Enabling a smooth, fair and just transition
Bridging the Gap
What is required to decarbonise the power system by 2035

• Forecast growth in electricity demand sees total capacity requirement growing from 61GW in 2021 to 73GW in 2035
• Even with expected growth in renewables, the retirement of nuclear and unabated technologies leaves a potential 27GW gap in capacity without investment in new capacity
• Given variable intermittency of renewables, flexible, dispatchable capacity will be the most economic option to help fill this gap

SOURCE: Aurora Energy Research, 2024
Bridging the Gap
Dispatchable power at scale

CCGT capacity, assuming 30yr and 25yr retirement profile

SOURCE: Aurora Energy Research, 2024
Bridging the Gap
Dispatchable power at scale

Required abated capacity to fill the gap

SOURCE: Aurora Energy Research, 2024
Hydrogen needs an integrated value chain

Hydrogen CCGTs require an integrated and scaled hydrogen production, transport and storage system to become a reality.

- Blue and green hydrogen production
- Large scale geological storage
- Hydrogen-fired power station

Hydrogen pipeline

Low carbon electricity to grid
SSE’s hydrogen projects
Developing across the value chain

- The world's first major 100%-hydrogen-fired power station
- Hydrogen blending options at our existing power generation sites
- Hydrogen readiness at HVO development sites in Ireland
- One of the world's largest hydrogen storage facilities at Aldbrough site
- Significant on and offshore wind pipeline
- Aldbrough Hydrogen Pathfinder uniting storage, electrolytic production and power.
- Blue hydrogen H2 NorthEast in Teesside
Our Humber low-carbon vision

Atwick Gas Storage
Owned and operated by SSE Thermal

Aldbrough Hydrogen Pathfinder
The first of a kind project in the Humber could see hydrogen production, storage & power generation in one location by the middle of the decade

Aldbrough Hydrogen Storage
With the potential to be one of the world’s largest hydrogen storage facilities, the project which is to be located at the existing gas storage site, will be pivotal in creating a large-scale hydrogen economy

Dogger Bank
Located more than 130km off the North East coast of England. Dogger Bank Wind Farm will be capable of powering 6 million British homes

Saltend Power Station
Talion Power, jointly-owned by SSE Thermal and Equinor; operates the plant which is a potential primary option to H2 Saltend

H2H Saltend
Equinor’s H2H Saltend hydrogen production project could kick-start the region’s wider decarbonisation

Drax

GOOLE

HULL

EASINGTON

IMMINGHAM

GRIMSBY

Deep-water Ports
The Ports of Hull, Immingham and Gimsby will help to unlock crucial import and export opportunities for the Humber

Keadby 2
SSE’s Keadby 2 Power Station is the most efficient CCGT in Europe – with the potential to blend up to 50% hydrogen in the future

Keadby Carbon Capture Power Station
The proposed 910MW power station equipped with CCS technology would capture up to 1.5 million tonnes of CO₂ a year and plug into the East Coast Cluster’s transport and storage infrastructure

Keadby Hydrogen Power Station
Our Keadby Hydrogen Power Station could become one of the world’s first major 100% hydrogen-fired power stations, with a peak demand of 1800MW of hydrogen

SSE Thermal
Bridging the Gap
Action needed to decarbonise dispatchable power

There is a clear destination but still no route to investment
Thank you
Keynote
Q&A
Refreshment Break
11:00-11:30