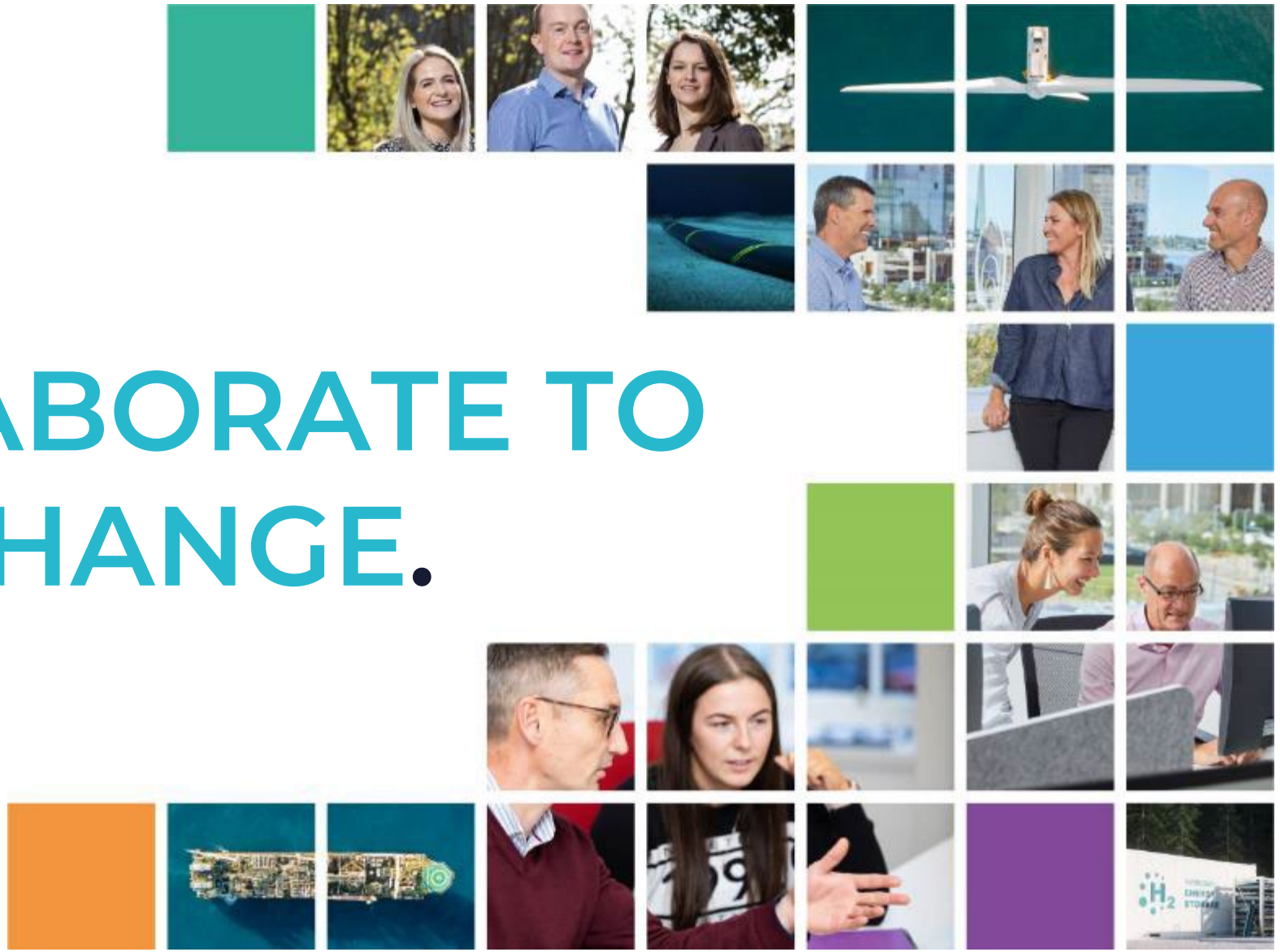
XODUS

Bacton Energy Hub

Infrastructure SIG Findings

WWW.XODUSGROUP.COM

WE COLLABORATE TO INSPIRE CHANGE.



Infrastructure SIG Core Group

- The Infrastructure SIG Core Group played a key role in contributing to the report and dedicated material time and effort over the past 12 months supporting the delivery of each of the work packages.
- Xodus would like to thank and acknowledge the people and companies.

XODUS

Cadent
Your Gas Network

Cavendish Management Consultants Ltd

FLUOR

MCDERMOTT

PERENCO

PARADIGM

NEPTUNE ENERGY

nationalgrid

Scope and Objectives

The focus of the assessment was to identify key infrastructure required for the production of hydrogen and the storage of resultant CO_2 from CCS-enabled hydrogen

Repurposing of offshore infrastructure for CO_2 or H_2 transport and storage

Repurposing of Bacton Terminals for H_2 production

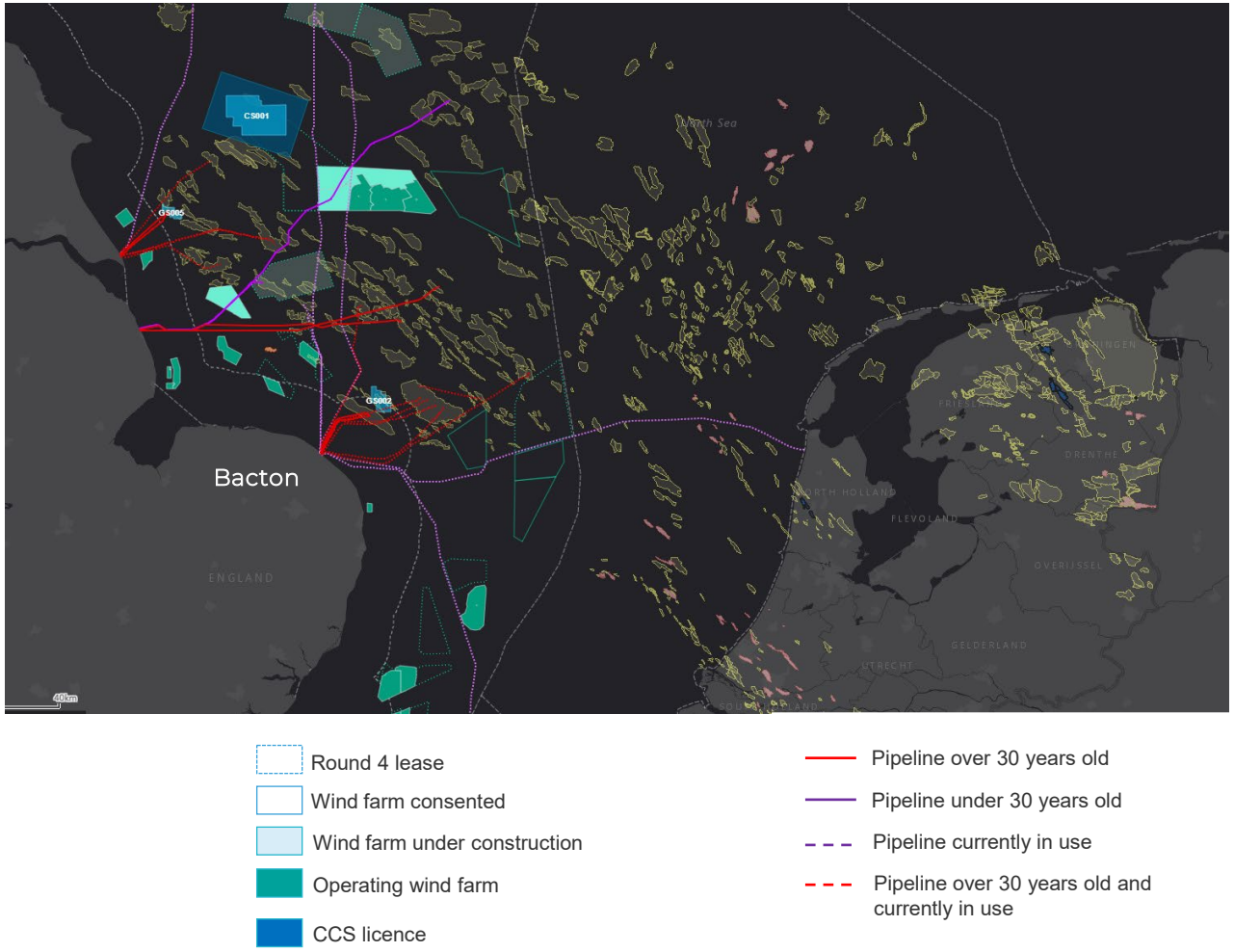
Greenfield offshore infrastructure

Offshore wind integration

Existing Infrastructure - Upstream

Bacton sits at the heart of a complex offshore gas, wind and CCS infrastructure landscape.

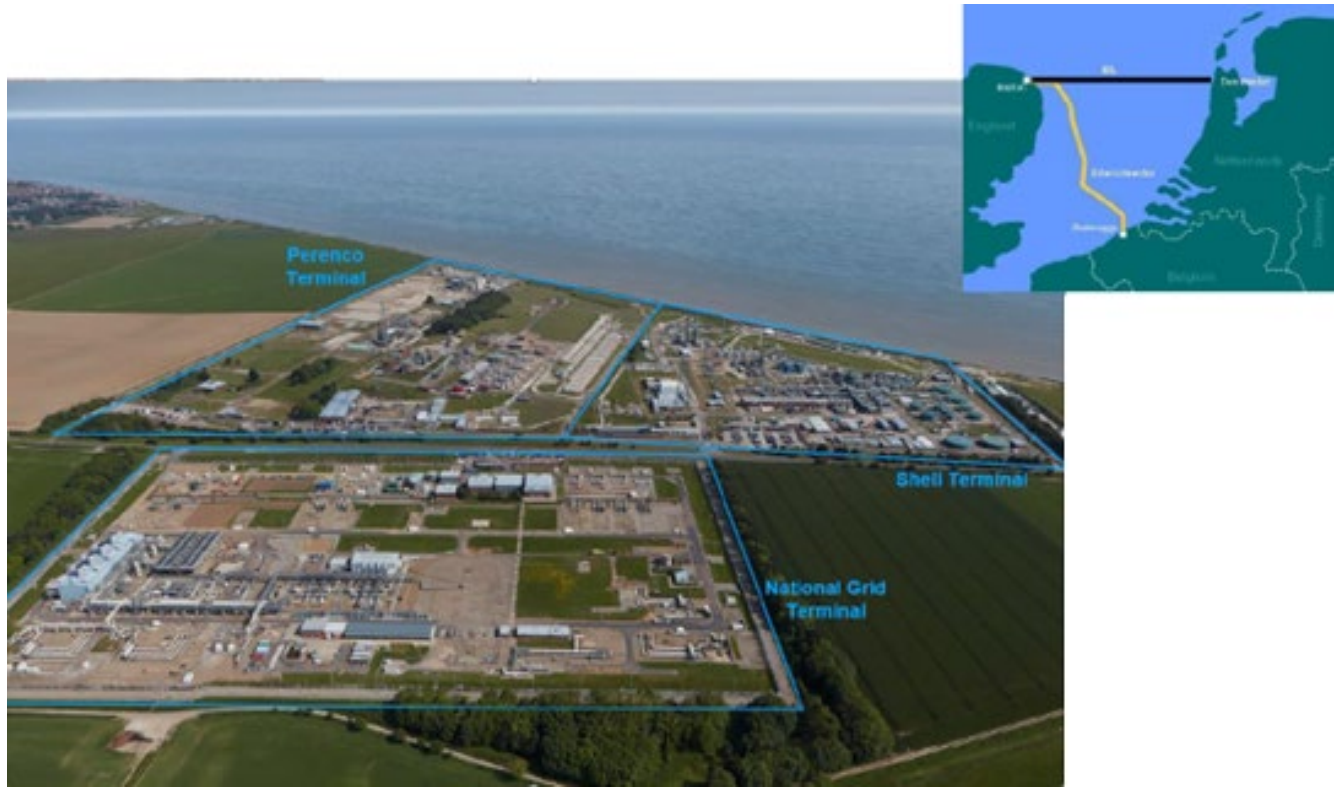
- A large number of gas trunklines land at Bacton.
- Two gas interconnector pipelines to/from Europe connect to the UK grid at Bacton.
- 15 GW of offshore wind is planned in the East of England by 2030
- NSTA CO2 storage licensing round areas are located close to Bacton.



Existing Infrastructure – Bacton Terminals

Bacton has established infrastructure that can process up to 1,650 mmscfd, with two interconnectors to Europe

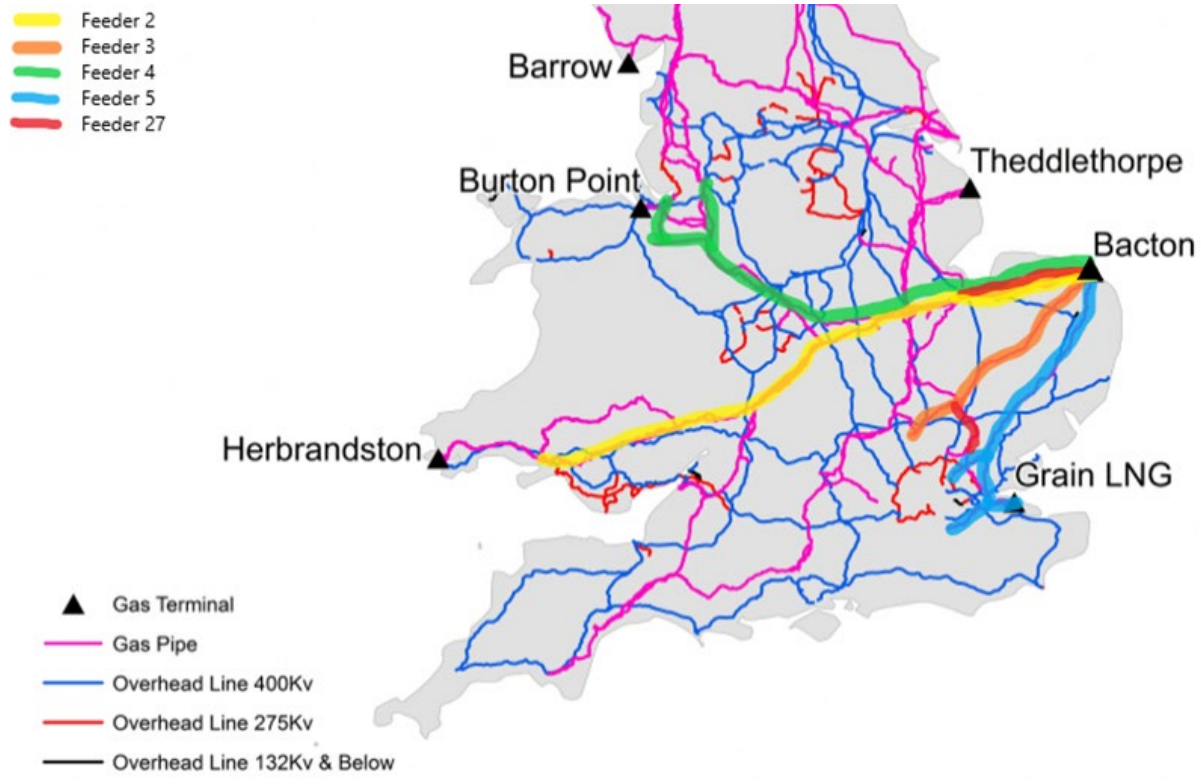
- Bacton receives natural gas from the Southern North Sea, Central North Sea and interconnectors from the Netherlands and Belgium.
- There are three gas processing plants, owned and operated by Shell, Perenco and National Grid.
- The existing ENI plant has been decommissioned.
- The total gas processing capacity at the Bacton terminals is 1650 mmscfd.
- Electricity supply to Bacton is relatively limited, with a local substation capacity of up to 28 MW.



Existing Infrastructure - Downstream

Bacton has excellent connections to the National Transmission System (NTS), providing a potential route to market for hydrogen

- Five onshore transmission feeders have connections to the National Grid Bacton Terminal which link into the wider NTS.



Repurposing Offshore Infrastructure

Trunklines to shore represent the best opportunity for repurposing existing upstream infrastructure.

- The majority of pipelines could transport CO2 in gaseous phase, however if dense phase transportation is required this would reduce the number of potential candidates.
- Sean is expected to reach CoP in the mid-2020s and therefore the pipeline represents a potential good candidate for re-use.
- The Perenco and Shell operated pipelines to Leman could be potential candidates, but there is uncertainty in CoP timing for the fields.

Item	CO_2	Hydrogen
Wells	Unlikely to be re-used unless can be proven to be compatible material (13 Cr) and with proven integrity.	Potential for repurposing, but dependent on well integrity and cement quality.
Topsides Structure	Could be re-used depending on condition, anticipated future lifetime and required brownfield modifications	Could be re-used depending on condition, anticipated future lifetime and required brownfield modifications
Topsides Production Equipment	Highly unlikely to be able to re-use topsides production equipment for CO_2	Highly unlikely to be able to repurpose for 100% Hydrogen processing
Jackets	May have potential for re-use depending on proximity to suitable reservoir, anticipated future lifetime and condition	May have potential for re-use depending on proximity to suitable reservoir, anticipated future lifetime and condition
In field gathering lines	May be re-used for CO_2 injection, but will depend on location of injection wells	May be re-used but require extensive assessment on material specification and suitability for 100% Hydrogen transport.
Trunklines to shore	Likely to be re-used for CO_2 transport, and already being considered in Acorn and Hynet.	May be re-used but require extensive assessment on material specification and suitability for 100% Hydrogen transport.

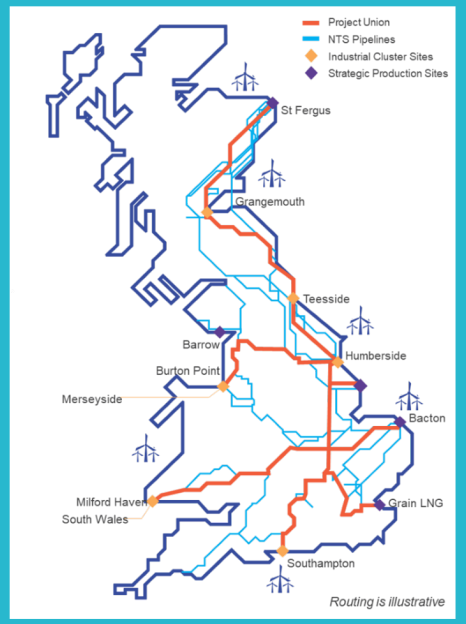
Repurposing Bacton Terminals

The Core Project could be situated within the existing plot boundary at Bacton, utilising the existing ENI site

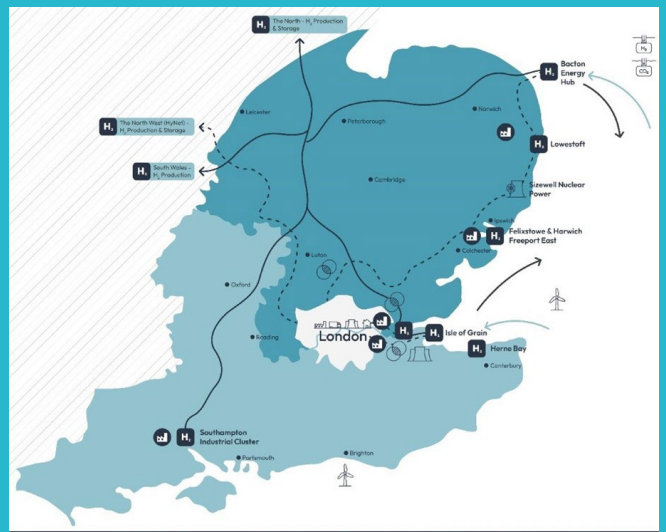
- A preliminary layout was carried out to assess the feasibility of situating a hydrogen production facility at Bacton.
- The Core Project (355 MW CCS-Enabled Hydrogen Plant) could be sited within the existing ENI terminal footprint
- Further assessment of brownfield remedial works are required to validate the executability.
- Build-out scenarios could be situated at Bacton, but require further investigation and timing to align with potential CoP of existing Bacton terminals

Blending H2 to Gas Network

- There are several onshore gas grid projects considering transition to hydrogen. Bacton is well placed to supply hydrogen to these.



Project Union – National Grid

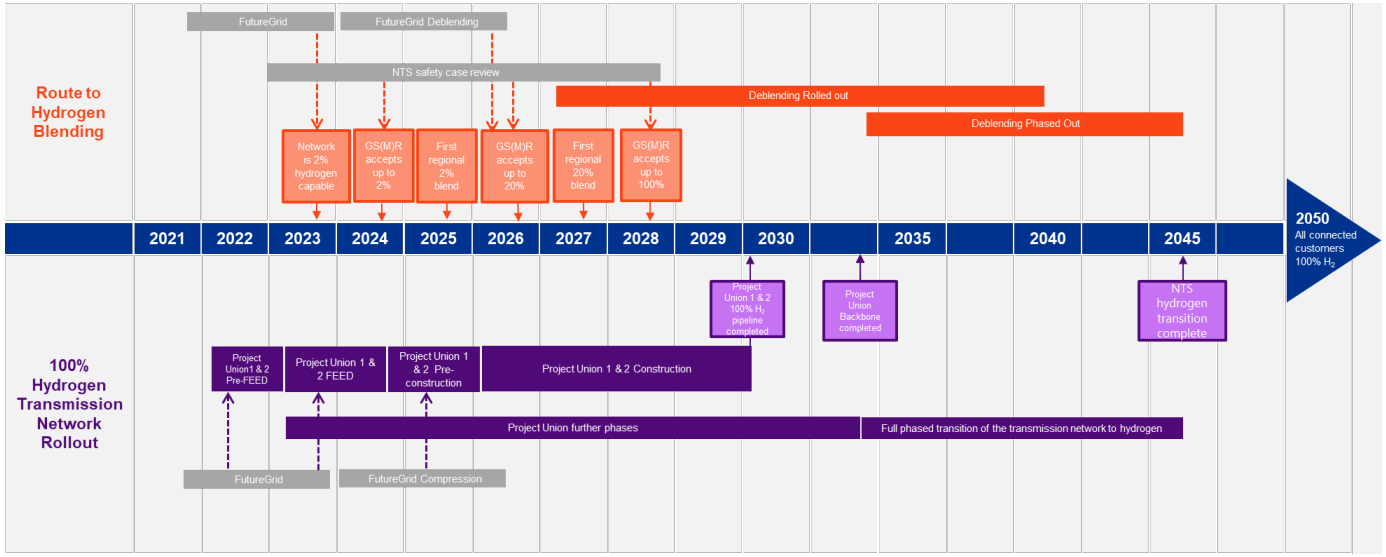


Capital Hydrogen – Cadent / SGN / National Grid

Hydrogen Valley – Cadent / National Grid

Blending Hydrogen to Gas Network

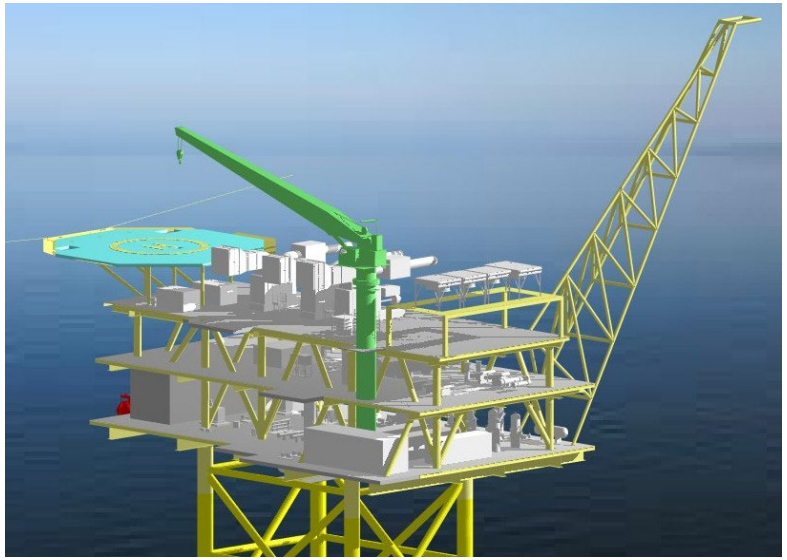
- Blending hydrogen to the gas grid requires changes to legislation.
- A pathway of 2% v/v by 2024, 20%v/v by 2026 and 100% by 2045 is envisaged by National Grid.
- Clear sight of and timing of these decisions is critical to success of the BEH concept.

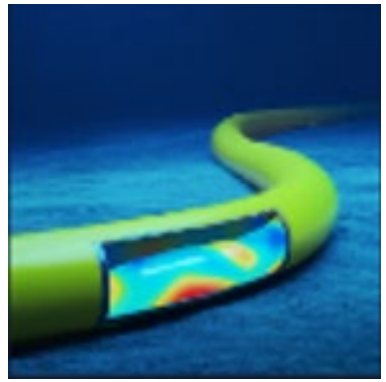


Greenfield Offshore Infrastructure

A greenfield pipeline could support build out of a CCS enabled hydrogen project as well as import of CO2 from Europe

- For a generic 30km pipeline, a 16” CO2 pipeline could accommodate 5Mtpa CO2 transport in dense phase, or up to 1Mtpa CO2 in gaseous phase. The Core Project requires 1Mtpa capacity.
- Injection wells with dry trees located at a normally unmanned wellhead platform would be preferred over a fully subsea solution.
- This is expected to give a lower lifecycle cost.
- Other CCS schemes in similar water depth have adopted a NUI approach for CO2 injection. This includes Hynet, Northern Endurance, Porthos and Aramis.



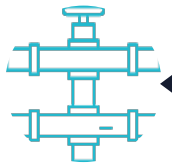


Conclusions

Bacton is ideally situated to leverage existing infrastructure to support transition to low carbon hydrogen production

Trunklines can potentially be repurposed for CO2 transport to stores situated within the NSTA's CCS licence round. This can support both BEH and future import of CO2 from Europe

The Core Project can be situated within the existing Bacton plant boundary



Bacton has excellent connections to the gas grid through five NTS feeders which can provide a route to market for hydrogen, if blending can be achieved

Bacton's proximity to offshore wind farms, provides potential alternative routes to market for offshore wind developers to supply electricity for future hydrogen production