Hydrogen: A Business Opportunity for the North East Region

Chair: Maggie McGinlay, ONE
Session 2: Hydrogen Opportunity

- Aberdeen Hydrogen Hub – Andrew Win, Aberdeen City Council
- Role of H2 in Decarbonising the Dutch Economy – Dr Jamie Frew
- The Opportunity which H2 presents the supply chain – Suzanne Ferguson, Wood
- Hydrogen in the UK and Internationally – Sarah Kimpton, DNV GL
Aberdeen Hydrogen Hub

Speaker: Andrew Win, Aberdeen City Council
Aberdeen Hydrogen Hub

Andrew Win
Aberdeen City Council
Vehicle Deployments

Promote vehicle deployments by a range of stakeholders in the region:
Refueling Infrastructure

Develop hydrogen refuelling infrastructure:
Market Constraints

• Vehicle Price
• Component and Servicing Costs
• Servicing Supply Chain
• Maintenance & Technicians
• Hydrogen production & infrastructure costs
Hydrogen in an Integrated Energy System
Encourage the development of the hydrogen economy’s supply chain, seeking opportunities for the region’s existing energy expertise to diversify and benefit from this growing industry:
Role of Hydrogen in Decarbonising the Dutch Economy

Speaker: Jamie Frew, PhD, MBA
IMPORTANT DIFFERENCES
IMPORTANT SIMILARITIES
## COMPARISON – Economy

<table>
<thead>
<tr>
<th></th>
<th><strong>Netherlands</strong></th>
<th><strong>UK</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GDP per capita $</strong></td>
<td>53</td>
<td>42</td>
</tr>
<tr>
<td><strong>Debt (%GDP)</strong></td>
<td>52%</td>
<td>86%</td>
</tr>
<tr>
<td><strong>Innovation Ranking</strong></td>
<td>2nd</td>
<td>4th</td>
</tr>
<tr>
<td><strong>vehicles/1,000 people</strong></td>
<td>553</td>
<td>584</td>
</tr>
<tr>
<td>Metric</td>
<td>Netherlands</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>-------------</td>
<td>----------------</td>
</tr>
<tr>
<td>GDP per capita $</td>
<td>53</td>
<td>42</td>
</tr>
<tr>
<td>Debt (%GDP)</td>
<td>52%</td>
<td>86%</td>
</tr>
<tr>
<td>Innovation Ranking</td>
<td>2nd</td>
<td>4th</td>
</tr>
<tr>
<td>vehicles/1,000 people</td>
<td>553</td>
<td>584</td>
</tr>
<tr>
<td>CO2 Tons per capita (2017)</td>
<td><strong>10.26</strong></td>
<td><strong>5.73</strong></td>
</tr>
<tr>
<td>Comparison Item</td>
<td>Netherlands</td>
<td>UK</td>
</tr>
<tr>
<td>-----------------------------------------------------</td>
<td>-------------</td>
<td>-----</td>
</tr>
<tr>
<td>GDP per capita $</td>
<td>$33</td>
<td>$42</td>
</tr>
<tr>
<td>Debt (%GDP)</td>
<td>52%</td>
<td>86%</td>
</tr>
<tr>
<td>Innovation Ranking</td>
<td>2nd</td>
<td>4th</td>
</tr>
<tr>
<td>vehicles/1,000 people</td>
<td>553</td>
<td>584</td>
</tr>
<tr>
<td>CO2 Tons per capita (2017)</td>
<td>10.26</td>
<td>5.73</td>
</tr>
<tr>
<td>Imports % of GDP (2018)</td>
<td>70%</td>
<td>24%</td>
</tr>
<tr>
<td>Exports % of GDP (2018)</td>
<td>79%</td>
<td>17%</td>
</tr>
</tbody>
</table>
A CARBON INTENSIVE TRADE

INDUSTRIAL EMISSIONS (Mton)

<table>
<thead>
<tr>
<th></th>
<th>Emissions (Mton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>158</td>
</tr>
<tr>
<td>Industrial Sector</td>
<td>67</td>
</tr>
</tbody>
</table>

Netherlands

- High temperature heat >500 deg C
- Electrical consumption

- 22
- 19
- 14
- 7
- 5
A CARBON INTENSIVE TRADE

INDUSTRIAL EMISSIONS (Mton)

<table>
<thead>
<tr>
<th>Category</th>
<th>Emissions (Mton)</th>
<th>Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>158</td>
<td></td>
</tr>
<tr>
<td>Industrial Sector</td>
<td>67</td>
<td>&gt;40%</td>
</tr>
</tbody>
</table>

Map of Netherlands with ROTTERDAM highlighted.
Vision of decarbonised industry - 2050

- Thriving, globally leading industry
- Virtually zero emissions
- Demonstrate that complex system changes are possible + profitable

Key points

- 59% CO2 reduction (2030 vs 1990)
- National CO2 tax for industry, rising up to €120-150 per excess ton emitted
- Multi-billion euro support for emissions reducing technologies; specific support for Waterstof
Vision of decarbonised industry - 2050

• Thriving, globally leading industry
• Virtually zero emissions
• Demonstrate that complex system changes are **possible + profitable**

**Key points**

• 59% CO2 reduction (2030 vs 1990)

• National CO2 tax for industry, rising up to €120-150 per **excess** ton emitted

• Multi-billion euro support for emissions reducing technologies; specific support for **Waterstof**
What is this stuff? Waterstof
WATERSTOF | WATER-DUST
WATERSTOF | WATER-DUST | HYDROGEN
Hydrogen - Let’s all speak the same language!

1 Nm3 = 0.08988 kg = 38 scft = 10.8 Mj

= 10 KM per 1 KG H2

= 50 000 KM => 5 MT H2 per year
VISION OF A HYDROGEN ECONOMY

• National H2 network – stimulate expansion
• Based on soon to be retired Groningen-Gas Network
• Part of greater European Network
AIR LIQUIDE BENELUX NETWORK

- Europe’s largest hydrogen network
- World Scale production sites feeding industry in 3 countries
- High Availability, Reliability and Flexibility
- No fundamental barrier to large scale hydrogen networks
CURRENT APPLICATIONS OF HYDROGEN IN NL

Feedstock for chemicals

- Fertilizers
- Fuel refining
- Plastics

200 k
THE MANY USES OF HYDROGEN

- FUEL FOR: Transport
- HEAT FOR: Industry
- FEEDSTOCK FOR: Chemical

- Power
- Buildings
- Products
What colour is your hydrogen?

**GREY HYDROGEN**
Split natural gas into CO₂ & hydrogen
Est. 10 kg CO₂ per kg H₂

**BLUE HYDROGEN**
Split natural gas into CO₂ & hydrogen
Est. 1 kg CO₂ per kg H₂

**GREEN HYDROGEN**
Split water into hydrogen by electrolysis powered by wind & sun
Est. 0 kg CO₂ per kg H₂

CO₂ EMITTED IN THE ATMOSPHERE
CO₂ STORED OR RE-USED
NO CO₂ EMITTED
BP ROTTERDAM - GREY HYDROGEN

- Hydrocracker Investment of greater than €1 Billion
- World Scale Hydrogen Production Unit.
- Project delayed due to uncertainty about impact of climate legislation
- Huge disruption in Grey Hydrogen Market
- BP now pursuing Green Hydrogen
BP ROTTERDAM - GREY HYDROGEN

• Hydrocracker Investment of greater than €1 Billion
• World Scale Hydrogen Production Unit.
• Project delayed due to uncertainty about impact of climate legislation
• Huge disruption in Grey Hydrogen Market
• BP now pursuing Green Hydrogen
- BLUE HYDROGEN
• Solution for decarbonizing refineries and other high temperature heat applications

• Hydrogen for power generation when required

• Accelerator for large scale hydrogen deployment
North sea as a CO₂ sink

- CO₂ storage in Dutch sector is not unlimited
- H-vision type projects and other carbon capture technologies across Europe could greatly increase CO₂ volumes
- CO₂ exports to well understood geological sinks may be crucial
• **180 gigawatts** wind capacity required in 2050 to achieve the Paris climate targets for the North Sea countries.

• **Massive offshore development:** At 8 megawatts per windmill, 22,500 mills required, covering 5% of the North Sea.

• **Netherlands Ports as European Energy gateway** for renewable North Sea exports.
## NORTH SEA WIND ISLANDS - GREEN HYDROGEN

<table>
<thead>
<tr>
<th></th>
<th>BRITNED Cable</th>
<th>BBL Gas Pipeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>1 GW</td>
<td>15 GW</td>
</tr>
<tr>
<td>Length</td>
<td>276 km</td>
<td>225 Km</td>
</tr>
<tr>
<td>Construction Costs</td>
<td>£500 Million</td>
<td>£500 Million</td>
</tr>
<tr>
<td>Annual Volume</td>
<td>8 TWh</td>
<td>120 TWh</td>
</tr>
</tbody>
</table>

- Electrical transport lines **10-15x cost** of pipeline
- Hydrogen can be stored in large quantities in **geologic storage at reasonable cost**
- Large scale hydrogen storage can **balance variable renewable energy** generation
Netherlands could consume 14 Mt Hydrogen | Scale up of 15X from current level

2.8 Mn
Sources and more information about the role of hydrogen in decarbonizing the Dutch economy

1. https://countryeconomy.com/countries/compare/netherlands/uk
3. Source: RCI, ‘Port of Rotterdam CO2 hub: crucial stepping stone towards sustainable economic growth’
6. Technical Report Hydrogen - the key to the energy transition
2.8 Billion Euros of investment

Green and Blue Hydrogen proposed

13 production projects proposed

New infrastructure and applications also planned

NORTH OF NETHERLANDS - INVESTMENT ROADMAP

40 K
The Opportunity Hydrogen Presents For The Supply Chain

Speaker: Suzanne Ferguson, Wood
The Opportunity which Hydrogen Presents for the Supply Chain

1st October, 2019

Suzanne Ferguson
Suzanne.Ferguson@woodplc.com

woodplc.com
## Agenda

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Introduction to Wood</td>
</tr>
<tr>
<td>02</td>
<td>Conventional Hydrogen Production</td>
</tr>
<tr>
<td>03</td>
<td>Hydrogen Production with Carbon Capture</td>
</tr>
<tr>
<td>04</td>
<td>Other Routes to Hydrogen</td>
</tr>
<tr>
<td>05</td>
<td>Overall Hydrogen Supply Chain</td>
</tr>
<tr>
<td>06</td>
<td>Conclusions</td>
</tr>
</tbody>
</table>
Introduction to Wood
Our global footprint

- We’re accelerating and expanding in new sectors and geographies
- Unlocking our technology across an incredible sector spread

We have a global network of skilled professionals, delivering on our reputation for integrity and assurance.
## Our global footprint

<table>
<thead>
<tr>
<th>Clean Energy</th>
<th>Chemical</th>
<th>Refining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment and Infrastructure</td>
<td>Manufacturing</td>
<td>Marine and Defence</td>
</tr>
<tr>
<td>Mining and Minerals</td>
<td>Nuclear, Power and Process</td>
<td>Oil &amp; Gas</td>
</tr>
</tbody>
</table>
Extensive experience in Decarbonisation

**Designing the UK’s first 100% hydrogen local distribution network**

**Wood has performed 60+ CCS studies since the mid-1990s**

**High efficiency Steel Manufacturing** for reduced energy use and CO₂ footprint

**Full-Chain CCS Capability**
- CO₂ Capture and Compression
- CO₂ onshore and offshore pipelines
- Offshore Topside Modifications
- Onshore permitting and DCO

---

**Wood pioneered the high pressure Steam Methane Reformer, designed and built over 120 hydrogen plants**

**CO₂ capture cost study for national carbon emissions reduction for an EU country.**

**Galion Lidar and O&M services World’s first commercial floating wind farm**

**Wood designed and constructed key parts of the CO₂ pipeline network now operational in UAE**
Conventional Hydrogen Production
Decarbonisation will drive rapid growth in hydrogen

• Quarter of the global CO₂ reduction by 2050 (Hydrogen Council)
• Investment of $2.5tr with large capital projects already emerging, e.g. HyNet £920m
Conventional Hydrogen Production

Reforming of natural gas is an established technology at large scale

- Wide production capacity range (from 8,000 Nm³/h to 180,000 Nm³/h single train)
- Dedicated product line for small modular unit (from 3,000 Nm³/h to 8,000 Nm³/h)
- Suitable for a wide range of feedstocks from NG to LPG and Light Naphtha’s.
- Converts light hydrocarbons to H₂, CO and CO₂ with addition of water (steam).
- But, approximately 10 tonnes of CO₂ are emitted for every tonne of hydrogen produced.
Conventional Hydrogen Production

Terrace Wall™ Steam Reforming Furnace

The heart of our Hydrogen Units

- High Performance
- Flexibility
- Reliability
- Simplicity
Conventional Hydrogen Production

Pre-Treatments

Reforming

Purification

FEED

STEAM

Steam Export

FUEL

Tail Gas Recycle

A presentation by Wood.
Hydrogen Production with Carbon Capture
OGCI Climate Investments

Concept Design & Pre-FEED

Objective - designing the optimised and state-of-the-art carbon capture facilities for 7 main industries representing key emitters with high impact on climate change

Gas Power + Capture
- Power plant & CO₂ capture technology ranking / selection (techno-economic analysis)
- Power / Capture optimisation
- Power / Capture pre-FEED deliverables

Industrial Capture x 6
- Industrial process CO₂ capture optioneering
- Technology screening (down selection)
- Technology selection (techno-economic analysis)
- Industrial capture plant pre-FEED deliverables

<table>
<thead>
<tr>
<th>Gas Power Plant</th>
<th>CO₂ Capture Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen</td>
<td>CO₂ Capture Plant</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>CO₂ Capture Plant</td>
</tr>
<tr>
<td>Petchems</td>
<td>CO₂ Capture Plant</td>
</tr>
<tr>
<td>Cement</td>
<td>CO₂ Capture Plant</td>
</tr>
<tr>
<td>Steel</td>
<td>CO₂ Capture Plant</td>
</tr>
<tr>
<td>Refinery</td>
<td>CO₂ Capture Plant</td>
</tr>
</tbody>
</table>
Involvement in key global CCS Projects

- Post- and pre-combustion CO₂ capture evaluations for BP and IEAGHG
- Concept development, Pre-FEED and FEED contractor for Peterhead DF-1, pre-combustion capture plant
- FEED Contractor for MASDAR Hydrogen Power Abu Dhabi, pre-combustion capture plant
- FEED Contractor for E.ON Kingsnorth post combustion CO₂ capture from coal power plant
- FEED Contractor for Don Valley IGCC pre-combustion coal power plant
Involvement in key global CCS Projects

- Design and cost support to the ETI EMSE model development and analysis of novel technologies, including hydrogen turbines and salt cavern storage.
- Contributor to Teesside Collective Blueprint for Industrial CCS, followed by H21 Hydrogen study.
- BEIS 2017 Refresh of CO₂ capture Benchmarks with new state of the art cost and performance and evaluation of novel technologies
- BEIS CCUD Phase 1 - matching CO₂ capture technologies to CCU demonstration sites – Glass Manufacture, Brewing, Energy from Waste, Oil Refining, Biomass Power Plant
- CO₂ capture from 2 oil refineries in the Middle East for EOR
- CO₂ concept development cost study for national CO₂ emissions reduction, including CO₂ shipping to Norway
Other Routes to Hydrogen
Waste Gasification to Product Scheme

Key Features

- Waste material – Biomass (wood chips, Wood pellet, Torrified wood etc), Refuse Derived Fuel (RDF)
- Waste gasification using sub-stoichiometric $O_2$ into $H_2$ & CO ("Syngas")
- Higher value products generated
Waste-to-Hydrogen Study

Confidential, UK
Study for a 25 TPD end-of-life plastics waste-to-hydrogen plant.

- Plant can be configured for power generation only or Hydrogen product plus power (internal use).
- Process designed to handle plastics including black plastics.
- Purpose designed proprietary gasifier to convert feed to gas followed by clean-up
- Hydrogen separation by PSA to 99.999% purity.
- Gas engines for power when plant in generation mode.
- MP Hydrogen for passenger vehicle supply.
Green Hydrogen Example – SWIFTH2 Project

Overview

• SWIFTH2 Hydrogen Ferries Feasibility Study
• Involving:
  • vessel design
  • hydrogen generation (electrolysis)
  • storage & pipe infrastructure
  • port infrastructure including dispensing
  • renewables integration (wind)
• Hydrogen priced at £3.70/kg (£2.90 with RTFO)
• First step towards decarbonising shipping sector
• Supporting Scottish Government targets
Summary

The 76,000 panel solar PV plant is one of the largest facilities of its kind and generates enough energy to power around 9000 homes.

Scope of work

Wood acted as owner’s engineer throughout the pre-construction and construction phases of the project.
Hywind Scotland Floating Wind Farm – World First

- Investor diligence
- Lidar technology
Overall Hydrogen Supply Chain
Hydrogen for the future

Wood provide comprehensive supply chain coverage and proprietary technology
Wood provide comprehensive supply chain coverage and proprietary technology.
Hydrogen for the future

Wood works collaboratively with many other organisations

- Feasibility Studies, technology/financial/feedstock supply assessments, FEED, EPC, owner’s engineer, permitting

- Renewable energy integration, grid integration & infrastructure

- Life cycle cost, carbon footprint & environmental impact assessments

- Safety assessments, performance validation, operations management

- Trading, hydrogen transportation and storage
Hydrogen for the future

Wood works collaboratively with many other organisations
Green Hydrogen as an Energy Vector

Water

Electrolysis (Power to Gas)

Biomass

Anaerobic Digestion / Fermentation

Gasification

Nitrogen

Hydrogen

Carbon Dioxide

Hydrogen

Hydrogen

Biomass

Anaerobic Digestion / Fermentation

Gasification

Ammonia Synthesis Reactor

Methanol (Power to Liquid)

Methanation Reaction

Hydrogen / Biogas mixing

Biogas Upgrader

Ammonia

Methanol

Synthetic Natural Gas (SNG)

Hydrogen

Enriched Biogas

Biomethane (Bio-SNG)

Syngas
Renewable Hydrogen as an Energy Vector
Conclusions
Conclusions

• Ten-fold increase in hydrogen use anticipated by 2050
  • Development of hydrogen vehicles and appliances

• Significant increase required to supply this hydrogen
  • Bulk hydrogen production
    • Natural gas reformation with CCS
    • Renewable power electrolysis
    • Other routes, such as waste to hydrogen
  • Transmission and distribution
  • Storage

• Hydrogen as an Energy Vector is interlinked with many other industries and processes
Hydrogen in the UK and Internationally – A Perspective from DNV GL

Speaker: Sarah Kimpton,
Hydrogen in the UK and Internationally
A perspective from DNV GL

Sarah Kimpton
01 October 2019
Today, Hydrogen is Primarily used as a Feedstock

<table>
<thead>
<tr>
<th>Primary Energy</th>
<th>Conversion to Hydrogen</th>
<th>Hydrogen Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 %</td>
<td>Electrolysis</td>
<td>Ammonia 55 %</td>
</tr>
<tr>
<td>68 %</td>
<td></td>
<td>Methanol 10 %</td>
</tr>
<tr>
<td>16 %</td>
<td>Reforming</td>
<td>Refining 25 %</td>
</tr>
<tr>
<td>11 %</td>
<td></td>
<td>Other 10 %</td>
</tr>
</tbody>
</table>
Innovation - Hydrogen as an Energy Carrier

Heating (buildings)

Transport

Constrained renewable power generation

Energy intensive industry

Deutsche Fotothek
Hydrogen for
• Heat
• Transport

Pale Blue Dot + National Grid + SGN + DNV GL
UK – Hydrogen in the Gas National Transmission System

NTS 100% Carbon Dioxide

Hydrogen for
• Heat
• Transport
• Power
• Industry

NTS natural gas to direct connections

NTS de-blend hydrogen to direct connections

NTS hydrogen blend to direct connections

NTS 100% hydrogen to direct connections

SMR / ATR

H₂

Storage

Others
Europe, Asia, Canada and US – HyReady JIP

- No current guidelines for gas transmission and distribution operators
- Output
  - Practical guidelines for hydrogen injection
  - Mitigation measures
  - Up to 30% hydrogen blend
  - Phase one - gas networks
  - Phase two - compressors and end users
- DNV GL
  - Program coordination and implementation
  - Literature review
  - Building on NaturalHy and HIPS projects

Hydrogen for
- Heat
- Transport
- Power
- Industry
UK – BEIS Hy4Heat Programme

• Demonstrate safe delivery of 100% hydrogen to domestic consumers
• Work pack 2
  • Determine optimum purity of hydrogen
  • Necessity of adding a colourant to increase visibility of flames
  • Develop IGEM hydrogen standards
• Work pack 7
  • Experimental study to investigate how hydrogen leaks disperse in homes and streets
  • HyStreet at our Spadeadam facility
Europe – Burner Control System

<table>
<thead>
<tr>
<th>Natural Gas</th>
<th>100%</th>
<th>70%</th>
<th>40%</th>
<th>10%</th>
<th>5%</th>
<th>0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen</td>
<td>0%</td>
<td>30%</td>
<td>60%</td>
<td>90%</td>
<td>95%</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Full range fuel flexible burner control**

**Consortium of >25 companies**

- Hydrogen producers
- Gas transport/distribution companies
- Manufactures
- Suppliers of burners and control systems
- Boiler and oven manufacturers
- Industrial end-users
- Government
- Trade bodies

**Hydrogen for:**
- **Industry**
- **Commerce**
Europe - GERG and CEN Hydrogen/H2NG Initiative

Reduce barriers to injection of hydrogen into gas grid
Literature surveys
Subject areas prioritised by CEN
Bottlenecks from hydrogen roadmap
List gaps in knowledge
Benefits and costs of removal of barriers

<table>
<thead>
<tr>
<th>Priority / topic area</th>
<th>Expected Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>DNV GL</td>
</tr>
<tr>
<td>Gas Quality</td>
<td>GRT Gaz</td>
</tr>
<tr>
<td>Underground storage</td>
<td>DBI</td>
</tr>
<tr>
<td>Power Generation and Engines</td>
<td>DNV GL</td>
</tr>
<tr>
<td>Industry</td>
<td>Engie</td>
</tr>
<tr>
<td>Steel Pipes</td>
<td>GRT Gaz</td>
</tr>
<tr>
<td>Network Equipment</td>
<td>DBI</td>
</tr>
<tr>
<td>End use over 20% hydrogen</td>
<td>DGC</td>
</tr>
<tr>
<td>Integration coordination, interfaces and transverse subject management</td>
<td>GERG</td>
</tr>
</tbody>
</table>

Hydrogen for
- Heat
- Transport
- Power
- Industry
Netherlands - Rozenburg Apartment Complex

- Dutch Government running pilot projects
- 25 homes near Rotterdam
- Synthetic natural gas to hydrogen
  - 8% of heat demand (statutory limitation)
- DNV GL:
  - Burner engineering for hydrogen boilers
  - Life cycle emissions
  - Risk assessments
  - Verification of performance

Production from green electricity
Gas grid operator Stedin
Rozenburg Boiler house
Zero-carbon comfort
Netherlands - Energy Delivery Business Models and Investors

- Dutch start-up to build world-first integrated hydrogen wind turbine
- On-shore wind turbine supplying electrolyser
- Expanding to on- and off-shore wind turbines
- Business assurance for “green” investor
- Assessment of energy production
  - Verification of financial model and assumptions
  - Evaluation of subsidies and investments
  - Commercial analysis of business plan

Decentralised generation
Electricity grid congestion
Grid Reinforcement

Hydrogen for Green Power
South America - Combined Solar and Hydrogen Storage

Solar power
- Energy production
- Contracts
- Technical due diligence

Hydrogen storage
- Technology risks
- Monitoring of construction and commissioning
- Financial model
- Power grid contracts

Non-intermittent power

Hydrogen for Green Power
Innovation - Hydrogen as an Energy Carrier

Decarbonisation of heating (buildings)

Adding value to surplus electricity from renewable power generation

Transport applications

Decarbonisation of energy intensive industry applications
Thank you

For further information
sarah.kimpton@dnvgl.com
+44 7964 133 912

www.dnvgl.com

SAFER, SMARTER, GREENER