



Hydrogen's role in the energy transition – Market outlook in key applications

Graham Bennett

Vice President and Head of Energy Transition



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KEYNOTE - 18 MAY

Graham Bennett
Vice President and Head of Energy Transition



KEYNOTE - 19 MAY

Jon André Løkke
Chief Executive Officer



KEYNOTE 2 - 19 MAY

Morry Markowitz
President





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SESSION HOST:

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Vice President and Publisher

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Hydrogen's Role in the Energy Transition

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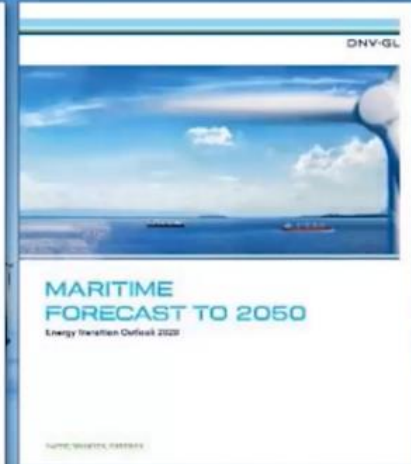
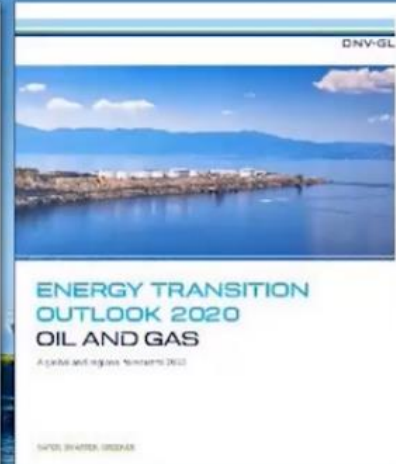
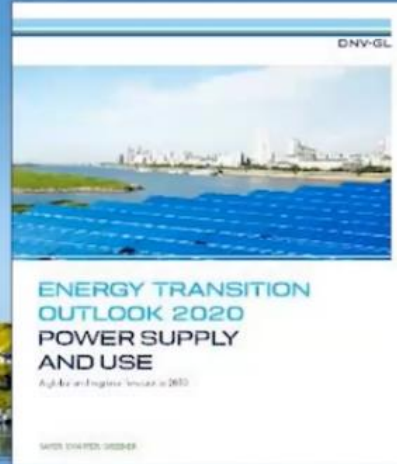
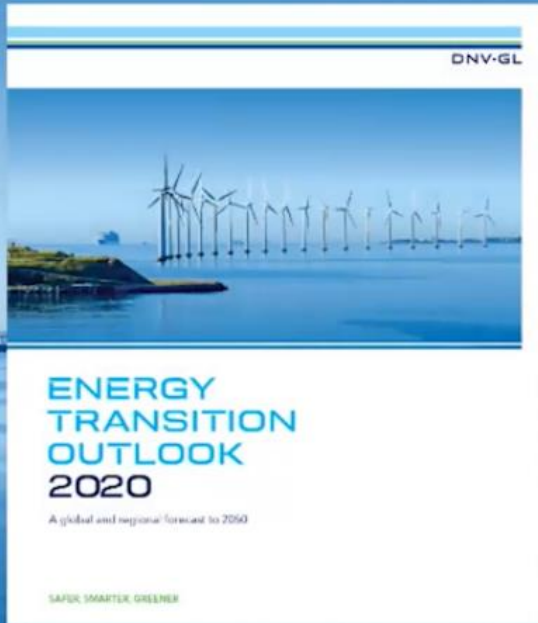
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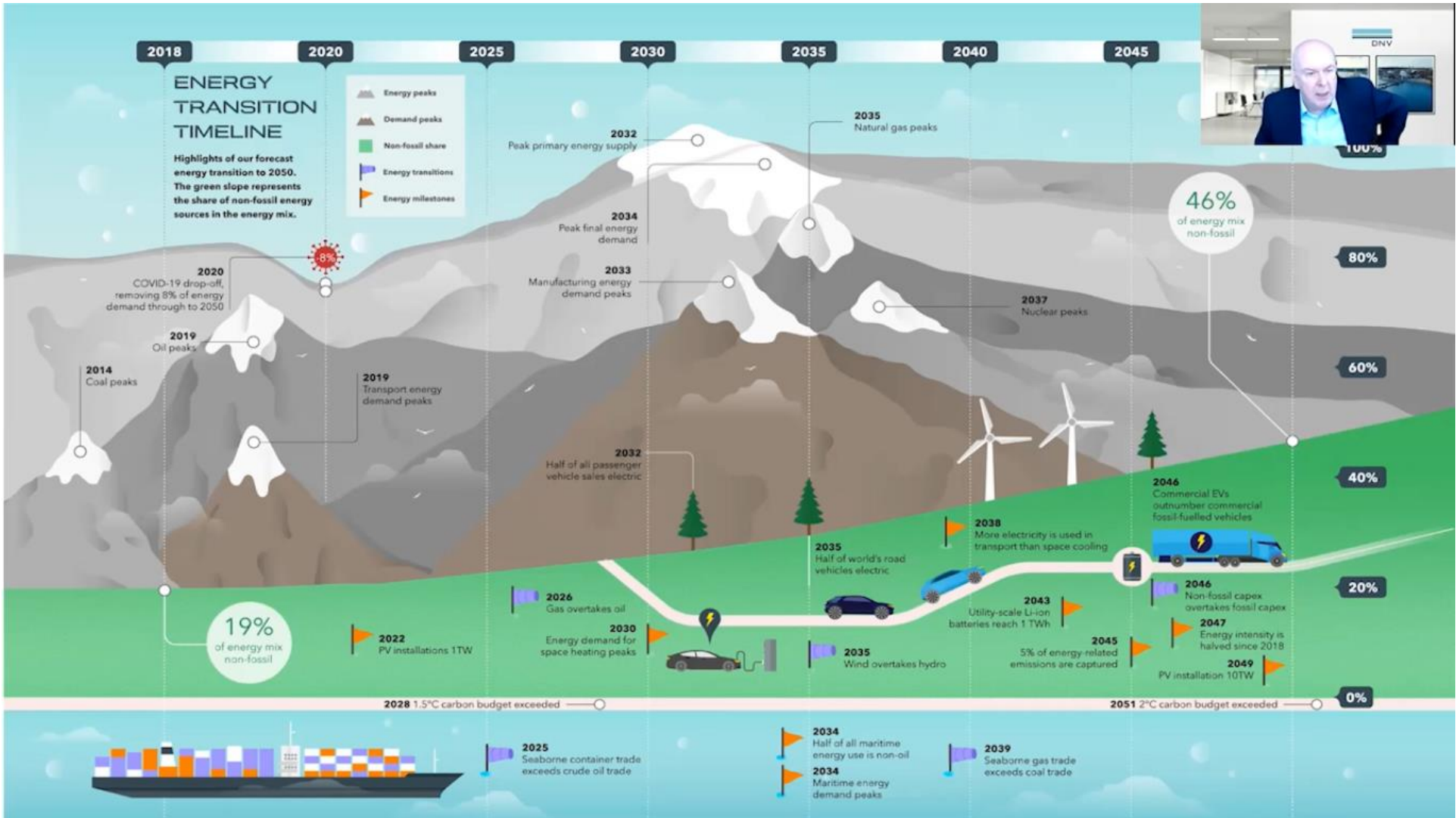


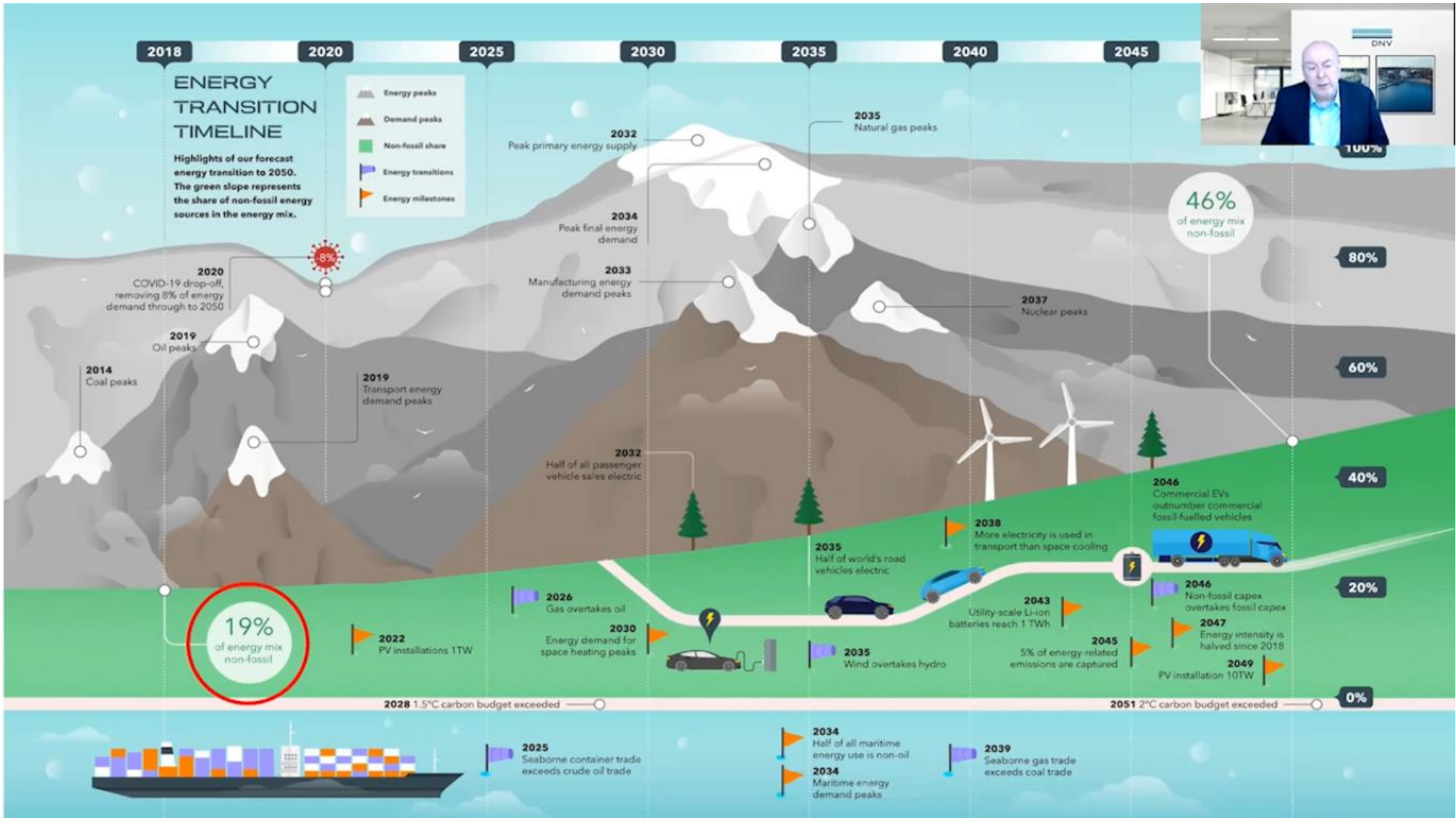


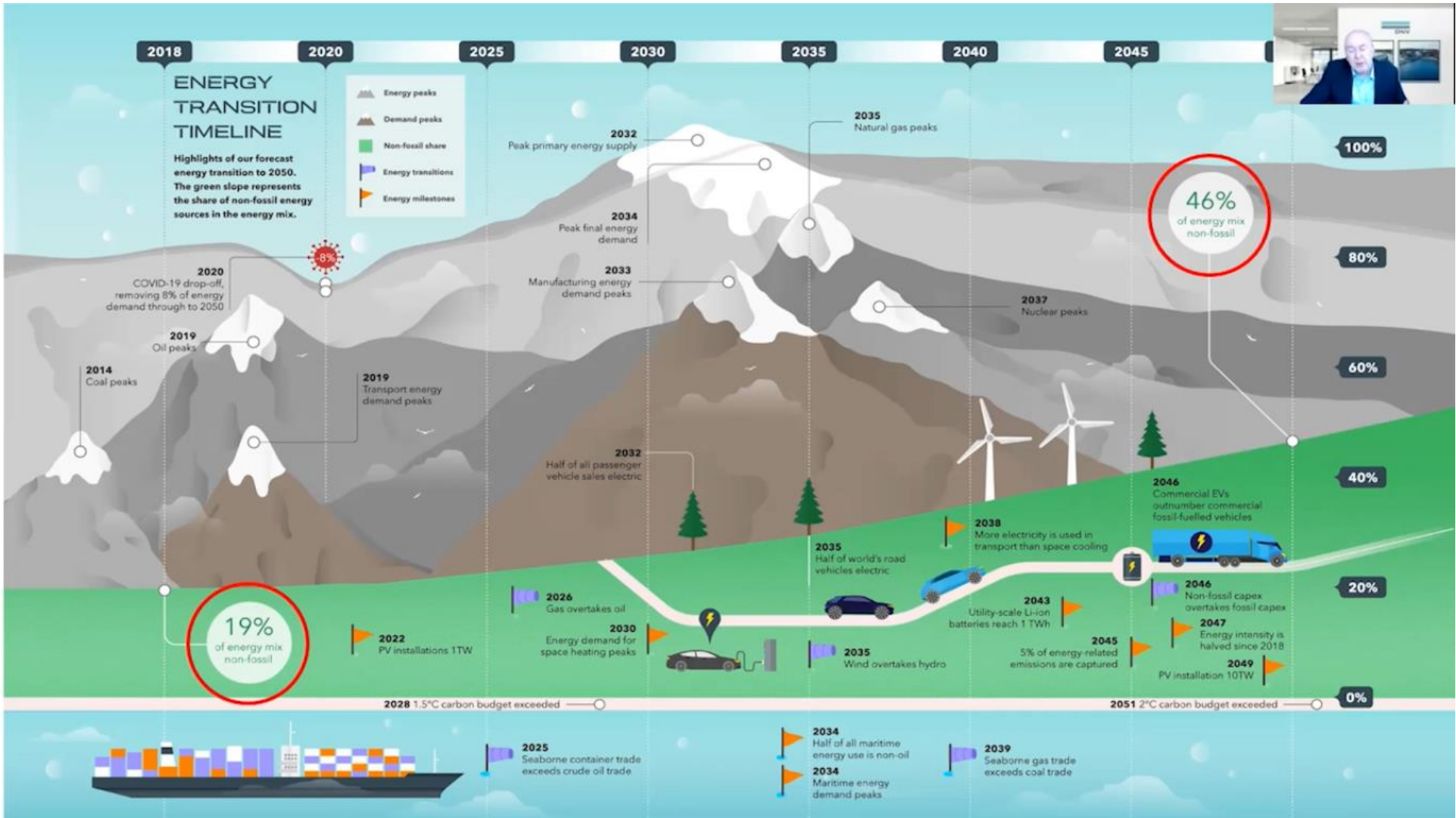
Why Hydrogen Now?

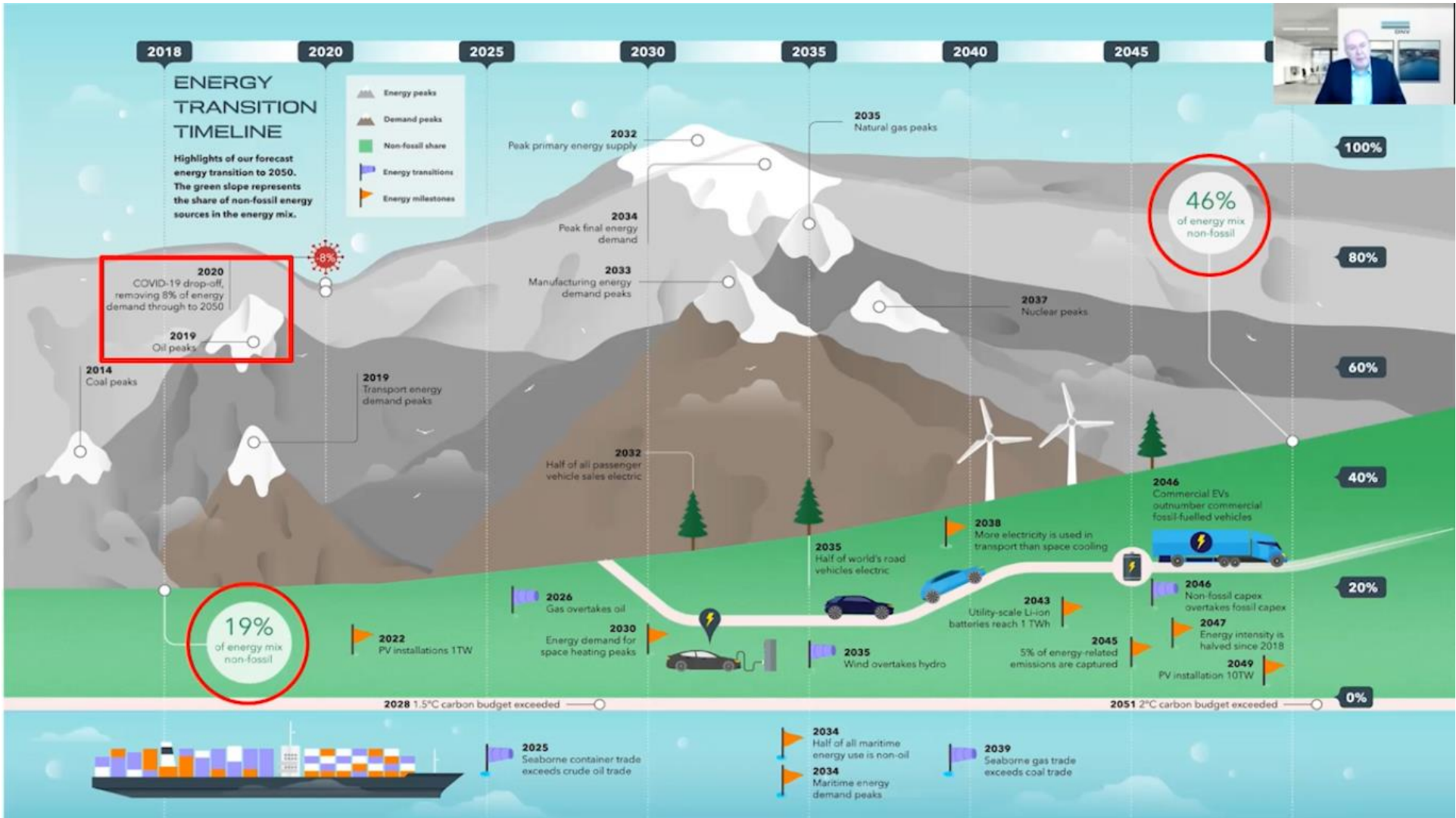
Suite of publications available at eto.dnvgl.com













Main drivers for introducing hydrogen as a major energy carrier

Decarbonization of heating (buildings)



Mobility applications



Valorisation (and storage) of excess electricity from renewable, low OPEX power



Decarbonization of heat in energy intensive industry applications



Deutsche Fotothek



Industries and governments are focusing on four key areas to scale the hydrogen economy



Safety Research

The scale of the future hydrogen society will be determined by success in demonstrating safety



Infrastructure Development

Hydrogen behaves differently to natural gas and will require new or adapted infrastructure



Hydrogen production

Hydrogen can be produced in several ways, but if it is to help in the battle with climate change, the process will have to be decarbonised



Policy and strategy

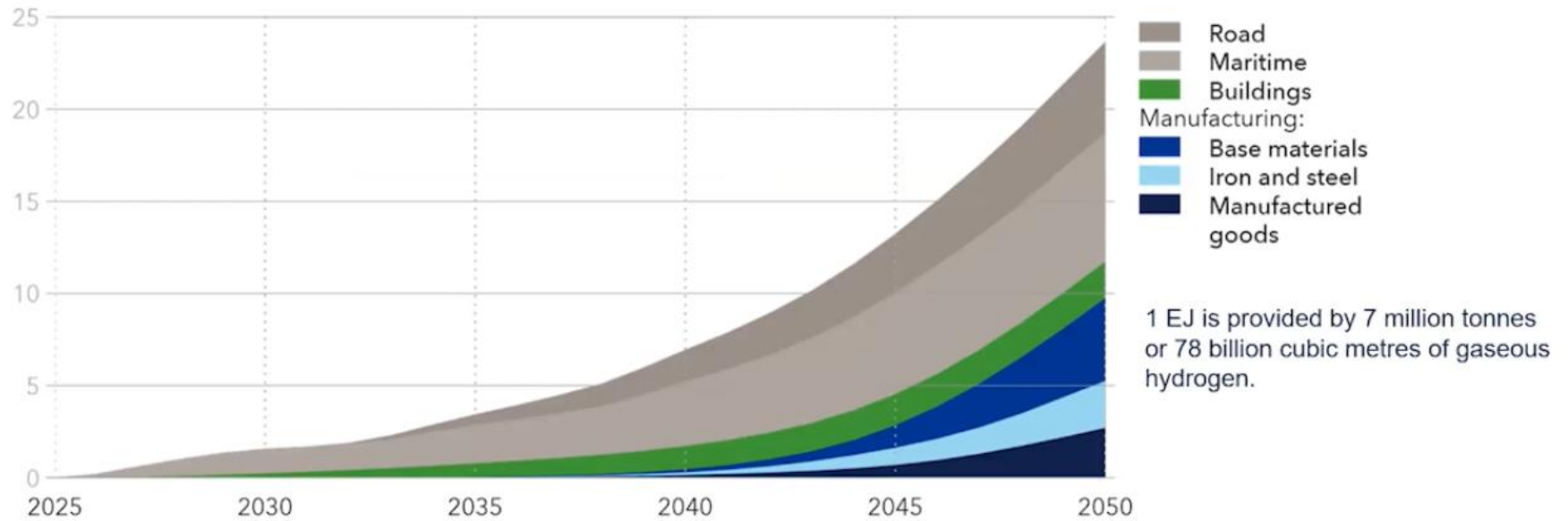
Long-term policy commitments will be essential to building demand for hydrogen, and supporting investment. Companies will need effective, long-term strategies



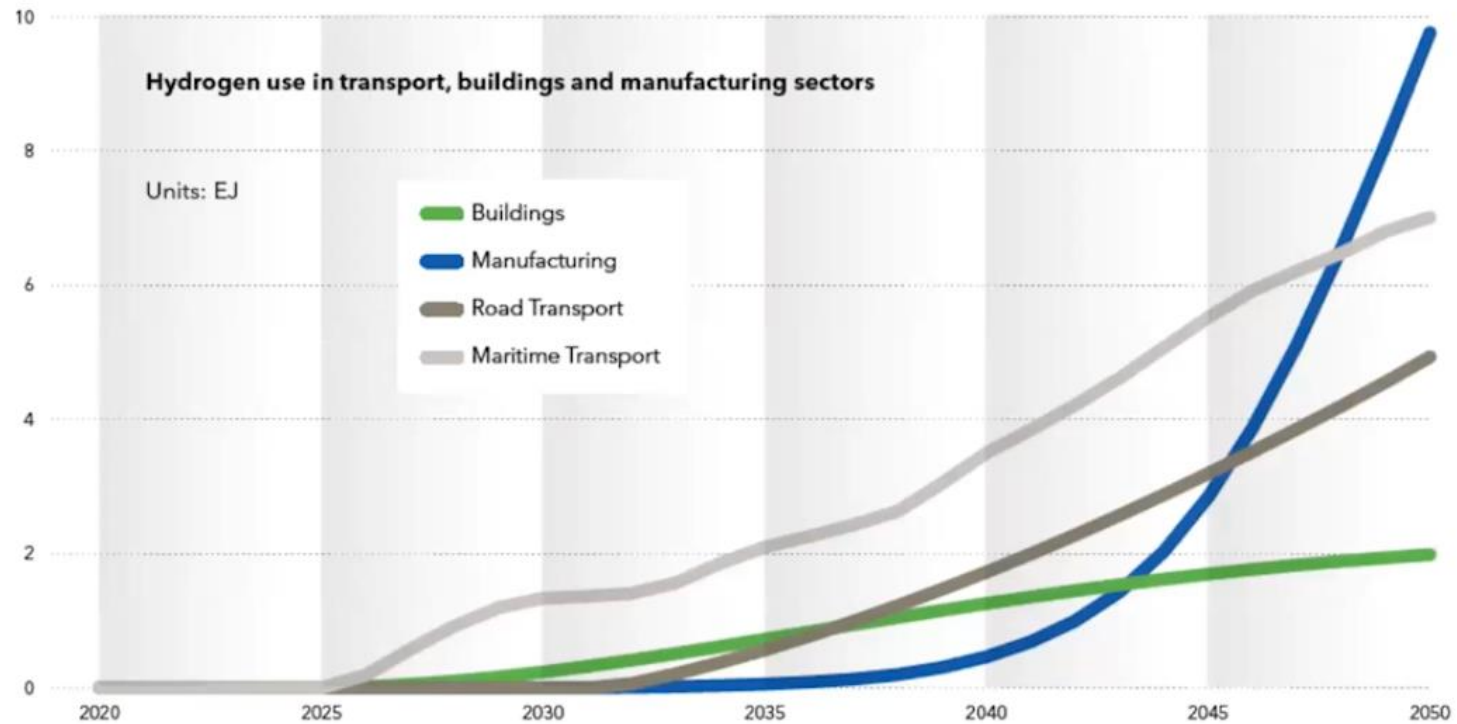
Hydrogen - late but strong growth: >6% of global energy demand in 2050

World hydrogen demand by sector

Units: EJ/yr



Overall hydrogen market outlook

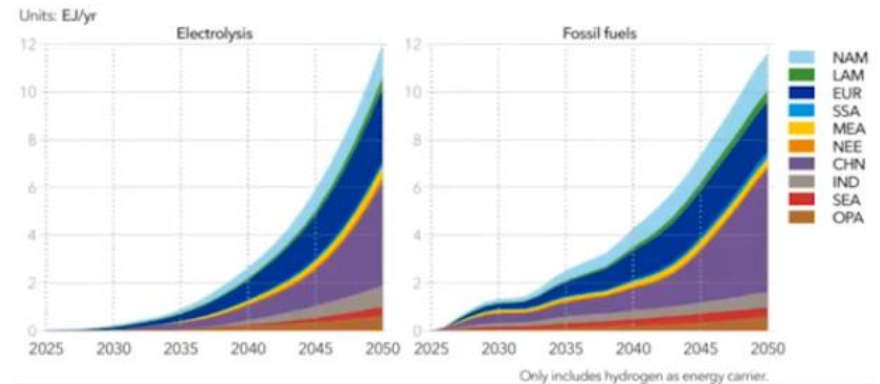




Hydrogen production – a veritable rainbow!

- The rapid rise in interest for hydrogen has led to many production sources being proposed.
- The main production method today is via steam methane reforming (SMR), where hydrogen is derived from hydrocarbons, this has lower overall costs due to low fossil-fuel prices.
- However, with an increasing carbon price on CO2 emissions and ongoing process improvement for electrolysis based hydrogen, this gap is going to decrease.
- DNV believe that green hydrogen will become cost competitive at scale with blue hydrogen by the early 2030's.

World hydrogen production from electrolysis and fossil fuels by region



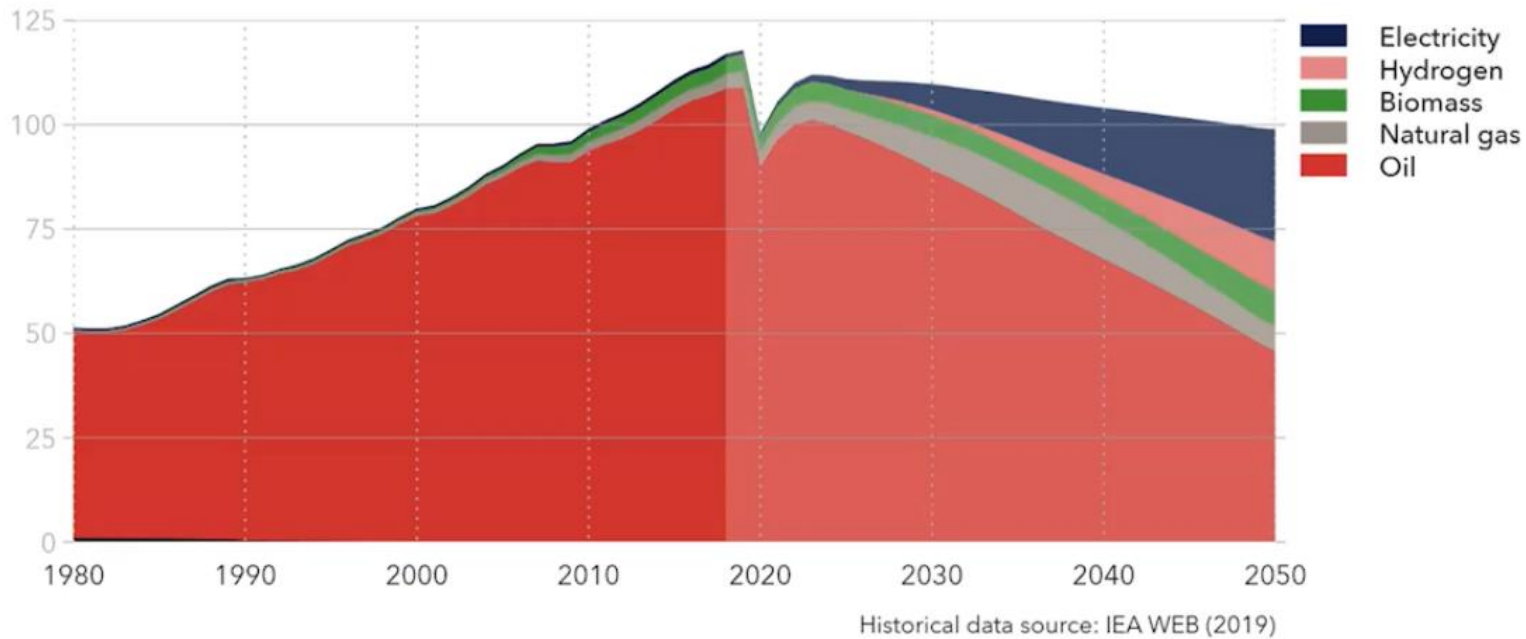
2050 level values	Parameter uncertainly tested										
	Base	Carbon price				Gas price		SMR learning rate		Electrolysis learning rate	
Sensitivity range	Base	-50%	+50%	+100%	+300%	-50%	+50%	-50%	+50%	-50%	+50%
Hydrogen demand (EJ/yr)	24	13	32	34	43	20	22	24	24	24	24
Share in hydrogen production Electrolysis/SMR (%)	51/49	59/41	62/38	69/31	57/43	58/42	50/50	51/49	51/49	51/49	50/50



Electricity makes big inroads in transport, hydrogen grows rapidly after 2030, mainly for HGV's

World transport sector energy demand by carrier

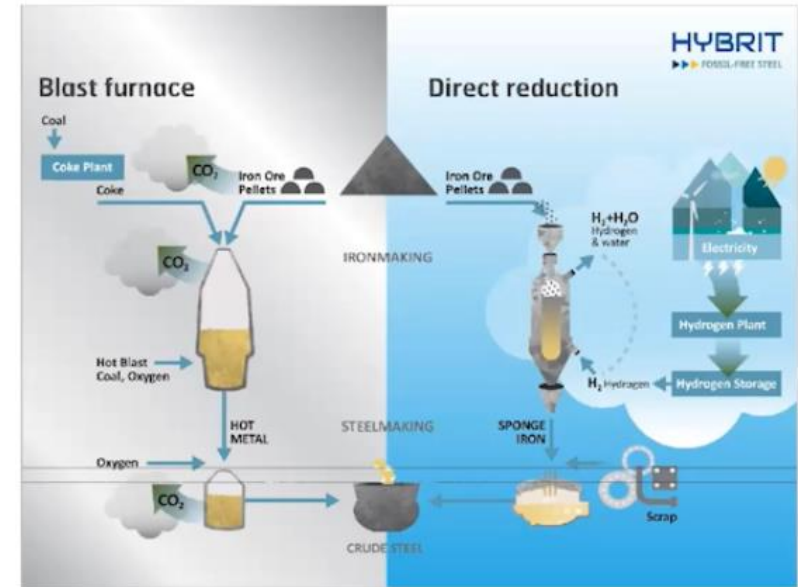
Units: EJ/yr



Hydrogen for Industry



- In all regions, electrification of heat processes in base-material production will be significantly less pronounced than in the manufactured-goods subsector due to the limited efficiency gains from switching to electricity in high-heat furnaces and hydrogen will play a significant role there.
- Hydrogen will start to become a viable heat medium in those regions where it can compete with natural gas, something not visible at scale until 2035. Hydrogen's share of energy demand in global manufacturing in 2050 is forecast to be 7%.
- Industrial clusters play a key role in the development of hydrogen, not only as a consumer, but also as a location for both SMR and green hydrogen production. Having supportive hydrogen and CCUS business models for industry will be essential to avoid carbon offshoring.
- Gas networks will be critical to move hydrogen between industrial clusters, and from production locations to other consumers.



Hydrogen for building heat?



Hydrogen for building heat?



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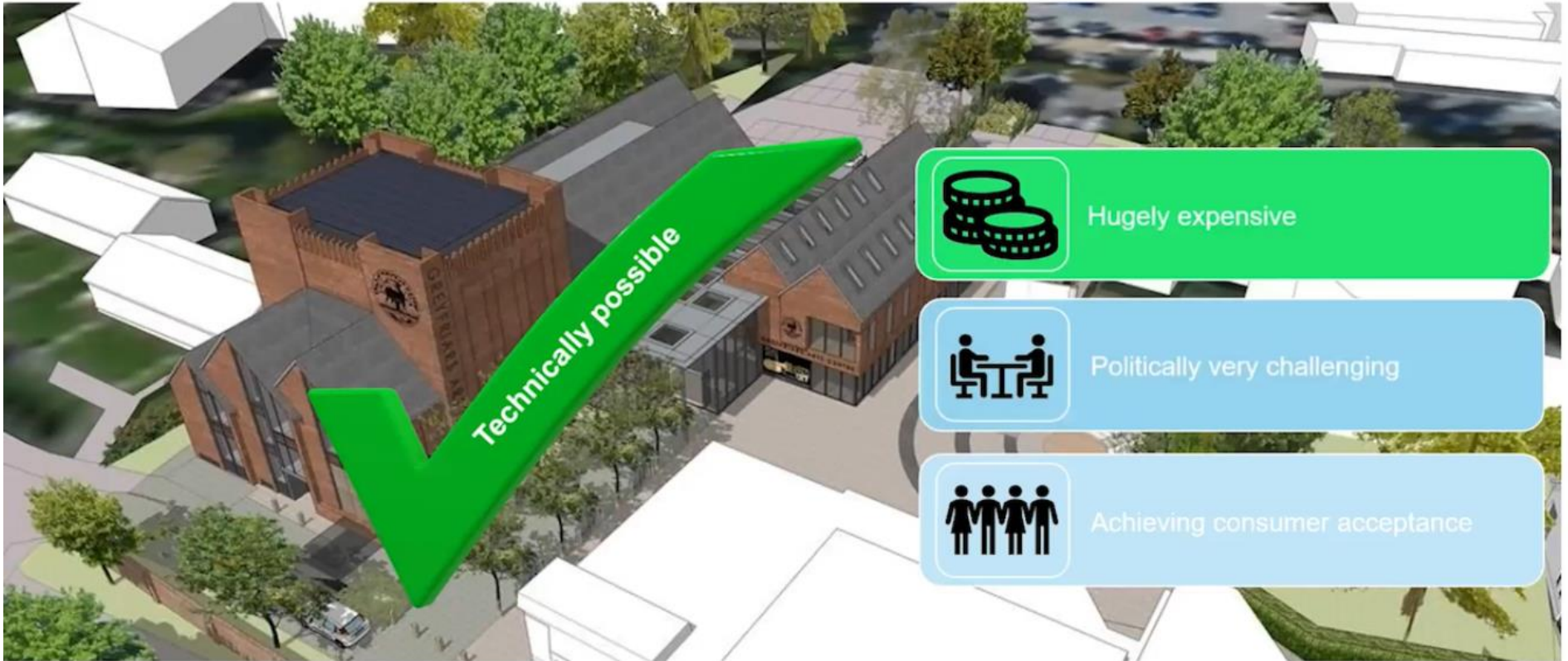


DNV

Hydrogen for building heat?

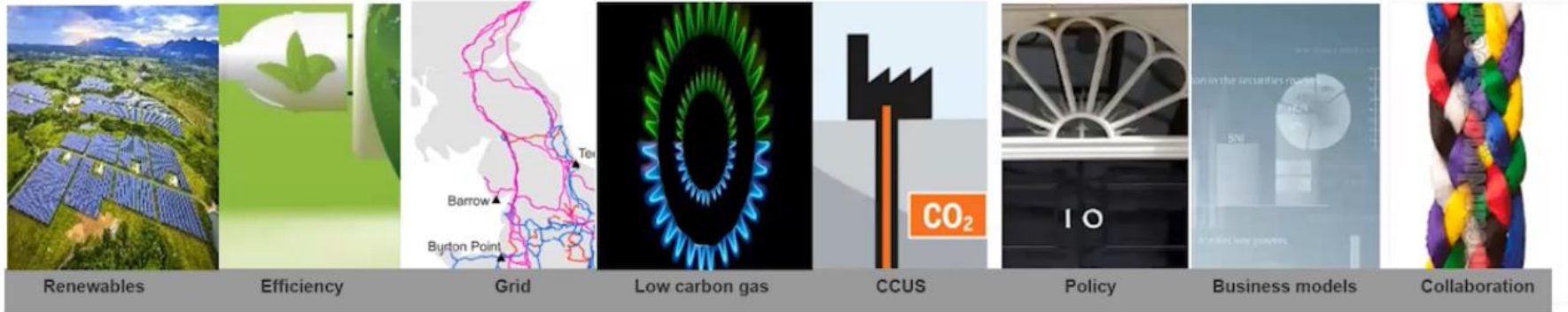


Hydrogen for building heat?



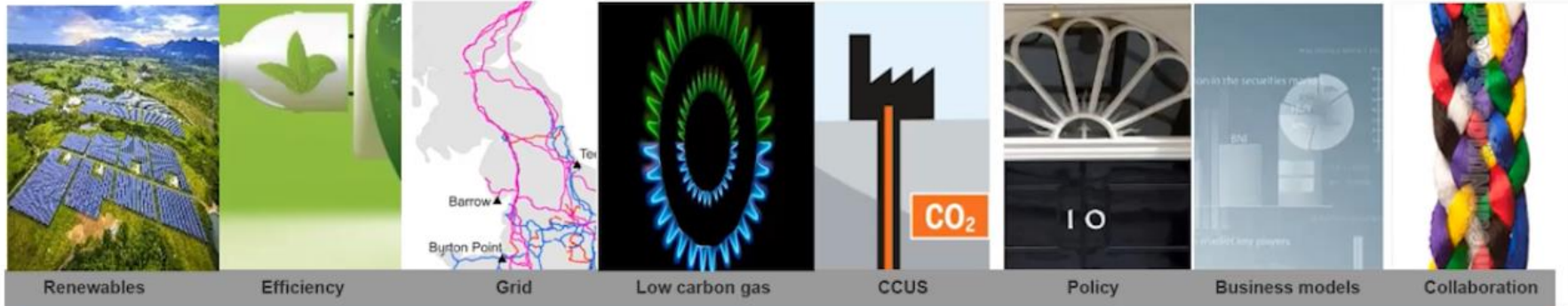


What do we need for deep decarbonisation?





What do we need for deep decarbonisation?



- Maximum renewables plus gas and nuclear
- Substantial investment in energy efficiency measures for homes and industry
- Significant reinforcement of the electricity grid
- Conversion and life extension of the gas grid
- Lower/zero carbon gas sources such as biomethane, hydrogen and syngas
- CCUS at scale both for hydrogen production and for industrial decarbonisation
- Cross party political consistency on energy policy and key energy vectors
- Business models for the hard to decarbonise sectors
- Greater collaboration, and fewer silos

We provide foresight to the Industry



OIL & GAS, UK

HYDROGEN - DECARBONISING HEAT

How we use Hydrogen to decarbonise domestic and industrial heat

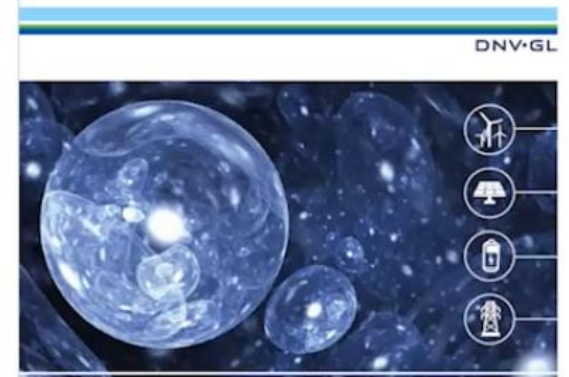


GROUP TECHNOLOGY & RESEARCH - POSITION PAPER 2018

HYDROGEN AS AN ENERGY CARRIER

An evaluation of emerging hydrogen value chains

Various production technologies for hydrogen and the likely end users in industry, transport and buildings



GROUP TECHNOLOGY & RESEARCH, POSITION PAPER 2019

HYDROGEN IN THE ELECTRICITY VALUE CHAIN

Hydrogen production from electrolysers and its place in the electricity value chain as a potential energy storage medium

WHEN TR



Thank you for your attention

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KEYNOTE

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 **Catherine Watkins**
Hydrocarbon Processing / Gas Processing & LNG
Publisher, VP Downstream

 **Graham Bennett**
DNV
Vice President and Head of Energy Transition

🕒 4:00 AM - 4:45 AM CDT on Tuesday, May 18
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 **Graham Bennett**
DNV
Vice President and Head of Energy Transition

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