



## The Economics and Policies of Global Energy Transition

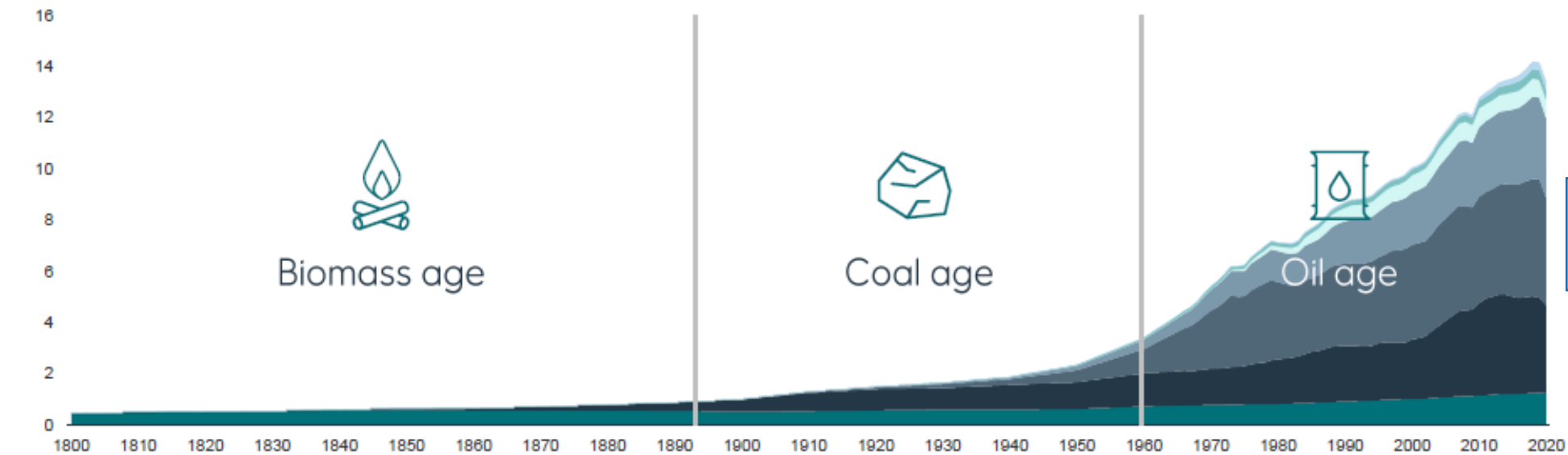
8 December 2020

***Global Energy Transition:  
Challenges and opportunities for natural resource rich countries***

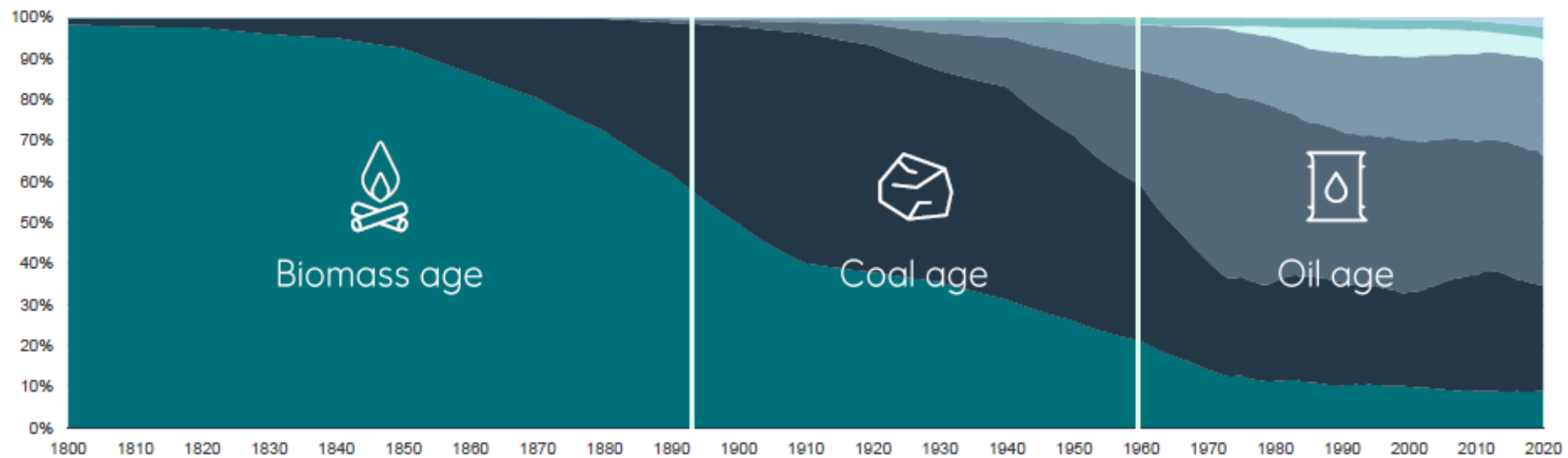
Steve Griffiths, SVP R&D and Professor of Practice, Khalifa University

**Energy Transition:** *evolution of the global energy system from predominantly one form of energy to another*

Total primary energy demand  
Billion toe



■ Biomass ■ Coal ■ Oil ■ Gas  
■ Nuclear ■ Hydro ■ New Renewables

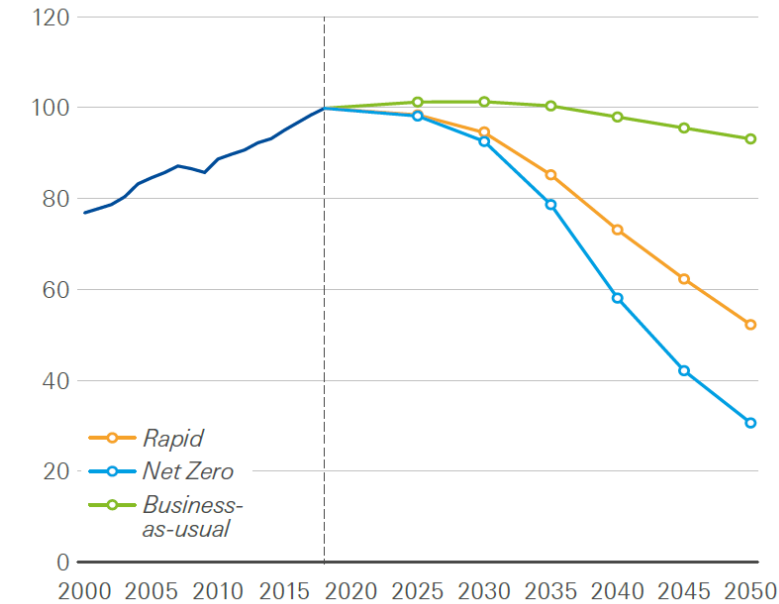


### Transition scenarios to consider...

- Business-as-usual
- “Rapid transition” to a low-carbon energy system
  - Carbon emissions from energy use fall by around 70% by 2050, limiting the rise in global temperatures by 2100 to well below 2-degrees Celsius above preindustrial levels
- “Net Zero” energy system
  - Carbon emissions from energy use fall by over 95% by 2050, in line with a range of scenarios consistent with limiting the rise in global temperatures by 2100 to 1.5-degrees Celsius above preindustrial levels

Liquid fuels consumption

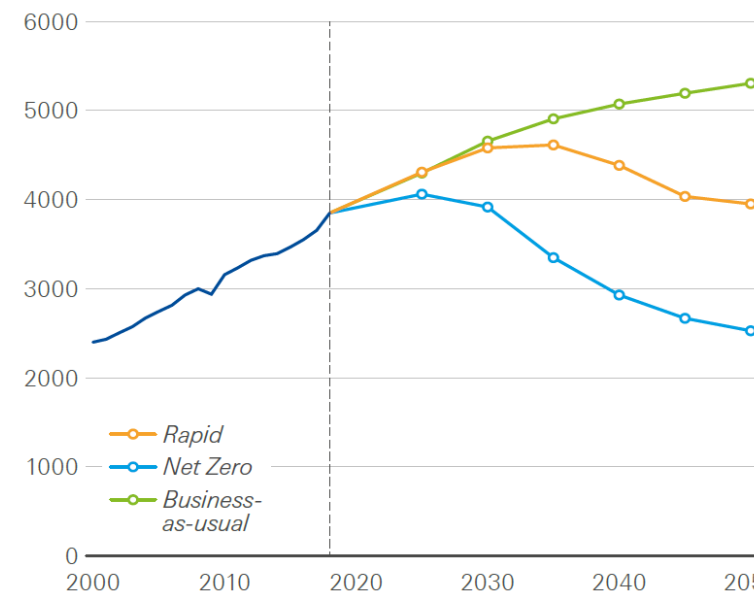
Mb/d



A very uncertain, but nonetheless concerning, outlook for oil producing and exporting countries

Gas consumption

Bcm



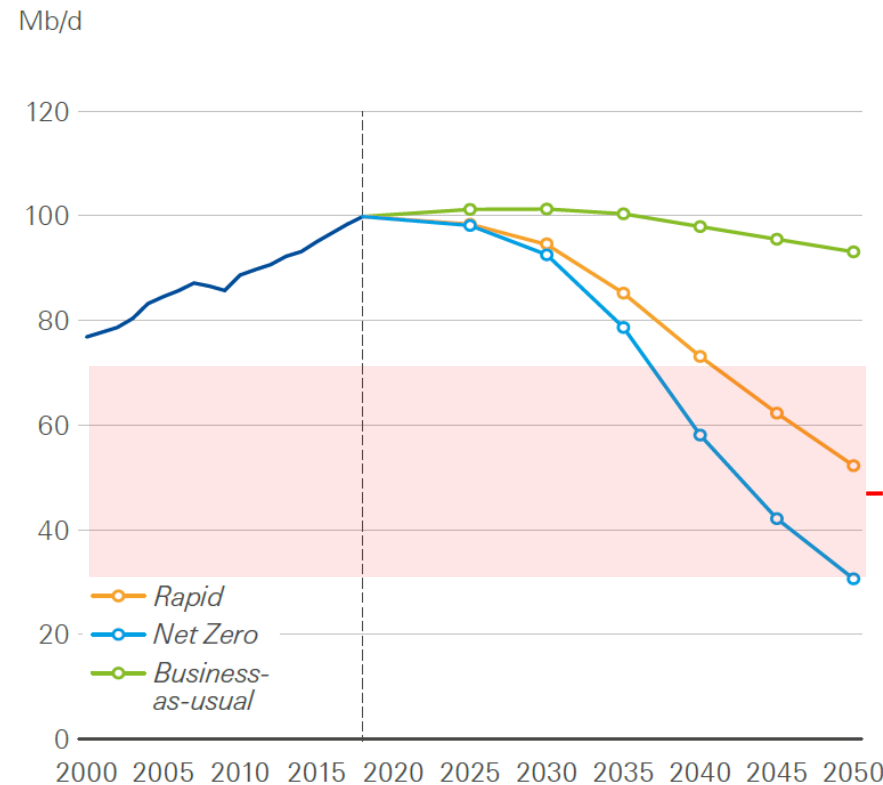
A very uncertain, but slightly less concerning, outlook for gas producing and exporting countries



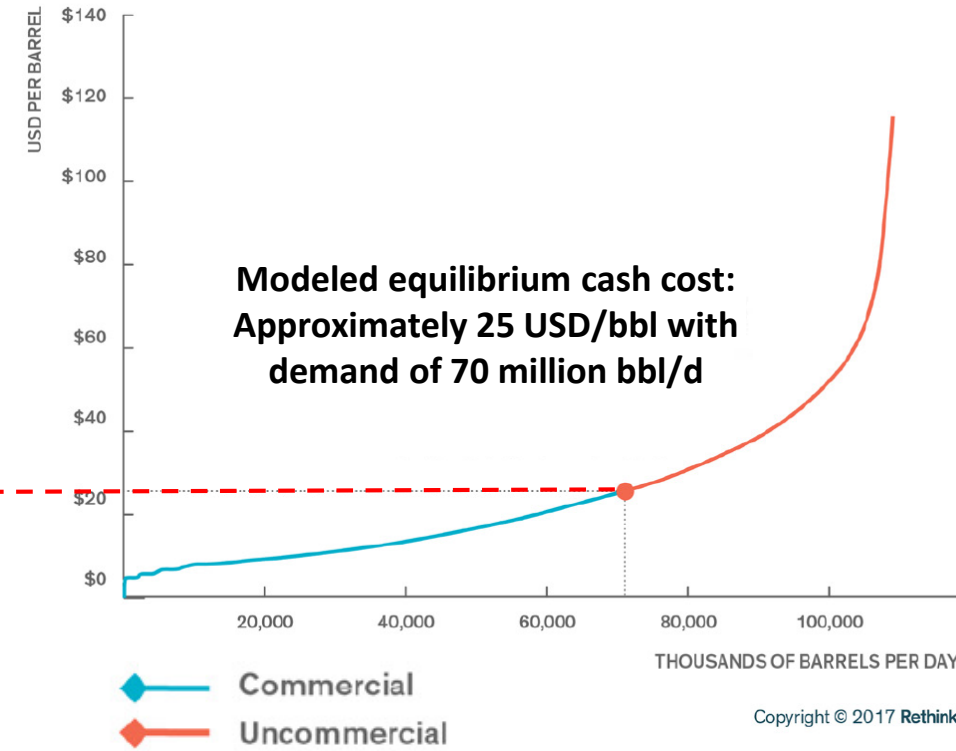
# Energy Transition and the Outlook for Oil

## Potential demand destruction

### Liquid fuels consumption



Reduced Oil Demand  
= Lower Oil Prices

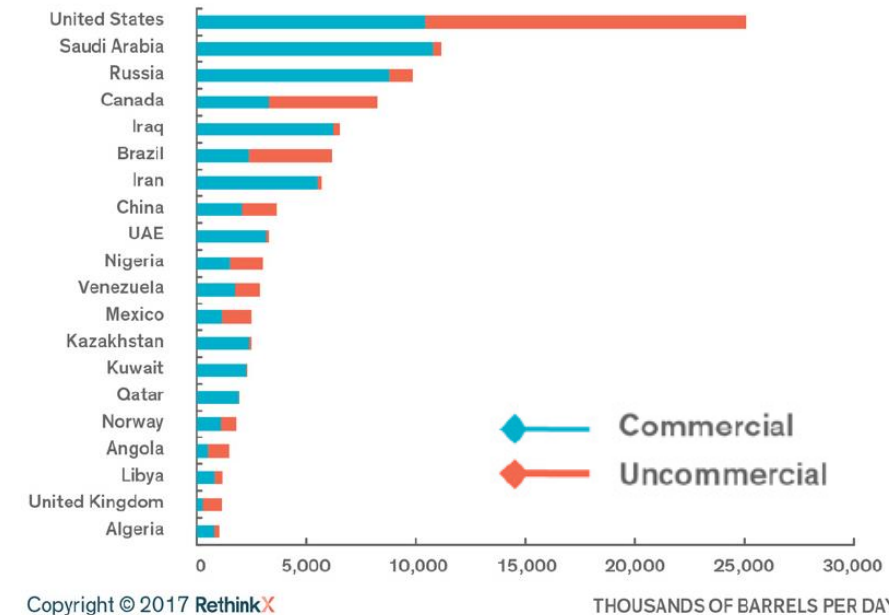


Creates “Uncommercial”  
Oil Reserves

### Options for the oil and gas industry

- Reduce production costs, maximize profit
- Invest in low-carbon energy **and/or** transition from an “oil and gas” company to an “energy company”
- Move downstream into chemicals
- Sell assets

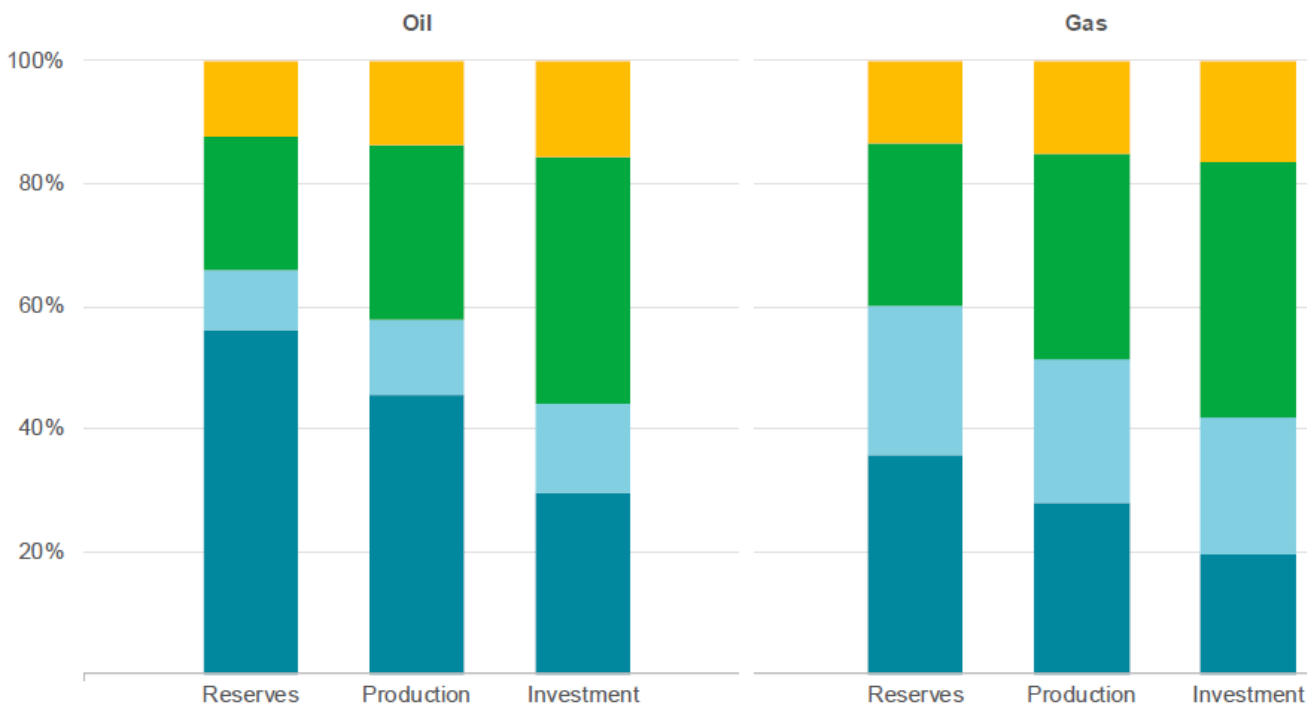
Requires New  
Business Models



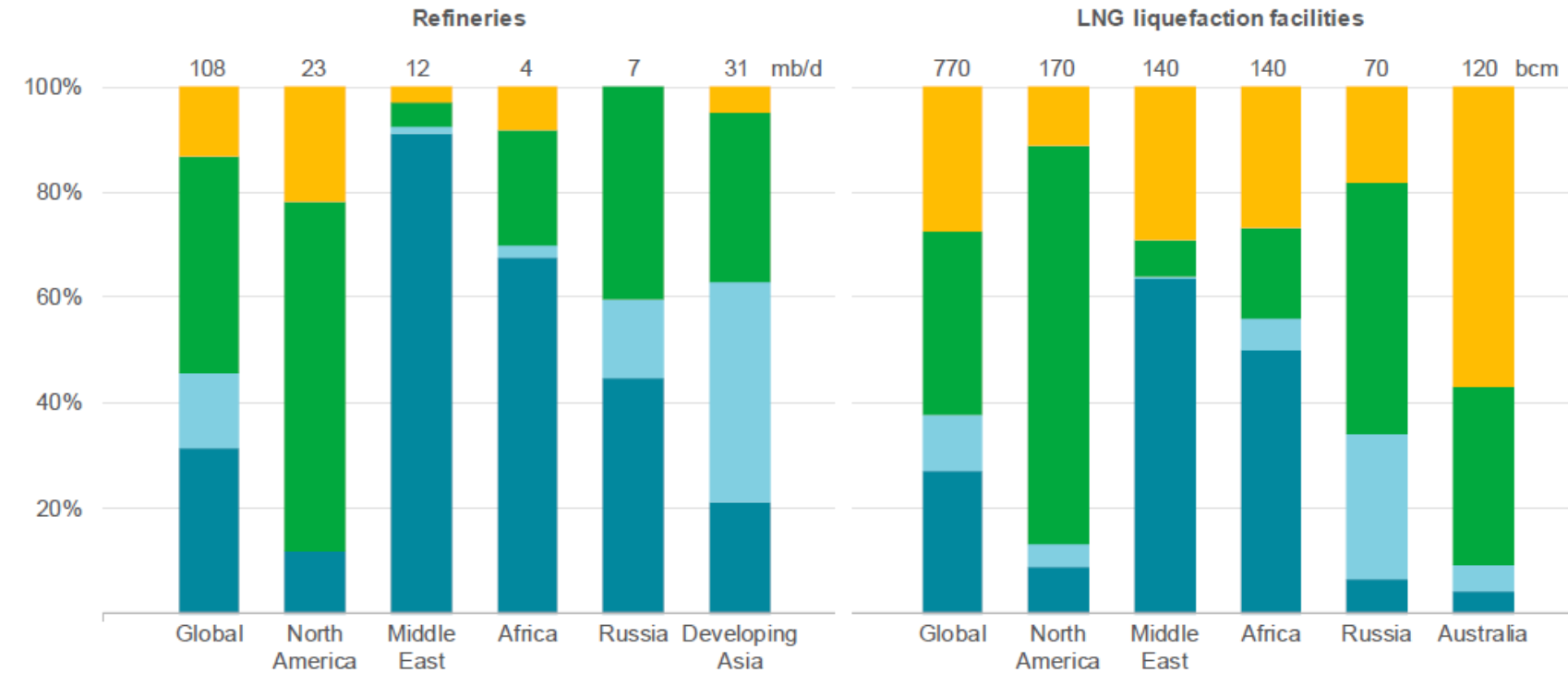
# Energy Transition and the Outlook for Oil

Strategic response is context dependent

■ Majors  
■ Independents  
■ INOCs  
■ NOCs



Ownership of oil and gas proven-plus-probable reserves, production and upstream investment by company type, 2018



Composition of refinery and LNG asset ownership in selected regions, 2018

- NOCs need to monetize oil and gas reserves
- Selected NOCs, IOCs and Independents have downstream opportunities to explore

# Energy Transition and the Outlook for Oil

## IOC and INOC strategic positioning

Investment and strategic responses to energy transitions by selected companies (illustrative, based on 2015-19 activity)

Company	Enhancing traditional oil and gas operations			Deploying CCUS		Supplying liquids and gases for energy transitions		Transitioning from fuel to “energy companies”			
	Reducing methane emissions	Reducing CO <sub>2</sub> emissions	Sourcing renewable power	For centralised emissions	For EOR	Low-carbon gases	Advanced biofuels	Solar PV and wind generation	Other power generation	Electricity distribution/retail	Electrified services / efficiency
BP	●	●	◐	◐	◐	●	◐	●	◐	◐	●
Chevron	●	◐	●	●	◐	◐	◐	◐	○	○	◐
Eni	●	◐	●	◐	◐	◐	●	●	●	●	◐
ExxonMobil	●	◐	●	●	◐	◐	◐	○	○	○	○
Shell	●	●	●	●	◐	●	◐	●	●	●	●
Total	●	●	●	◐	◐	●	●	●	●	●	●
CNPC	◐	○	◐	◐	●	◐	◐	●	○	○	○
Equinor	●	●	●	●	◐	◐	◐	●	○	◐	◐
Petrobras	◐	◐	●	●	●	●	◐	◐	●	◐	○
Repsol	●	●	◐	◐	◐	◐	◐	●	●	●	◐

### Key Trends

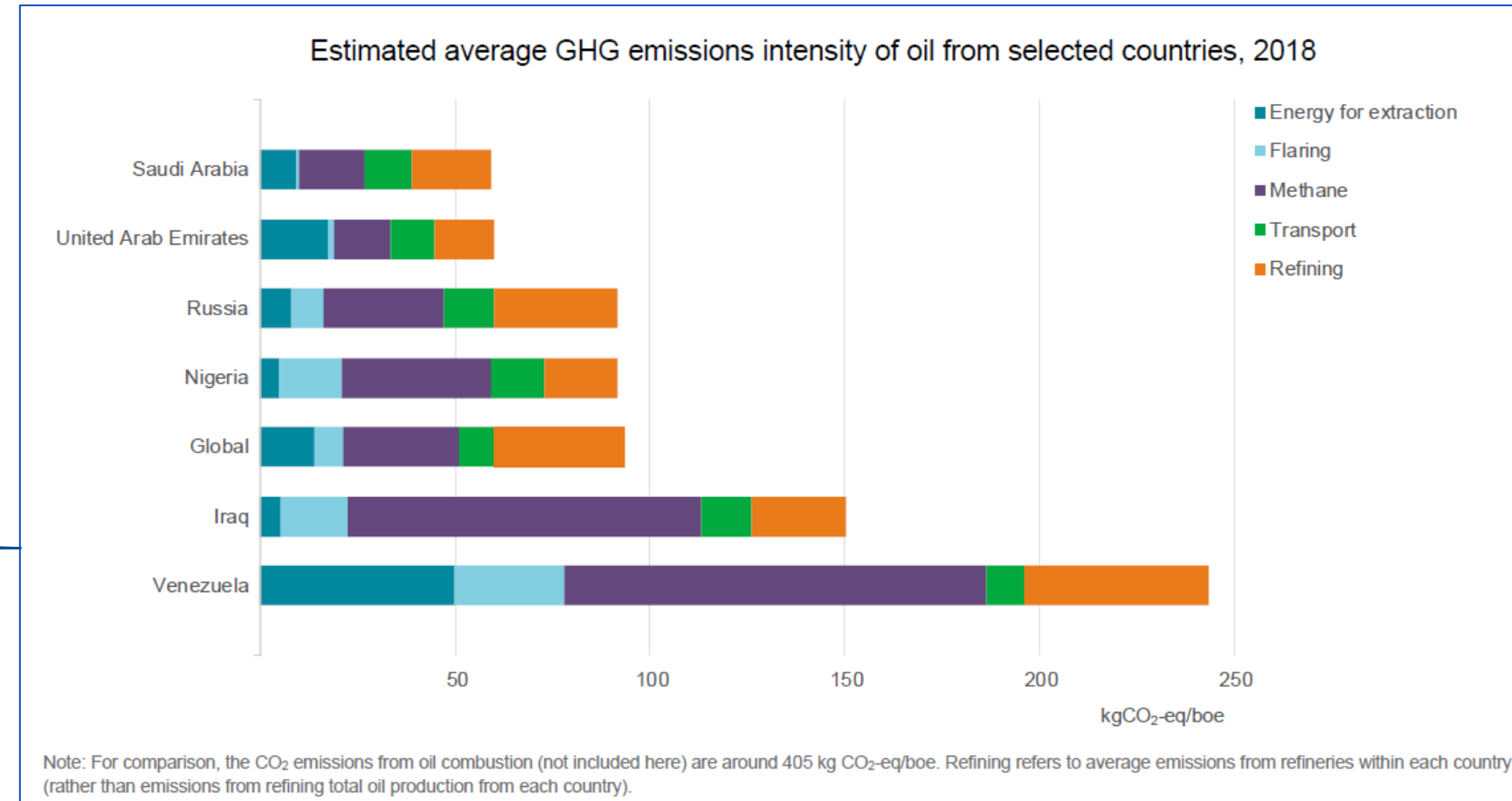
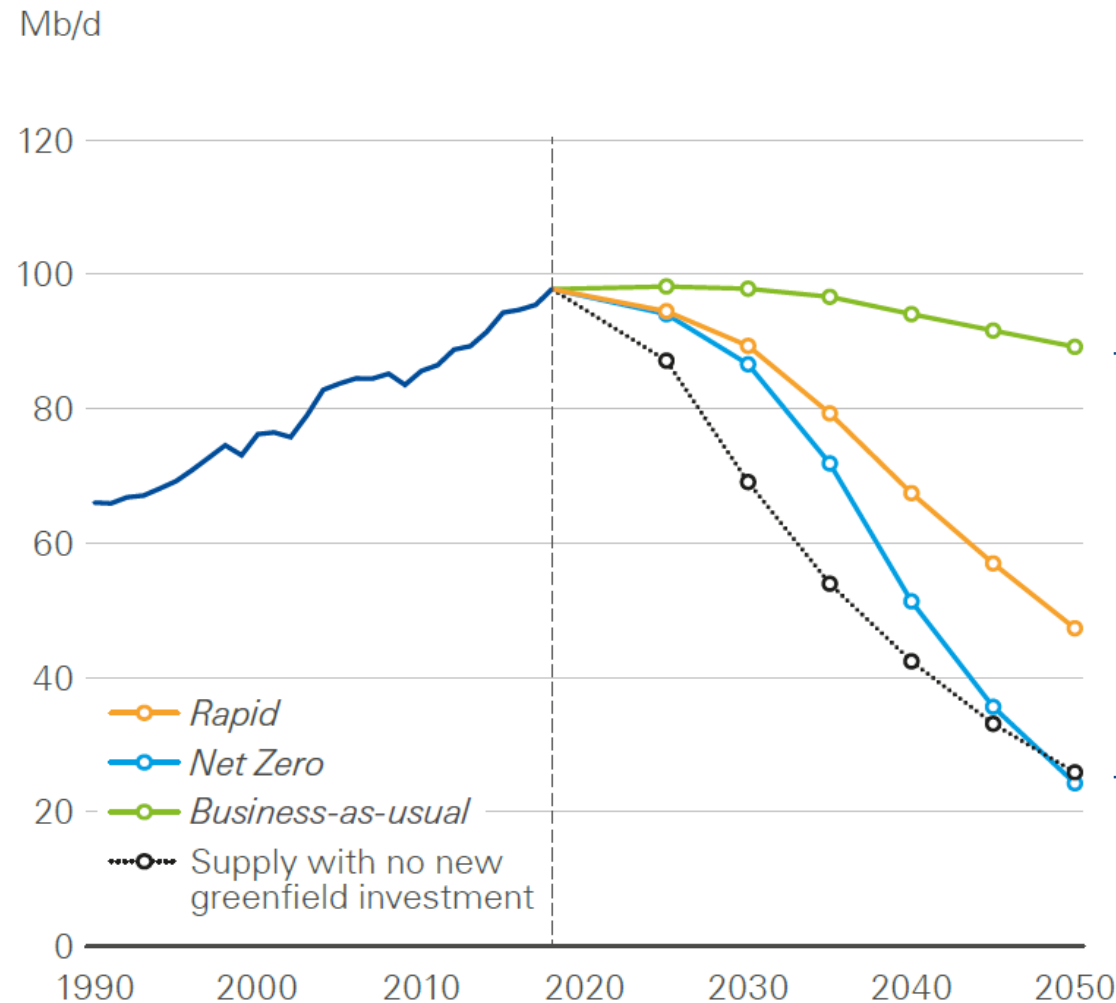
- **IOCs** are reducing operational costs, focusing more on natural gas and reducing operational carbon footprints (particularly methane reduction)
- **European IOCs** are investing in **low-carbon energy** and becoming “energy companies”
- **CCUS** and **low-carbon gases** present a cross-industry opportunity to leverage technical knowledge and infrastructure

- **Full circle** = growth area supported by observed strategic investments (e.g. M&A) and/or capital/operational expenditures in commercial-scale activities
- **Half circle** = announced strategy and/or minor investments, venture capital and/or research and development (R&D) spending
- **Empty circle** = limited evidence of investment activity

# Energy Transition and the Outlook for Oil

NOCs have an important role to play in developing low-cost, low-carbon resources

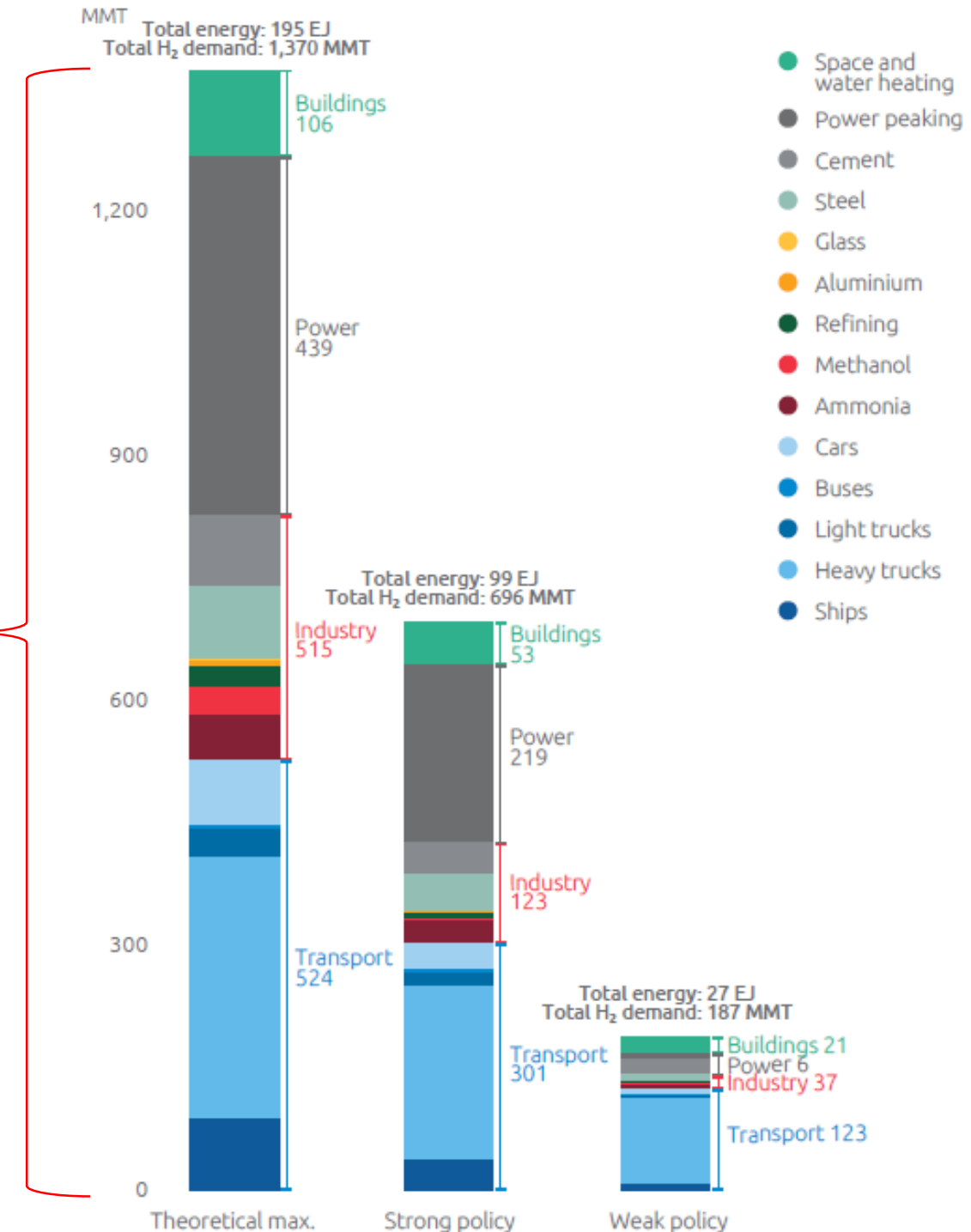
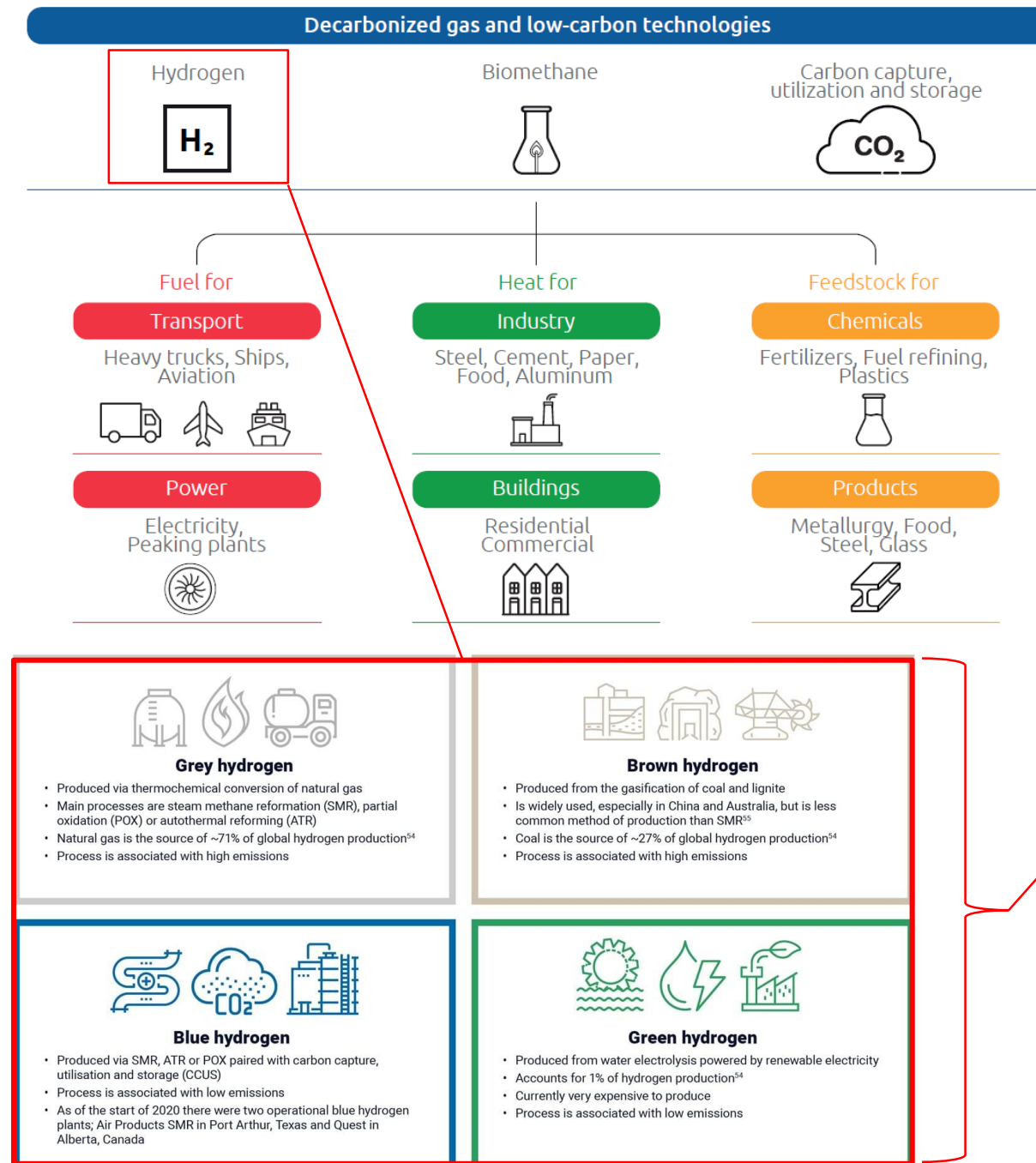
## Consumption and production of oil



- Supply gaps optimally met by low-cost, low-carbon producers
- Profitability of exports may fall and so continued innovation in oil and gas production is needed
  - Digitalization to enable maximally efficient operations is essential

# Energy Transition and the Outlook for Gas

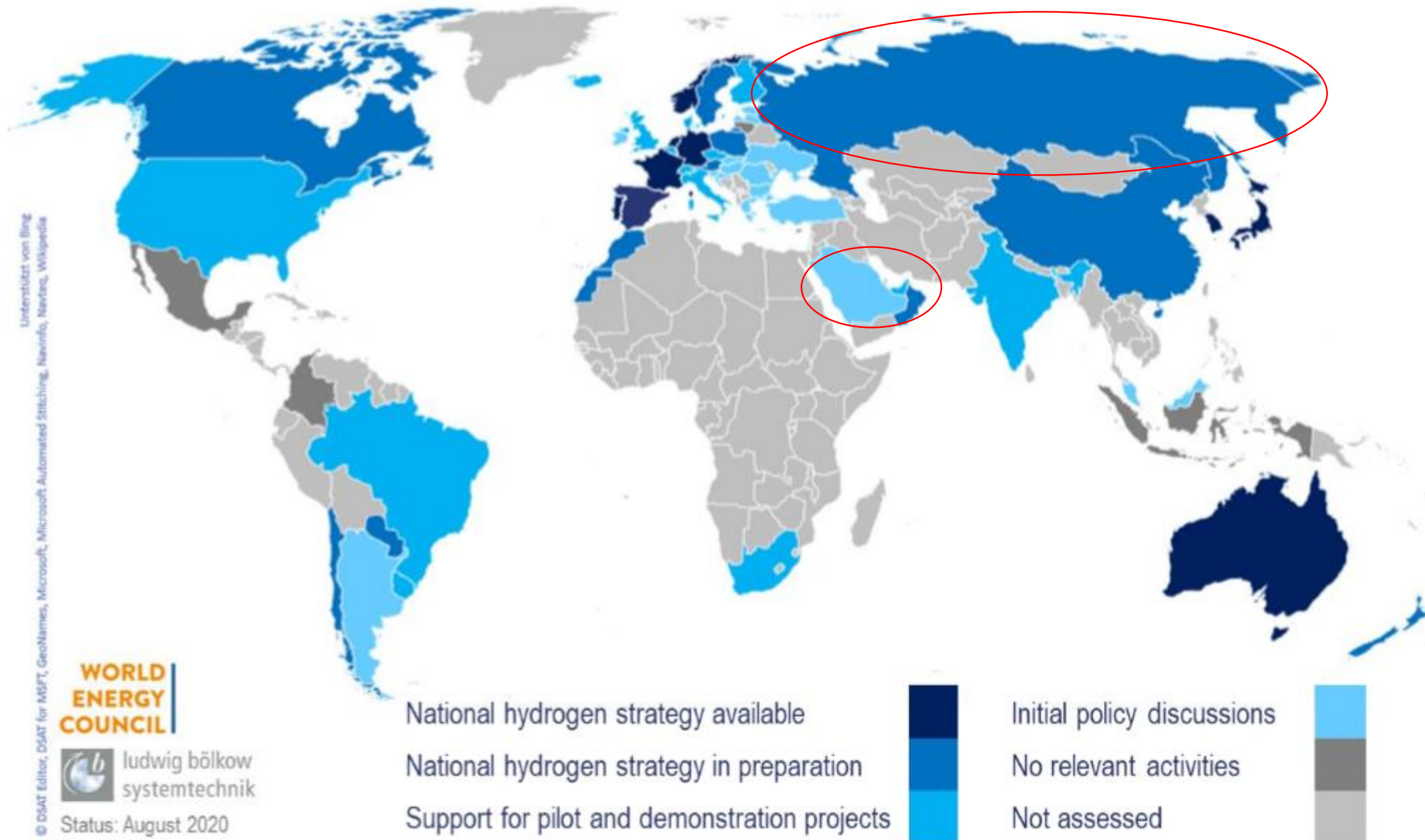
Low-carbon gases are a cross-cutting, but uncertain opportunity





# Energy Transition and the Outlook for Gas

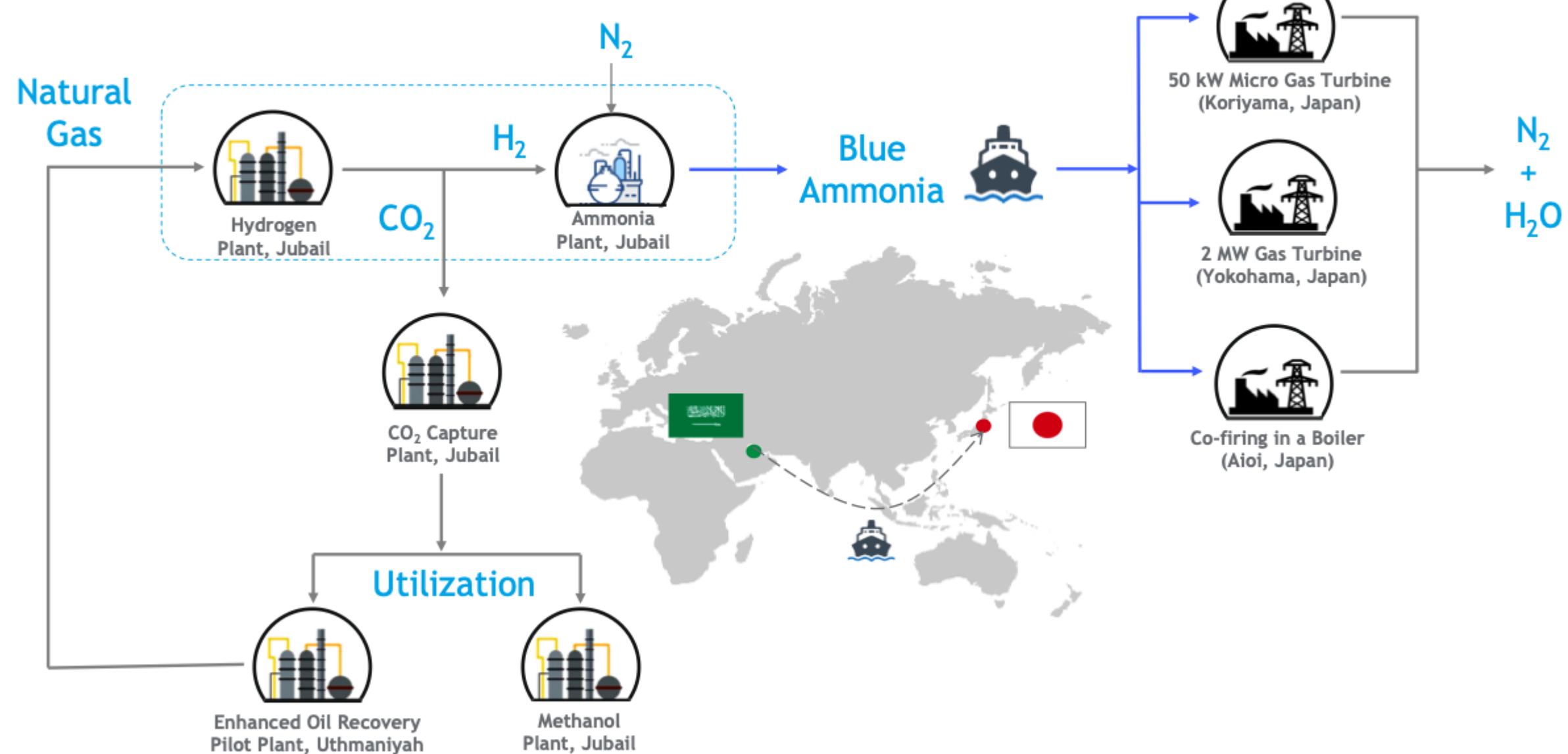
Hydrogen enthusiasm is widespread



# Energy Transition and the Outlook for Gas

## Blue ammonia export – Saudi Arabia

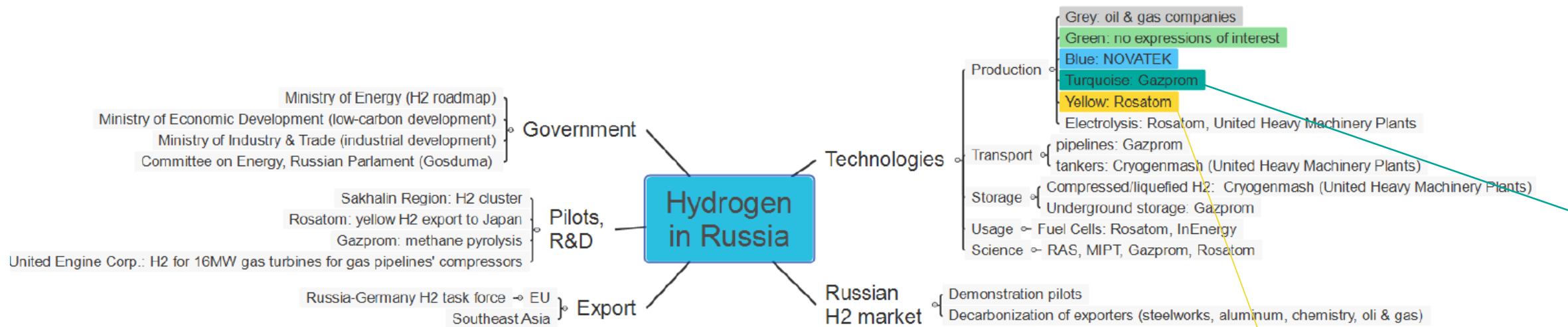
Conceptual Flow Diagram of “Blue Ammonia” Supply Chain Demonstration  
(Duration: August 2020 - October 2020)



# Energy Transition and the Outlook for Gas

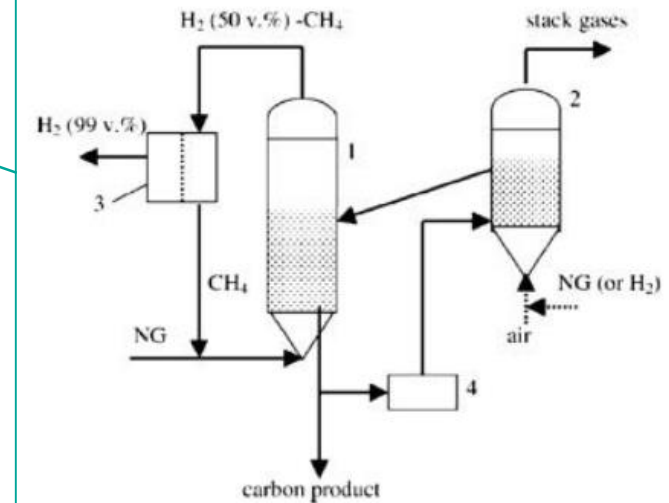
## Blue, turquoise and yellow hydrogen – Russia

### Major Stakeholders in the Russia's Hydrogen Plans



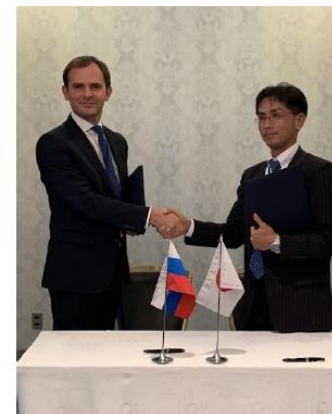
### Turquoise Hydrogen from Methane Pyrolysis

#### Gazprom's Methane pyrolysis / Methane-Hydrogen fuel



### Yellow Hydrogen from Nuclear Power

#### Rosatom-METI (Japan) MoU on yellow H2



#### Yellow H2 for the local railway (Sakhalin)





# Energy Transition and the Outlook for Gas

## Blue hydrogen - UAE

*The National* newspaper  
November 22, 2020

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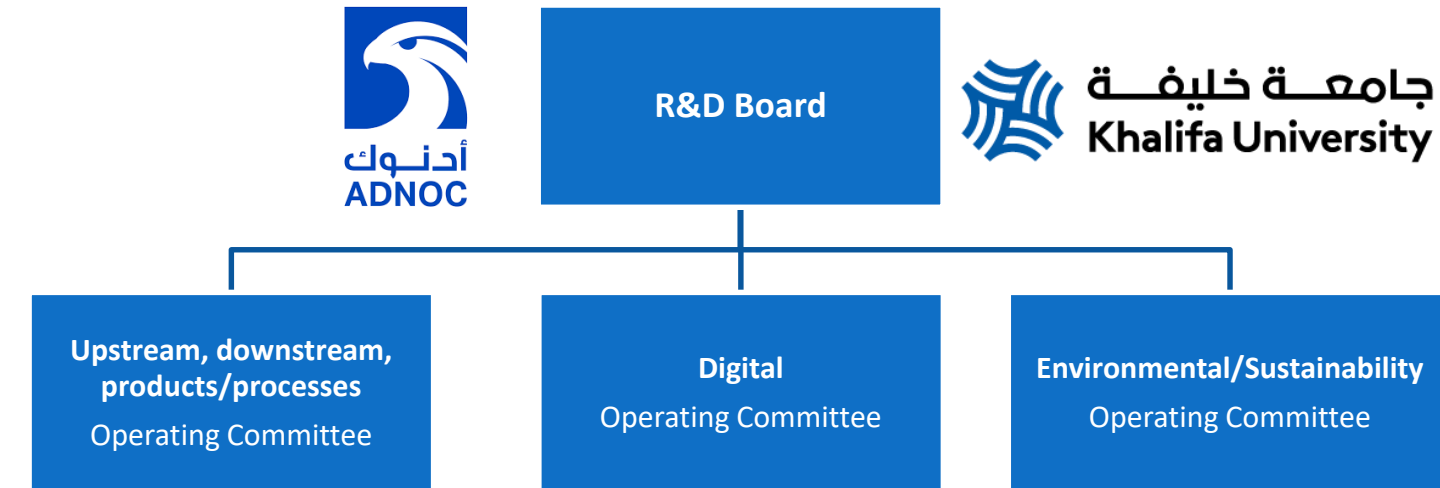
Jennifer Gnana  
Nov 22, 2020

### Adnoc plans to develop a 'hydrogen ecosystem' in its latest spending push

► Hydrogen is being trialled as a promising alternative to fossil fuels, particularly in transportation



The Middle East's first hydrogen refilling station in Al Badia, which was developed in partnership with France's Air Liquide. Dubai plans to trial a hydrogen fuel cell powered fleet of cars during the Expo next year. Reem Mohammed/The National



#### Board Members

**KU:** SVP R&D (co-Chair), Senior Director, Petroleum Institute, Senior Director, Masdar Institute  
**ADNOC:** CTO (co-Chair), VP R&D, VP Sustainability

- ADNOC-KU R&D Board combines all core capabilities to address the energy transition, including the hydrogen opportunity
- For hydrogen -
  - R&D in natural gas processing, carbon capture and system modeling offer a holistic blue hydrogen capability



## Closing thoughts

- The global energy transition will, over time, reduce dependency on fossil energy sources.
  - The timing and extent of the transition are uncertain.
  - Impacts on the oil and gas industry are uncertain, but oil demand impacts are expected to be more significant than gas demand impacts.
- Oil producers and exporters will face economic challenges if the transition is rapid and broad.
  - Strategies to address these challenges are context dependent.
  - International oil companies may choose to pivot towards clean energy production while national oil companies will need to find ways to monetize their natural resources and provide needed supply.
    - Cost and carbon-efficient operations will be essential.
- Gas producers and exporters are expected to have opportunities in natural gas itself as well as low-carbon gases, particularly hydrogen.
  - Blue hydrogen is an opportunity, although an uncertain one, to leverage oil and gas industry competencies and assets, including carbon capture, utilization and storage.

**THANK**  
**YOU**

