



Melbourne
Energy
Institute

MEInetwork22
Seminar #3

Liquefied natural gas and export

Speaker: Ms Carolyn Au,
Operations Manager, Shell

Moderator: Professor Michael Brear,
Melbourne Energy Institute

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MEInetwork22 Seminar Series

Seminar topic	Month
<u>Conventional and unconventional natural gas - Mr Steve Henzell, Advisian</u>	10 May
<u>Gas markets and gas retailing - Mr Matthew Clemow, Australian Energy Market Operator</u>	7 June
● <u>Liquefied natural gas and export - Ms Carolyn Au, Shell</u>	5 July
Natural gas and hydrogen transmission and distribution	August
Green hydrogen as an alternative to natural gas	September
Blue hydrogen as an alternative to natural gas	October
Options for hydrogen export	November

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The LNG Value Chain

Shell Australia

Carolyn Au

Operations Manager



Agenda

- Welcome & Safety briefing
- Acknowledgement of Country
 1. LNG Fundamentals and History
 2. LNG Value Chain Basics
 3. Global LNG Demand Projection
 4. LNG and Transition to a Net Zero World
- Q&A



We acknowledge the Traditional Owners of the lands upon which we operate and meet today, paying our respects to elders past, present and emerging.

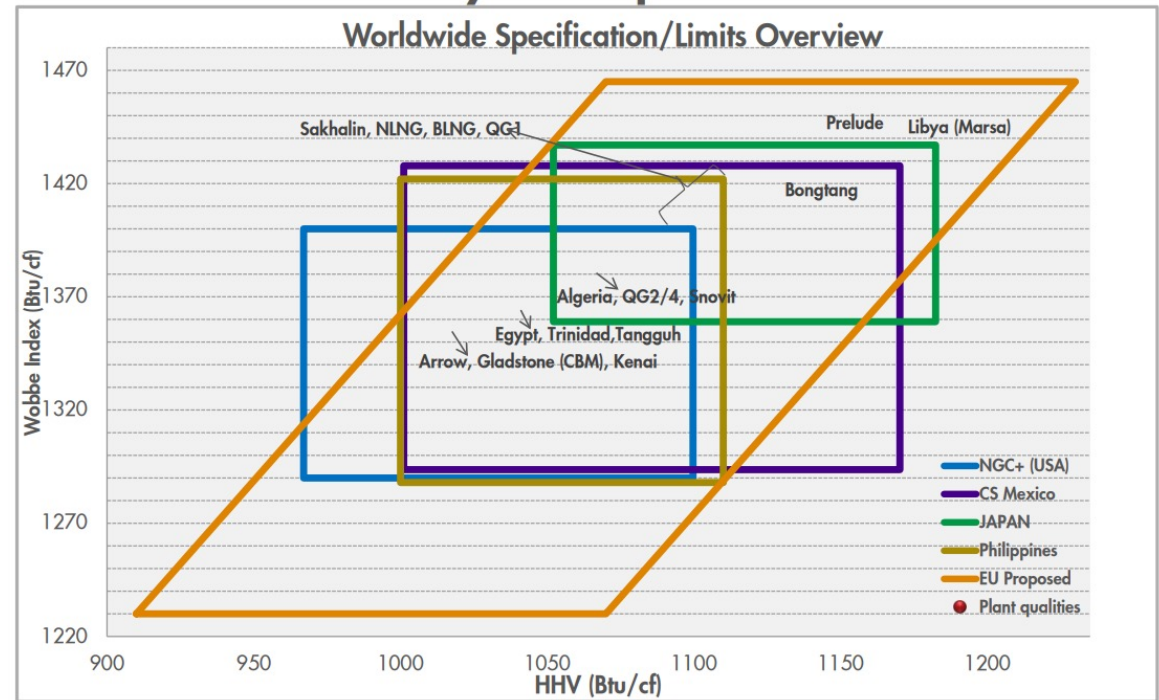
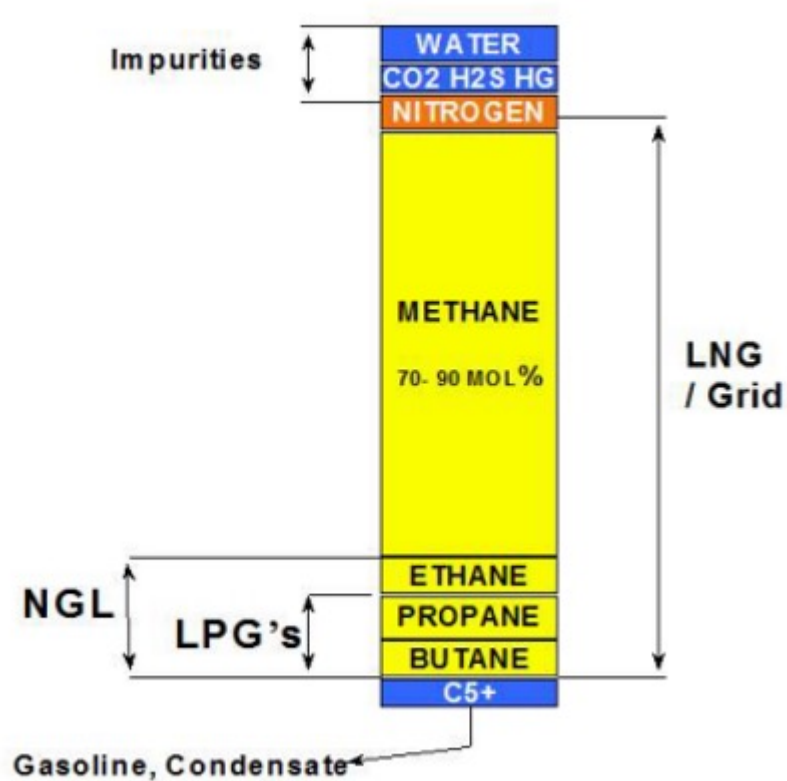


The LNG Value Chain

1. LNG Fundamentals & History



What – Is Natural Gas?



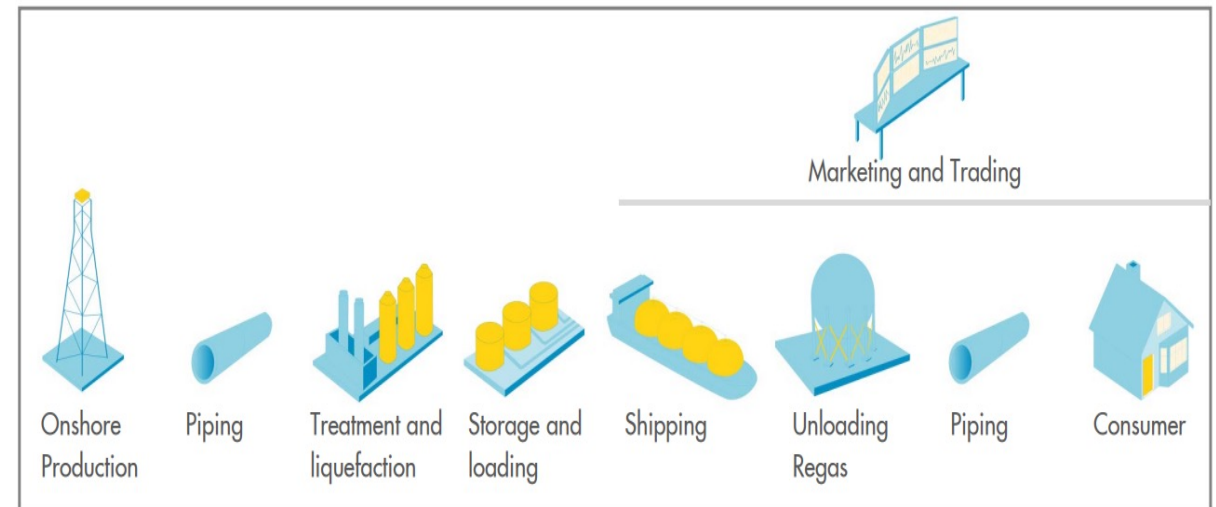
■ LNG Characteristics

- Clear, colourless, nontoxic, nonflammable liquid at -162 degC and atmospheric pressure
- 1/600th volume of natural gas

Why – LNG is Just a Form of Gas

- LNG is an efficient way of getting gas to users
- Gas fields tend to be away from users (people, industry, economies)
- If the distance is short and volumes are reasonable, pipelines work – simple and economic
- Over approx. 3500 km, cost/complexity of pipeline gas is greater than LNG and inflexible
- Turning gas to LNG reduces its volume by a factor of 600, allowing efficient transport
- LNG is low pressure, nonflammable liquid and thus lower safety risk in transport

- LNG Enables
 - International trade of energy
 - Energy security for countries without own energy supply
 - Flexibility of supplier and destination

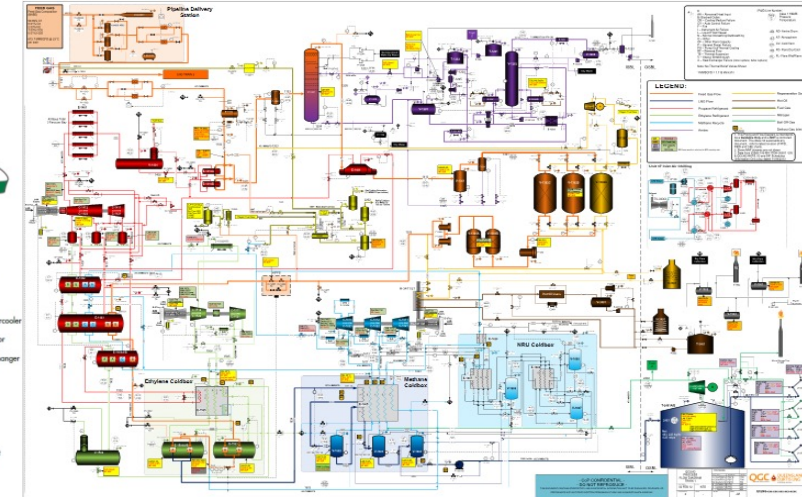
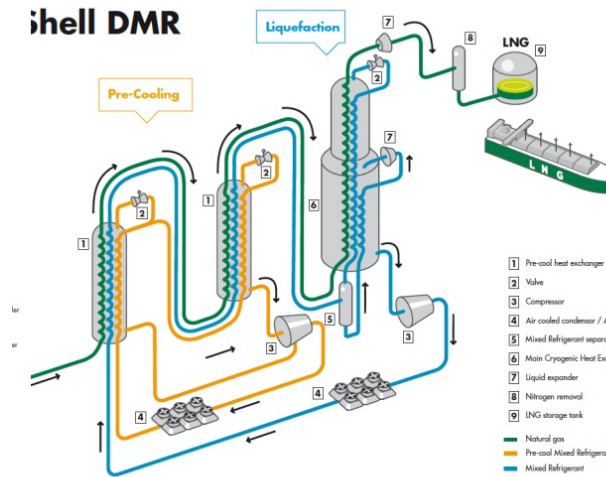


How - Making LNG is a simple 3 step Process

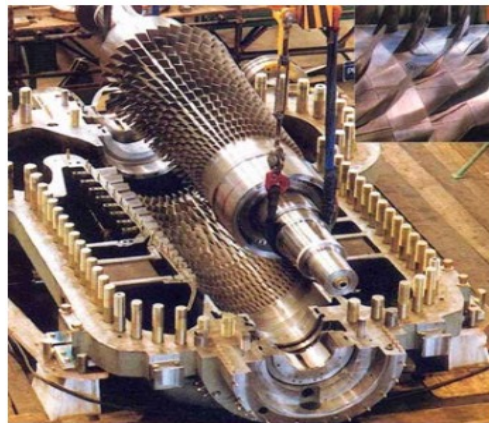
- Clean the gas
- Dry the gas
- Cool the gas to LNG

then

- Store the LNG and deliver to customer



Axial Compressor



Coilwound Heat Exchanger



Aircoolers



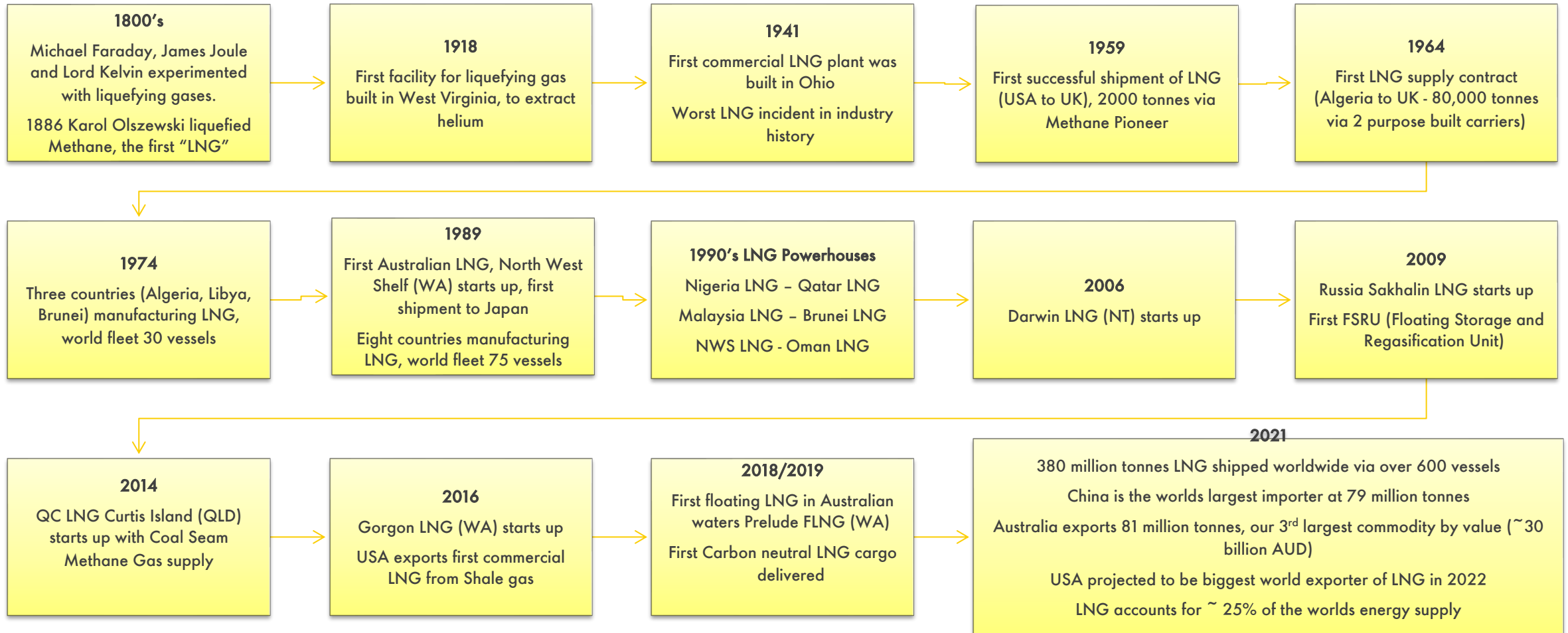
LNG Storage Tanks



LNG Loading Arms



When – LNG's First Steps to Now



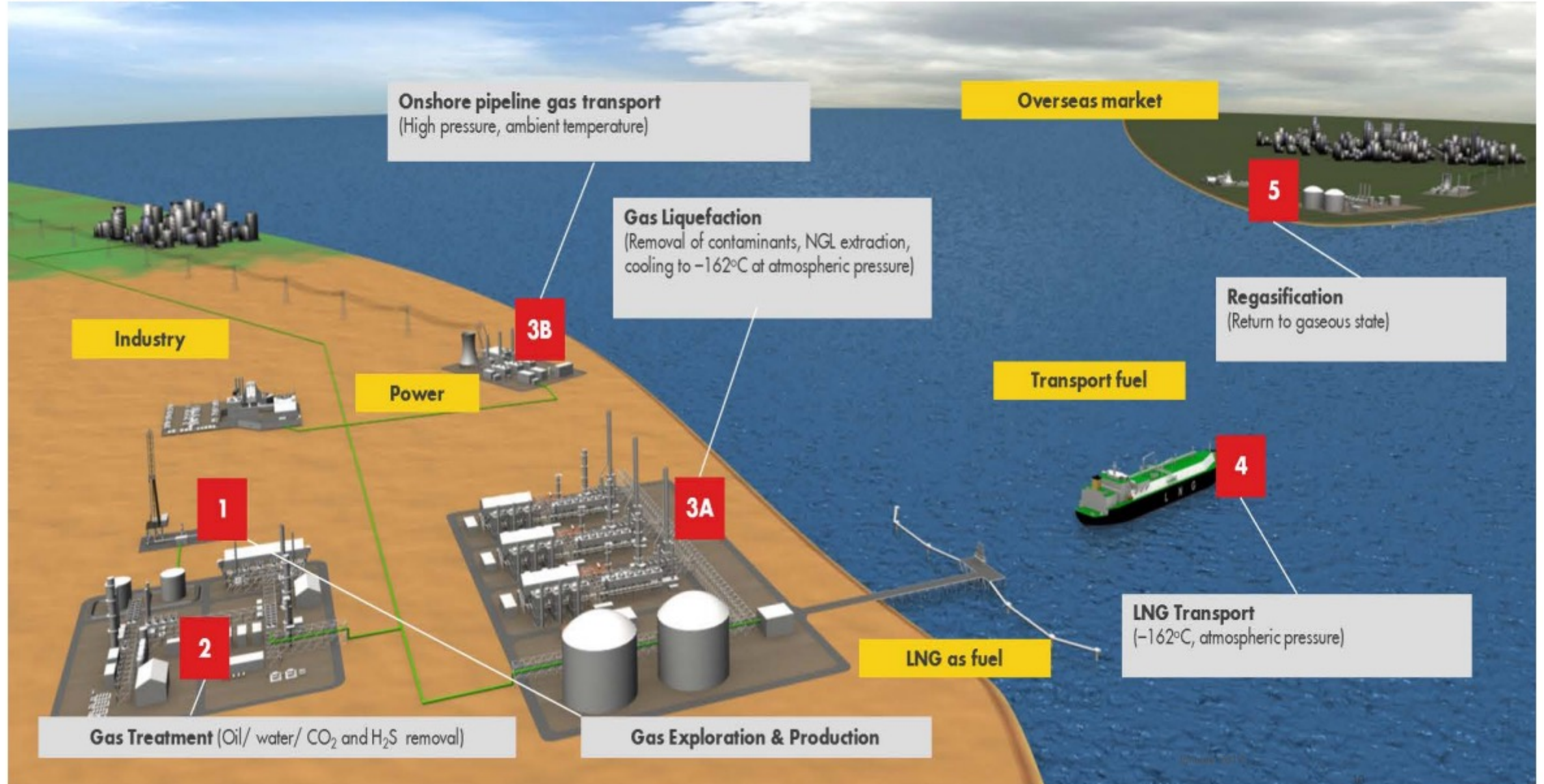


The LNG Value Chain

2. LNG Supply Chain Basics



The (Liquified) Natural Gas value chain



LNG Sales and Purchase Agreements (SPA)

- LNG is a high investment and long term business – agreements are signed before facilities built
- Cost and effort of building LNG Production and Regasification facilities is high, and buyers look for security of supply
- Both supplier and customer engage in long term Sales and Purchase Agreements which guarantee stability for terms in the order of 10 years and more
- Shipping may be by buyer or seller, LNG vessels may be chartered or owned



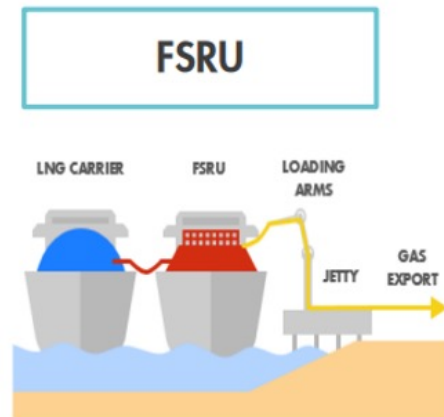
- SPA Contents examples
 - LNG contractual specification (Heating value, impurity and component limits)
 - Delivery points (FOB or DES)
 - Shipping and Port locations and compatibility
 - Loading requirements (eg gauging devices and specific procedures, calculation of volume loaded)
 - Price and invoicing
 - Dispute process

Terminals, Regasification and Emerging Users

- LNG must be turned back to natural gas (vapourised) before send out to the domestic gas grid
- Storage of LNG is important consideration for continuity of supply – storage is expensive
- Transport sector - marine and heavy road haulage are now new end users moving to lower-emission LNG
- 30% of new ship orders are for LNG fuelled vessels



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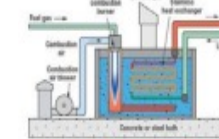


AVAILABLE REGASIFICATION TECHNOLOGIES



Open Rack Vaporizers

- Sea water as heating medium



Submerged Combustion Vaporizers

- Fired-heated water as heating medium;
- Higher greenhouse gas emission.



Shell & Tube Vaporizers

- Requires waste heat as heat source to the intermediate fluid that vaporizes LNG.



Ambient Air Vaporizers

- Ambient air as heating source

Questions and Answers

Q&A



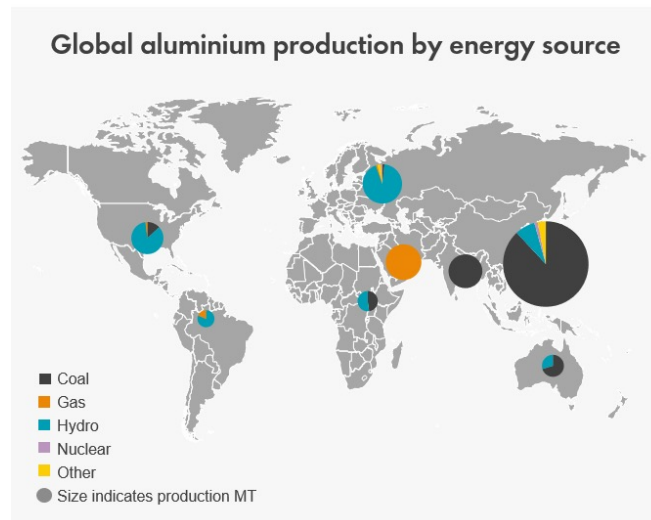
The LNG Value Chain

3. Global LNG Demand

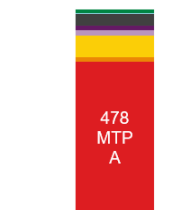


LNG Demand Themes and Impacts

- Country energy security
- Seasonal demand
- Climate change current impacts
- High-emission industry decarbonization
- Renewables mix and grid stabilization

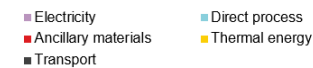
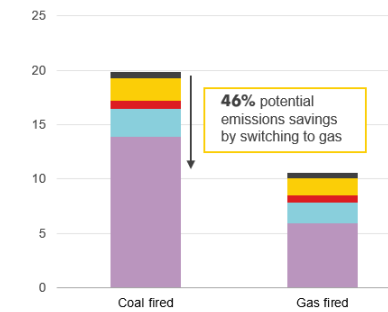


Global CO₂ direct emissions from aluminium production



CO₂ saving options

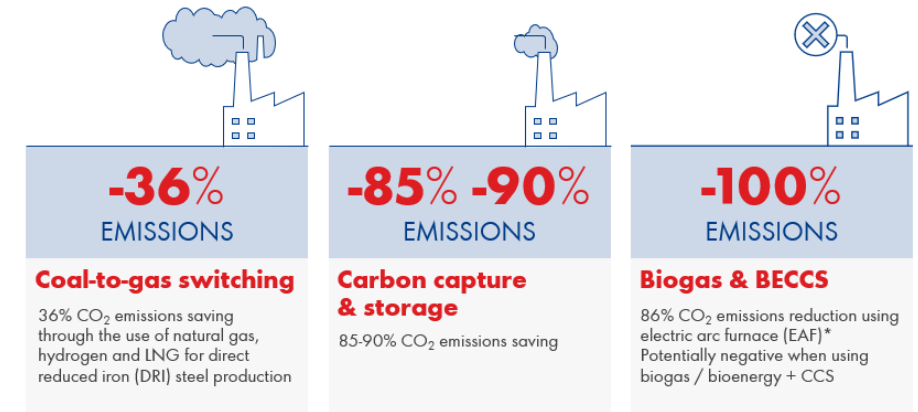
tCO₂ eq/t Aluminium



Gas enables reduction of industrial emissions

Iron and steel sector benefitting from coal-to-gas switching

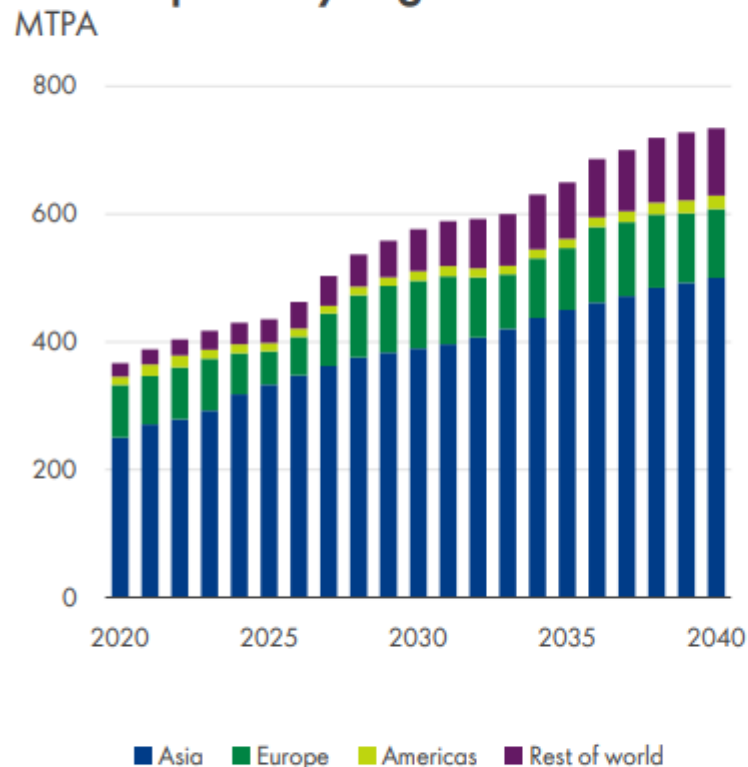
Benefits of using gas in the iron & steel sector



Asian gas demand to drive future LNG growth

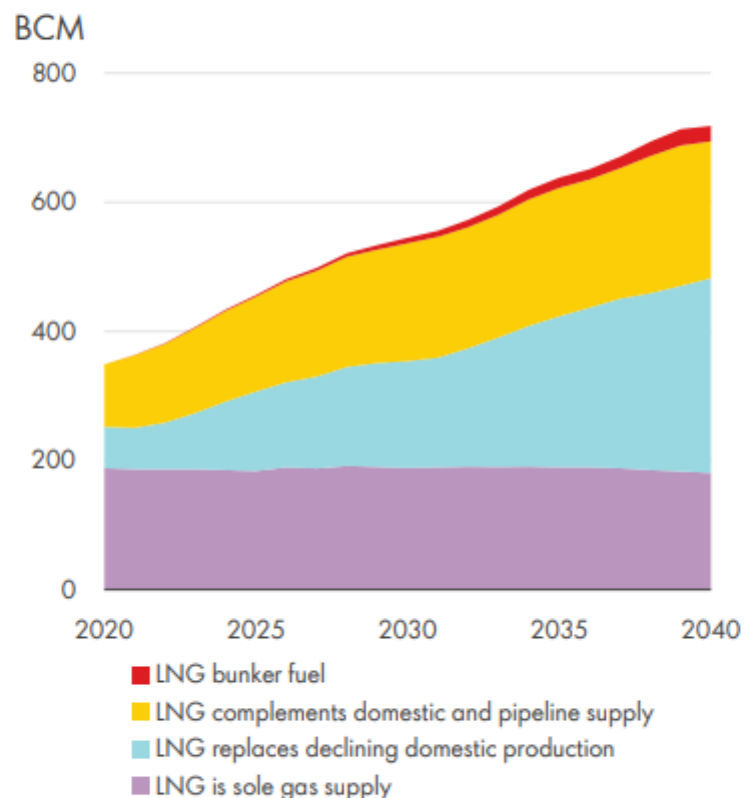
LNG needed to replace declining domestic gas and coal-to-gas switching

LNG imports by region

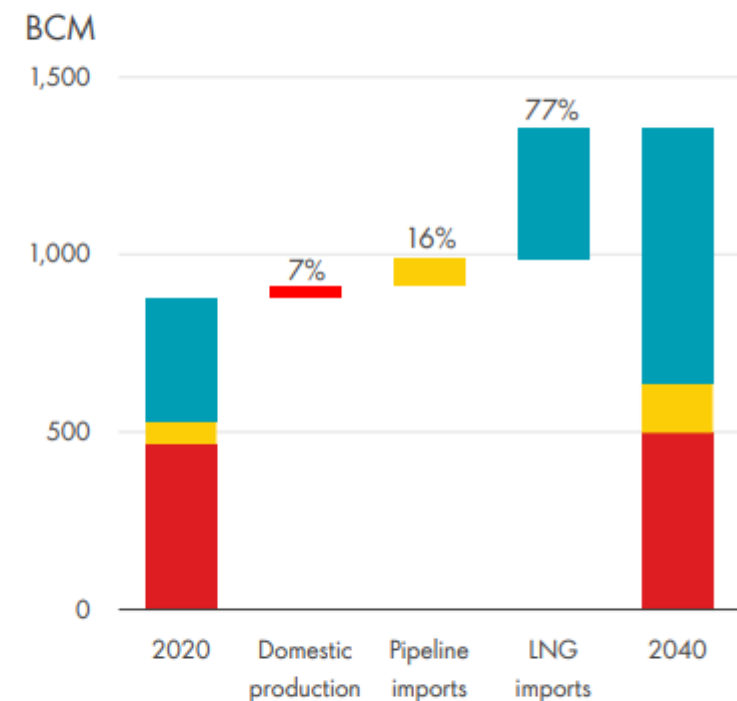


Source: Shell interpretation of Wood Mackenzie 2021 data

Demand drivers of LNG in Asia



Asian gas demand by supply source

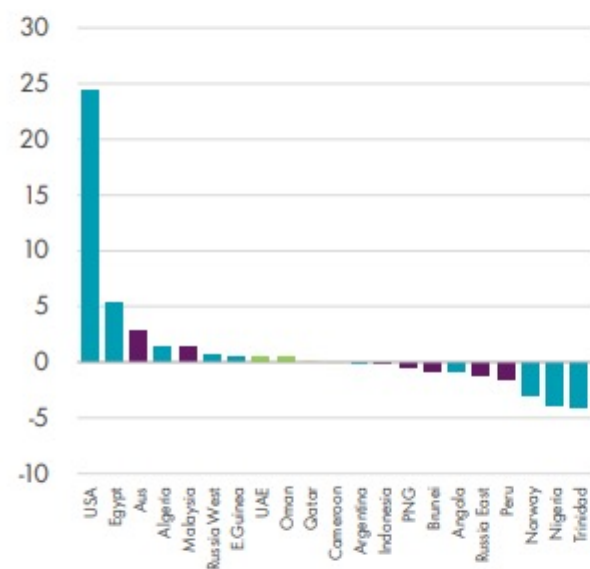


Domestic production is net of LNG exports

Global LNG supply increases by 21 million tonnes

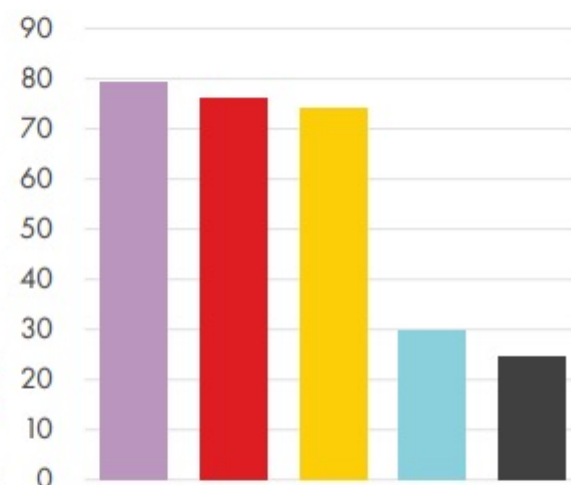
US LNG export growth offsets supply constraints elsewhere

Net LNG exports 2021 y-o-y
MT



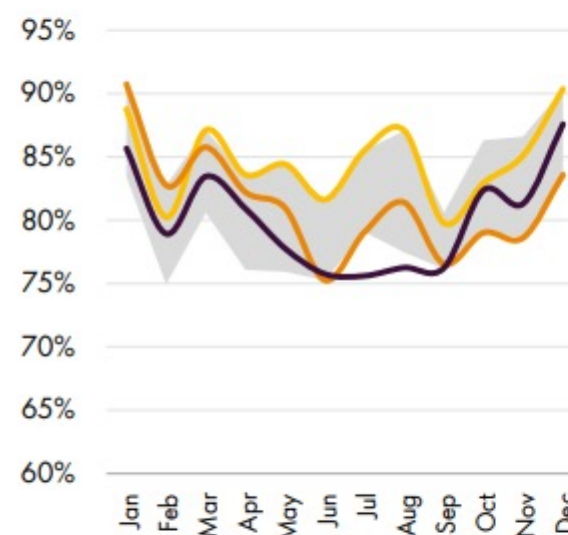
Atlantic Basin M East Asia Pacific

Top exporting countries 2021
MT



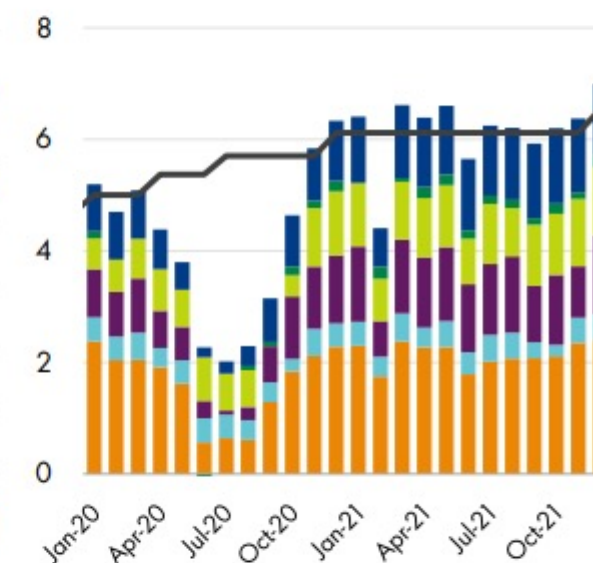
Australia Qatar US
Russia Malaysia

Non-US liquefaction utilisation
%



2016-2020 2019
2020 2021

US exports by month vs capacity
MT

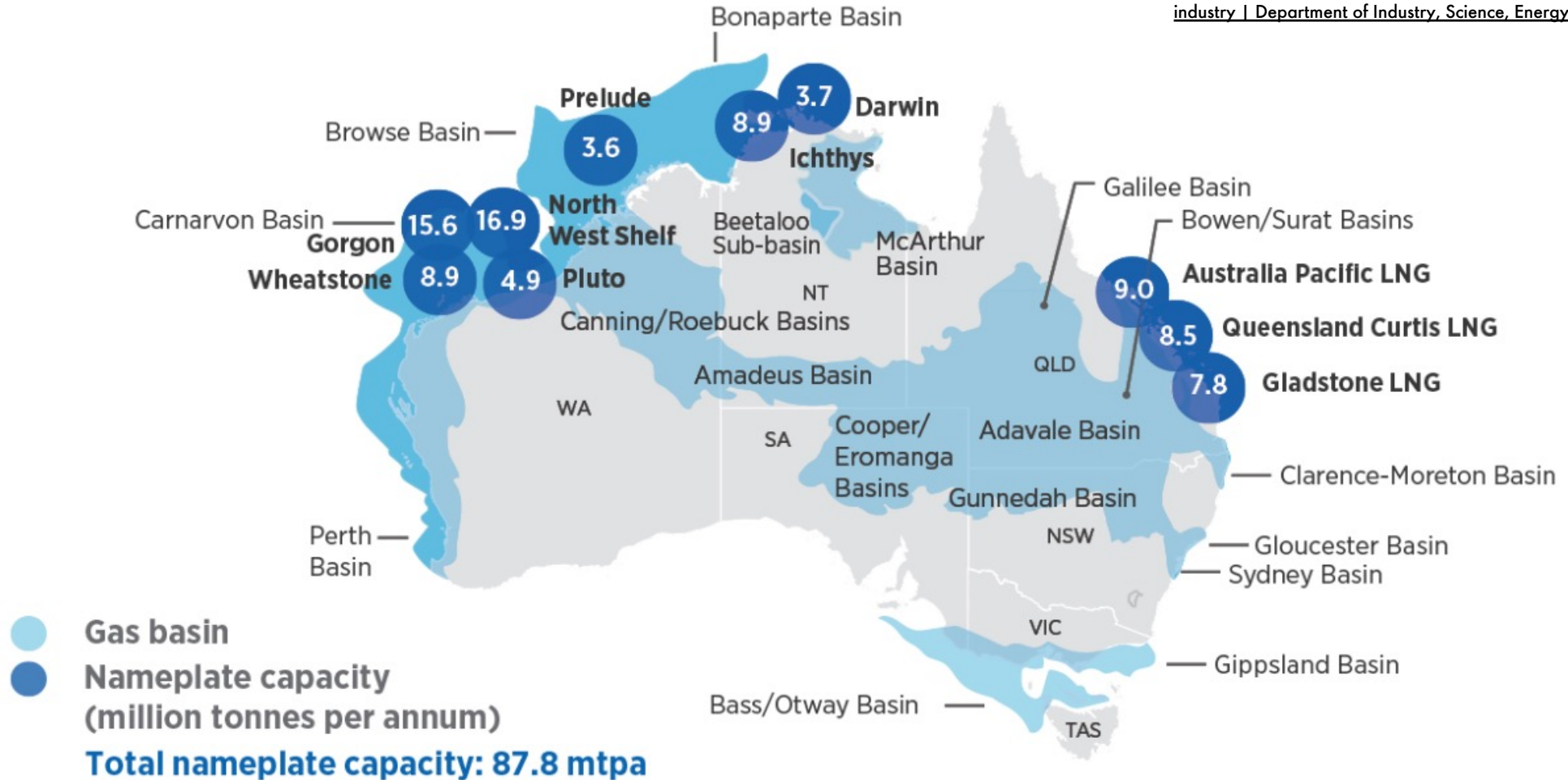


Corpus Christi Elba
Cameron Freeport
Cove Point Sabine Pass
Liquefaction capacity

Shell interpretation of Kpler, Wood Mackenzie & Customs 2021 data

Today - Australian LNG Capacity

Source: DISER Resources and Energy Quarterly via [The Australian LNG industry | Department of Industry, Science, Energy and Resources](#)





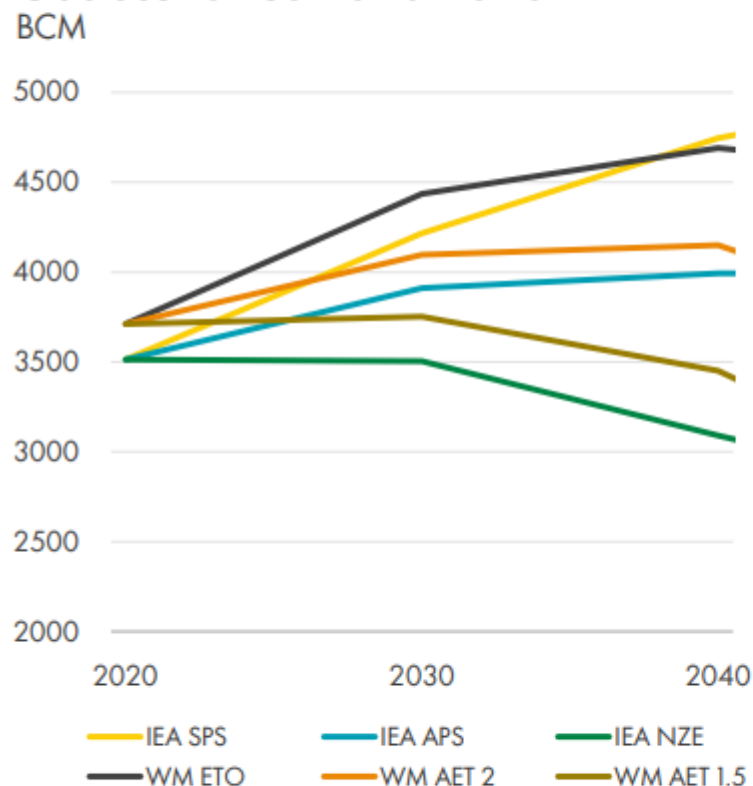
The LNG Supply Chain

4. LNG and Net Zero Transition

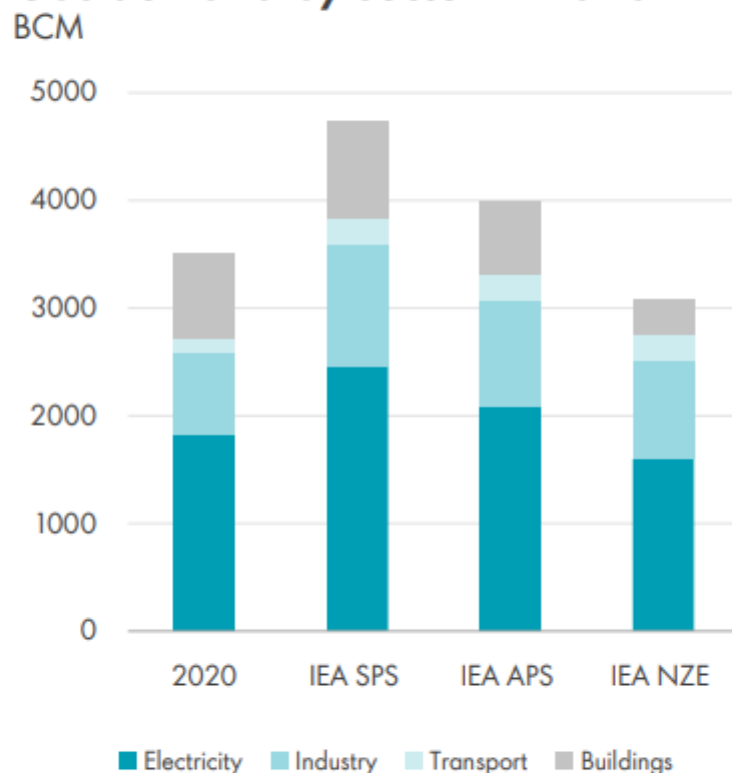


The role of gas in a changing energy system

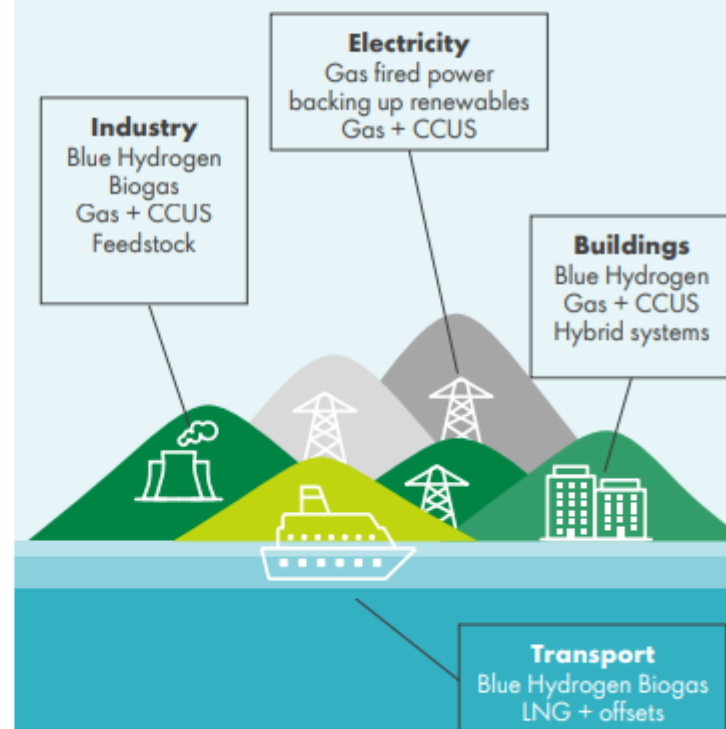
Gas scenarios 2020-2040



Gas demand by sector in 2040



Use of gas in a decarbonised world

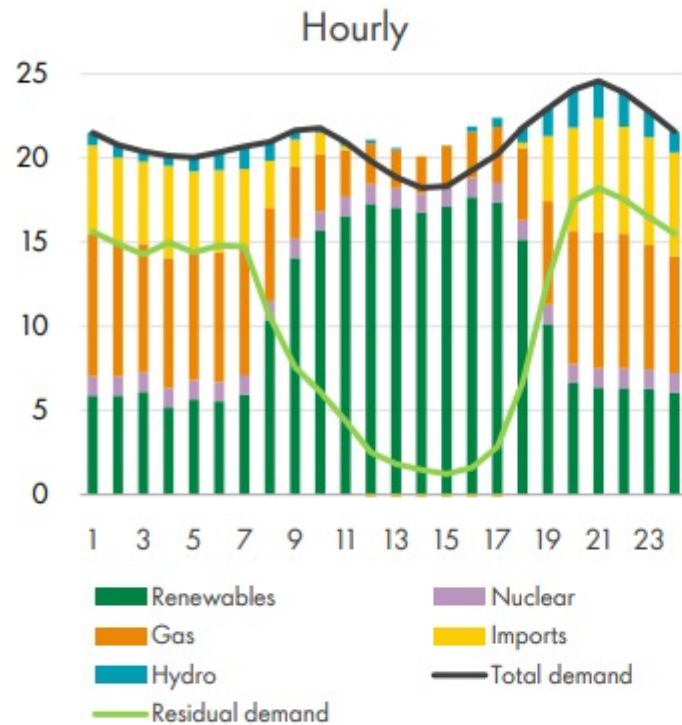


Source: Shell's interpretation of IEA World Energy Outlook 2021 and Wood Mackenzie 2021 data
 Wood Mackenzie's Energy Transition Outlook (ETO) and Accelerated Energy Transition (AET); IEA's Stated Policies Scenario (SPS), Announced Pledges Scenario (APS) and Net Zero Emissions Roadmap (NZE).

Gas is there when the sun does not shine, wind does not blow or rain does not fall

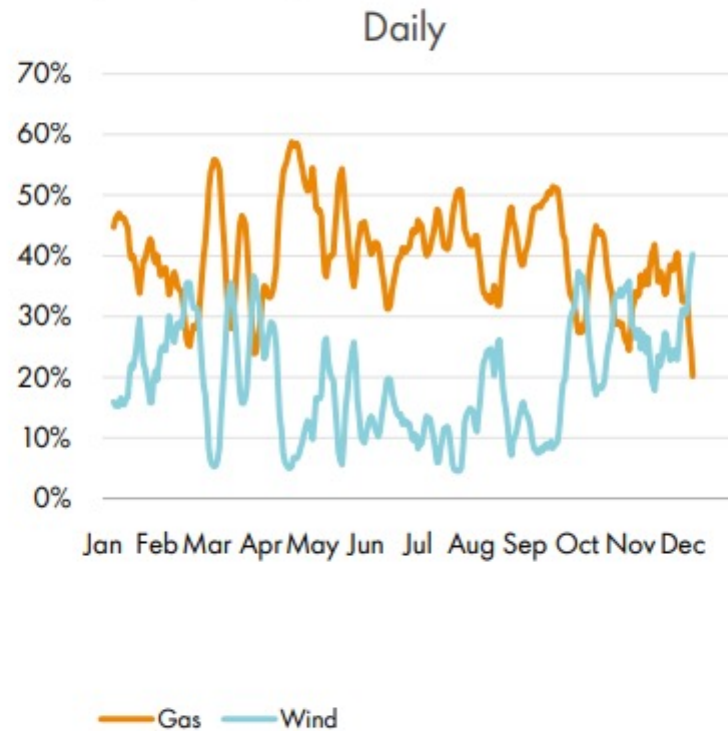
California electricity mix 24-04-2021

GW



Share of UK generation 2021

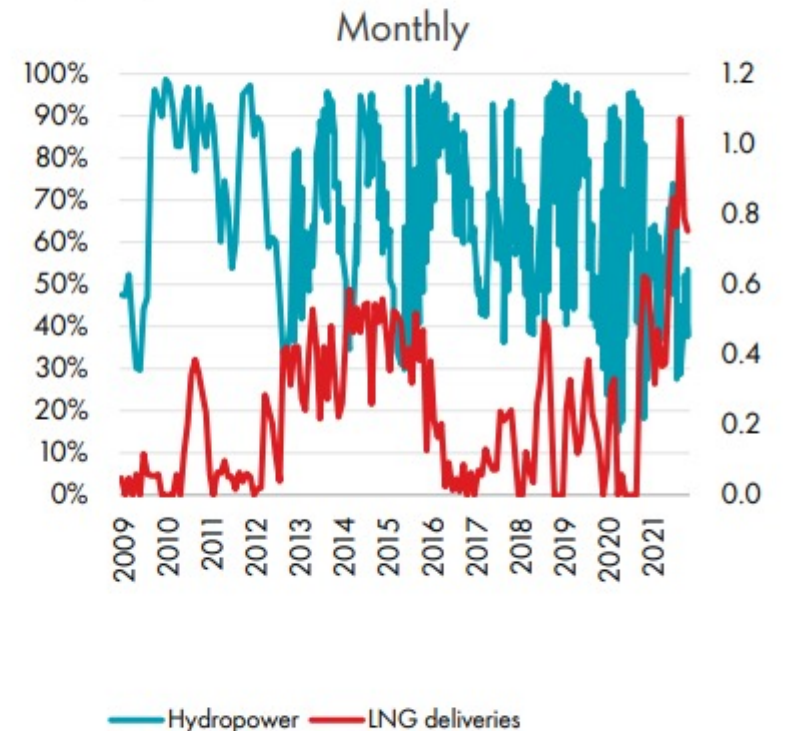
7 day rolling average



Brazil hydro levels & LNG deliveries

% hydropower available

LNG MT



Source: Shell's interpretation of California Independent System Operator, National Grid, Grid Watch UK, IHS Markit, ONS and ANP 2021 and 2022 data



Electricity sector

Momentum builds in decarbonising the LNG value chain in 2021



UPSTREAM



LIQUEFACTION



SHIPPING



REGASIFICATION



CONSUMPTION

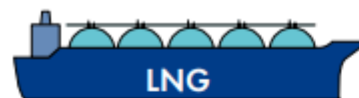
Carbon capture utilisation & storage (CCUS) projects planned with gas fields in **Indonesia** and **Malaysia**



World's largest LNG liquefaction project under construction, North Field East, to feature CCUS and solar



First commercial ME-GA low-speed, dual-fuel engines design for LNG carriers tested successfully



Liquid hydrogen plant using waste cold energy generated from regasifying LNG to be built in **South Korea**

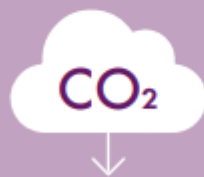
~30

LNG cargoes offset with carbon credits in 2021

GIIGNL establishes an MRV & GHG neutral LNG framework for the industry

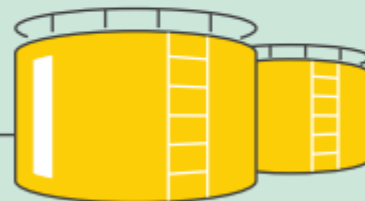


Over **80%** increase in CCUS for gas with **63 MTPA** of new projects announced in 2021



Pluto LNG and Cryogas-Vysotsk LNG share plans to use **renewable energy** for liquefaction

Agreement signed to begin pilot for **hydrogen blends into liquefaction** to reduce emissions from LNG



Singapore LNG Regasification terminal goes solar



15 Japanese companies form alliance to promote and improve processes for offsetting carbon emissions from LNG

Source: Shell interpretation of published announcements 2021

Decarbonisation requires early action

Switching to gas can lower emissions today

Power



Switching just **20% of coal-fired power** in Asia to gas can potentially save:

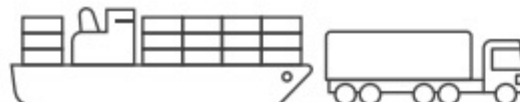
CO₂
EMISSIONS

**EQUIVALENT TO ALL
EMISSIONS FROM
GERMANY**

680
MTPA

Indicative annual gas demand
310 BCM

Transport



Switching **10% of heavy goods vehicles and 10% of shipping fleet** to run on gas can potentially save:

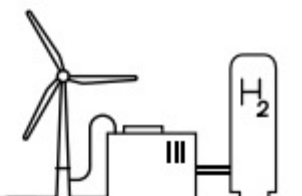
CO₂
EMISSIONS

**EQUIVALENT TO
16.3 MILLION CARS TAKEN
OFF THE ROAD**

75
MTPA

Indicative annual gas demand
120 BCM

Hydrogen use



Moving global energy mix to **5% hydrogen** of which 30% is blue hydrogen can potentially save:

CO₂
EMISSIONS

**EQUIVALENT TO
EMISSIONS FROM MORE
THAN 70 COUNTRIES**

475
MTPA

Indicative annual gas demand
350 BCM

Source: Shell interpretation of IHS Markit Sustainable Flame Study 2021

Questions and Answers

Q&A







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