



decisions with confidence

Australian Gas Markets - a whirlwind tour

May 2021



In the last 5 years:

- We have advised on transactions totalling over \$20 Billion
- We have provided independent advice
 - To over 500 clients
 - on over 1500 oil and gas fields
 - With a total value in excess of \$100 Billion
- Including:
 - Over 120 due diligence exercises on assets and portfolios
 - More than 110 Independent Technical Specialist and Expert assignments
 - More than 100 Resources and Reserves reviews and audits
 - Over 140 Technical and Commercial Consulting assignments

We have covered LNG projects totalling more than 120MTPA or over 30% of the world’s current total LNG production.



In a typical month we work on	✓	✓	✓	✓	✓	✓
~25 Projects/~85 Assets	20	10	20	5	30	3
Annually we work on						
100+ Projects/500+ Assets	100+	80+	100+	30+	200+	25+



Australian Gas Markets Overview

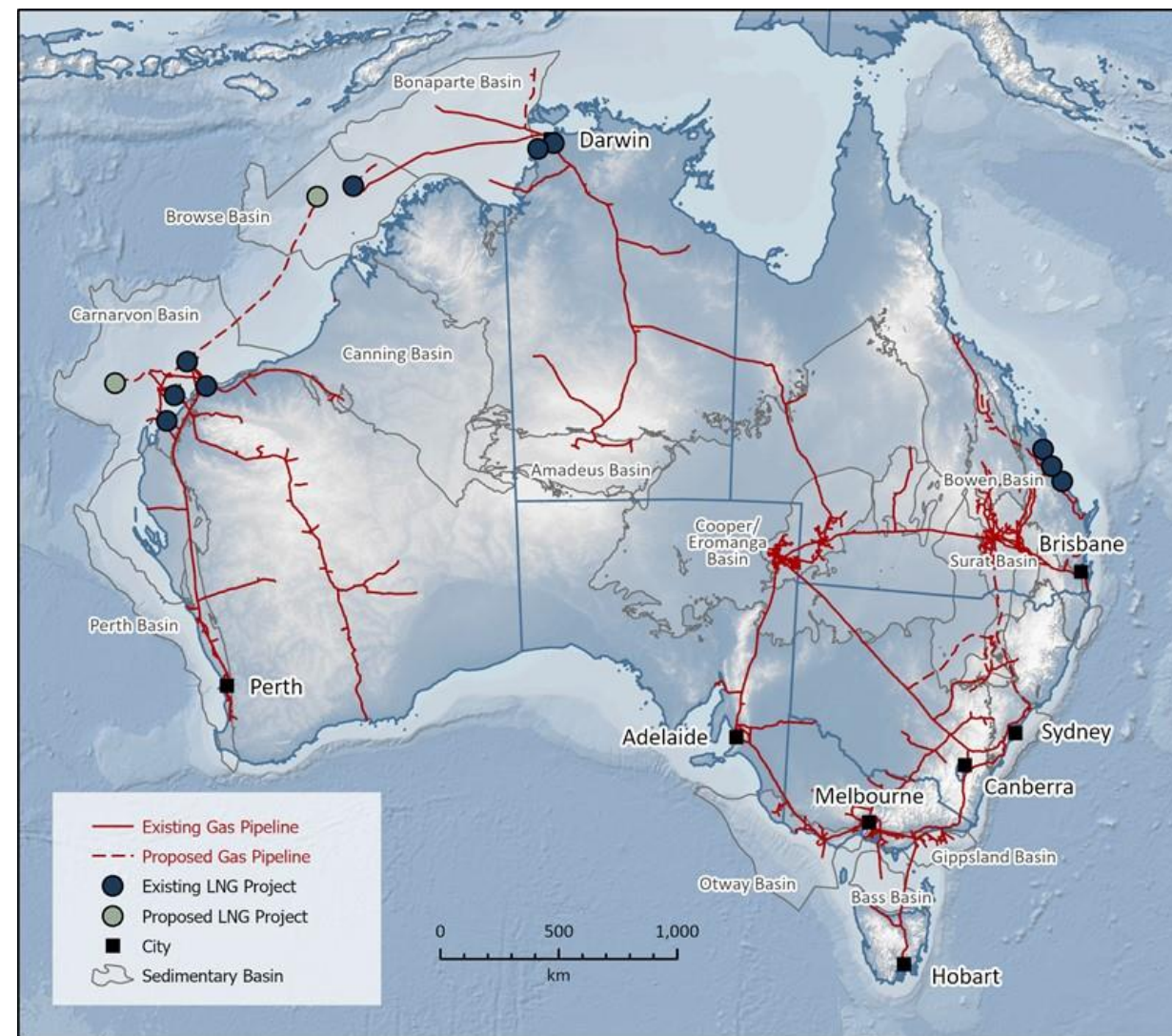


Australian gas markets

Australia's gas markets comprise of three geographically separate and discrete markets:

- The eastern states (VIC, NSW, QLD, SA, ACT, TAS, NT);
- The Northern Territory (export);
- Western Australia.

All markets are dominated by LNG exports, but the impact of this is different in each case.



Australian gas basins and transmission infrastructure

Thoughts & observations on Australian Gas markets – what we'll cover

- Domestic Gas Obligations work - when applied well (e.g. WA)
- WA will remain well supplied with Domgas for the next decade
- A trans-continental pipeline is the “white elephant in the room” that just won't go away

- The Beetaloo is not the next Marcellus
- The Northern Gas Pipeline is not useful in solving the Eastern States gas issues
- LNG imports are...

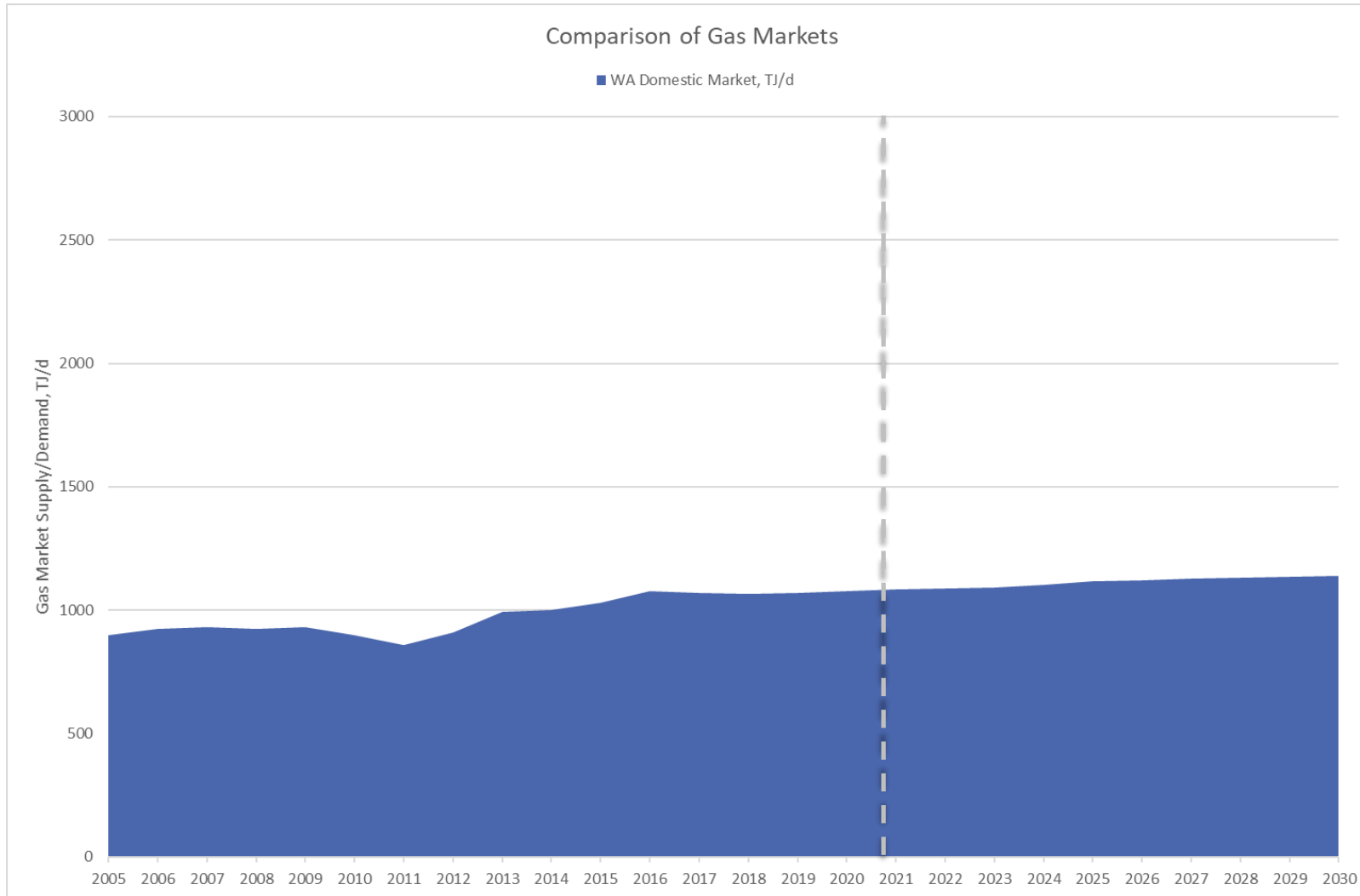
- Renewables (Solar) are not cheaper than gas-fired power generation
- Batteries do not (cannot) provide the dispatchable baseload power required
- Hydrogen is still an awfully long way off

- Gas is the “natural” partner to renewables

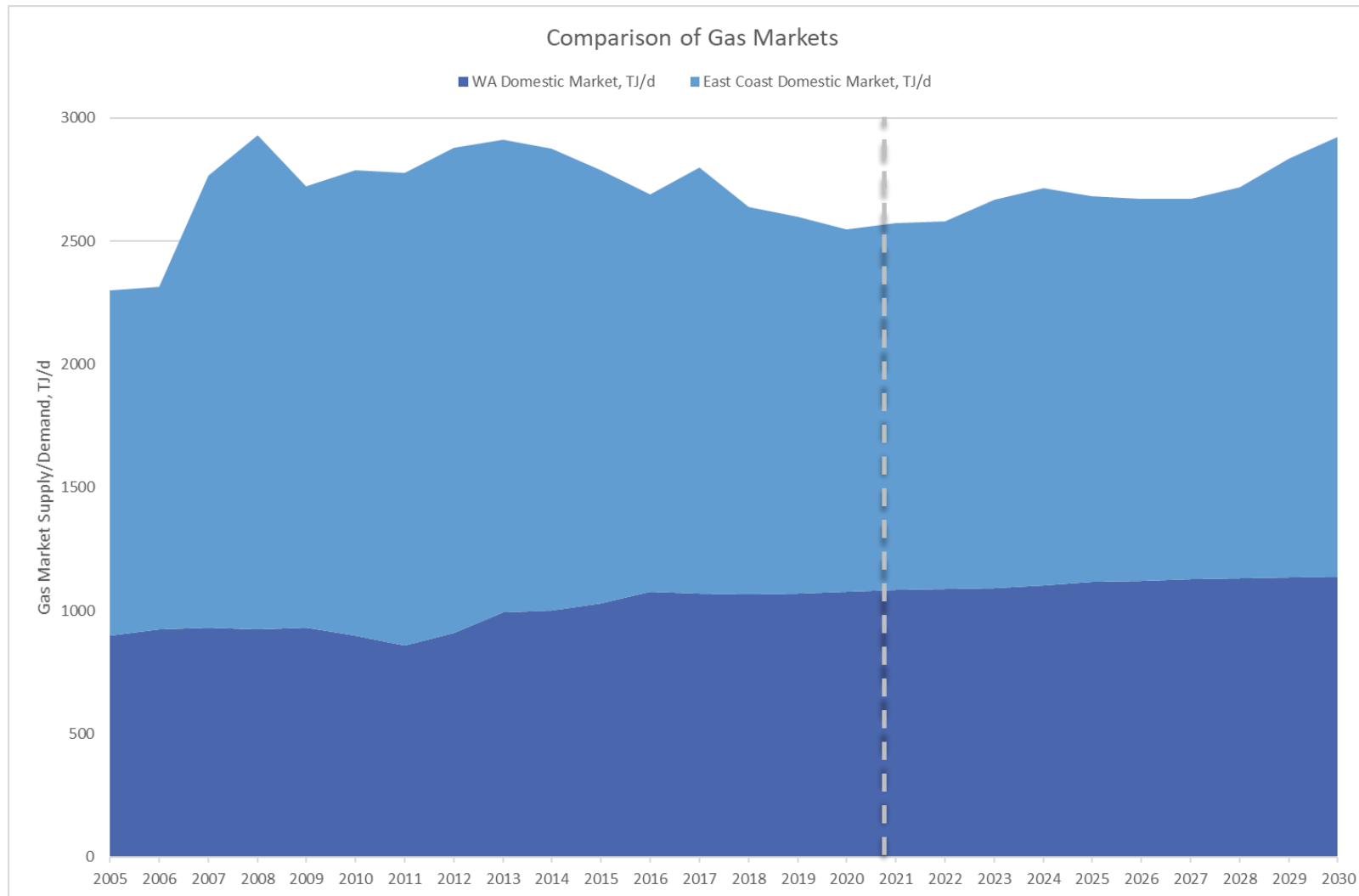
Australian Gas Markets in context



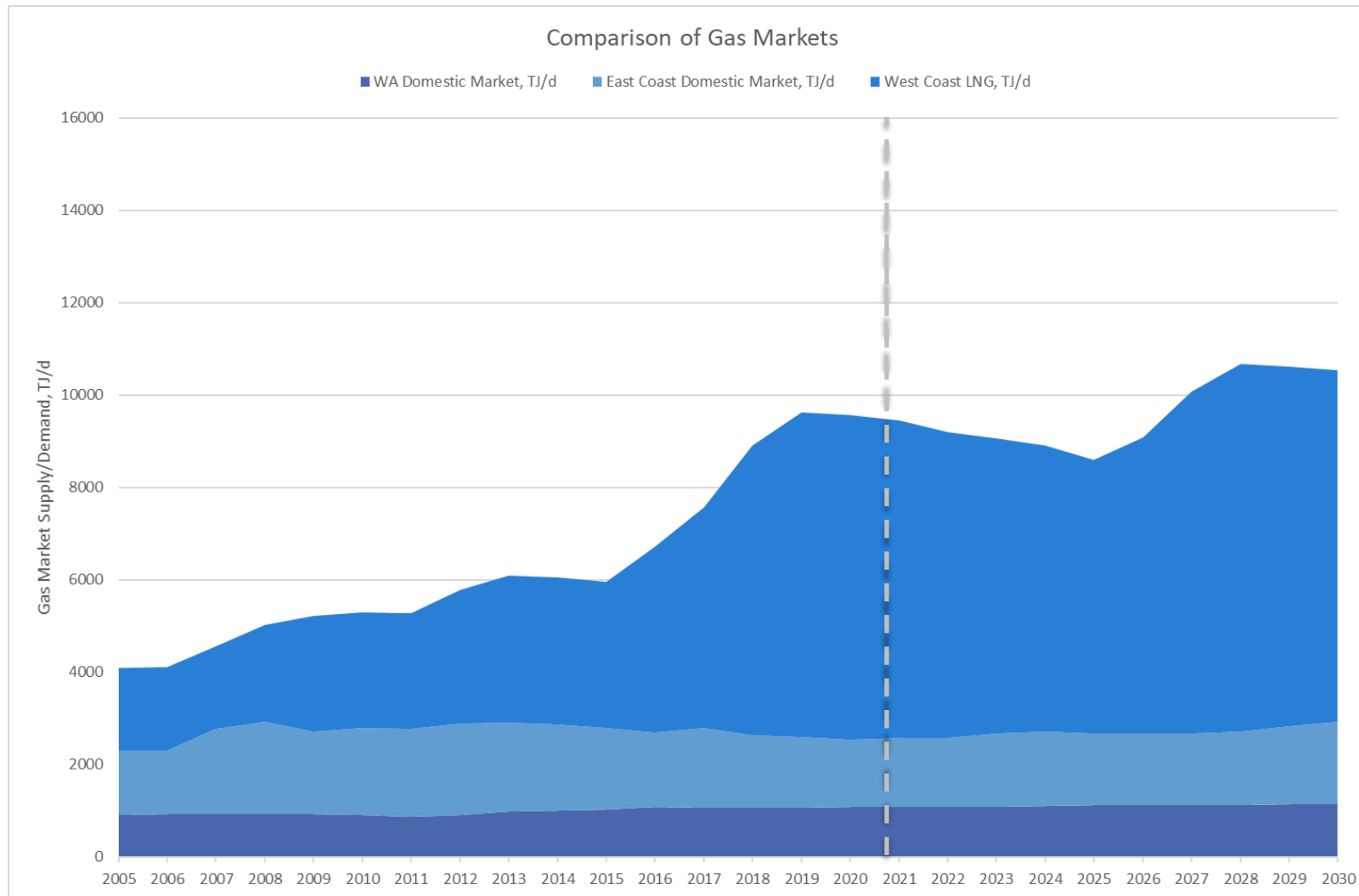
WA Domestic gas market



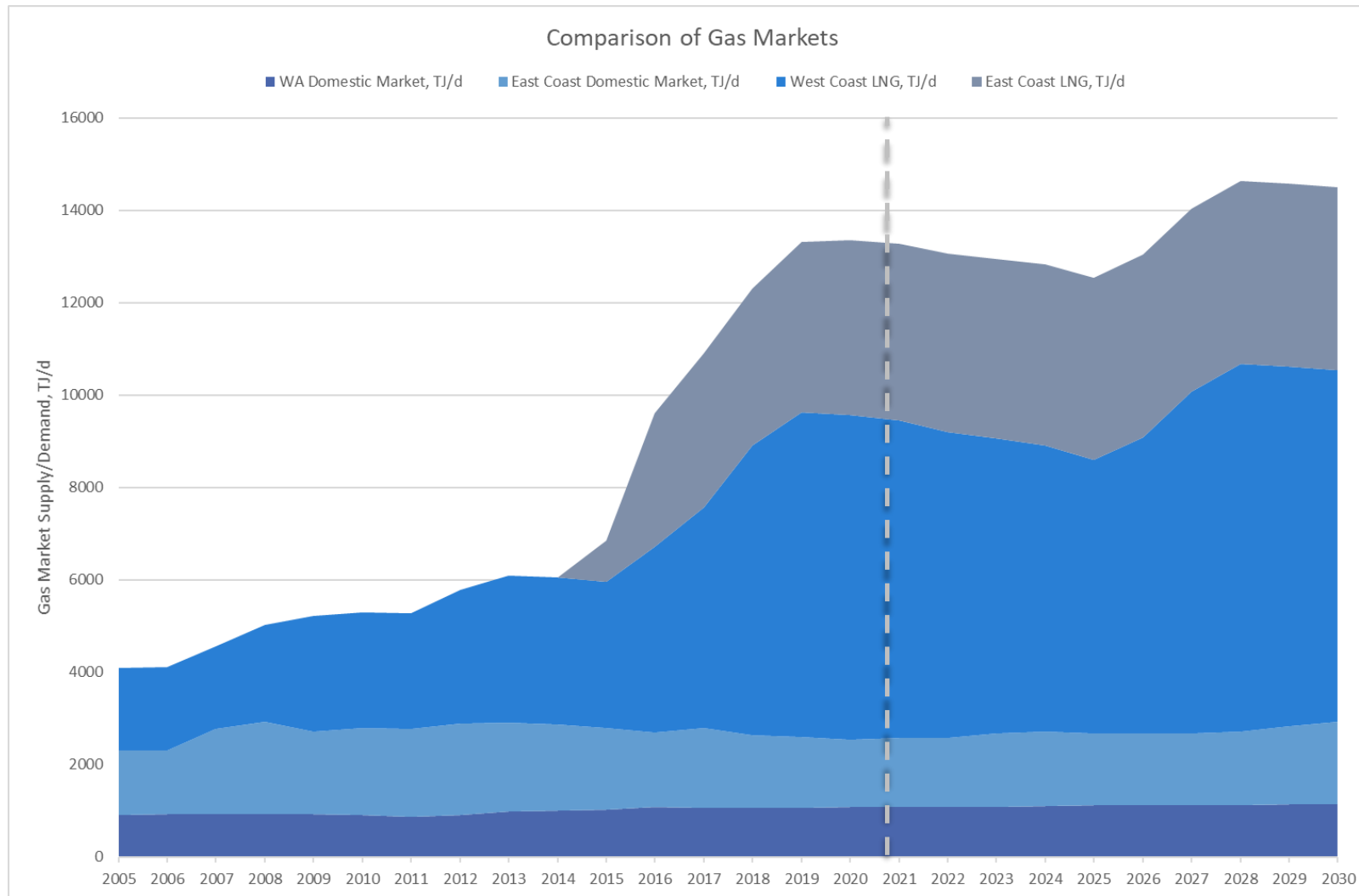
Australian Gas Markets comparison



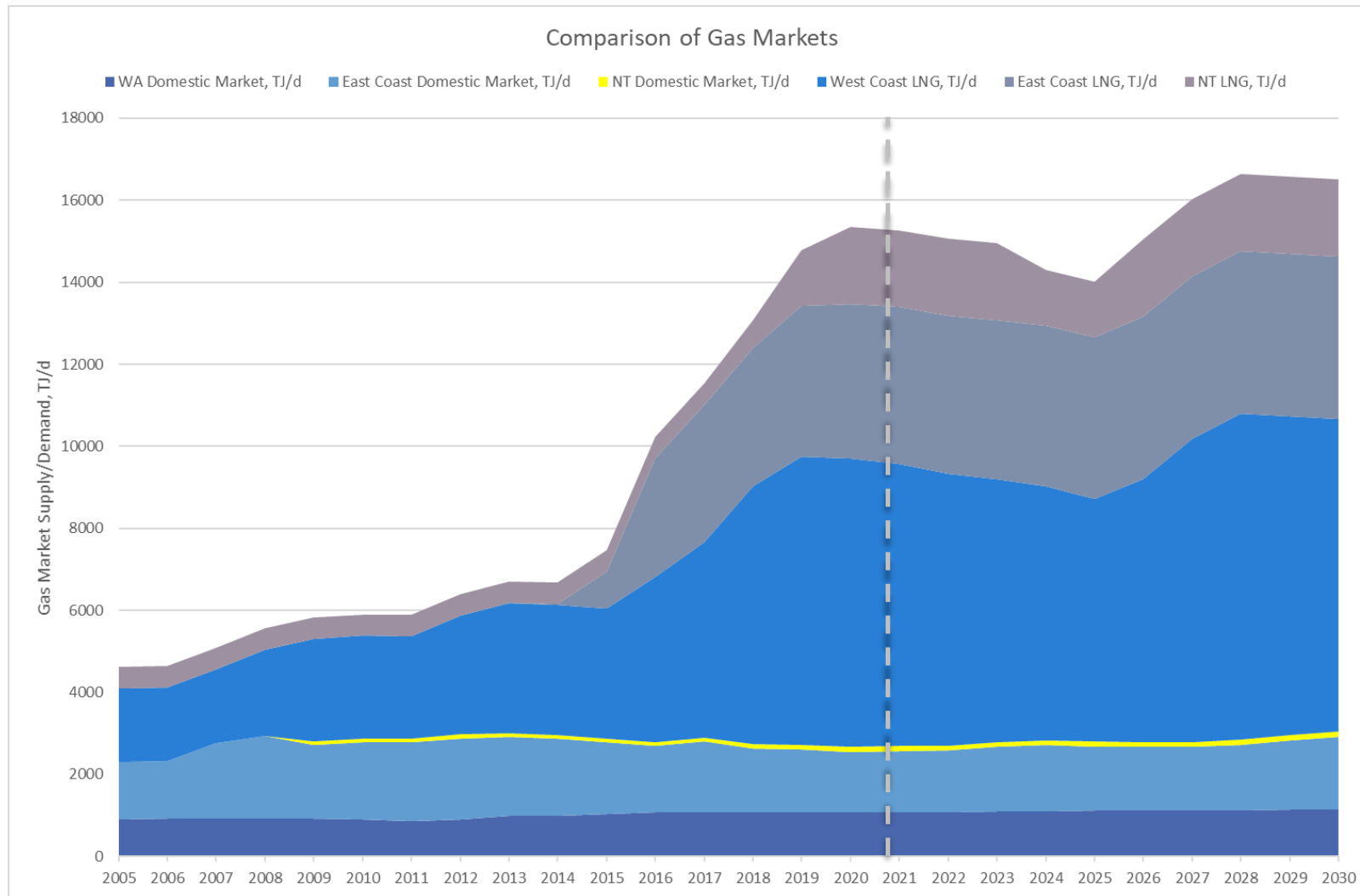
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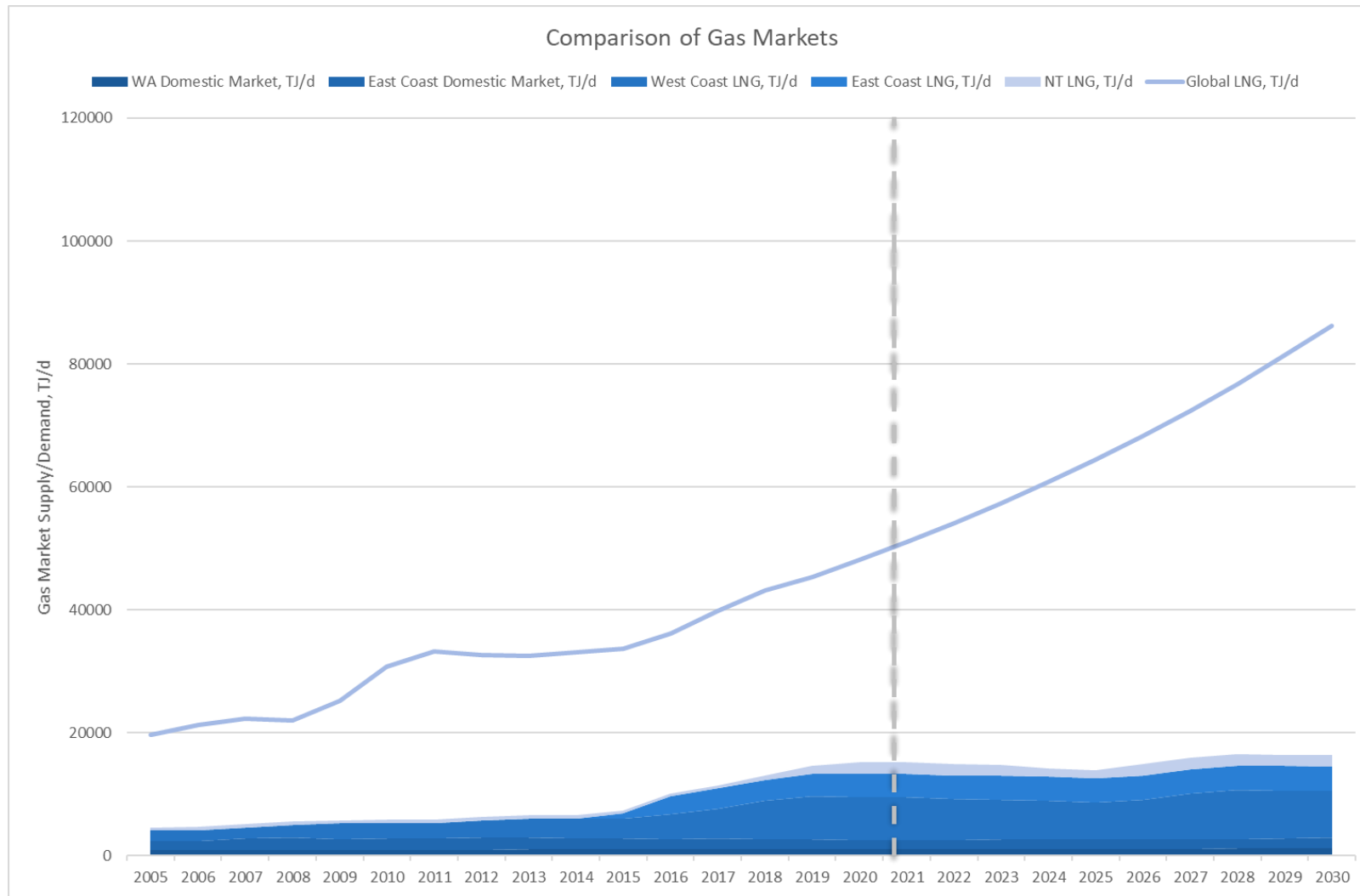
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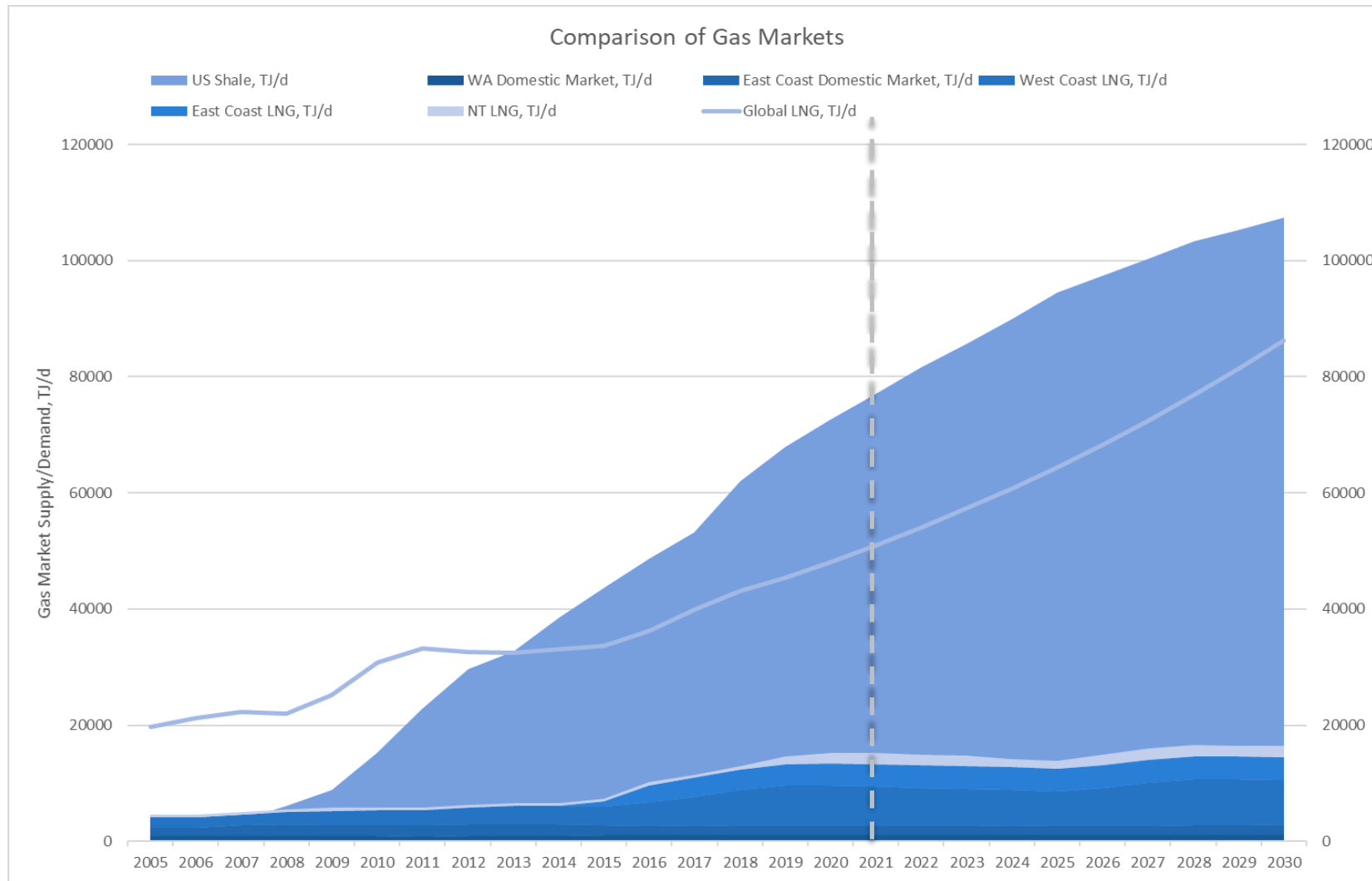
Australian Gas Markets comparison



Australian and Global LNG Markets



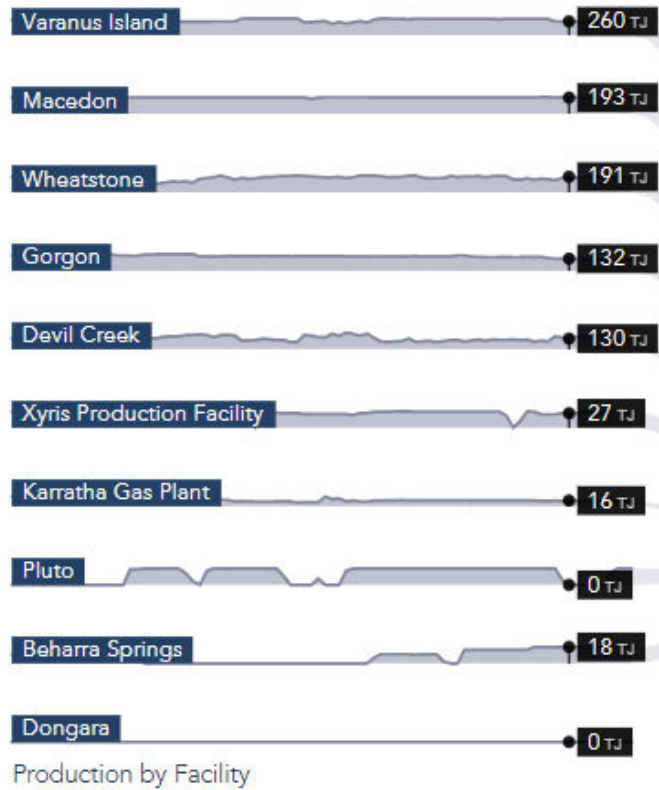
Australia, Global LNG and US Shale



Thoughts & observations on Australian Gas markets

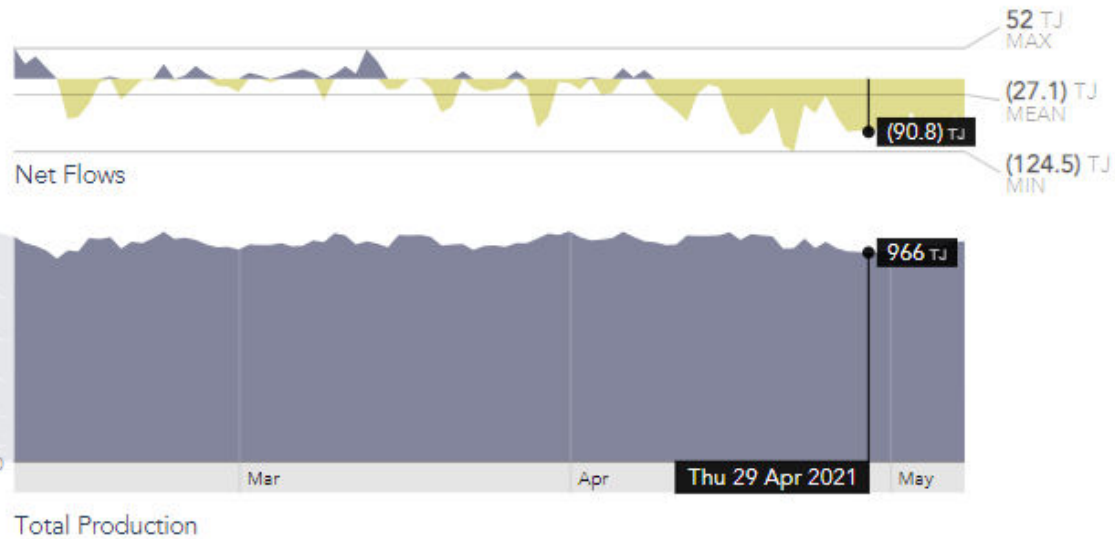
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Why isn't WA supply dominated by LNG suppliers?

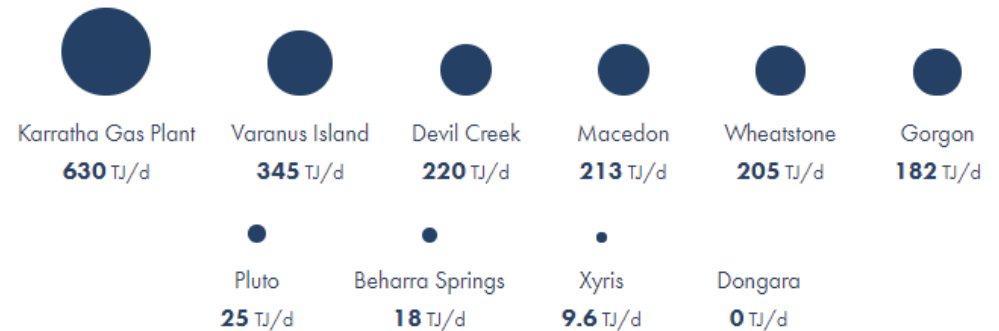


Gas Production by Facility

LAST 3 MONTHS



PRODUCTION CAPACITY



There is other, cheaper gas available that is being developed...

Long Gas Pipelines

Nord Stream

- 1225 km
- 40 MTPA LNGe
- 6000 TJ/d

DBNGP

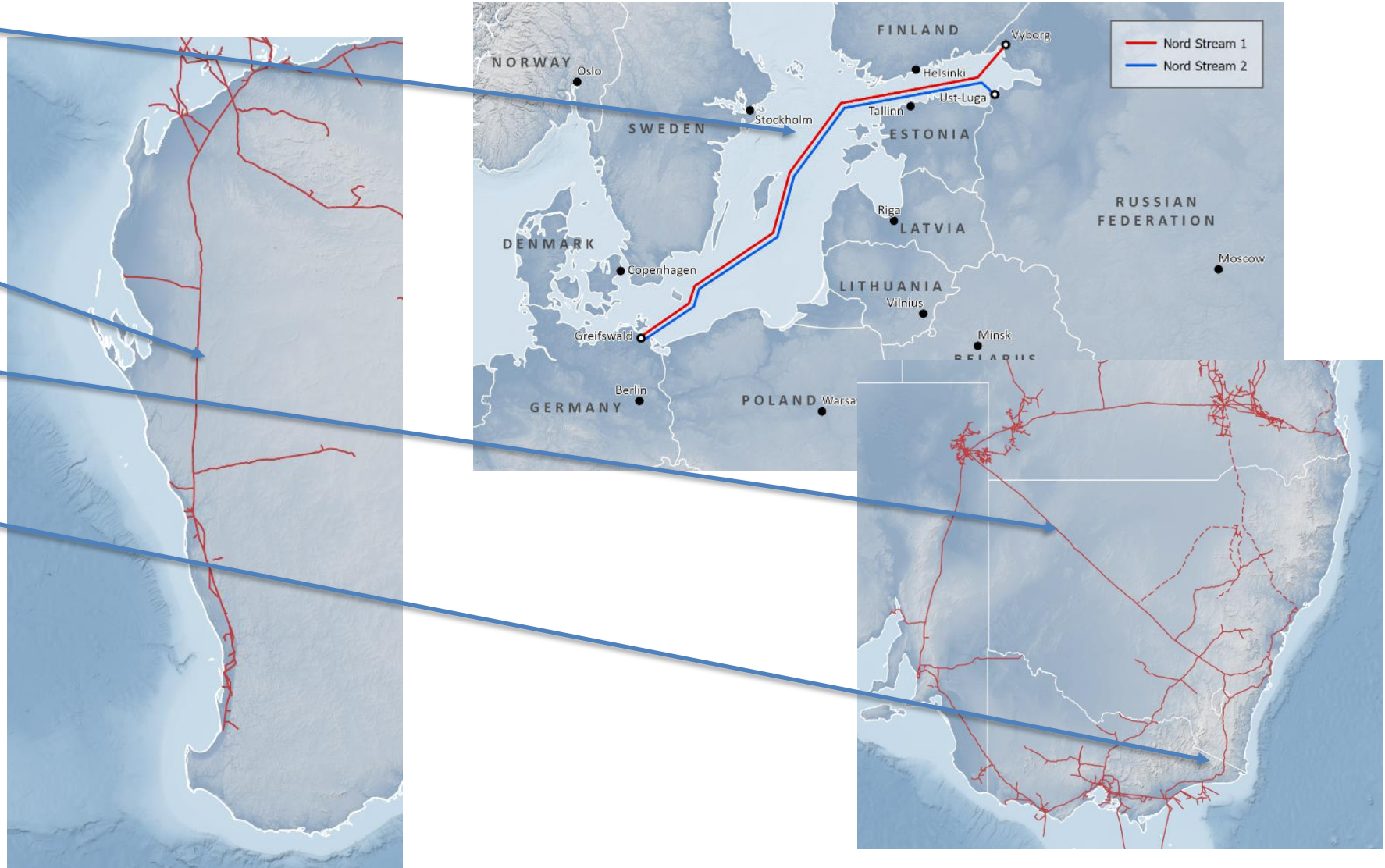
- 1800 km
- 845 TJ/d

MSP

- 1375 km
- 450 TJ/d

EGP

- 800 km
- 350 TJ/d



West–East Gas Pipeline

Telfer -Moomba

- 2000 km
- Telfer pipeline ~30 TJ/d

Laverton – Moomba

- 1700 km
- Goldfields pipeline ~200 TJ/d

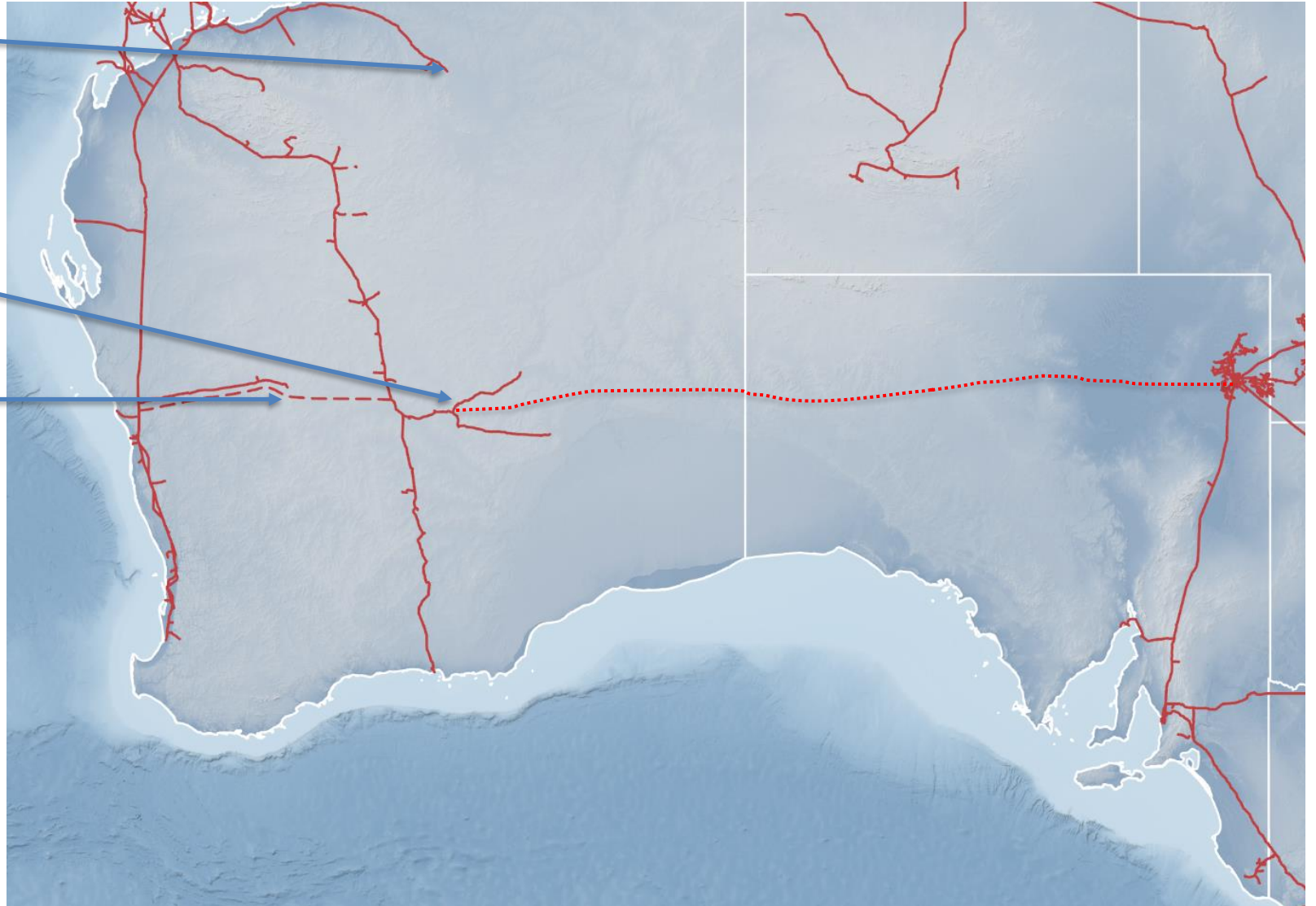
Northern Goldfields Interconnect (NGI)

- 1900 km
- NGI ~ 80 TJ/d
- 580 km, 12", \$460 million, 18 months

W-E Pipeline

- At least \$3-4 Billion (up to \$6 Billion)
- At least 3-4 years to construct
- Would probably require ~1000 TJ/d

- Highly unlikely & doesn't solve the East Coast problems



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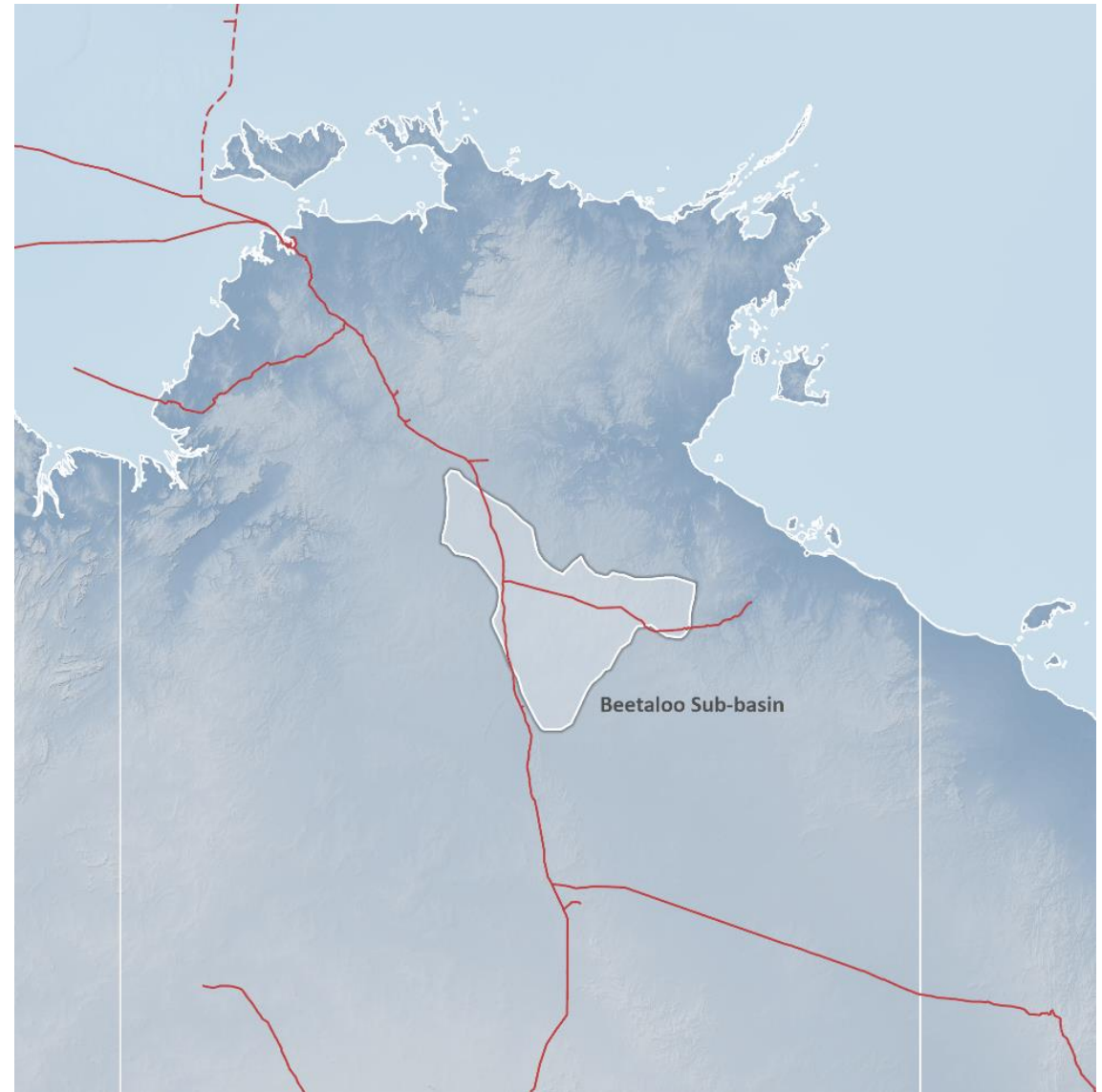
Why the Beetaloo is not the next Marcellus

Marcellus

- Proven conventional petroleum system
- Producing area since 1820's
- Relatively young geology

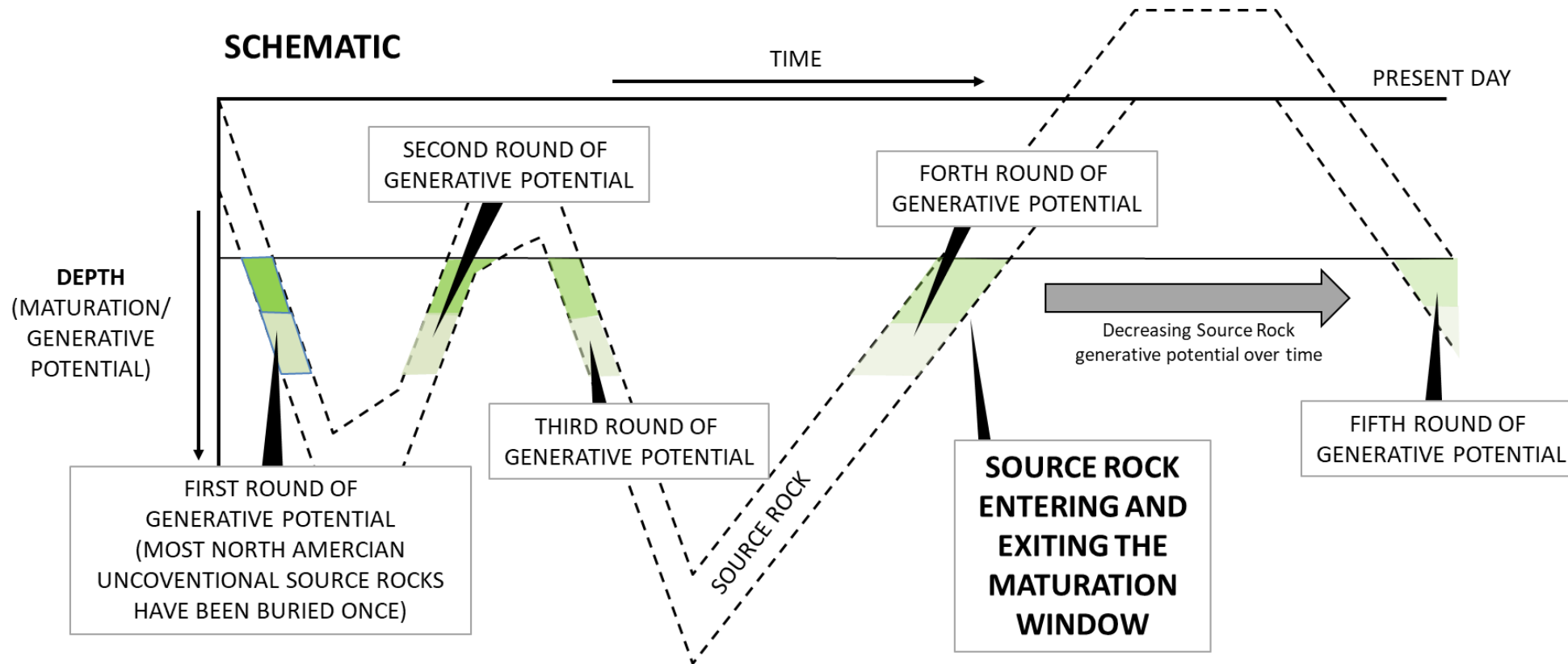
Beetaloo

- No conventional production
- No Production
- Old Rocks



The challenge with very old rocks

- Old rocks have convoluted burial histories meaning their generative capabilities may have been compromised over time.



Why the Beetaloo is not the next Marcellus

Marcellus

- Proven conventional petroleum system
- Producing area since 1820's
- Relatively young geology
- Significant petroleum infrastructure
- 1st producing unconventional well in 2005
- By 2010
 - Over 1000 producing wells.
 - Over 500 TJ/d

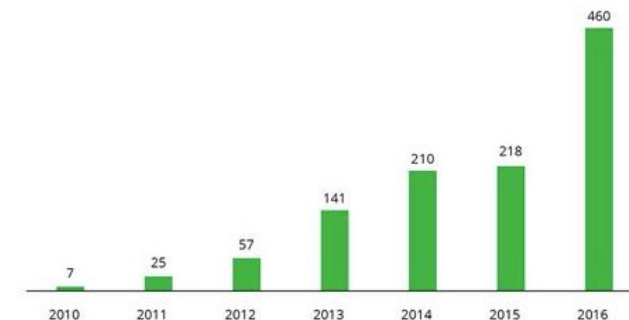
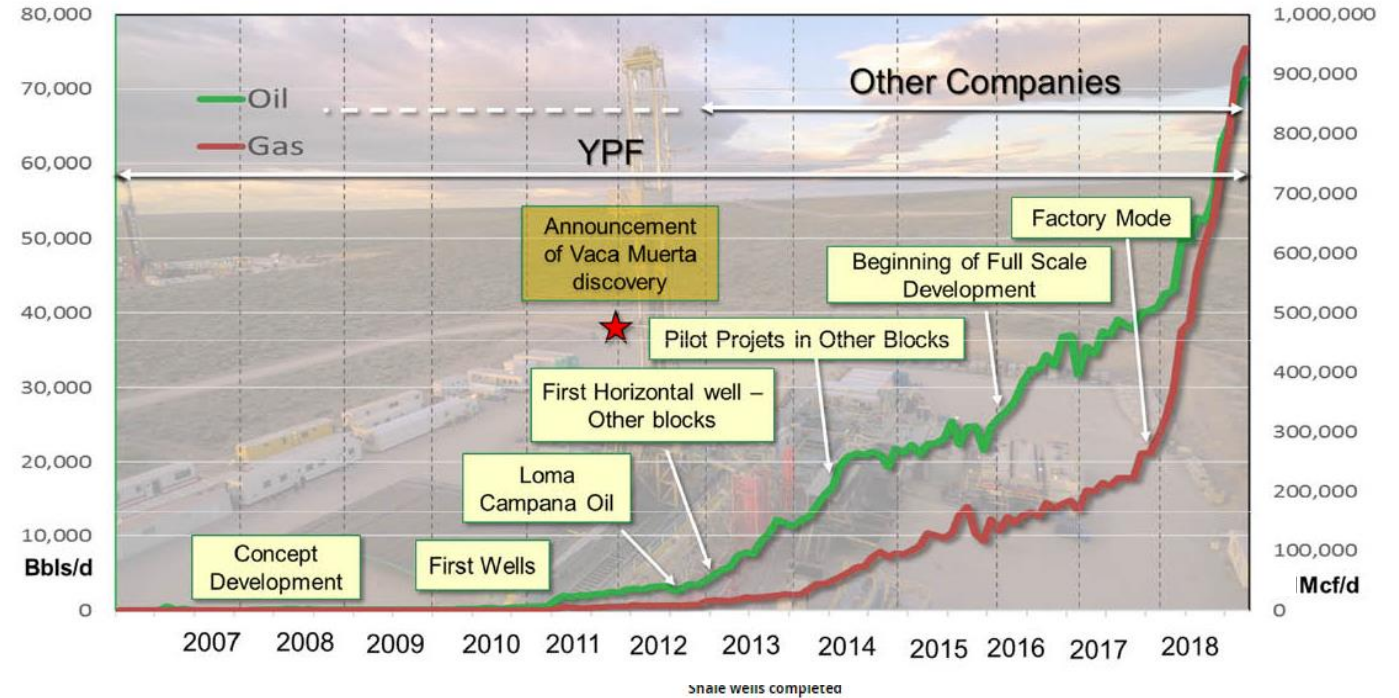
Beetaloo

- No conventional production
- No Production
- Old Rocks
- No petroleum infrastructure
- First test in 2016 – (Amungee NW-1H, Origin) inconclusive
- Moratorium
- 2020 Activity:
 - Origin, Kyalla 117 – successfully fractured, failed to flow
 - Santos, Tanumburini 1 – 4 stage frac, good performance
 - Empire, Carpenteria 1 – liquids rich
- By 2021 – no production
- Planned activity
 - Santos 2 wells 2021 (ongoing)
 - Origin – trying to flow Kyalla 117 – latest news?
 - Empire to frac Carpenteria 1 (June)
 - Santos 2 wells in 2022
 - Empire 5-year plan
 - 2D seismic
 - Up to 7 (appraisal) wells
- By 2026 – no production planned

Comparison with Vaca Muerta may be more suitable

Vaca Muerta

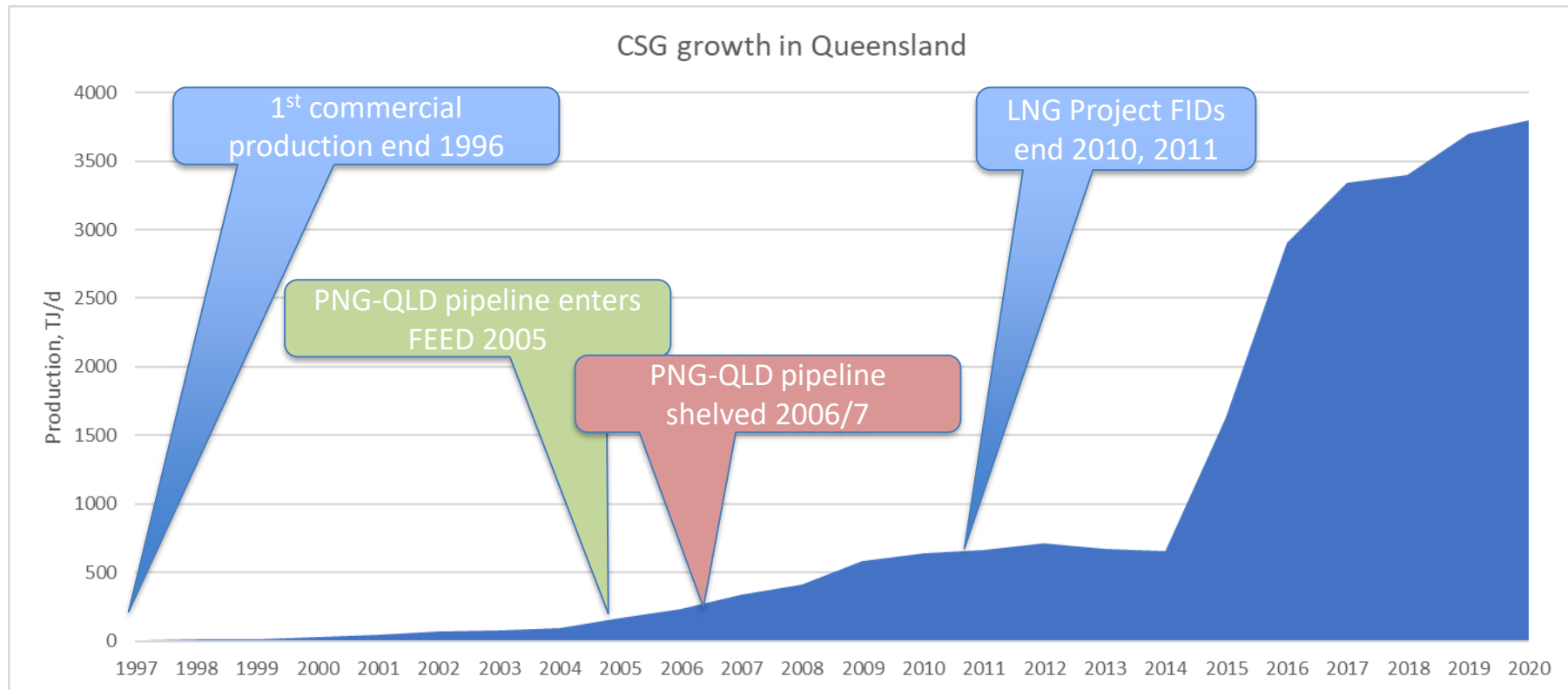
- Known source rock for Neuquen Basin conventional production since 1918.
- Limited existing infrastructure
- “Discovered” in 2010
- First horizontal well in 2011
- By 2012 50 wells had been drilled
- By 2016 over 1000 wells had been drilled
- Production in 2019 at ~1000 TJ/d
- LNG Export started in 2019 (FLNG Tango)
- LNG Export ceased in 2020
- Production in 2020 at ~800 TJ/d
- Activity ramping up again
- Political uncertainty
- Lack of unconventional service industry
- Lack of infrastructure
- High costs



Comparison with CSG in Queensland is also relevant

It took CSG:

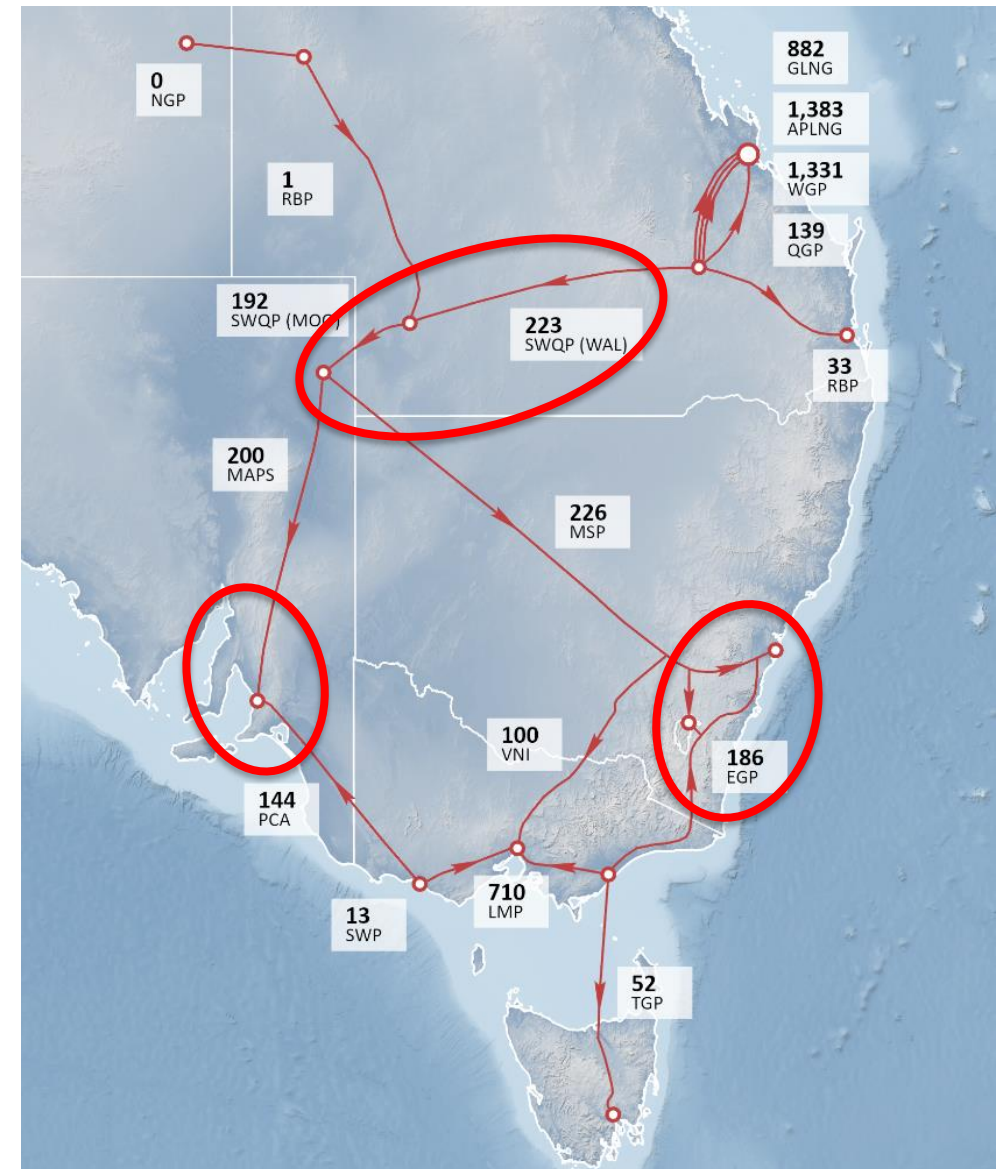
- 14 years from initial commercial production to FID on the first LNG project (QCLNG)
- 20 years to get to full-scale production
- Plenty of gas – just most of it is contracted for exports...



East Coast market - infrastructure limitations

Getting gas to where it is needed when it is needed is an issue:

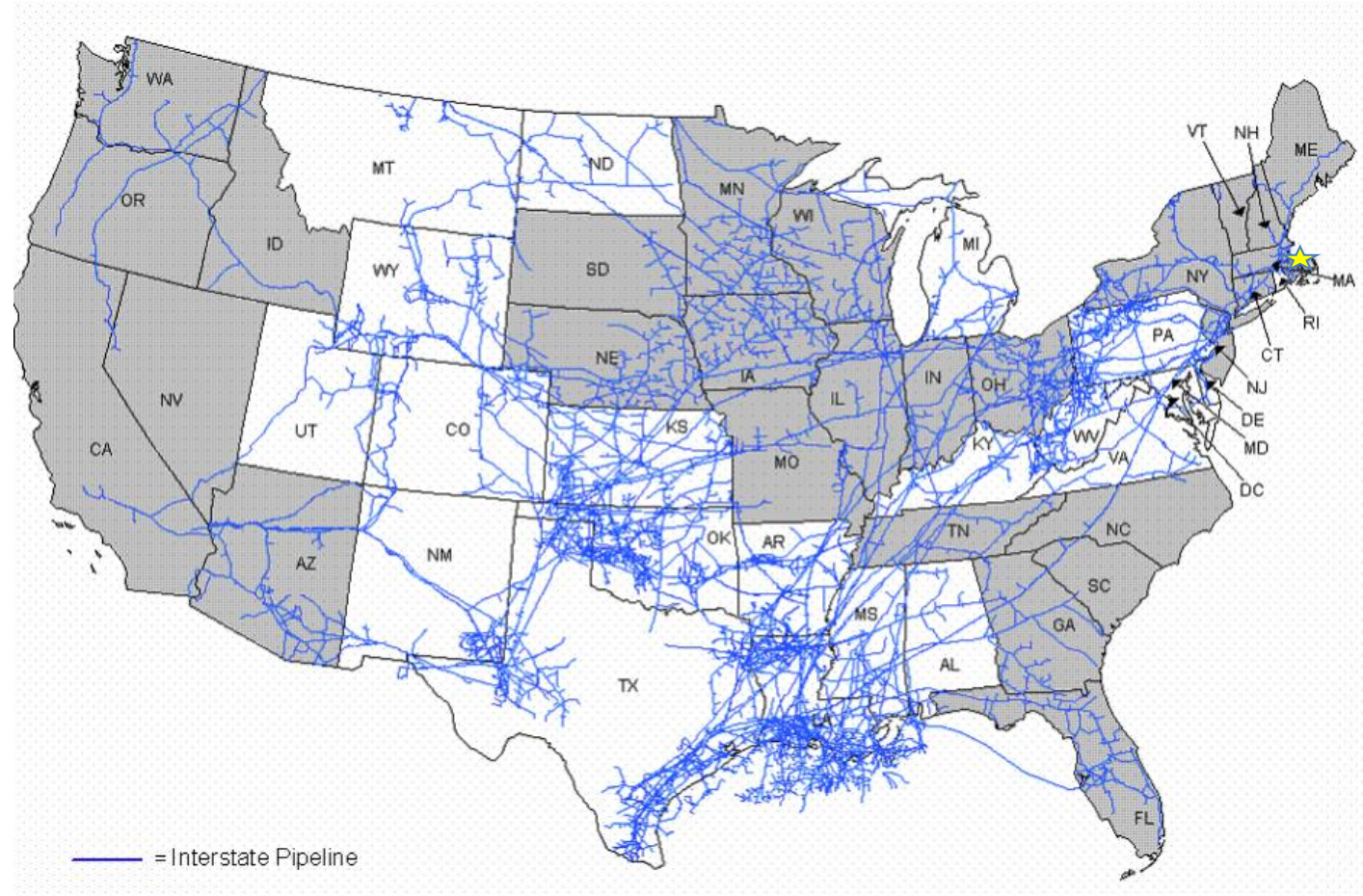
- NSW (Sydney) and SA (Adelaide) are most vulnerable parts of the system as they are the furthest sinks from sources, and have already experienced infrastructure limitations.
 - NSW larger population
 - SA larger resource base
- QLD SWQP designed to flow West to east, but flows the other way during periods of high demand
- Iona Gas Storage and Longford Gas Plant together struggle to supply Victoria and South Australia.
- There is a limit on how much gas can be brought down from Queensland
- The Northern Gas Pipeline has these constraints and more
- In 2016 following the announcement of the first moratorium in Victoria RISC indicated that this might result in LNG imports into Australia...



Other examples of import and export

- Indonesia
- Malaysia
- Russia
- USA
In winter getting gas into the Boston area is difficult due to infrastructure (pipeline) restrictions

- The Netherlands
- France
- UK



Source US EIA

4 LNG Terminals currently in planning stages for Eastern Australia

NSW

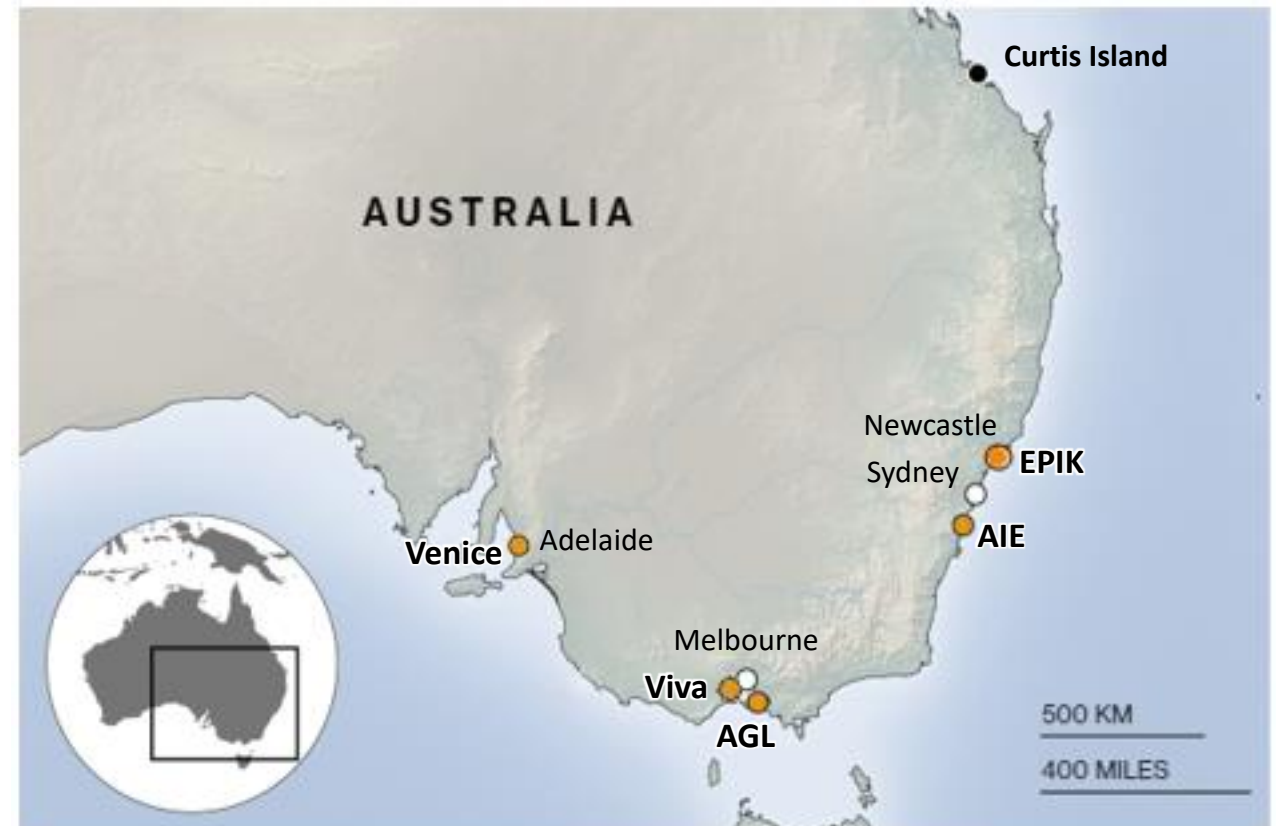
- Newcastle Gas Dock
 - EPIK Energy (Energy Projects and Infrastructure Korea)
- Port Kembla Gas Terminal
 - Australian Industrial Energy (AIE)
Squadron Energy, Marubeni, JERA)

VIC

- ~~Longford (Gippsland)~~
 - ~~ExxonMobil~~
- ~~Crib Point (Melbourne)~~
 - ~~AGL, APA~~
- Geelong refinery (Melbourne)
 - Viva, Engie/Mitsui, Vitol/VTTI

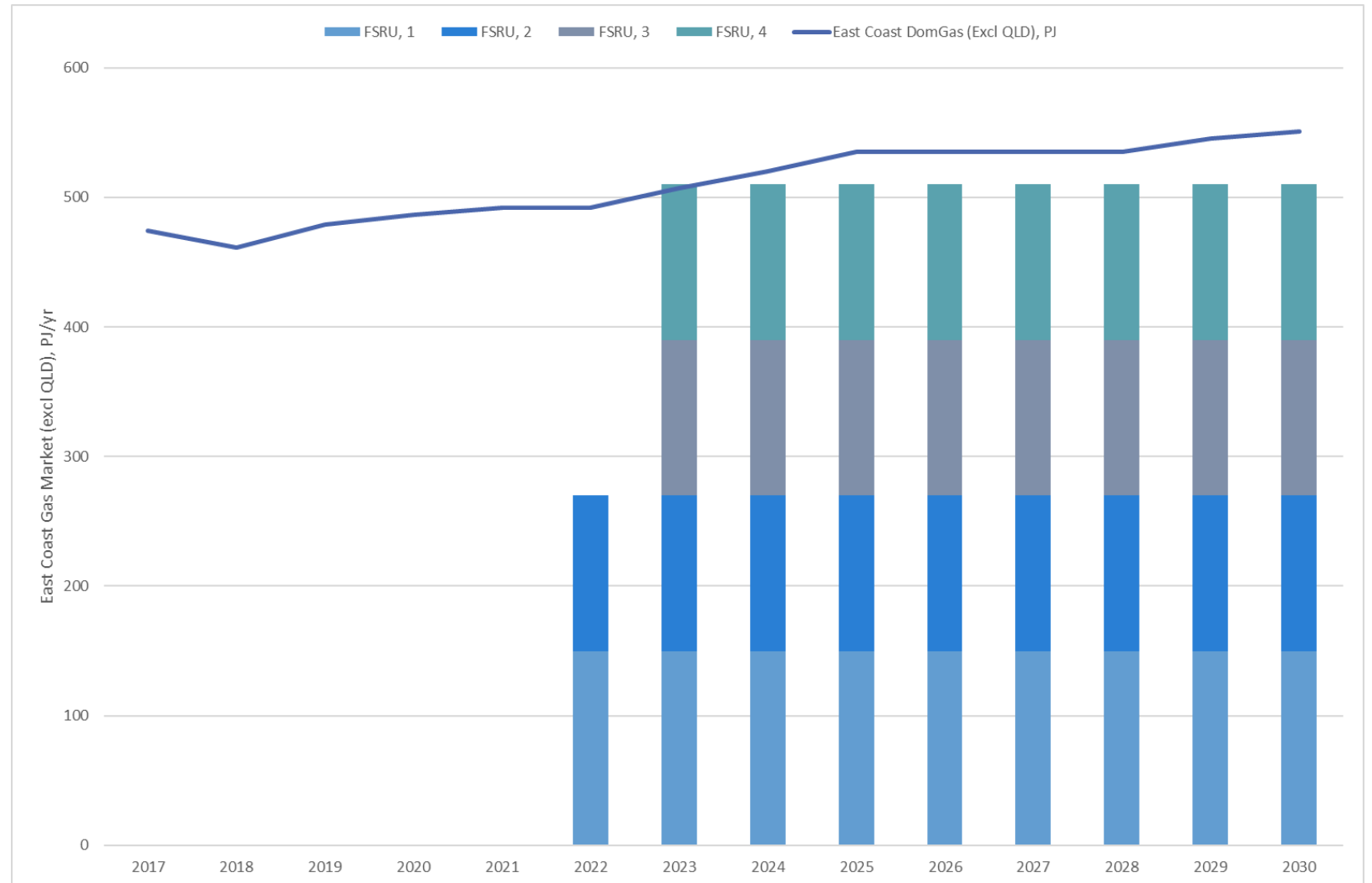
SA

- Pelican Point (Adelaide)
 - Venice Energy /Mitsubishi



Eastern Australia Market

- 4 LNG import terminals would be sufficient to supply just about the whole of the South Eastern States requirement.
- The need for gas is much lower than this and is seasonal.
- The issue is similar to the US situation.
- 1 Terminal might be all that is required...



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2020 Comparison of Solar and Gas costs and scale...

US – N Carolina Largest Battery System – Duke Energy

- 9 MW / 9 MWh system
- US\$15 million
- **US\$1.6/W**
- System generates ~27 MWh/day
- **Cost US\$0.55/Wh/day**

US – Combined Cycle Gas Turbine Power Station – Duke Energy

- 344 MW
- US\$817 Million
- **US\$2.4/W**
- System generates 8000 MWh/day
- **Cost US\$0.1/Wh/day**

Australia – Clean Energy Finance Corporation

- 3000 houses, 5 kW solar and 13.5 kWh Tesla Powerwall
- 15 MW solar / 40.5 MWh Storage
- A\$60 million
- System generates ~60 MWh per day
- CAPEX Cost of A\$1/Wh/day
- OPEX \$0.000001/Wh/day
- **Total Cost A\$1/Wh/day**

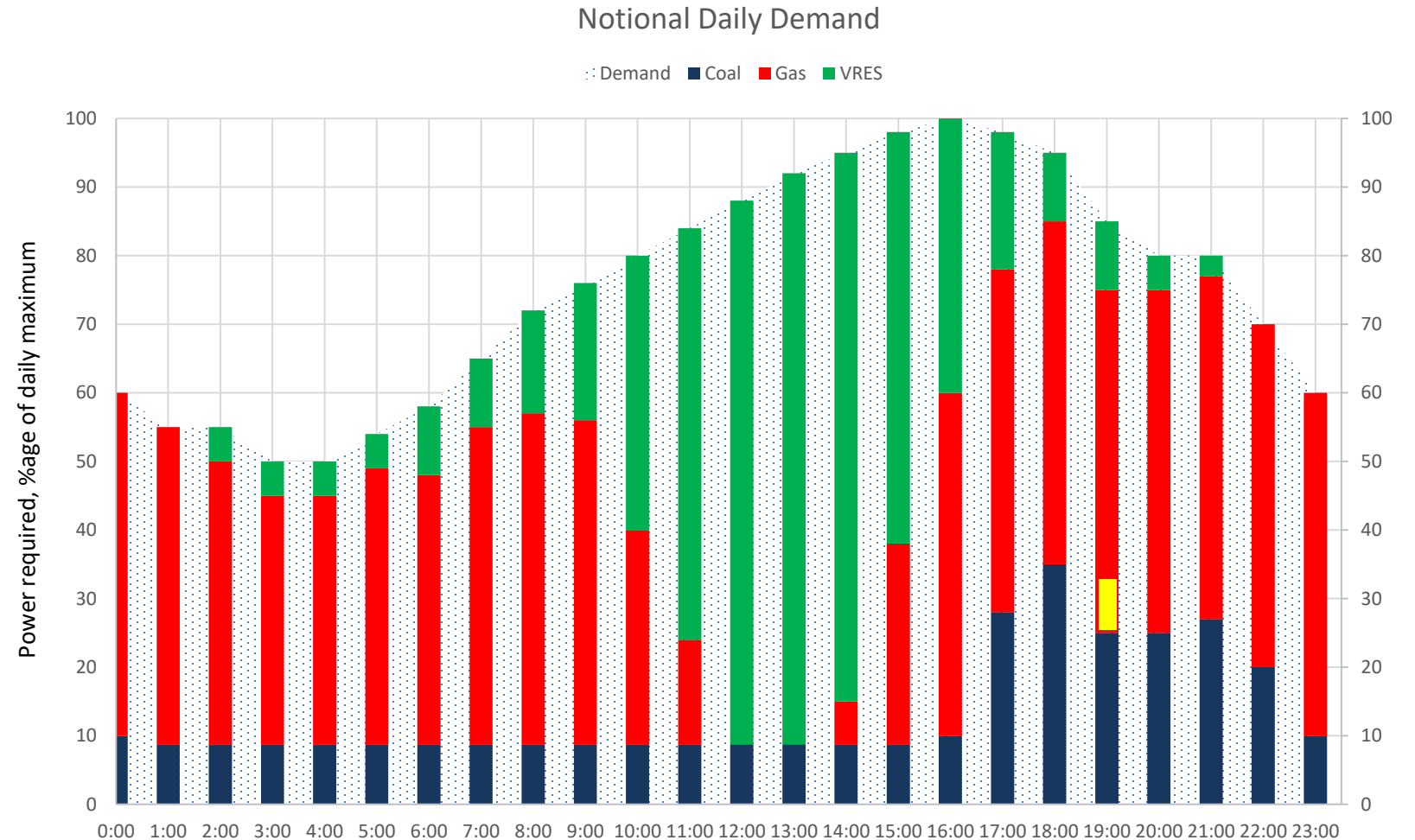
Australia – Combined Cycle Gas Turbine Power Station (GHD)

- 500 MW CCGT
- A\$710 million
- System generates ~11,600 MWh per day
- CAPEX Cost of A\$0.06/Wh/day
- OPEX \$0.00005/Wh/day
- **Total Cost A\$0.06/Wh/day**

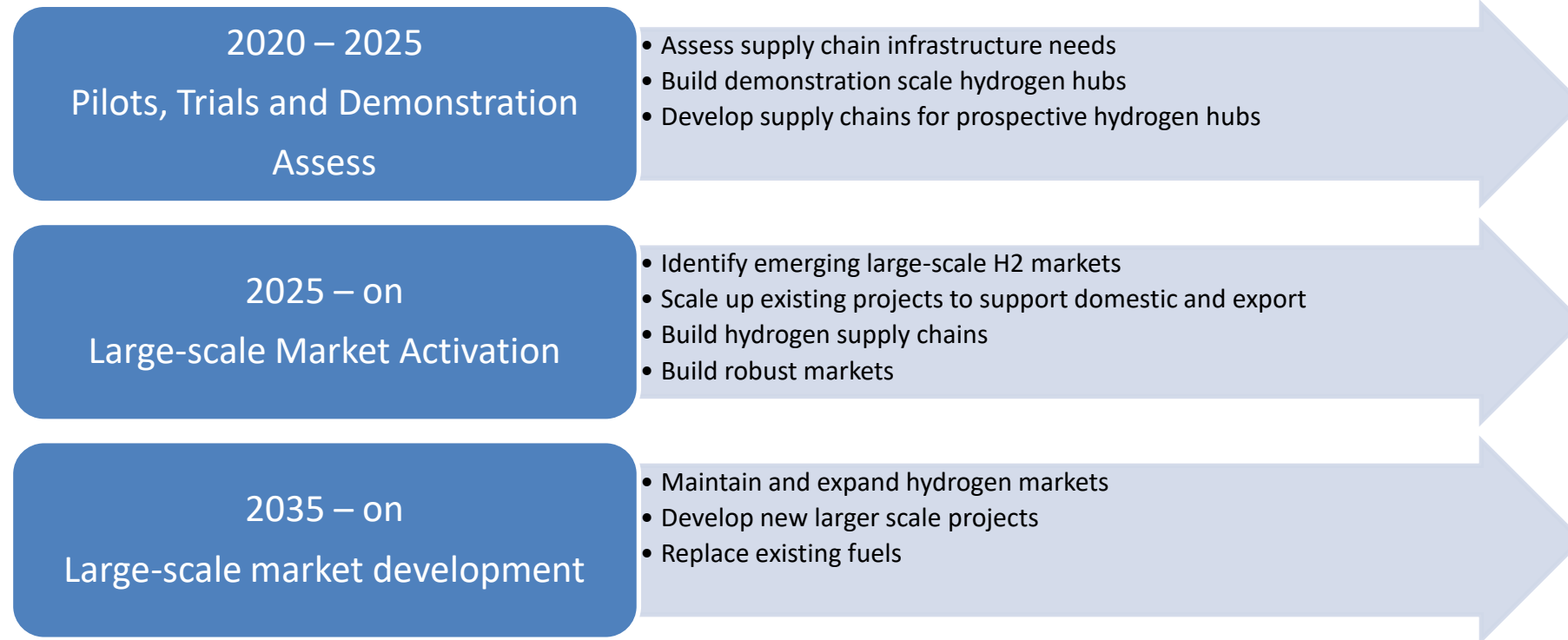
Cost and scale are both issues

Impact of World's largest Battery in SA (2017)

- When installed in 2017 the South Australian Battery was the largest in the world, and could supply 10% of SA baseload requirement for one hour (or 1% for 10 hours).
- The battery is now approximately 50% bigger, and is no longer the largest in the world (but still in the top 4).
- It can still only provide 15% of requirements for up to one hour.
 - It's not really a storage mechanism
 - It provides fast acting back-up, grid and frequency stability in times of disruption of supply.
- Batteries do not have the scale to provide dispatchable supply.

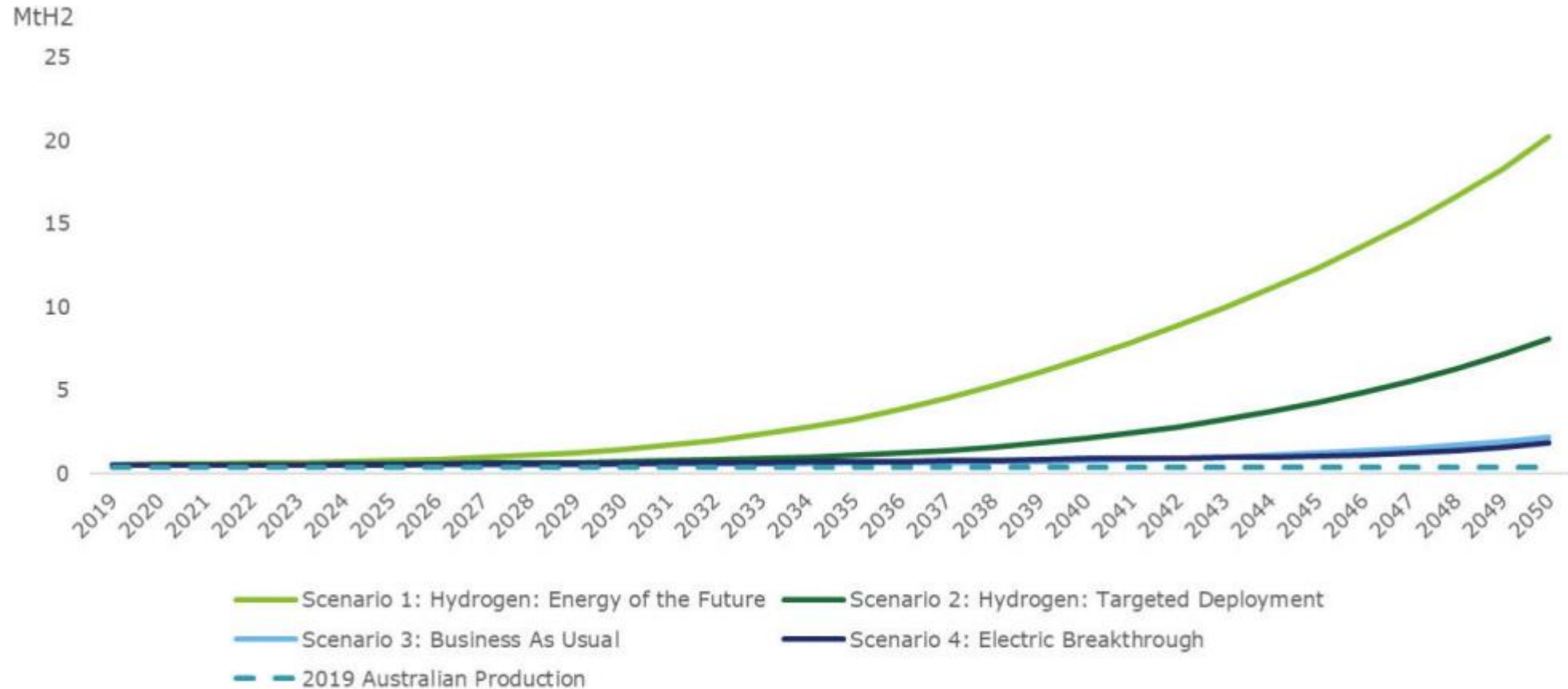


Hydrogen Pathway (Australia's National Hydrogen Strategy)



Australian H2 Production Forecasts

- By 2040 Australia “might be producing” ~5 MTPA of H₂ (energy equivalent of ~12 MTPA of LNG)



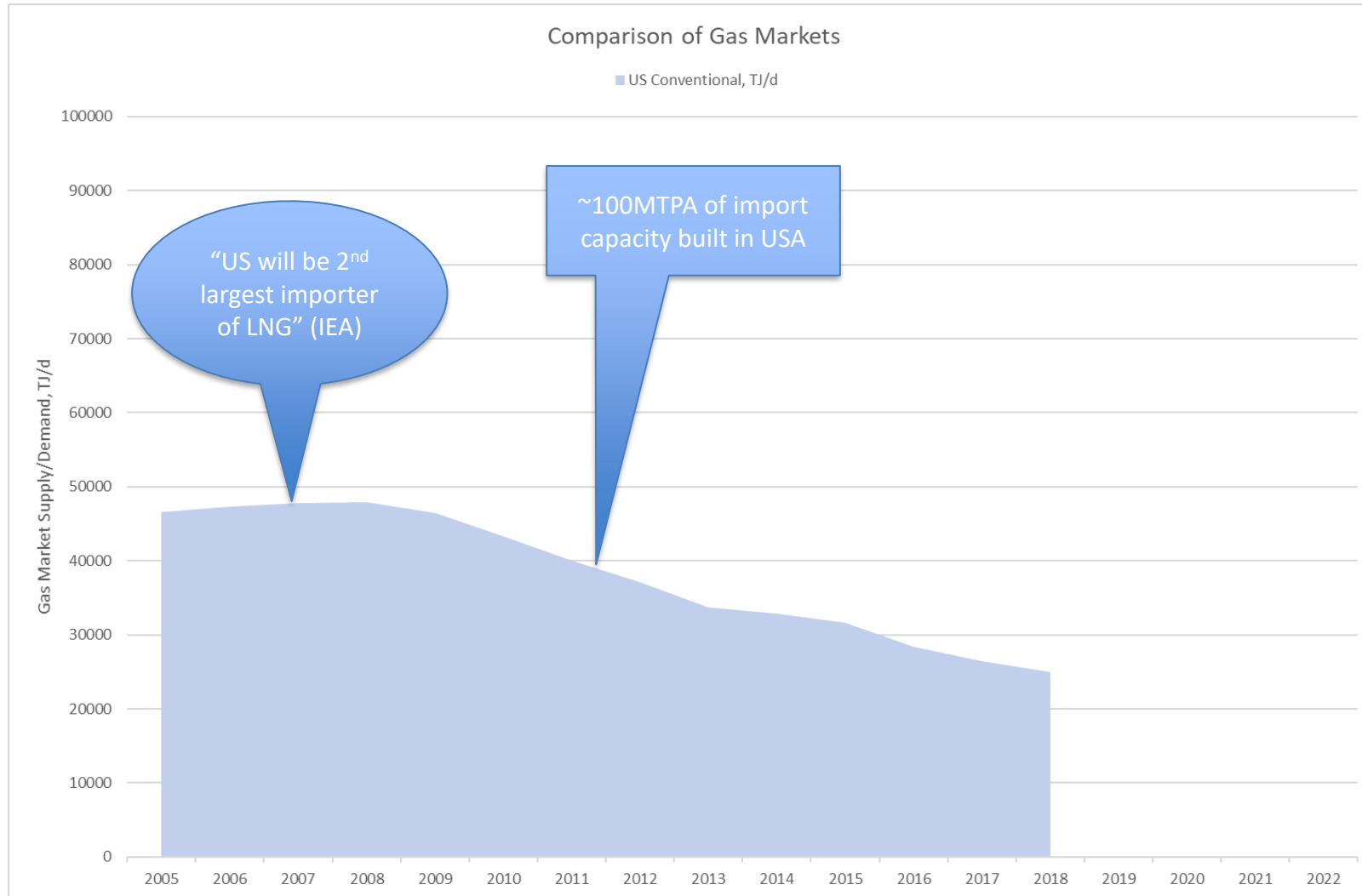
Source: Deloitte Analysis

Source Australia’s National Hydrogen Strategy 2020

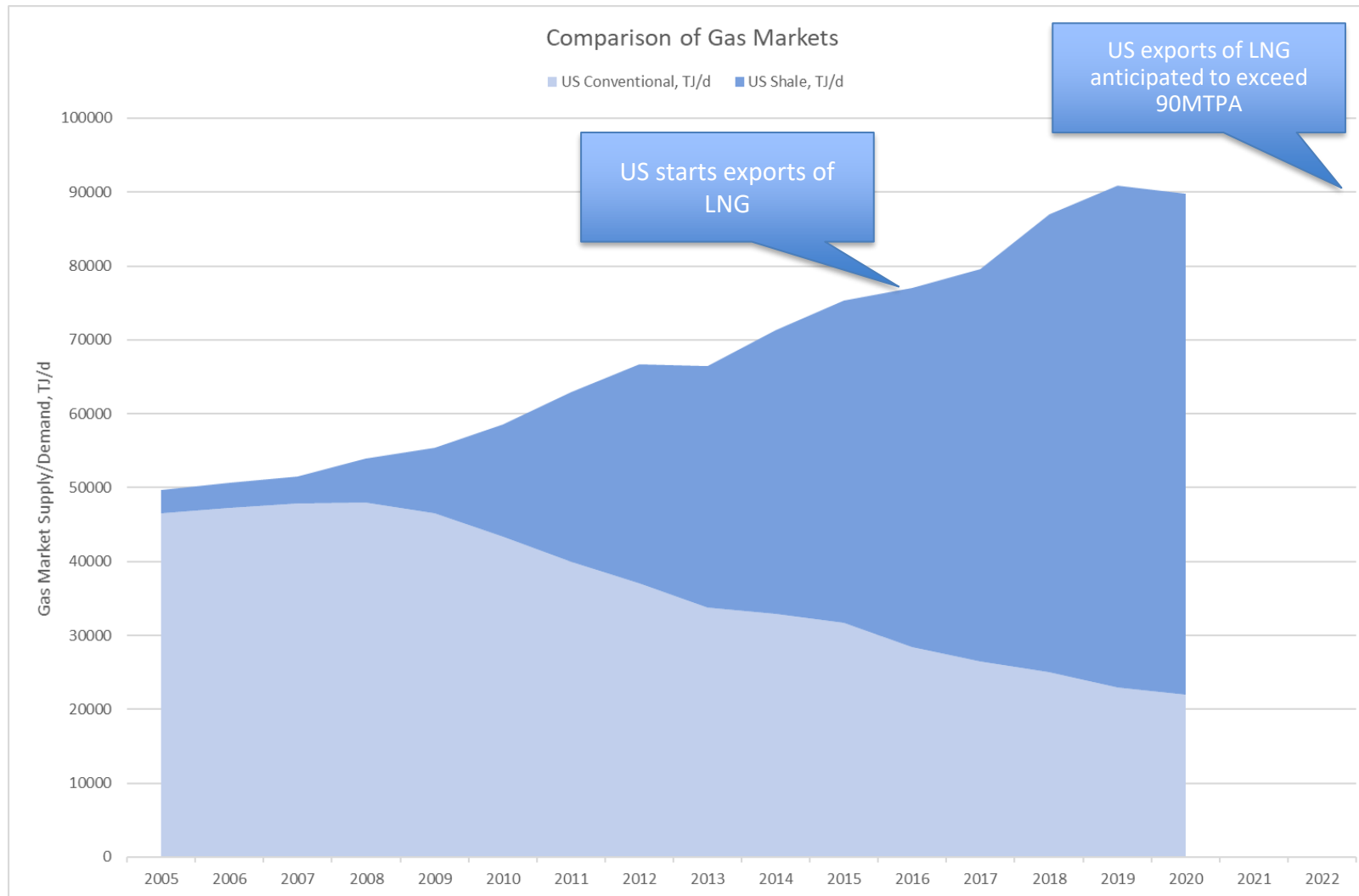
Closing thoughts and conclusions



US Gas Market changes over the past 2 decades



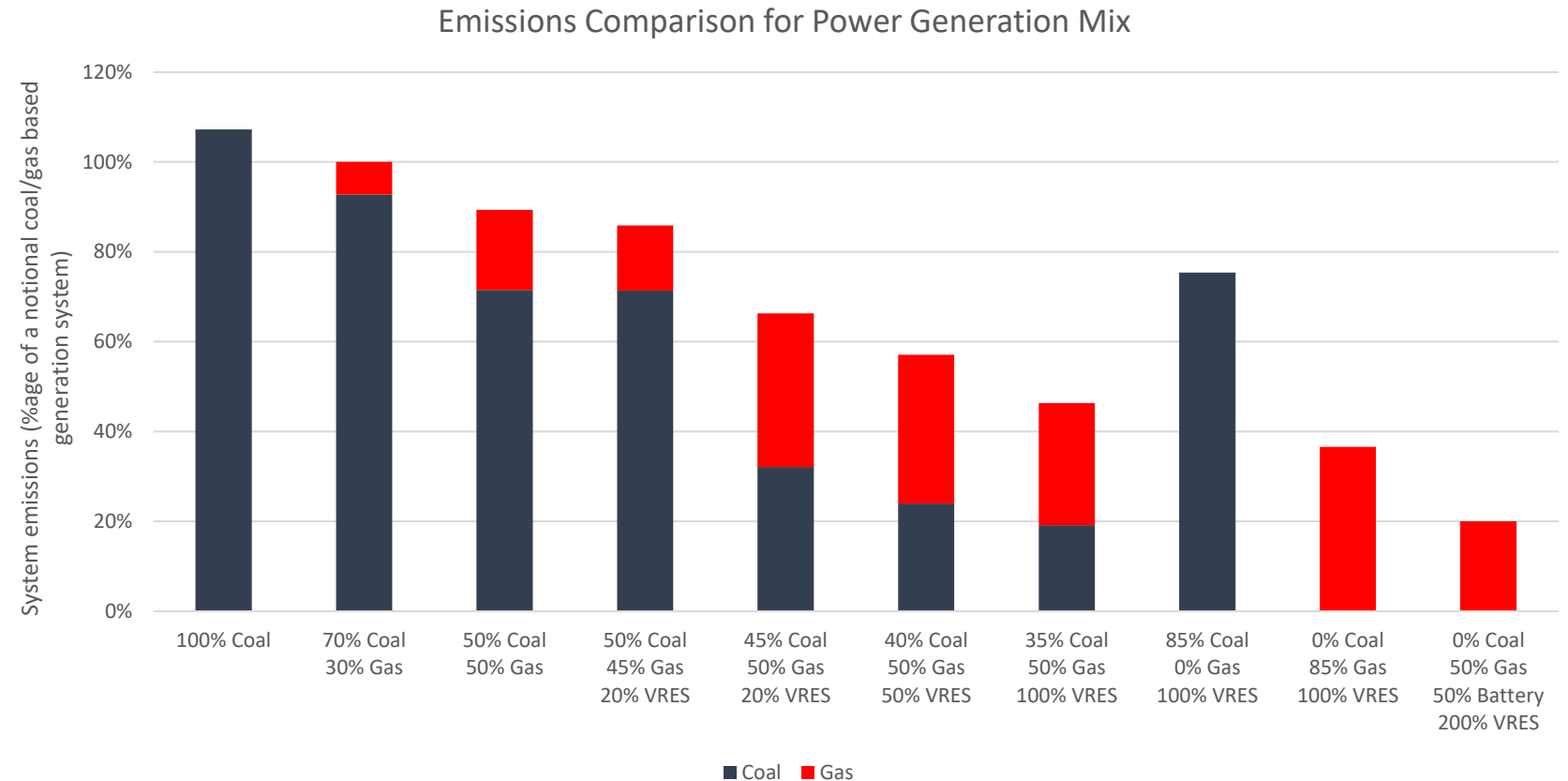
US Gas Market Changes (II)



The energy mix has a significant impact on emissions

Previous RISC analysis (2016) suggests a system based on Renewables and Gas is significantly lower in emissions than any system retaining coal because Gas Fired Power Plants produce less CO₂ and can be switched on and off

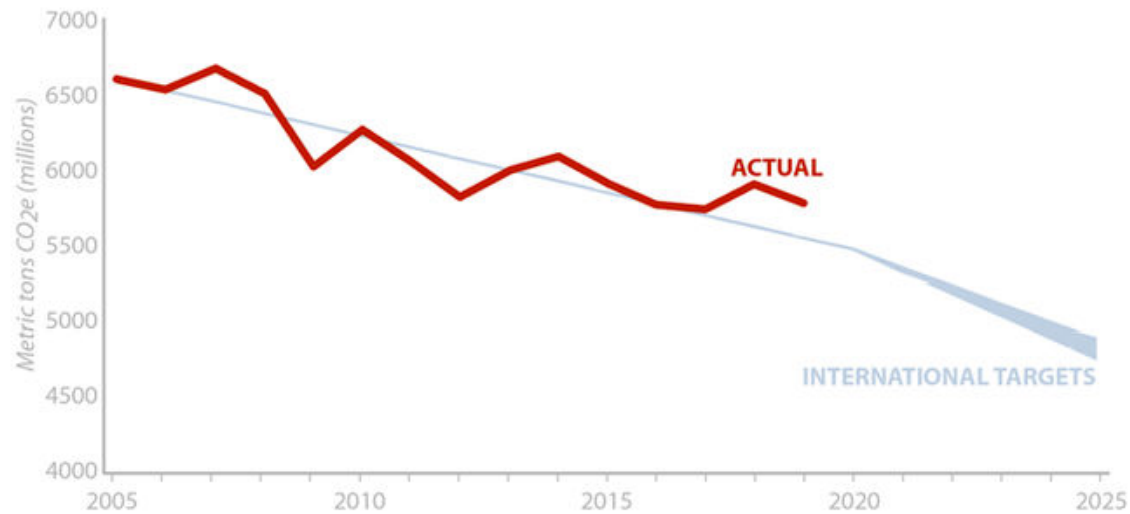
- Increasing renewables won't have the desired impact of reducing emissions if gas is pushed out of the mix instead of coal.
- If significant amounts of coal are left in the mix then emissions remain high because of the inflexibility of the coal fired power stations.



Increased gas use has helped the USA reduce emissions

- Emissions decline in US has been driven by Market forces – not policy
- Coal plants have been shut in favour of cheap gas (and renewables)
- New policies will likely drive further reductions

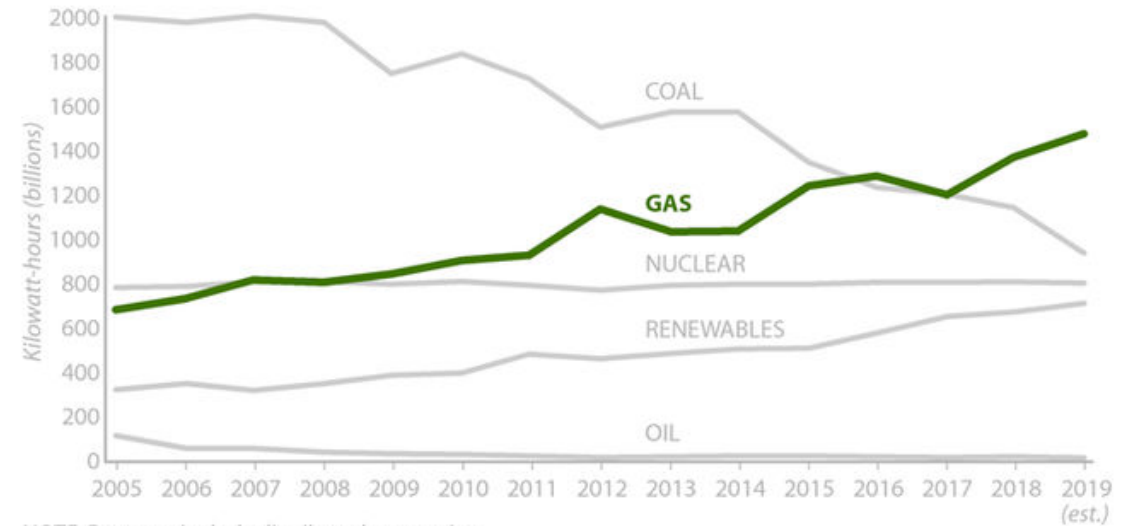
U.S. NET GREENHOUSE GAS EMISSIONS RELATIVE TO INTERNATIONAL COMMITMENTS
In millions of metric tons CO₂e, excludes international bunker fuel use, 2005-2019



SOURCE: Rhodium Climate Service

InsideClimate News

U.S. POWER GENERATION BY ENERGY SOURCE
Electric power sector only, in billions of kilowatt-hours, 2005-2019



NOTE: Does not include distributed generation

SOURCE: Rhodium Climate Service

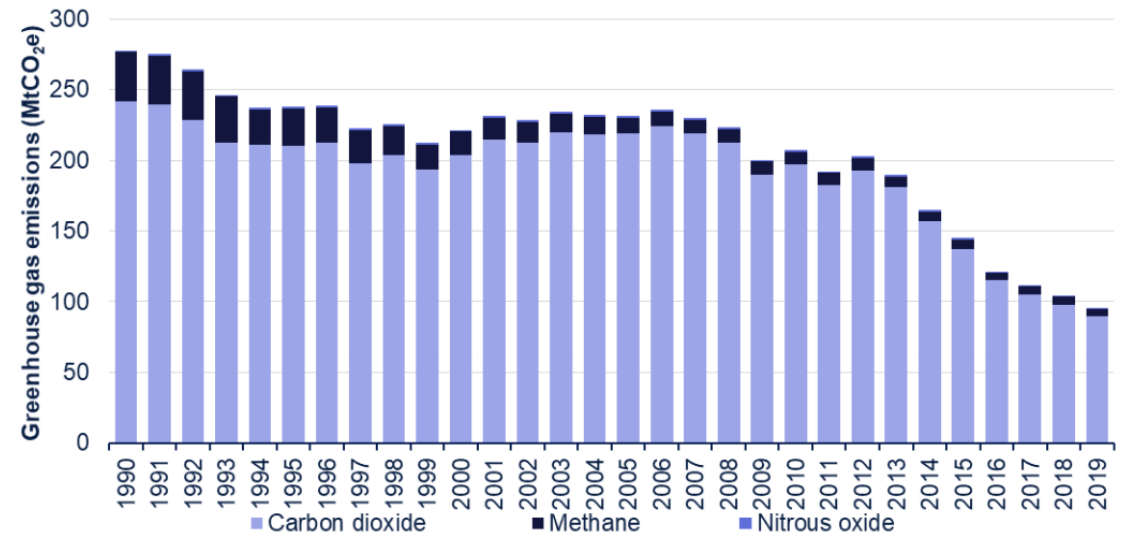
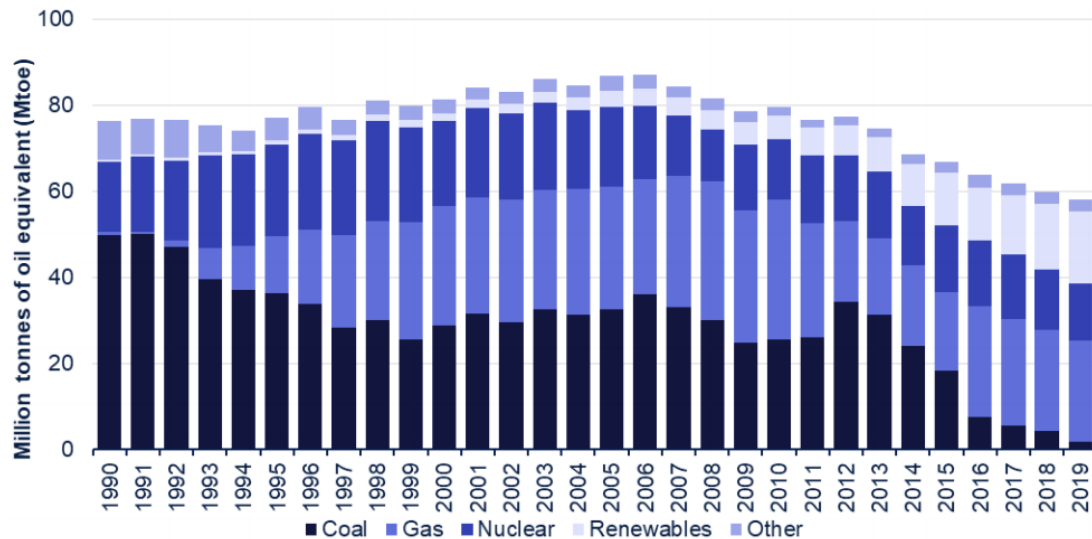
InsideClimate News

Increasing gas use has contributed to reducing emissions

Globally emissions reductions have been driven by a switch from coal-fired power generation to gas-fired

In the UK emissions from power generation have fallen by approximately 55% since 2010.

- Coal use in power generation has fallen from around 40% to less than 2% in 2019.
- UK went for 2 months “coal free” in 2020.
- Gas use remained relatively unchanged and its share of the generation market increased to around 40%
- UK emissions now the lowest in over 130 years (since the 1880’s)



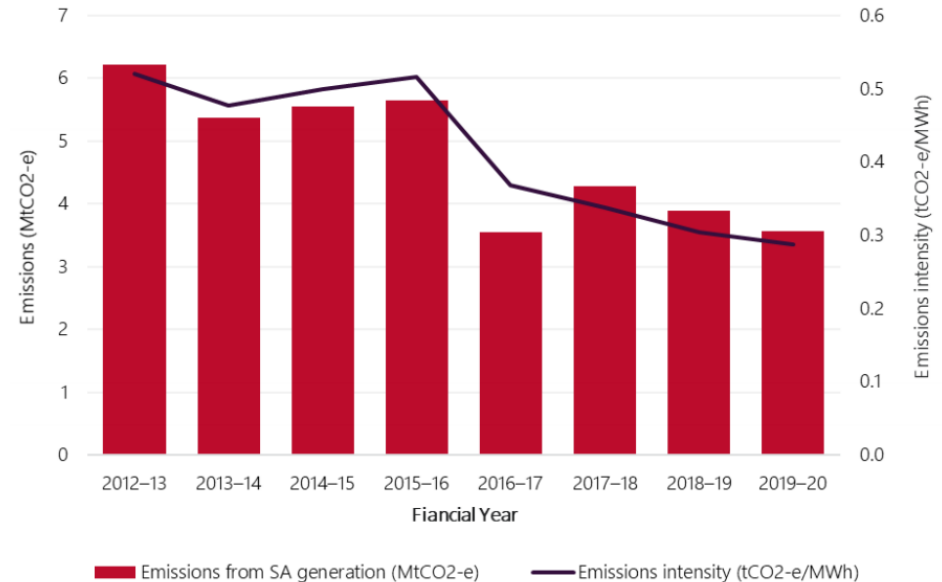
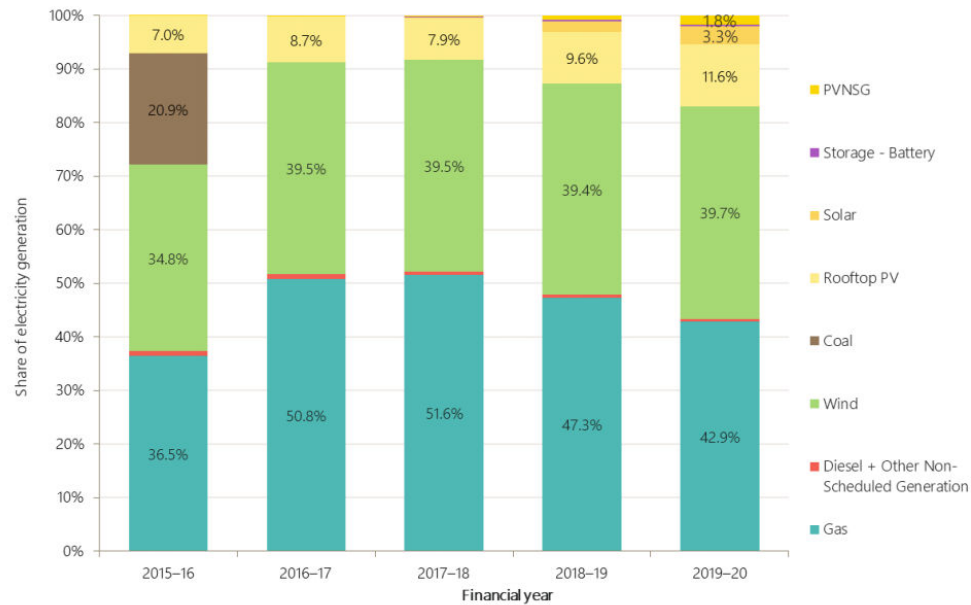
Source: 2019 UK Greenhouse Gas Emissions, Final Figures

South Australia's renewables success depends on gas

- Solar and wind are variable and non-dispatchable sources of energy.
 - They need back-up

Given the penetration of renewable generation, there will be increasing value in generation technologies that can complement the natural variability of renewable generation by providing rapid start capabilities and increased operational flexibility

- Gas-fired power can achieve maximum power within several minutes of start-up and complements the timeframe of wind and solar
 - 40-50% of SA generation comes from gas



- Solar and gas-powered micro grids, Onslow WA
- Infigen Energy purchase of Smithfield gas power station, Sydney NSW

Source AEMO SA Electricity Report 2019
PVNSG = 100kW-30MW “non-scheduled generation”

Thoughts and observations revisited...

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- Hydrogen is still a long way off

Conclusion:

- **Gas is still the “natural” partner to renewables**

Famous misquotes....

- “Heavier than air flying machines are impossible”
Lord Kelvin, President British Royal Society, 1895
- “By 1950 London will be under 9ft of smelly horse manure”
London Times, 1898
- “The peak of oil production will be passed possibly within 3 years”
US Geological Survey, 1919

- “There’s a world market for about 5 computers”
Thomas Watson, Chair IBM, 1943
- “World oil production will peak at 12.5 Bbbl/yr (34 mmbbl/day) in ~2000”
M. King Hubbert, 1956
- “There’s no reason anyone would want a computer in their home”
Ken Olsen, DEC (later Compaq), 1977

- “The PNG-QLD pipeline could supply 15% of East Coast Gas by 2015”
ACIL ,1998
- “CBM reserves are small and can supply only a fraction of the PNG pipeline”
Petroleum Economist, 2002

- “By far the largest source of US incremental gas supply is expected to be LNG”
EIA, 2006
- “It is unlikely that significant changes in LNG pricing will take place”
IEEJ, 2006
- “Natural gas prices will remain high in the US for the foreseeable future”
EIA, 2007

- “LNG will never become commoditized, the capital costs are too great”
Unknown Engineer, FLNG conference 2013

- *“The Beetaloo is like the Marcellus 10-12 years ago....”*
Multiple commentators at SEAOC 2019



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