Gas and LNG Growth –

Coal Replacement

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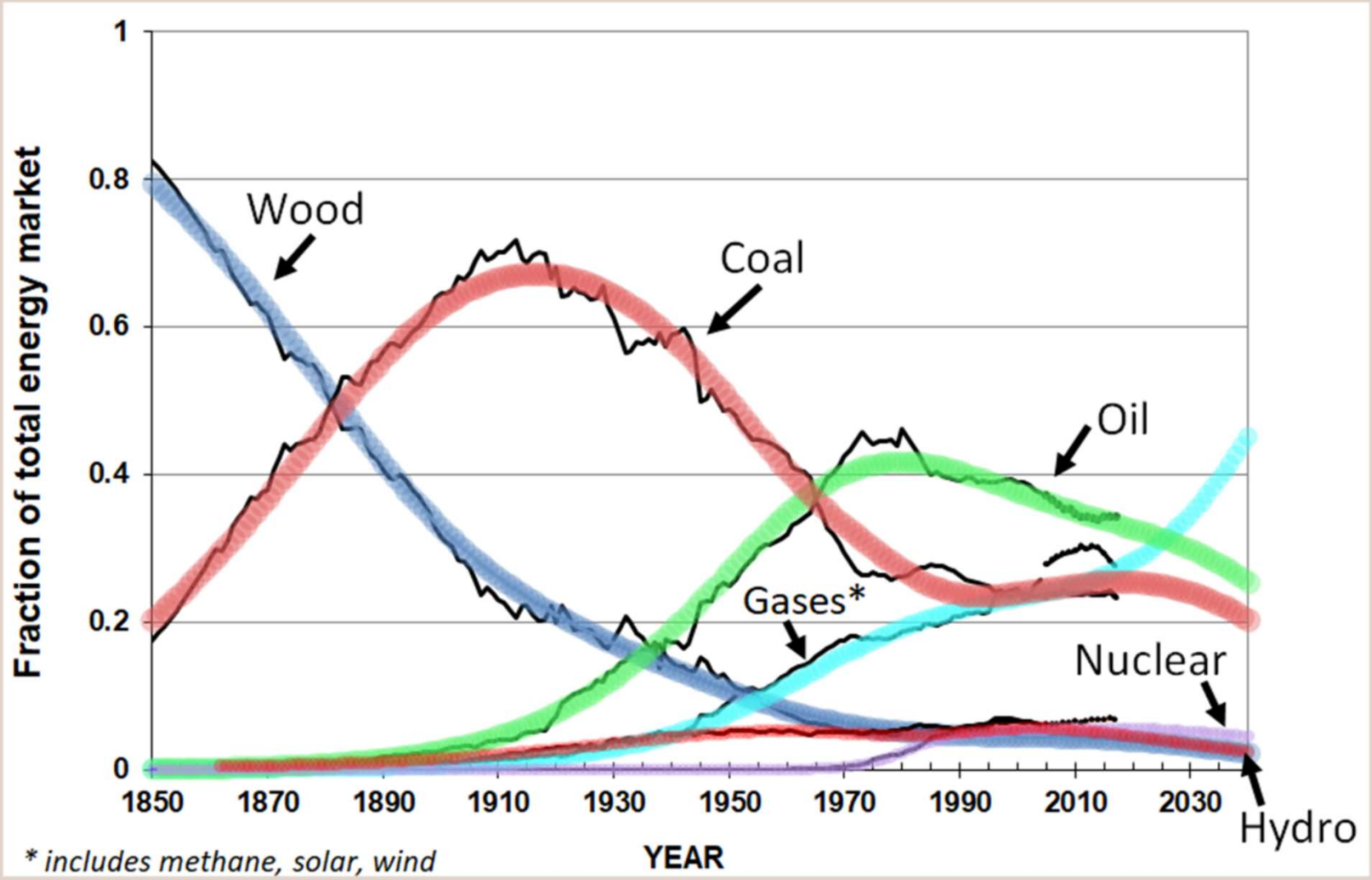
Outline

- Energy mix history & future
- Benefits of coal-to-gas substitution
- Gas resource prospects, including unconventional
- Gas & LNG market evolution
- Rising LNG competition; Australia's role

Primary energy mix (1850 - 2040)



- Past consumption led initially by **wood & biomass**, followed by **coal** and then **oil**
- **Natural gas** to take over? Straight to r**enewables**?

- Source: Aguilera and Aguilera, *Society of Petroleum Engineers 110215-MS (2007)*; updated in *Mineral Economics (2018)*

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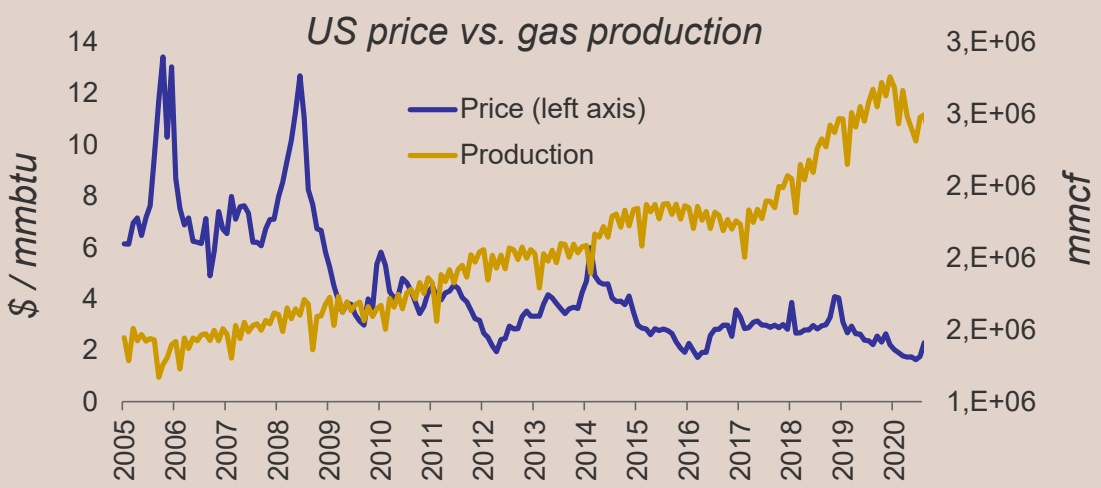
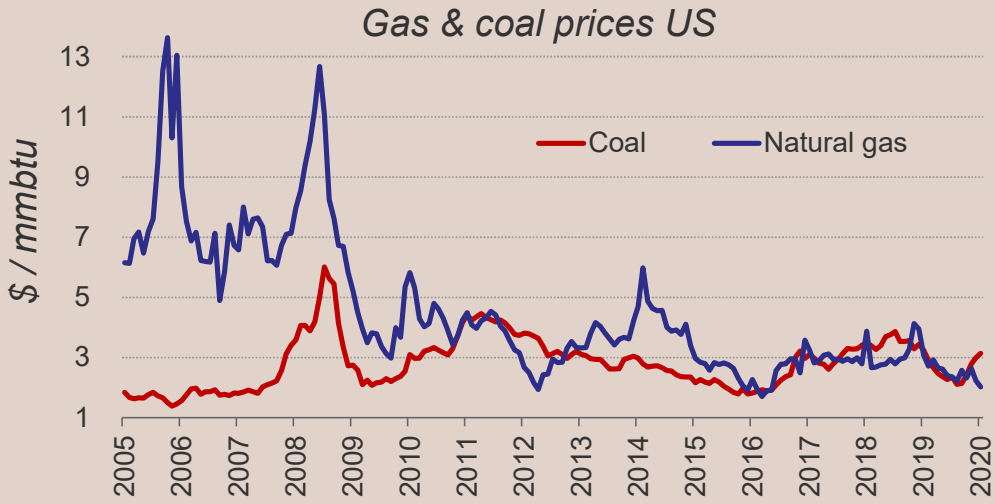
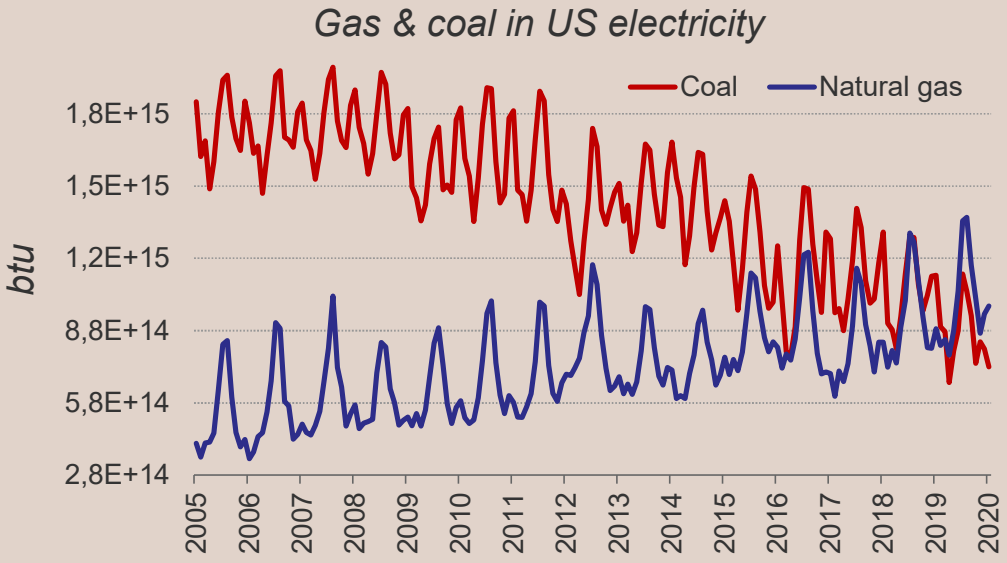
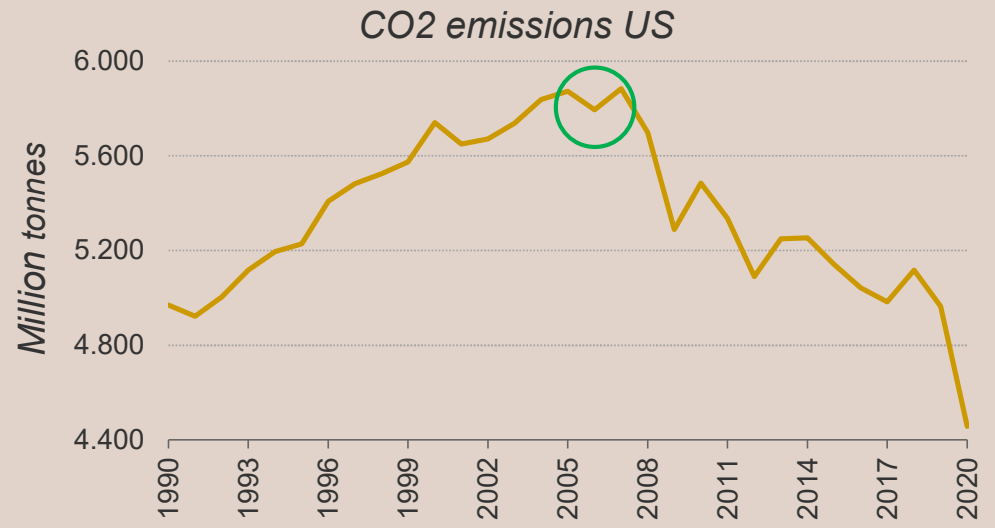
Natural gas: Bridge to low carbon future?









Source: US Energy Information Administration (EIA) & BP statistics

World primary energy demand by source

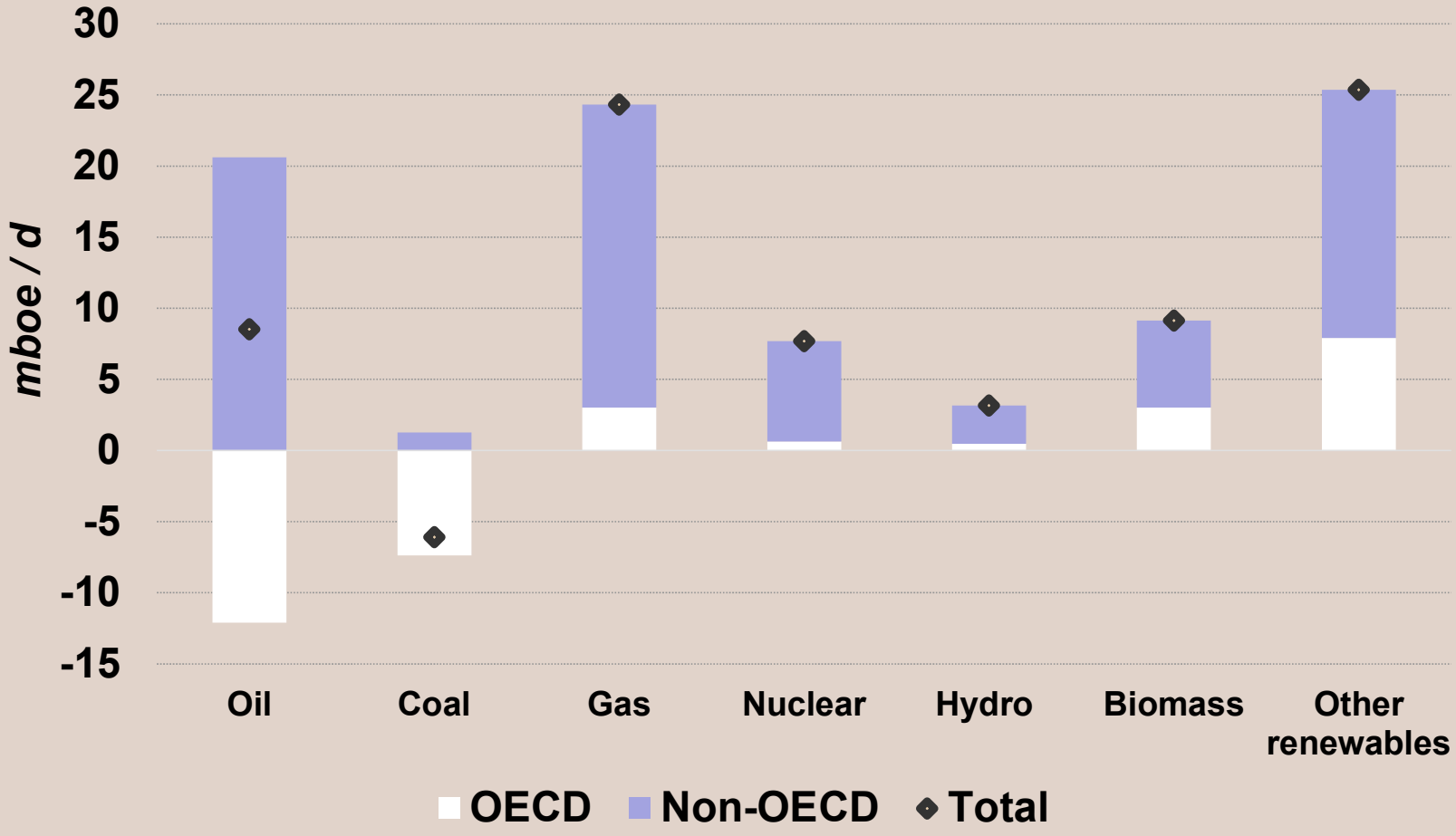
	Levels mboe/d						Growth mboe/d	Growth % p.a.	Fuel share %	
	2019	2025	2030	2035	2040	2045	2019–2045	2019–2045	2019	2045
Oil	91.0	94.4	97.7	99.3	99.7	99.5	8.5	0.3	31.5	27.5
Coal	77.1	75.1	75.1	74.3	72.8	71.0	-6.1	-0.3	26.7	19.7
Gas	66.9	69.8	76.2	82.2	87.3	91.2	24.3	1.2	23.1	25.3
Nuclear	14.4	16.1	17.5	19.1	20.8	22.1	7.7	1.7	5.0	6.1
Hydro	7.3	8.1	8.8	9.5	10.2	10.5	3.2	1.4	2.5	2.9
Biomass	26.4	28.9	31.0	32.9	34.6	35.5	9.1	1.2	9.1	9.8
Other renewables	6.0	10.6	15.5	20.8	26.8	31.4	25.4	6.6	2.1	8.7
Total	**289.1**	**303.0**	**321.9**	**338.1**	**352.3**	**361.3**	**72.1**	**0.9**	**100.0**	**100.0**

- *Source: OPEC World Oil Outlook (2020)*

- Gas grows faster than oil
- Non-fossil grows fastest

  Accounts for 27.5% of energy mix in 2045 (same as oil)

Energy demand growth; fuel type & region (2019 - 2045)



- Renewables growing fastest
- Energy demand led by emerging Asia

- *Source: OPEC World Oil Outlook (2020)*

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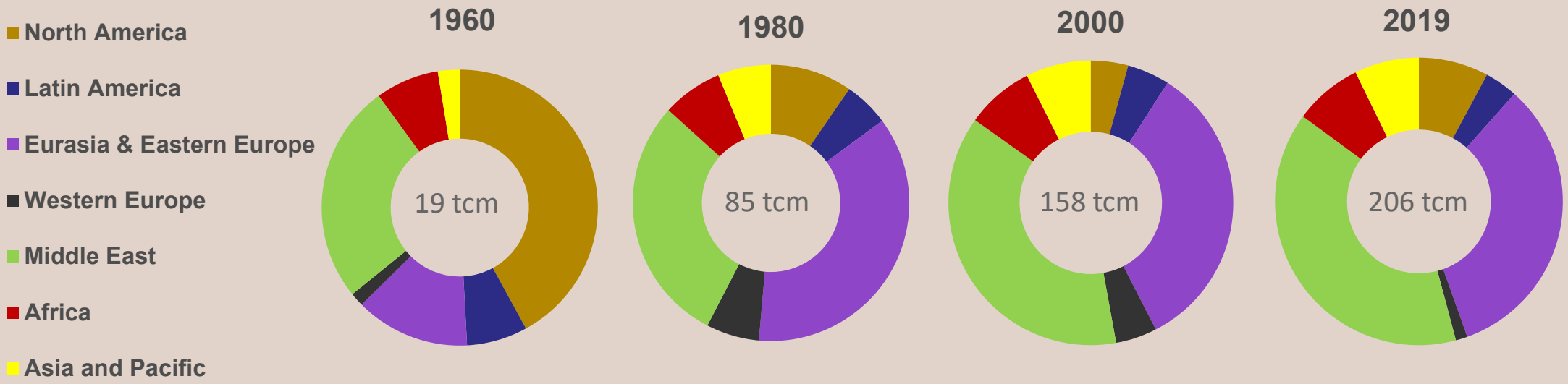
Distribution of proved (conventional) gas reserves



Source: OPEC Annual Statistical Bulletin (2020)

- Middle East (primarily Iran & Qatar) and Eurasia (mostly Russia) experienced significant growth in gas share

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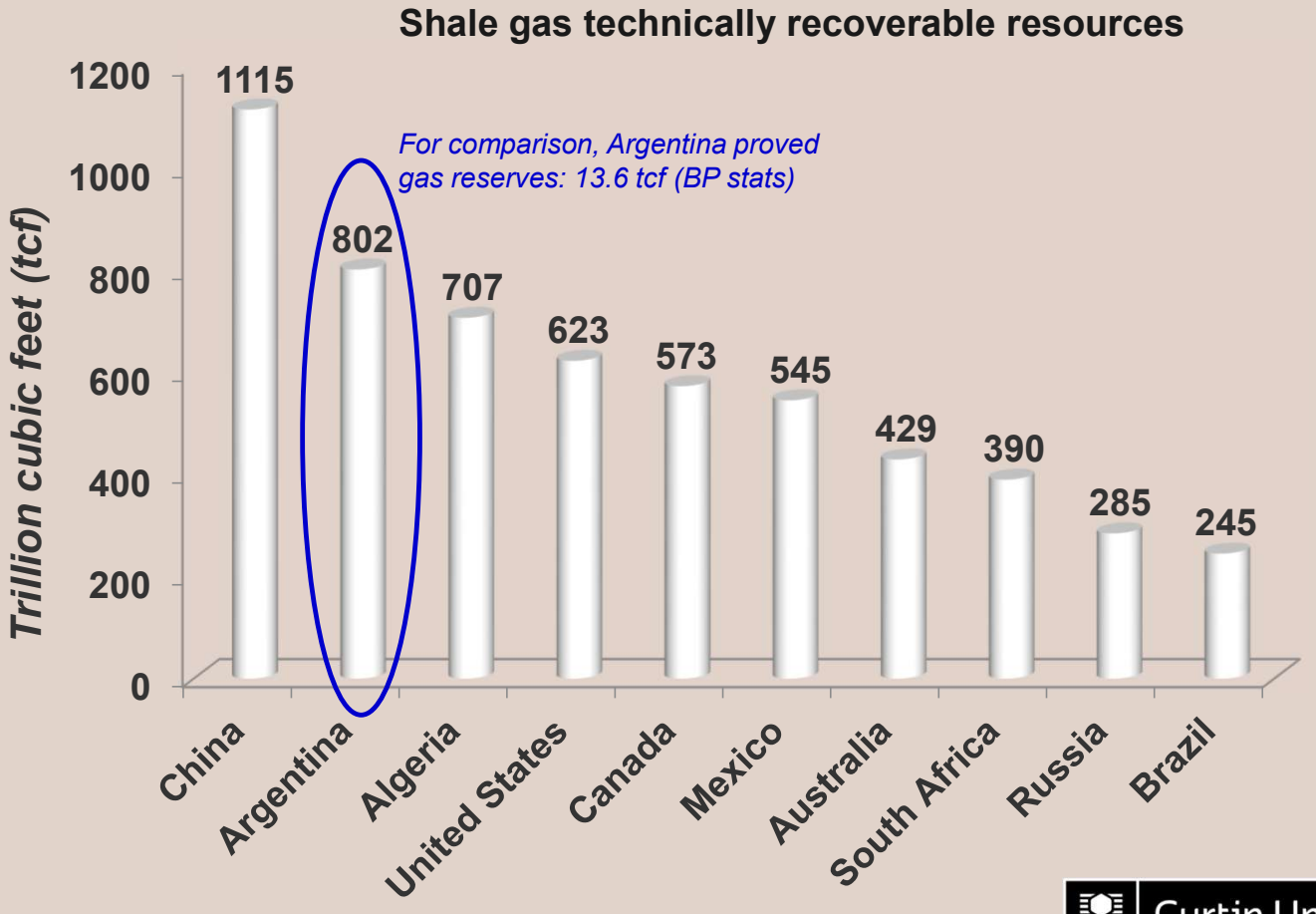
Global shale gas widely distributed

- Shale gas resource ~7577 trillion cubic feet
- Some important regions excluded
- Of the total:
  - *China, 15%*
  - *Argentina, 11%*
  - *Algeria, 9%*
  - *United States, 8%*
  - *Canada, 8%*



Source: US EIA, Advanced Resources International (2015)

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Key considerations for global shale development

1. Geology
2. Infrastructure
3. Ownership
4. Drilling rigs
5. Technical progress
   (*e.g. to mitigate steep decline rates*)
6. Risk capital
7. Regulation
8. Environmental impact
9. Public acceptance

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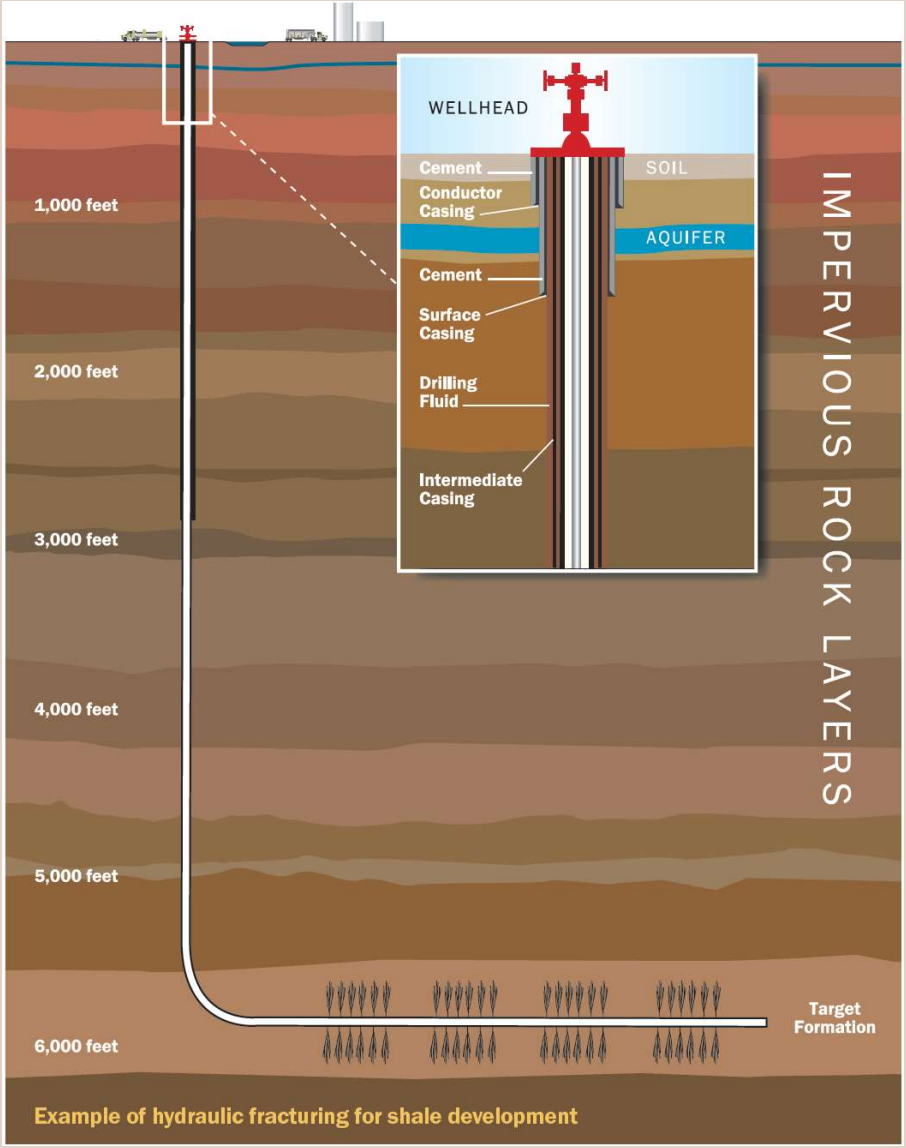
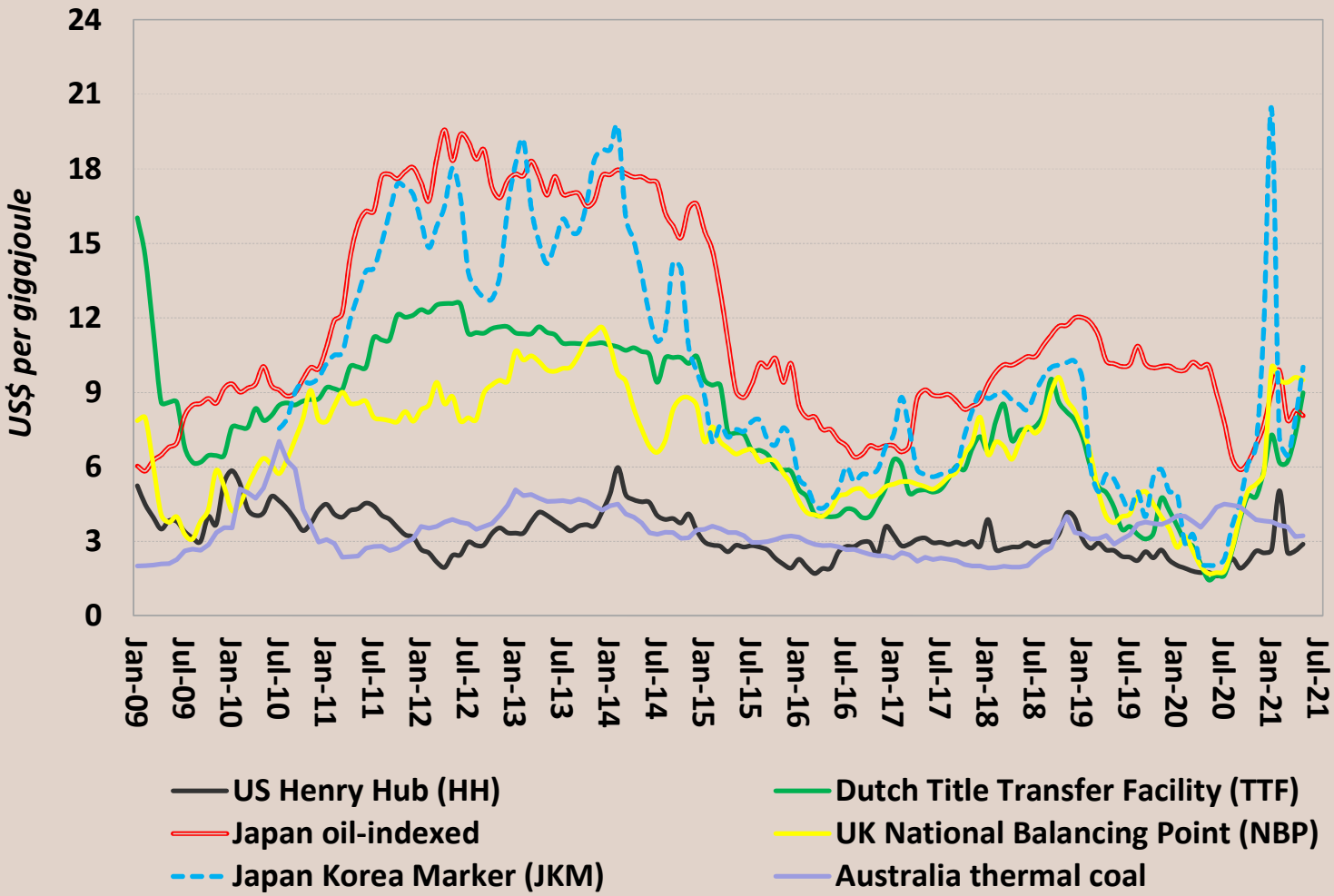
Environmental impacts

- Most concerns relate to hydraulic fracturing:
  - *Intensive water use*
  - *Water contamination*
  - *Methane leakage*
  - *Induced seismicity*
- Environmental risks from extraction methods, though often exaggerated by media
- Damage caused by infant industry, but hazards overcome as industry matures



Natural gas price developments



- Regional prices diverged in 2010 as shale gas supply ↑ and oil price ↑
- Divergence narrowed in 2015 as oil price ↓ and global gas trade expanded
- Extreme northern temperatures in 2021 and supply disruptions raised gas prices

- *Source: International Monetary Fund & Cedigaz statistics*

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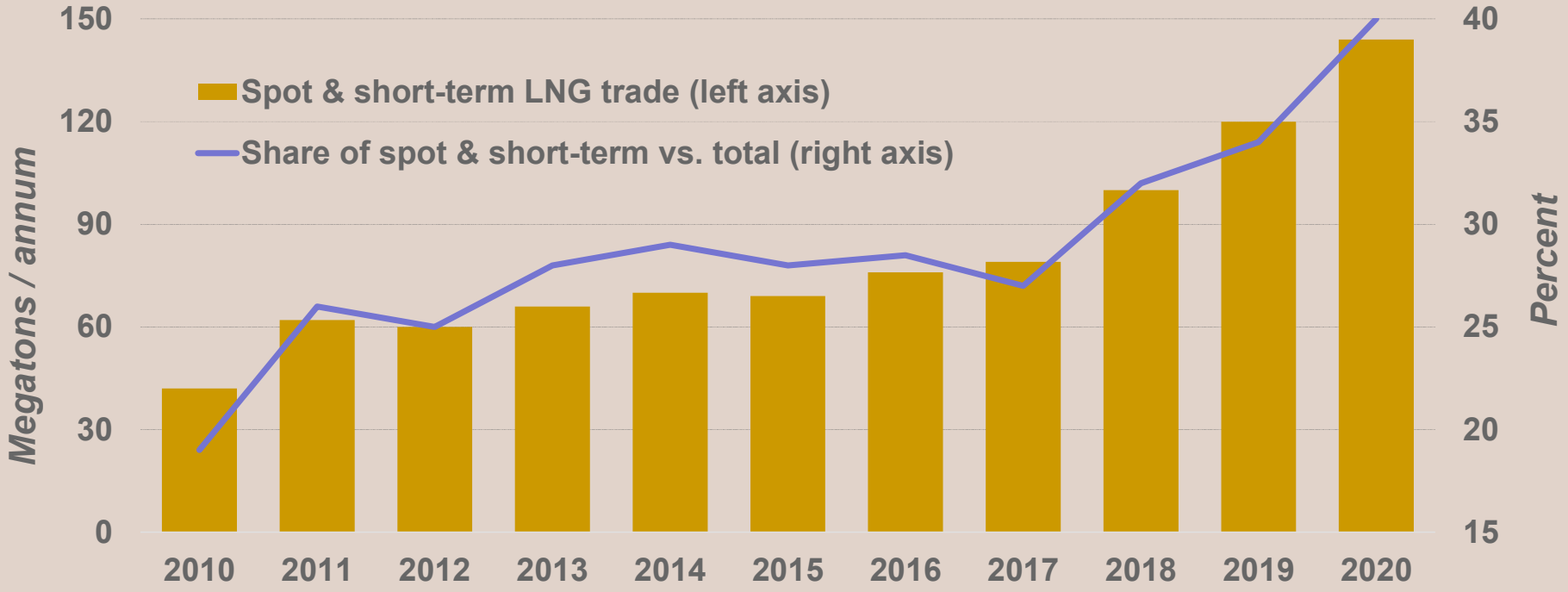
Spot and short-term vs. total LNG trade



Source: International Group of Liquefied Natural Gas Importers (GIIGNL, 2021)

- Short-term, gas-on-gas pricing rising, but progress is gradual and varies by region
- Some producers desire longer-term, oil-indexed prices for security to invest in capital-intensive projects

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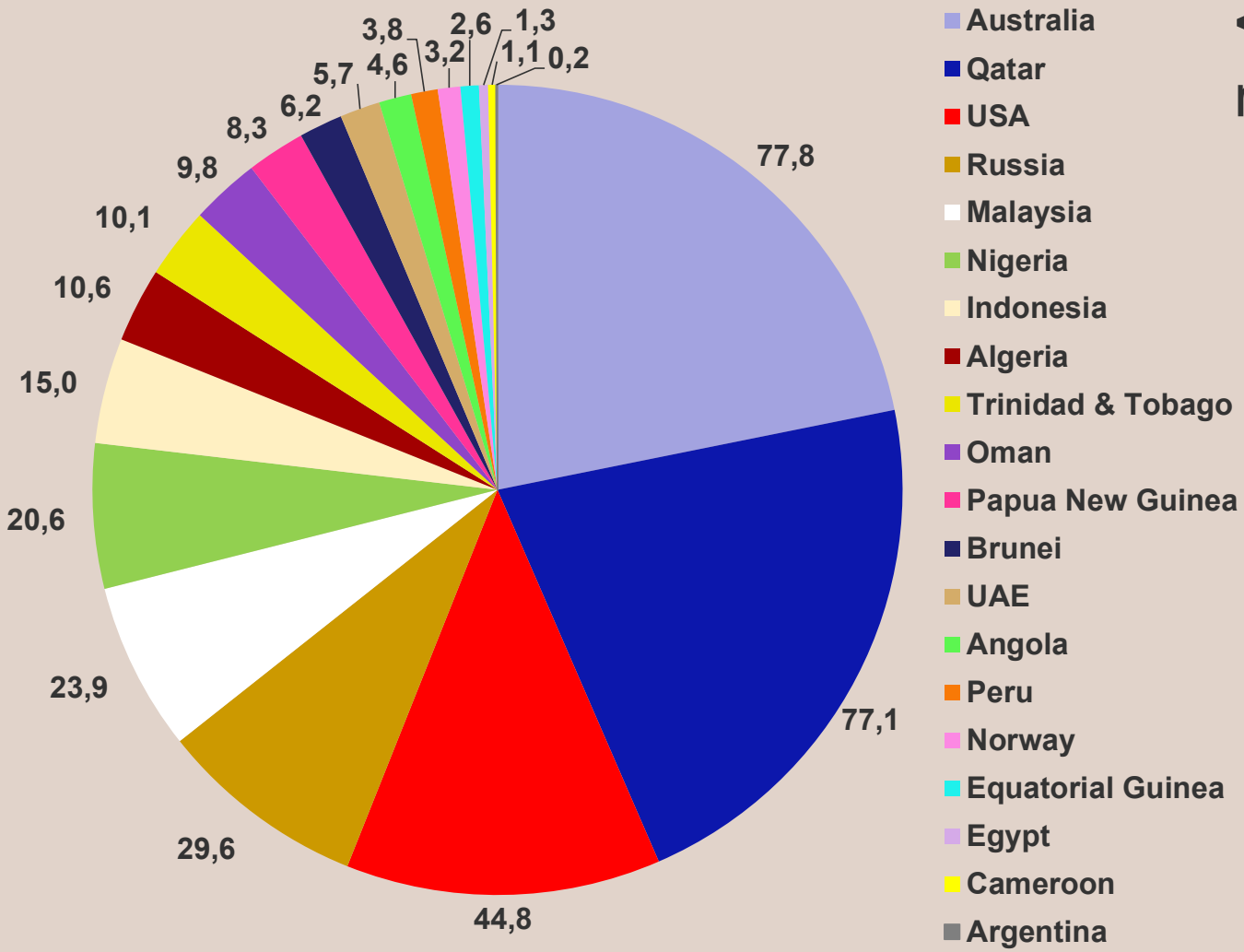
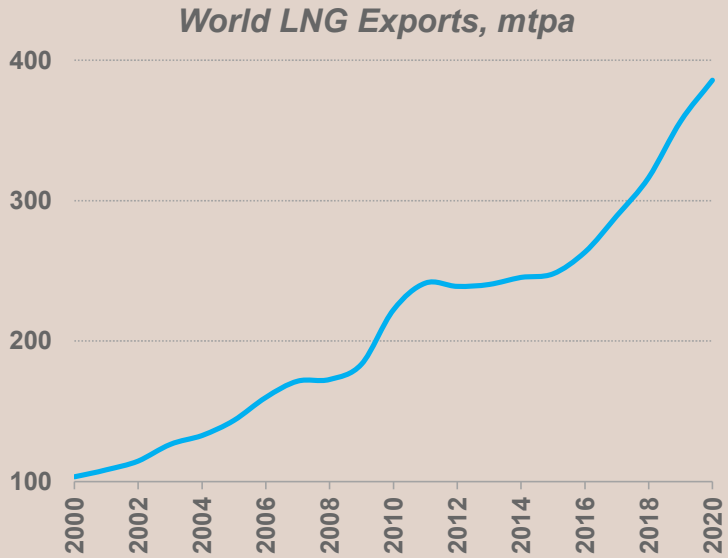


Source: International Gas Union (IGU, 2021)

<= LNG exports (2020), million tons per annum



Source: British Petroleum (2021)

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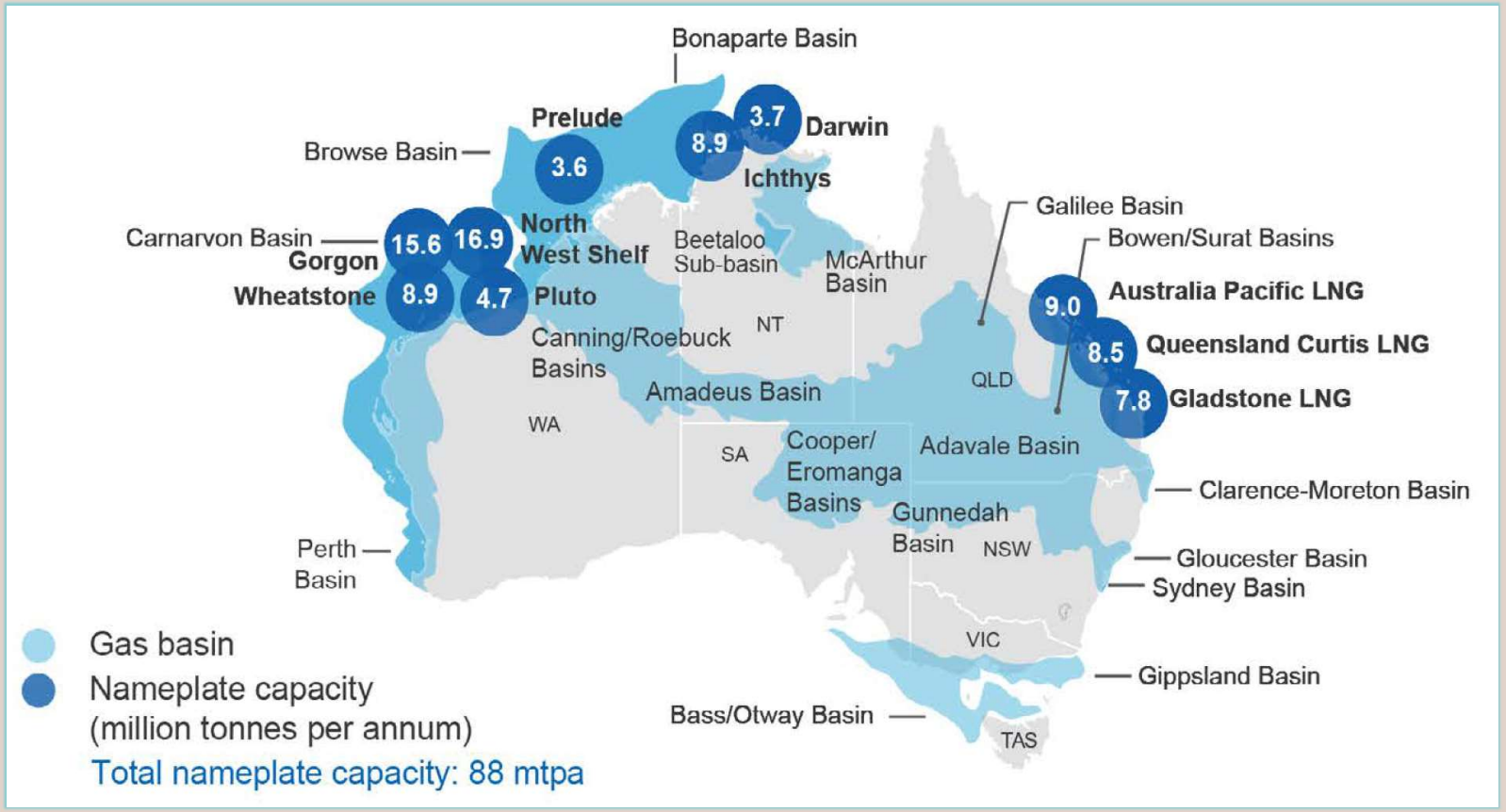
Australian LNG projects (and gas basins)

- ~$200 billion LNG investment over past 15 years
- Proximity to Asia ideal for exports (low shipping costs)
- Most LNG sold on oil-linked contracts
- Plans to leverage LNG for hydrogen development



Source: Australian Government – Department of Industry, Science, Energy and Resources. Resources and Energy Quarterly (March 2021)

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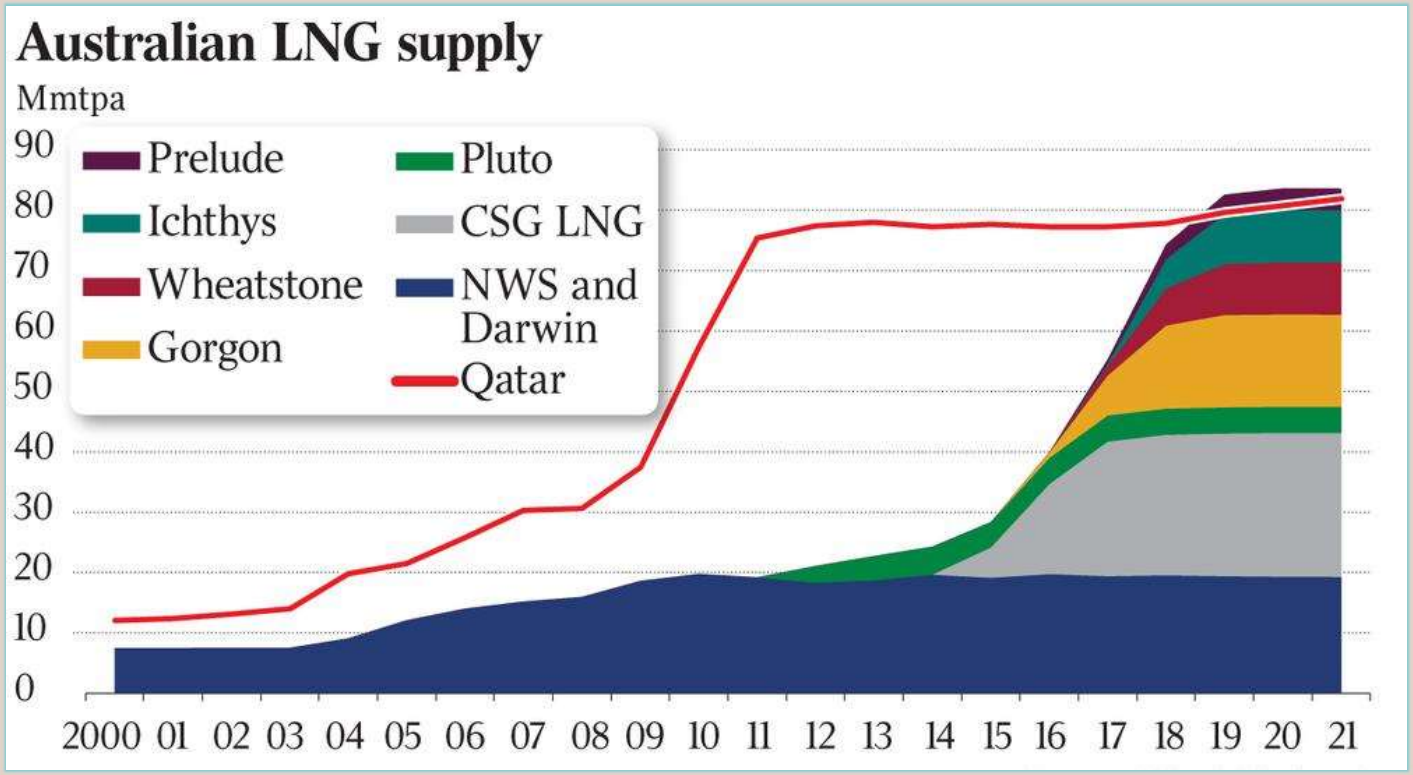
Australian LNG projects

- Australia quickly rose to become world's top LNG exporter
- Qatar flat over past decade, but planning capacity expansion



Source: 'The Australian' newspaper (2020)

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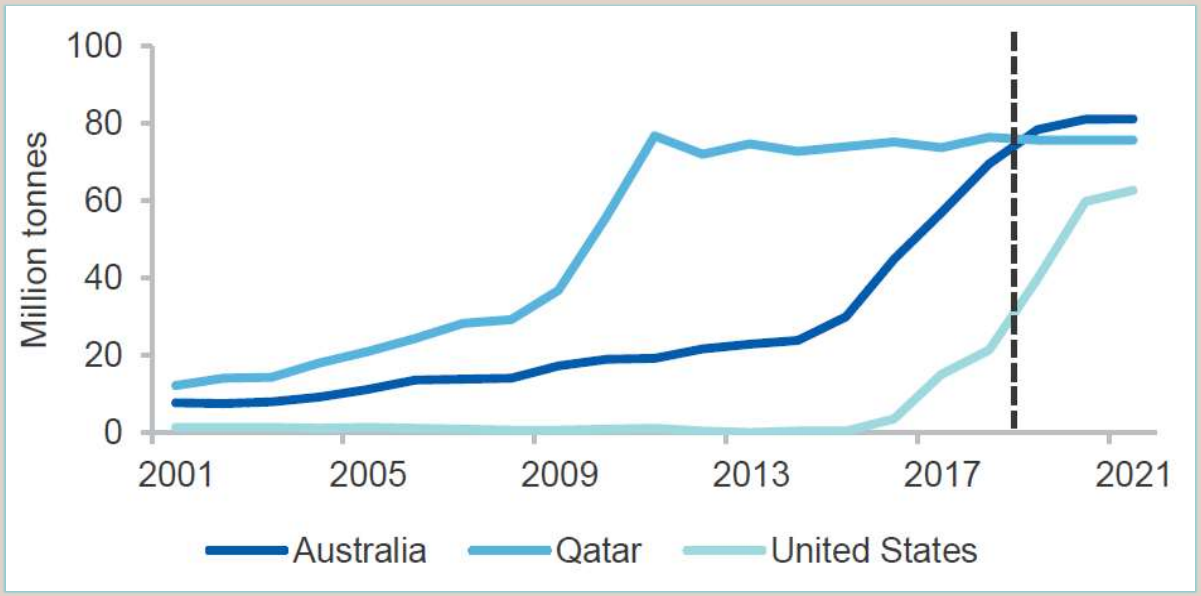
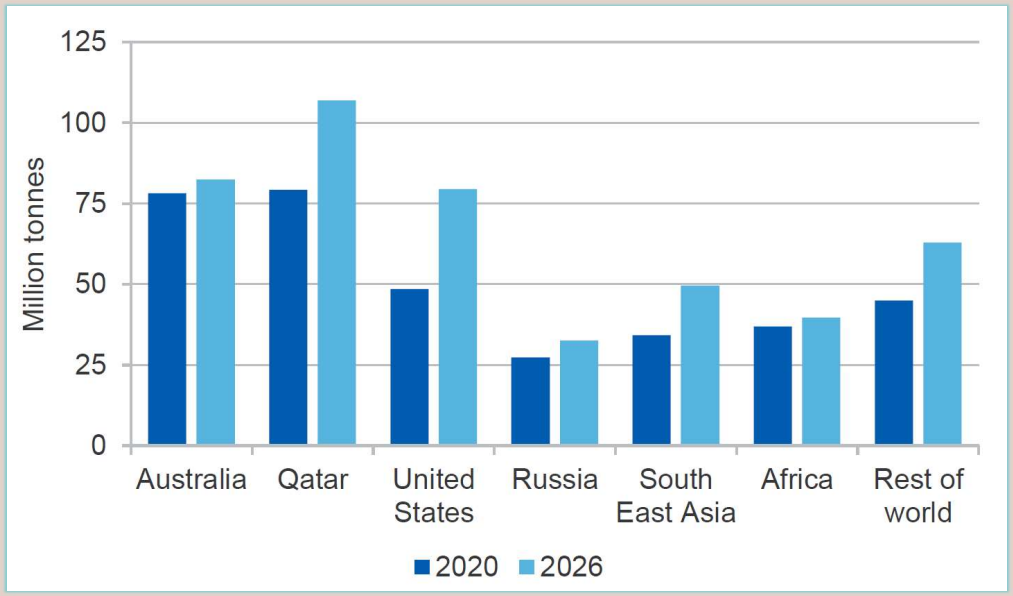
Increasingly competitive LNG trade





Source: Australian Government – Department of Industry, Science, Energy and Resources. Resources and Energy Quarterly (2019, 2021)

- Australia leads; US continues to expand capacity
- Qatar & Russia could compete on price

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Lower prices & increased competition => LNG industry reducing costs

- Improved productivity and operational efficiencies
- Better planning, cooperation, standardisation, simple construction, floating LNG
- On consumption side, floating LNG enables poor countries to increase gas use
- Lessons applicable to hydrogen, including floating vessels

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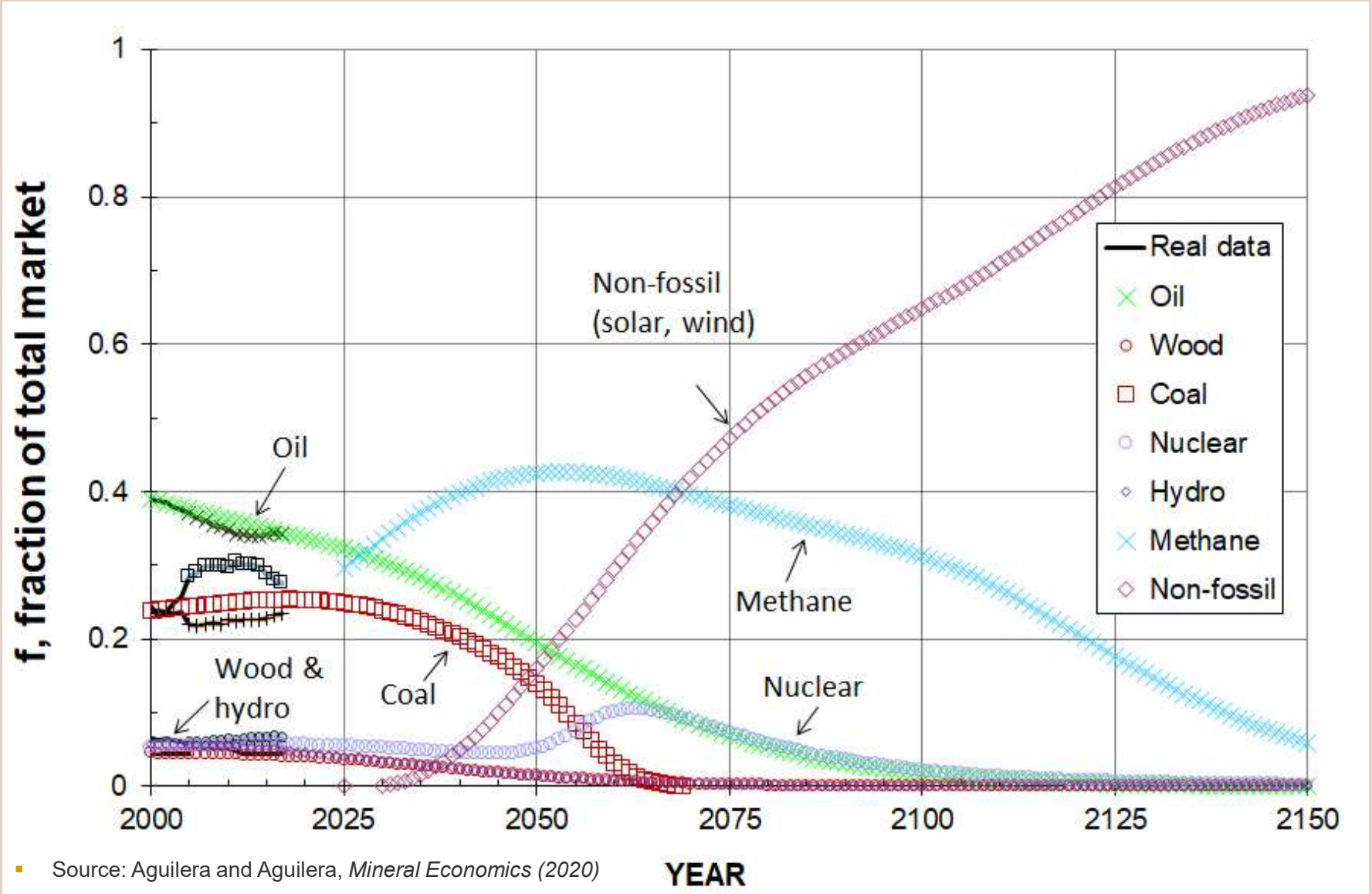
Primary Energy Mix (2000 - 2150)



- Source: Aguilera and Aguilera, *Mineral Economics (2020)*

- Natural gas share peaks near 2050
- Non-fossil energy leads market 2H 21st century

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Conclusions

- Natural gas & LNG are growing fast: bridge to low carbon future?
- Rising LNG & pipeline exports leading to increasingly integrated gas markets
- Some regional price differences persist
  - *Distinct market structures (competitive, oligopoly, bilateral monopoly/oligopoly, regulated)*
  - *Transportation by LNG must account for liquefaction, transport, regasification*
  - *Producers & consumers desire long-term security and stability*

Thank you!

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