OXFORD INSTITUTE FOR ENERGY STUDIES Natural Gas Research Programme

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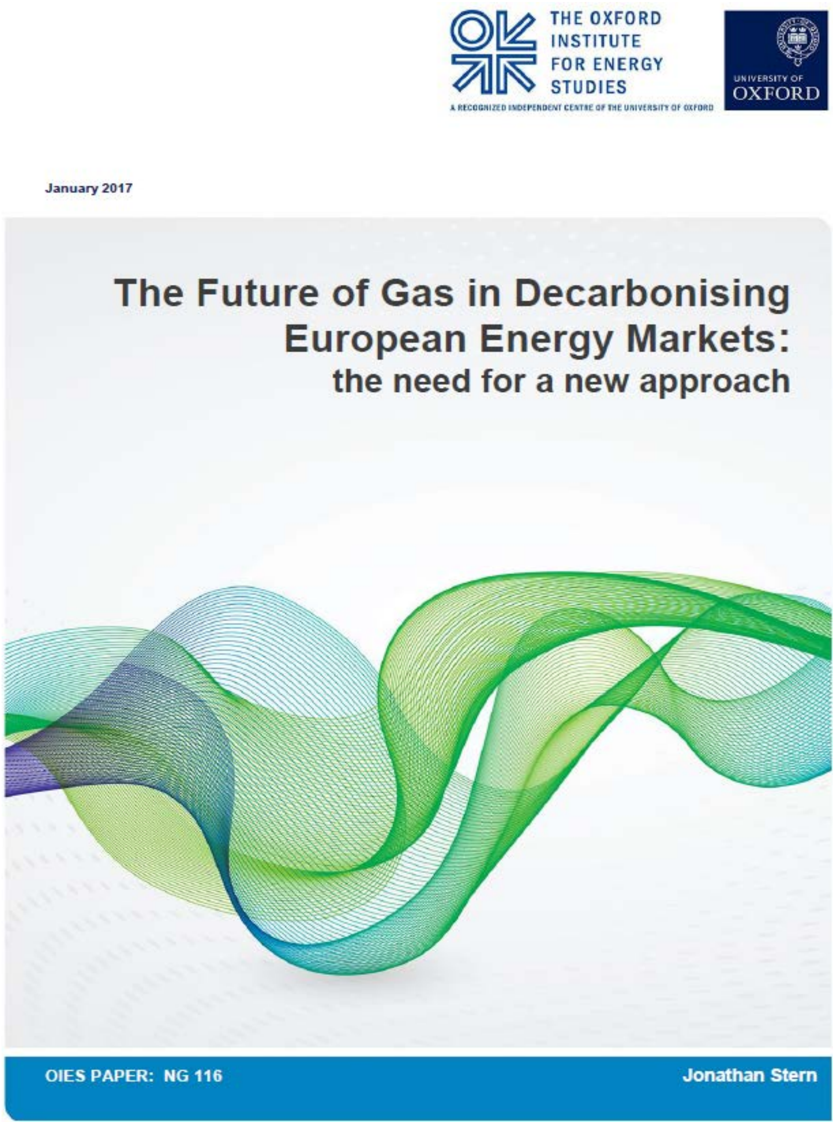
Challenges to the Role of Gas in a Sustainable Energy Future: decarbonisation and affordability

Jonathan Stern

IFGE2019, Putrajaya, July 16, 2019

Studies of Gas Decarbonisation in Europe



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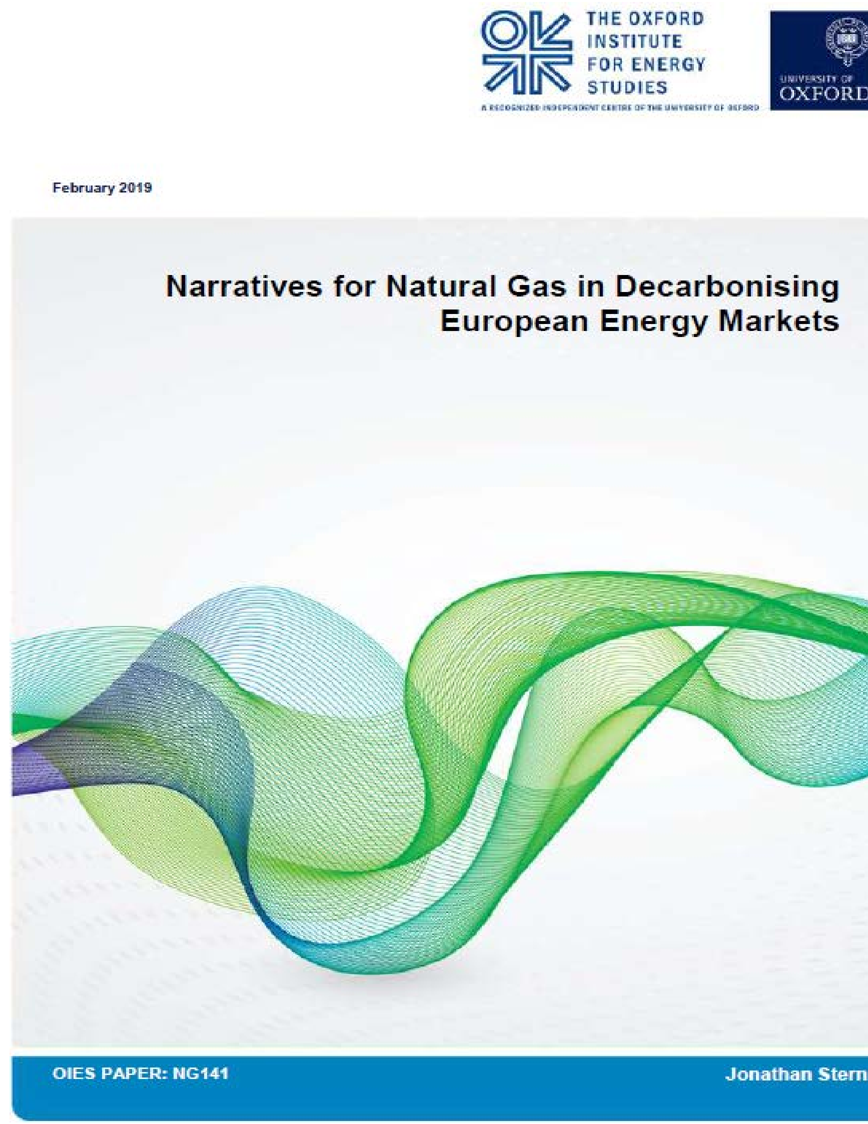
January 2017

The Future of Gas in Decarbonising European Energy Markets: the need for a new approach

OIES PAPER: NG 116

Jonathan Stern



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February 2019

Narratives for Natural Gas in Decarbonising European Energy Markets

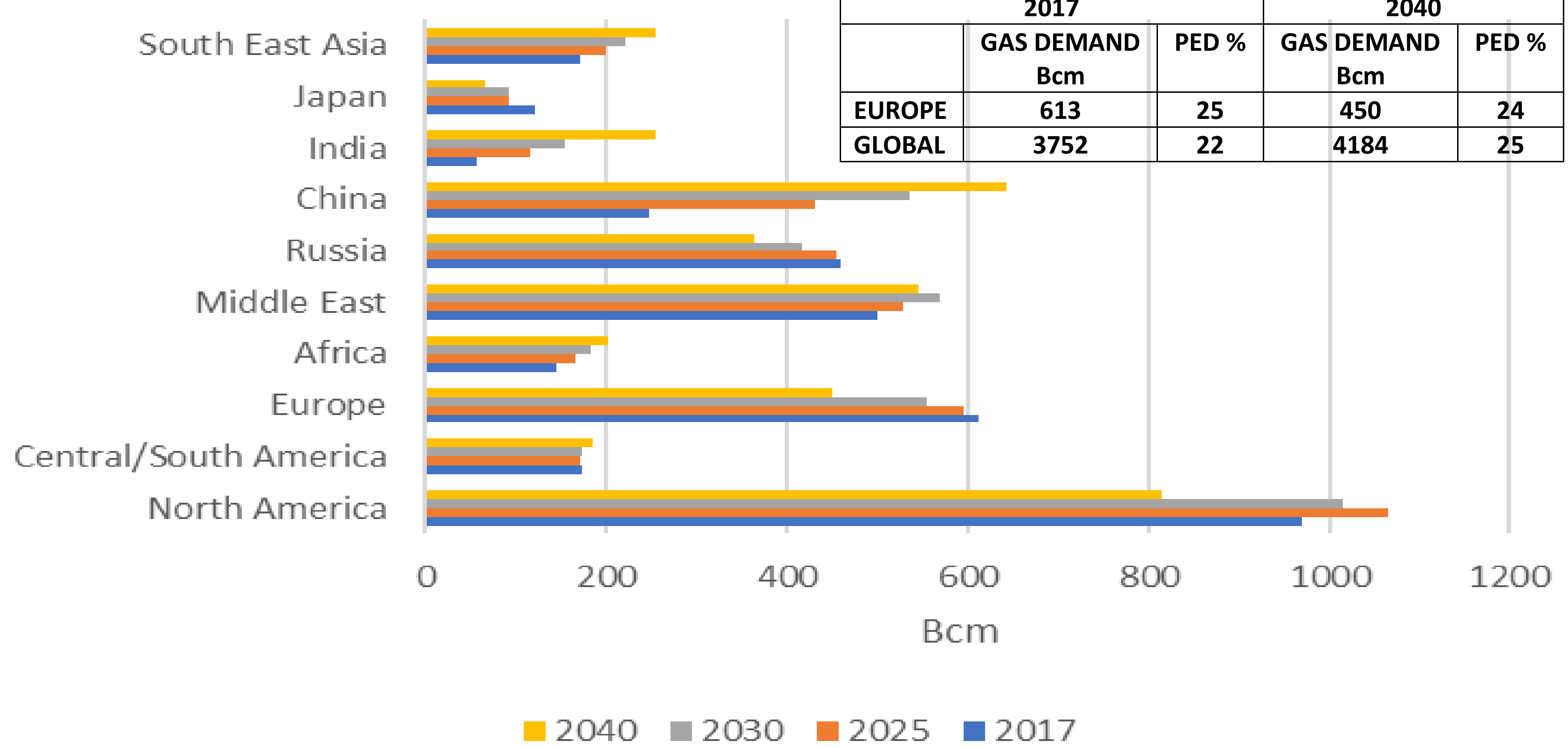
OIES PAPER: NG141

Jonathan Stern

THE FUTURE OF GAS UNDER COP 21 DECARBONISATION TARGETS: GLOBALLY AND IN EUROPE

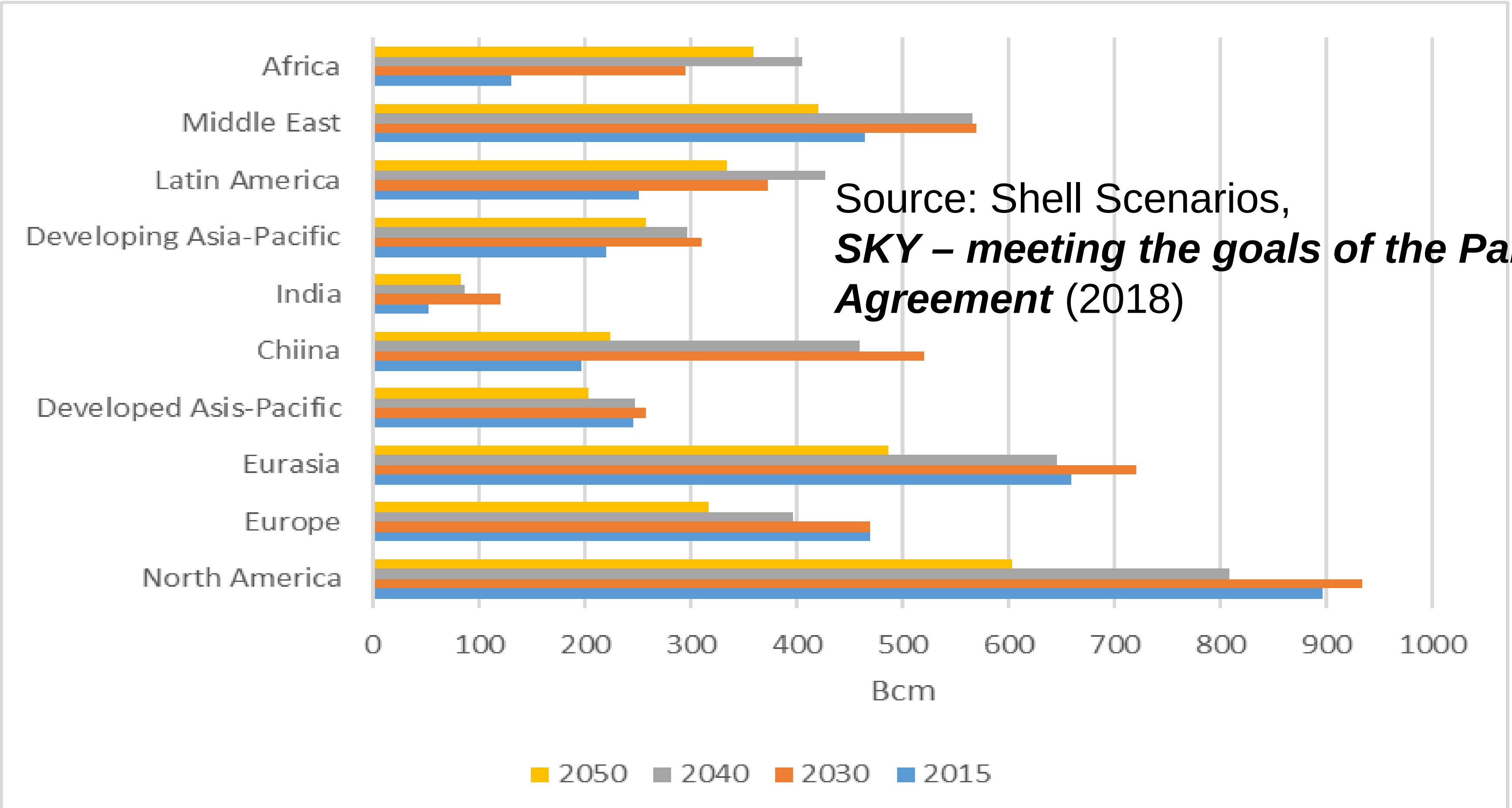
IEA Sustainable Development Scenario: significant gas demand growth in China and India, growth in SE Asia and Africa; stable or declining post-2030 elsewhere

	2017		2040	
	GAS DEMAND Bcm	PED %	GAS DEMAND Bcm	PED %
EUROPE	613	25	450	24
GLOBAL	3752	22	4184	25



Source: IEA WEO 2018

Shell SKY Scenario: significant gas demand growth outside OECD to 2030; decline in OECD to 2040; post-2040 major decline almost everywhere; note China and India



Source: Shell Scenarios, ***SKY – meeting the goals of the Paris Agreement*** (2018)

Global gas demand peak/plateau 2030-35 followed by modest decline to 2040 but <u>25% decline 2040-50</u>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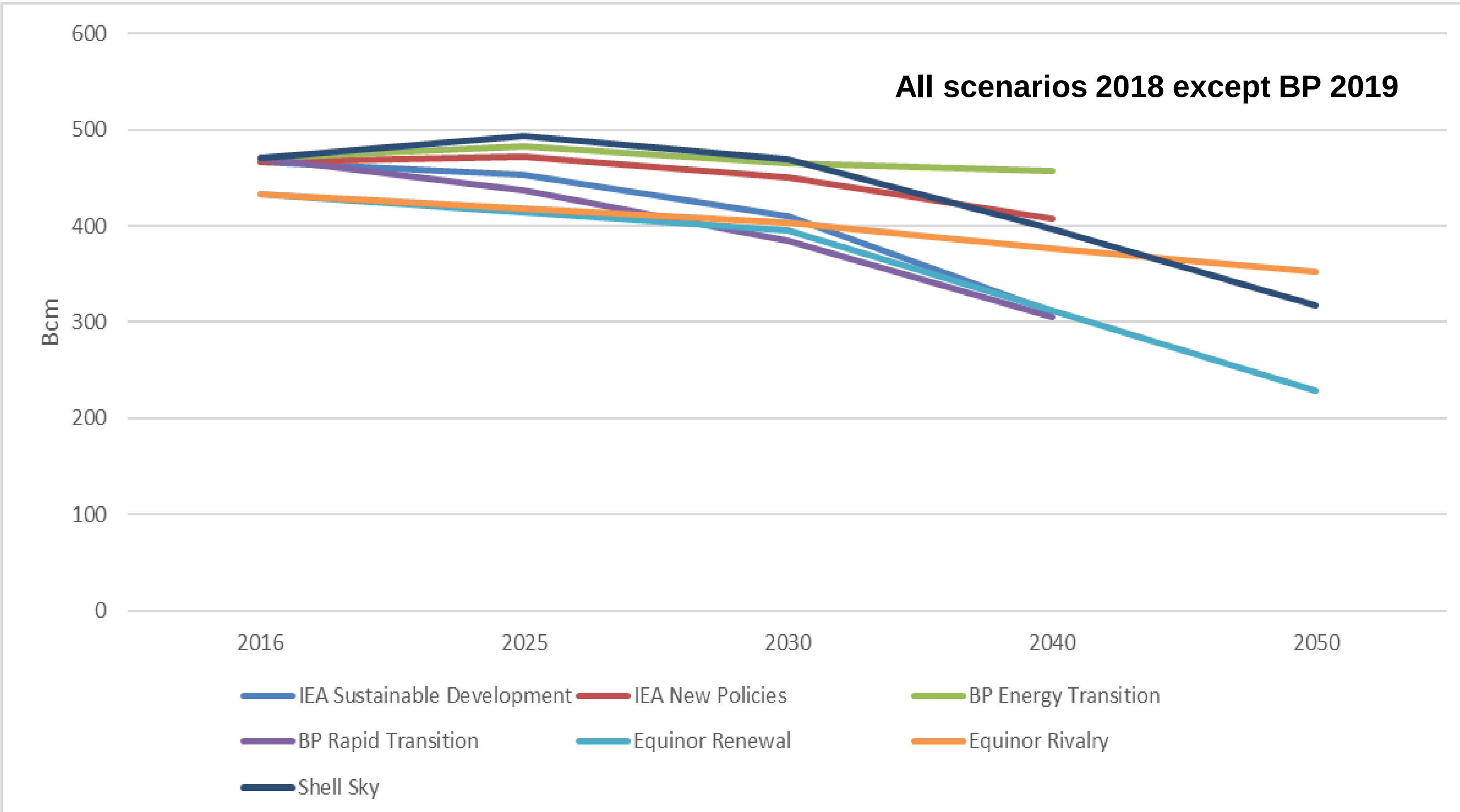
https://www.oxfordenergy.org/publications/narratives-natural-gas-decarbonising-european-energy-markets/

European Union Natural Gas Demand Scenarios Compatible with COP21 Targets



Not a `gloom and doom' scenario for gas: No <u>significant</u> decline in methane demand until 2030

European Gas Demand in the 2020s

- **European gas demand projected to be flat or slightly declining in the 2020s with decline accelerating thereafter due to carbon constraints**
- **But declining domestic production means that imports (and infrastructure) will increase in the 2020s to meet (even declining) demand and therefore…**
- **the next decade <u>could</u> be very positive for gas in Europe (if security issues can be resolved)**
- **the \`advocacy narrative': coal to gas switching and partnering with renewables, is logical up to 2030, but <u>policy focus is post-2030</u>**

EU Policy Assumptions and Consequences for Methane

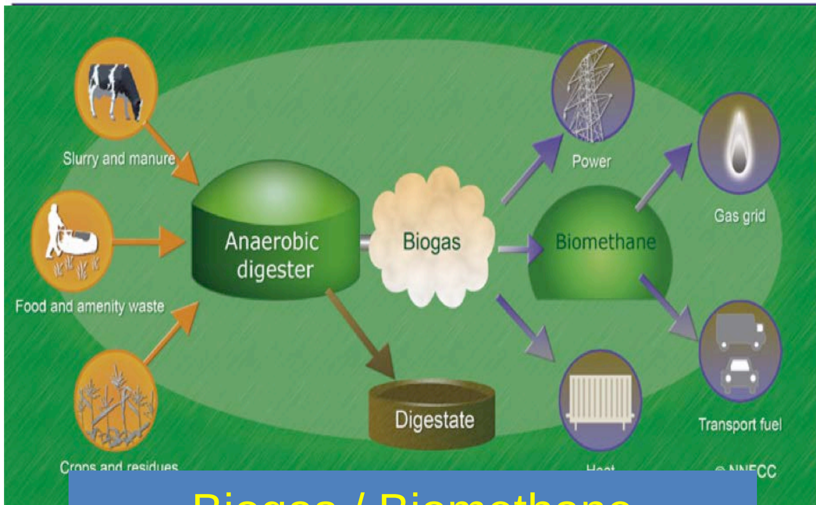
PRINCIPAL ASSUMPTION: GOVERNMENTS IN THE 7 MAJOR EU GAS MARKETS* WILL REMAIN DETERMINED TO MEET COP21 TARGETS THEREFORE:

- **post-2030 the future for methane demand is decline, which will accelerate if governments adopt more aggressive decarbonisation policies;**
- **maintaining gas markets will require `green or zero carbon methane' pathways**

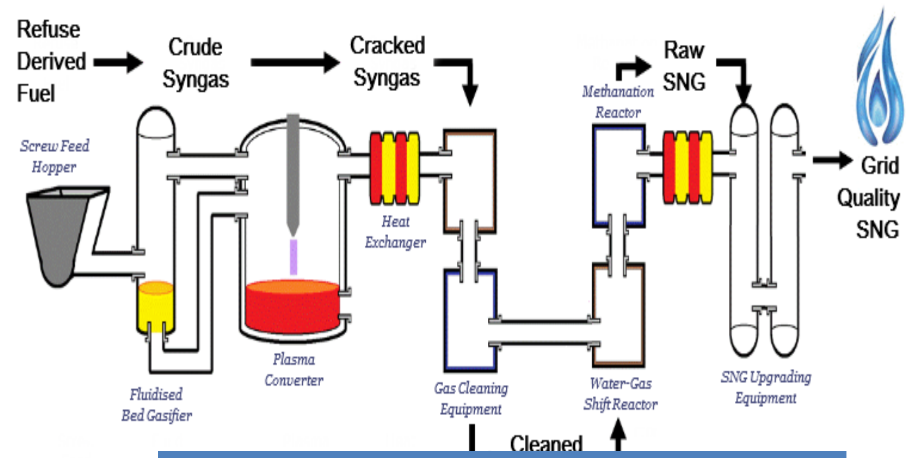
*Germany, Italy, France, Spain, UK, Belgium, Netherlands

SECOND ASSUMPTION: electrification + gas will be a lower cost decarbonisation pathway than electrification only; decommissioning gas assets (eg networks) before the end of their productive lives will be expensive

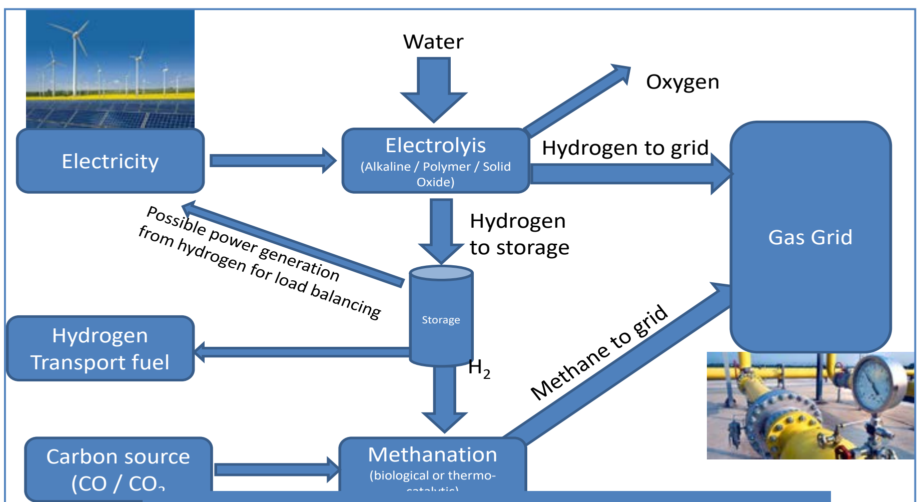
Pathways for Gas Decarbonisation



Biogas / Biomethane



Bio-SNG via Gasification

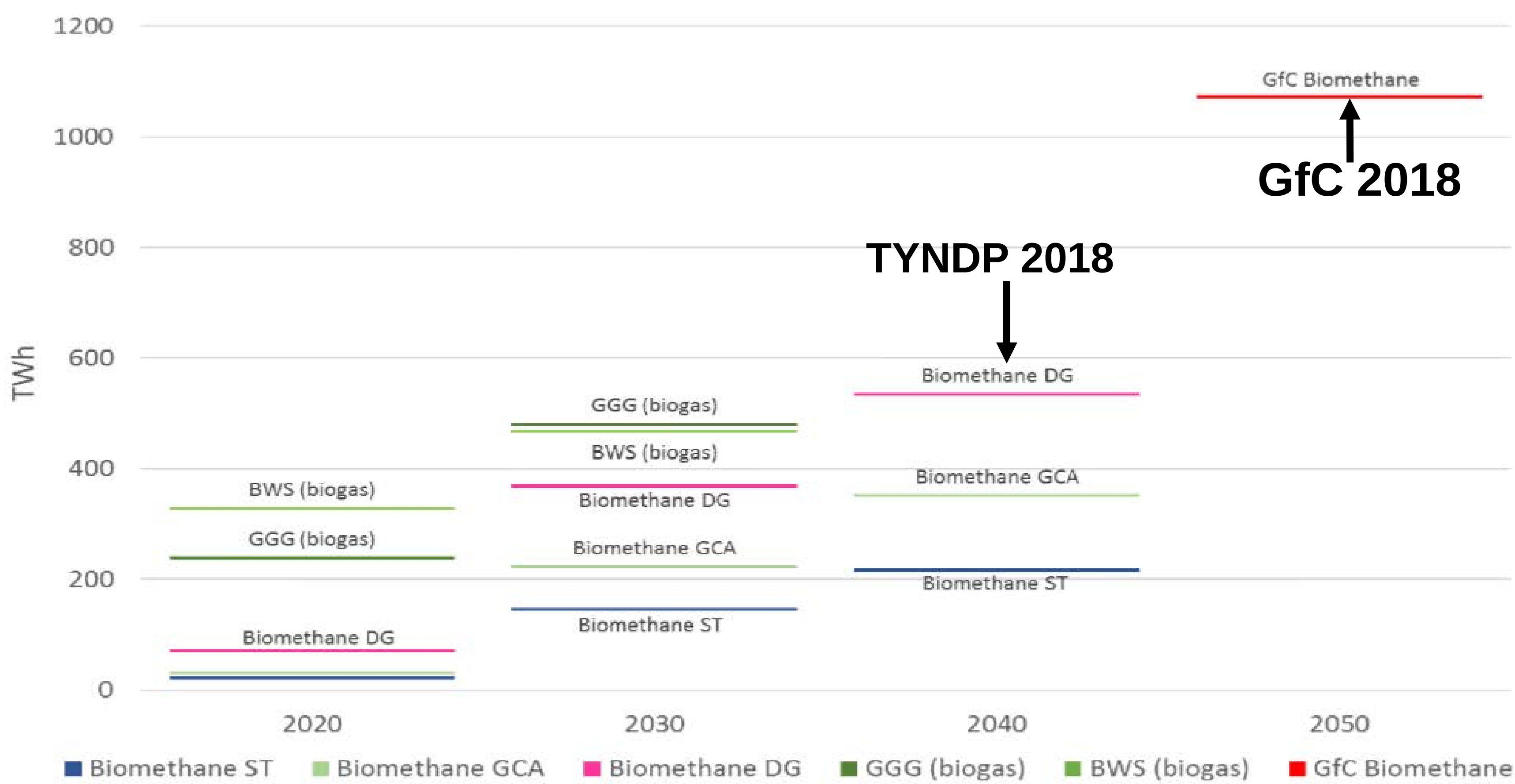


Power to Gas

Methane reforming with CCUS

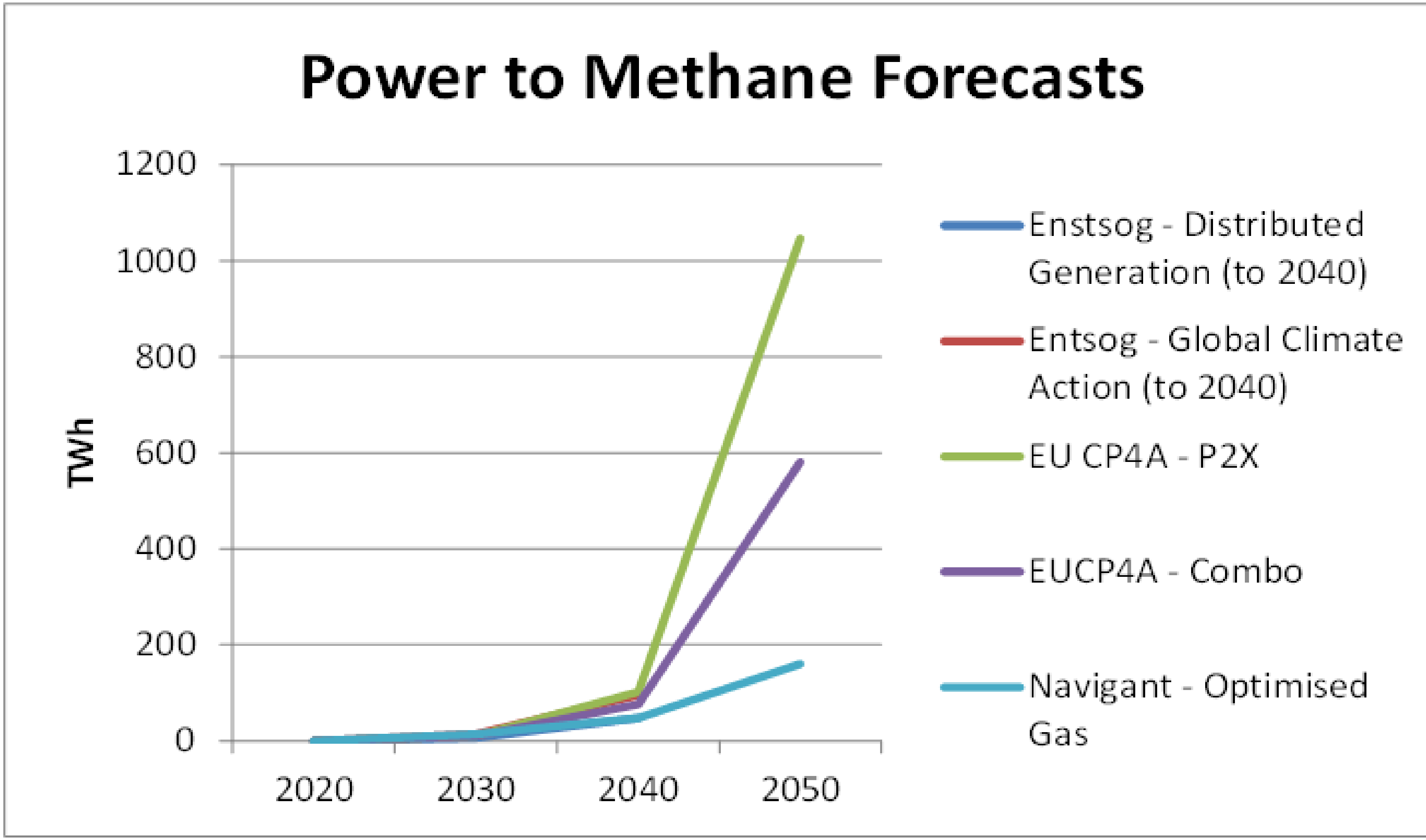
Biogas/Biomethane Projections 2020-50

Source: ENTSOG/TNYDP, Annex II, Methodology, March 2018, p.41.



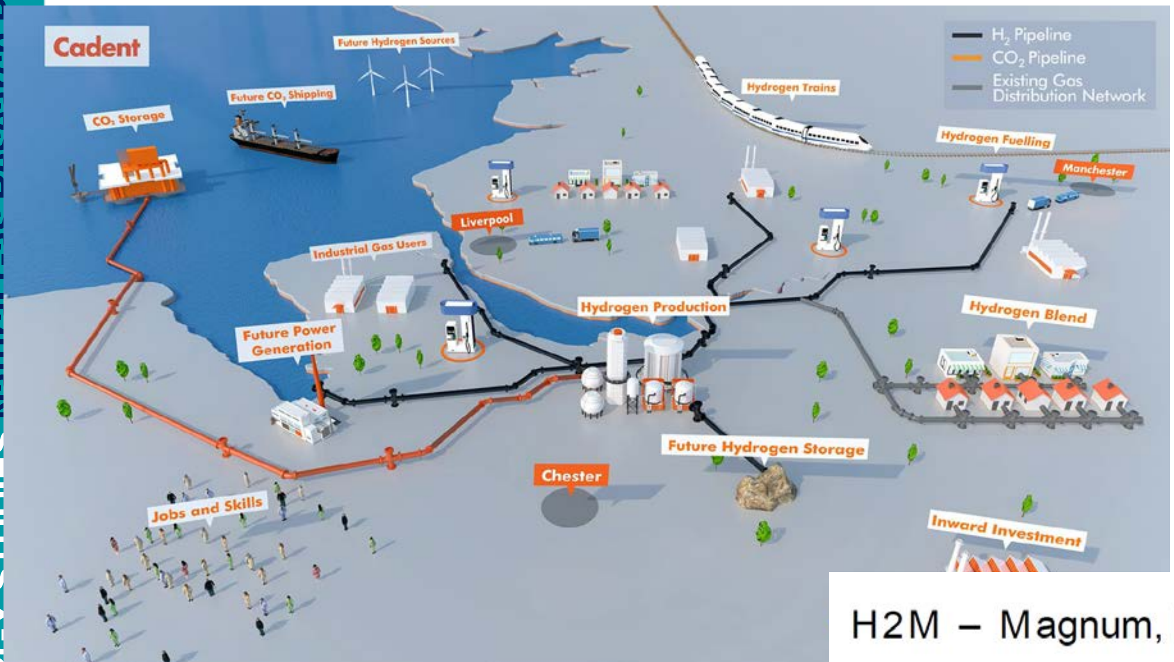
Maximum potential of biogas, biomethane and thermal gasification production - 95 Bcm in 2050 compared with demand of 470 bcm in 2018

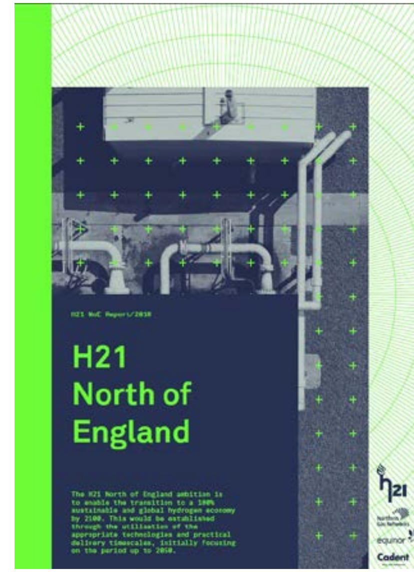
European Power to Gas Forecasts 2030-50



Until 2040, no significant production; too little `surplus' RES so off-grid RES will be needed; but small up to 2040 so an additional hydrogen source needed

Methane Reforming with carbon capture and storage – UK and NL leading the way?

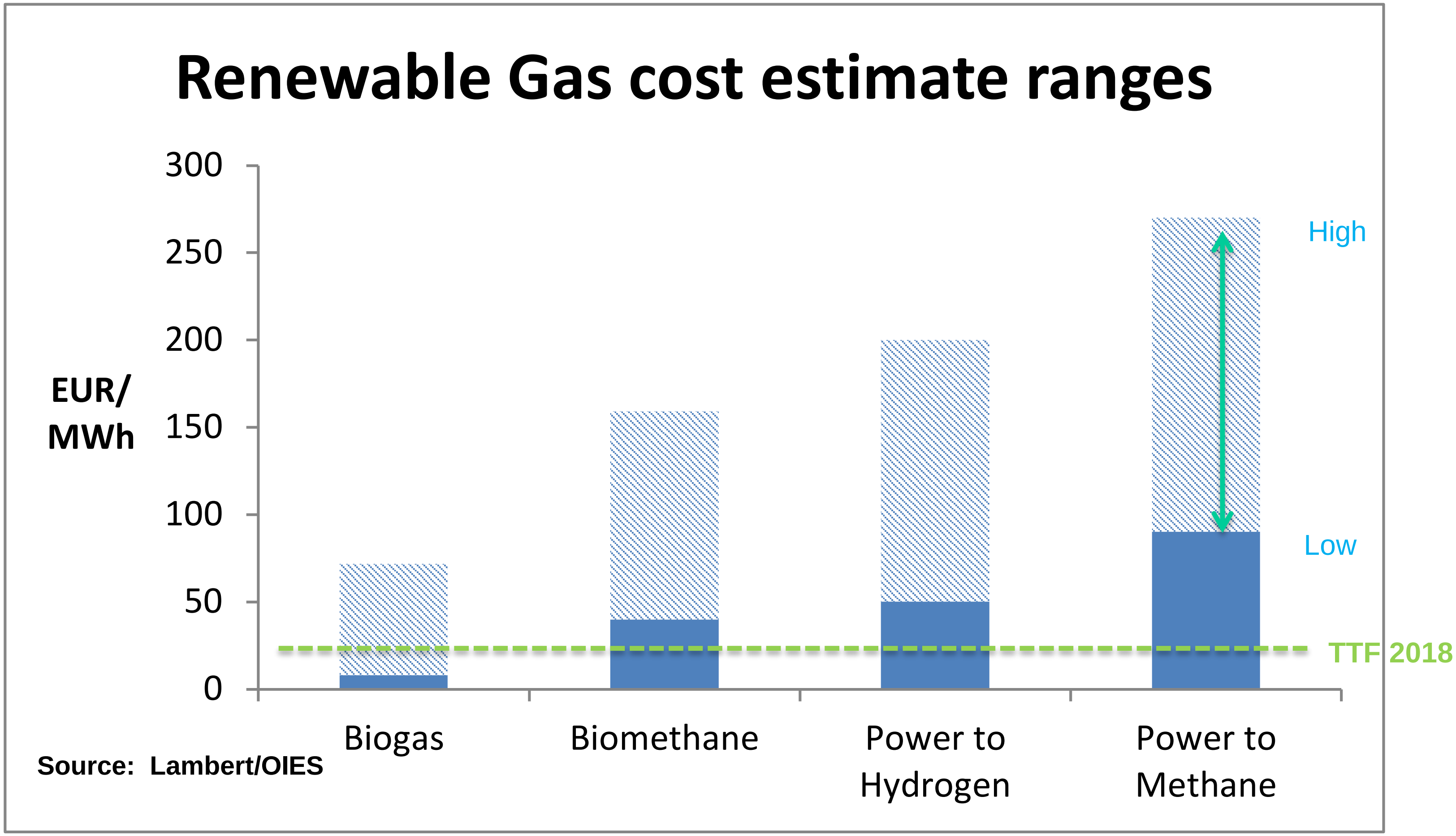




- **UK: H21 (North of England) and Hynet NW (Liverpool area)**
- **NL: H-vision (Rotterdam) and Magnum (Eemshaven)**

In many parts of Europe carbon storage is unacceptable

Range of Renewable Gas Cost Estimates



Very wide ranges of costs reflect uncertainty and widely different local conditions; increasing scale may reduce costs

Different Value Chain Sectors Have Different Business Models

PRODUCERS AND EXPORTERS:

- want to sell large quantities of methane over long time periods (if possible) underpinned by long term contracts

NETWORK COMPANIES:

- Want to prolong the life of their assets not necessarily transporting methane (also biogas, biomethane, hydrogen)

SUPPLIERS AND TRADERS:

- Supply power as well as gas and (unless they are producer affiliates) can switch from gas to power

OWNERS OF POWER, REGAS AND STORAGE ASSETS:

- Maximise life of assets: shorter for power than regas/ storage; may be stranded if others decarbonise

Liberalisation has caused value chain fragmentation

Pipeline Gas and LNG Producers/Exporters

- Exit the methane business in Europe and concentrate on selling in other regions – easier for LNG exporters
- LNG exporters:
  - Skip liquefaction, decarbonise in the exporting country, ship hydrogen (not LNG)
  - Decarbonise at the regas terminal (reforming+CCS)
- Reform to hydrogen (with CCS) for sale to which requires…
  - utilisation of offshore depleted fields for CO2 storage and offshore pipelines for CO2 transport
  - coordination of new H2 networks with TSOs

Reserve life and location, and alternative markets are key issues

Gas Transmission and Distribution Networks

- Gas networks provide major storage capacity – important for seasonal back-up
- Biomethane can replace fossil methane directly
- Blending hydrogen into the network can be a limited strategy in the 2020s (technical limits are unclear: up to 20% in some countries; 100% in others)
- Commercial scale projects must be committed to demonstrate a long term narrative: reforming of methane with CCS (where storage opportunities exist) can be a partner hydrogen technology for electrolysis of renewable energy
- DSOs: still part of a gas value chain or disconnected?

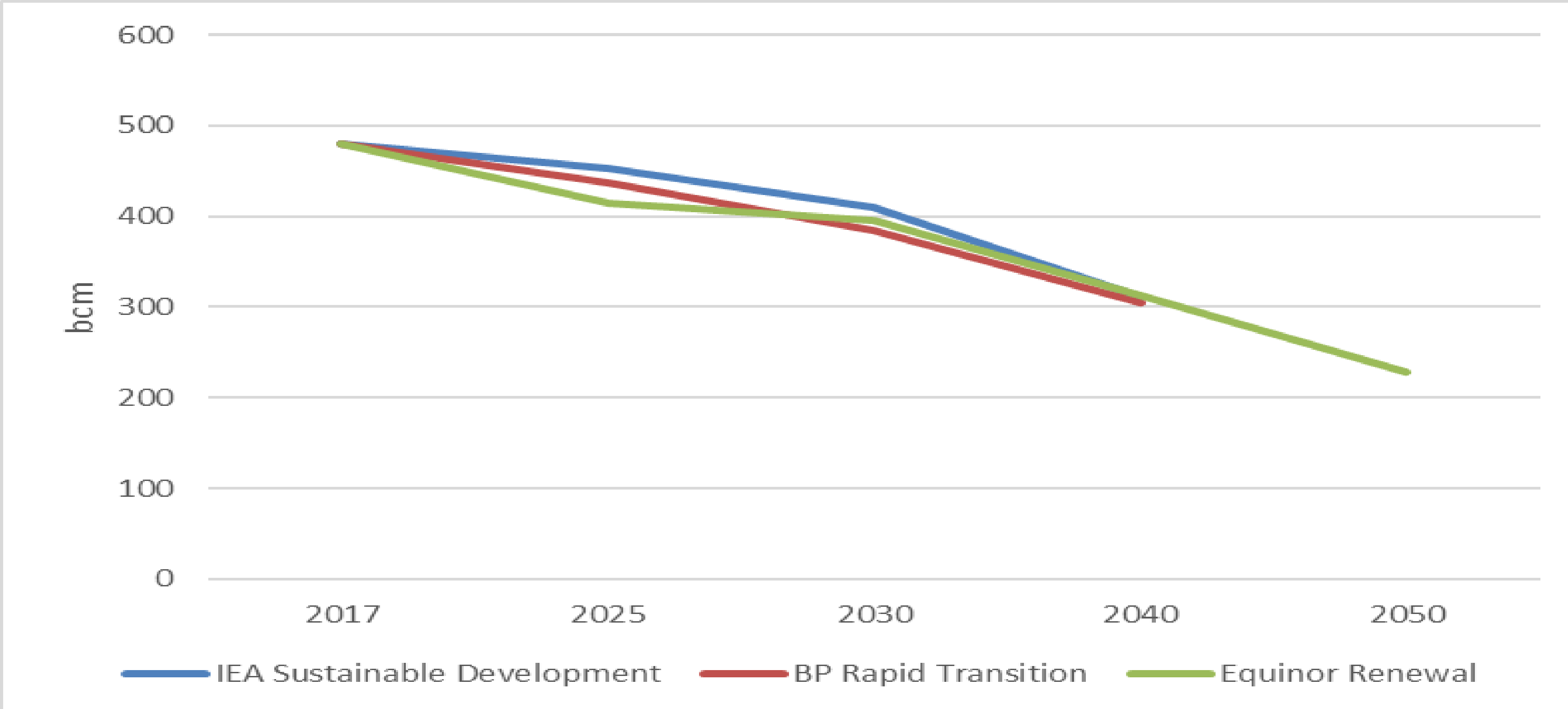
For networks, failure to develop a decarbonised gas business model is <u>an existential threat</u>

The regulatory framework may need to prioritise decarbonization over competition

- Reality of `competing' low carbon projects
- Involvement of network operators in new generation, storage technologies
- How to deal with stranded assets as/if throughput declines
- `Rebundling' (after decades of unbundling)
- Incentives must recognise avoided emissions
- Asset life – regulatory return – could become dependent on transitioning from methane to low/zero carbon gases

A revolution in regulatory thinking/practice will be needed, not yet visible (Madrid Forum)

EU Methane Demand Scenarios Compatible with COP21 Targets: optimistic scenario



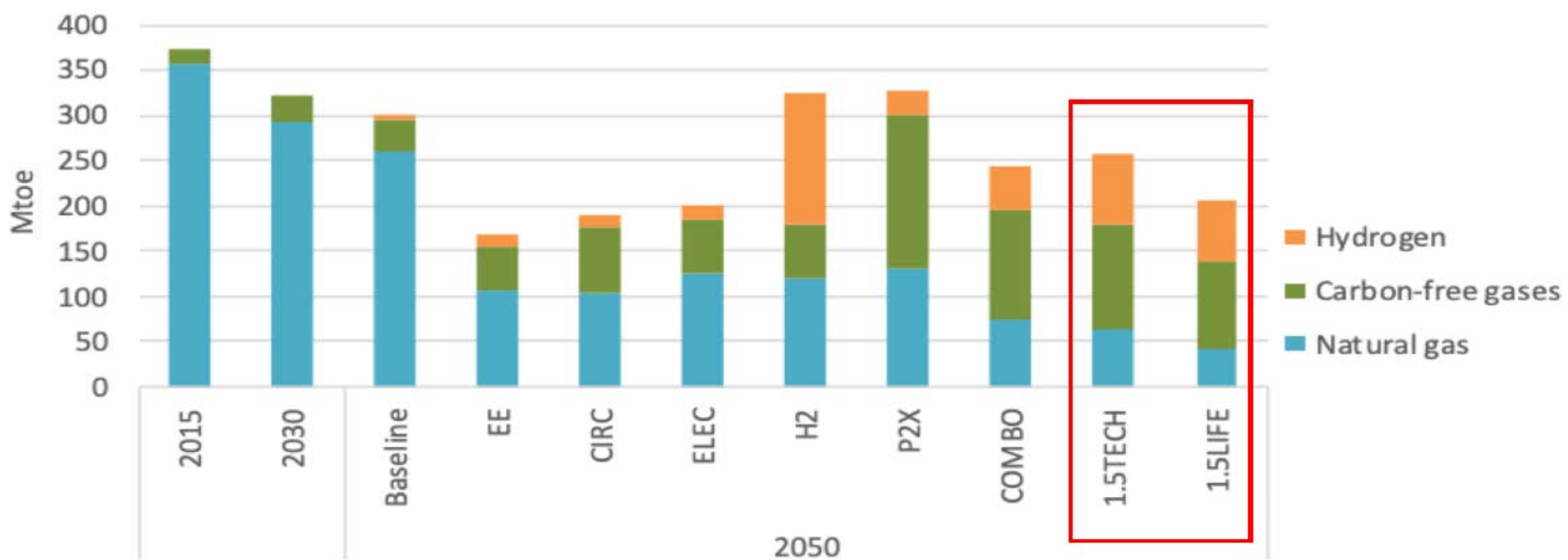
Maximum EU methane usage in 2050 – 200 bcm and maximum biomethane+green hydrogen = 272 bcm; ~100 bcm is more likely. Therefore in 2050 <u>maximum</u> gas availability could be 472 but 300 is more likely compared with 480 bcm in 2017. This means that either the market will shrink substantially, or hydrogen from methane reforming will continue to be necessary

Pessimistic Scenario: `net zero' emissions by 2050, gas is 10-15% of current level

Moving beyond natural gas

Net Zero by 2050 means natural gas plays virtually no role

Figure 33: Consumption of gaseous fuels



Note: "carbon-free" gases refer to e-gas, biogas and waste-gas.

Source: European Commission, 2050 Long-Term Strategy (2018)

Total gas demand in 2050: 200-250 bcm of which natural gas 45-60 bcm

Global Affordability of Gas and LNG

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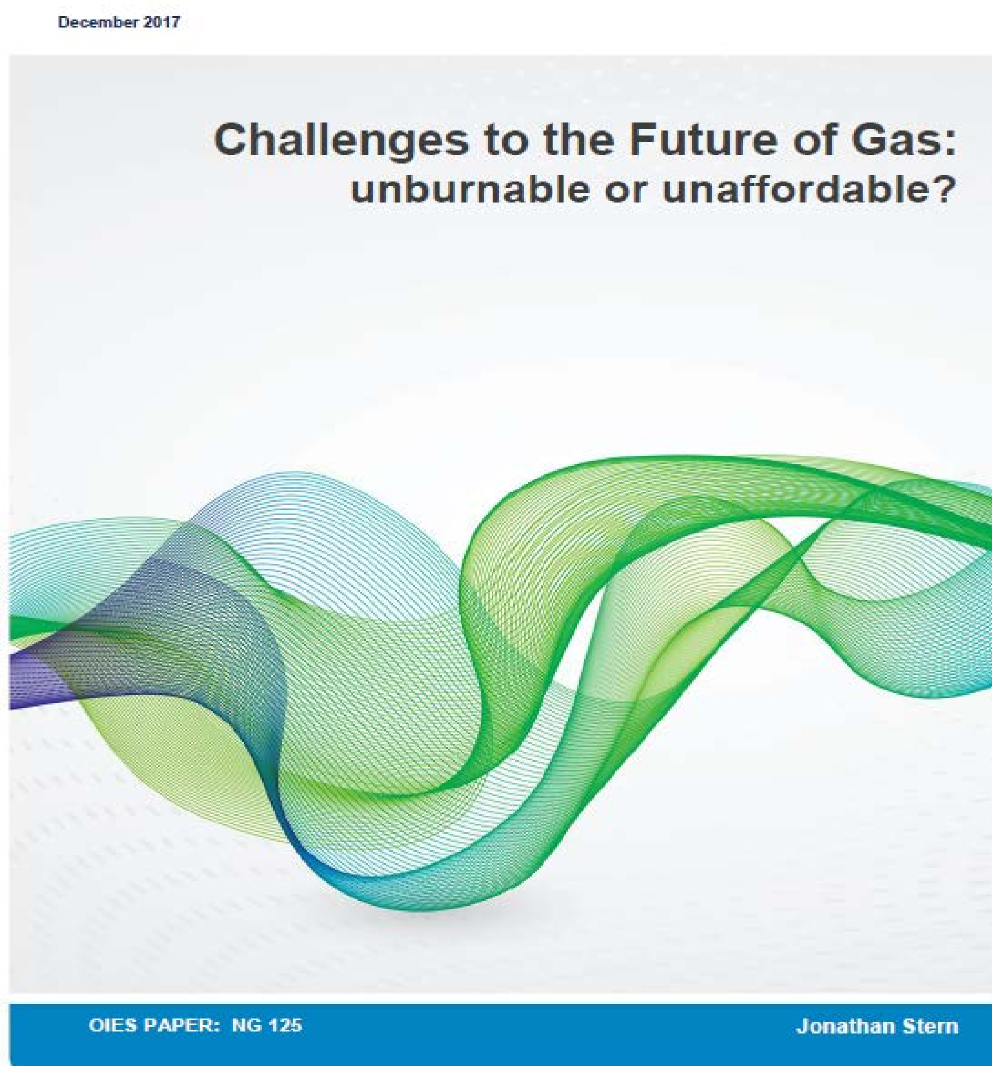

December 2017

Challenges to the Future of Gas: unburnable or unaffordable?

OIES PAPER: NG 125

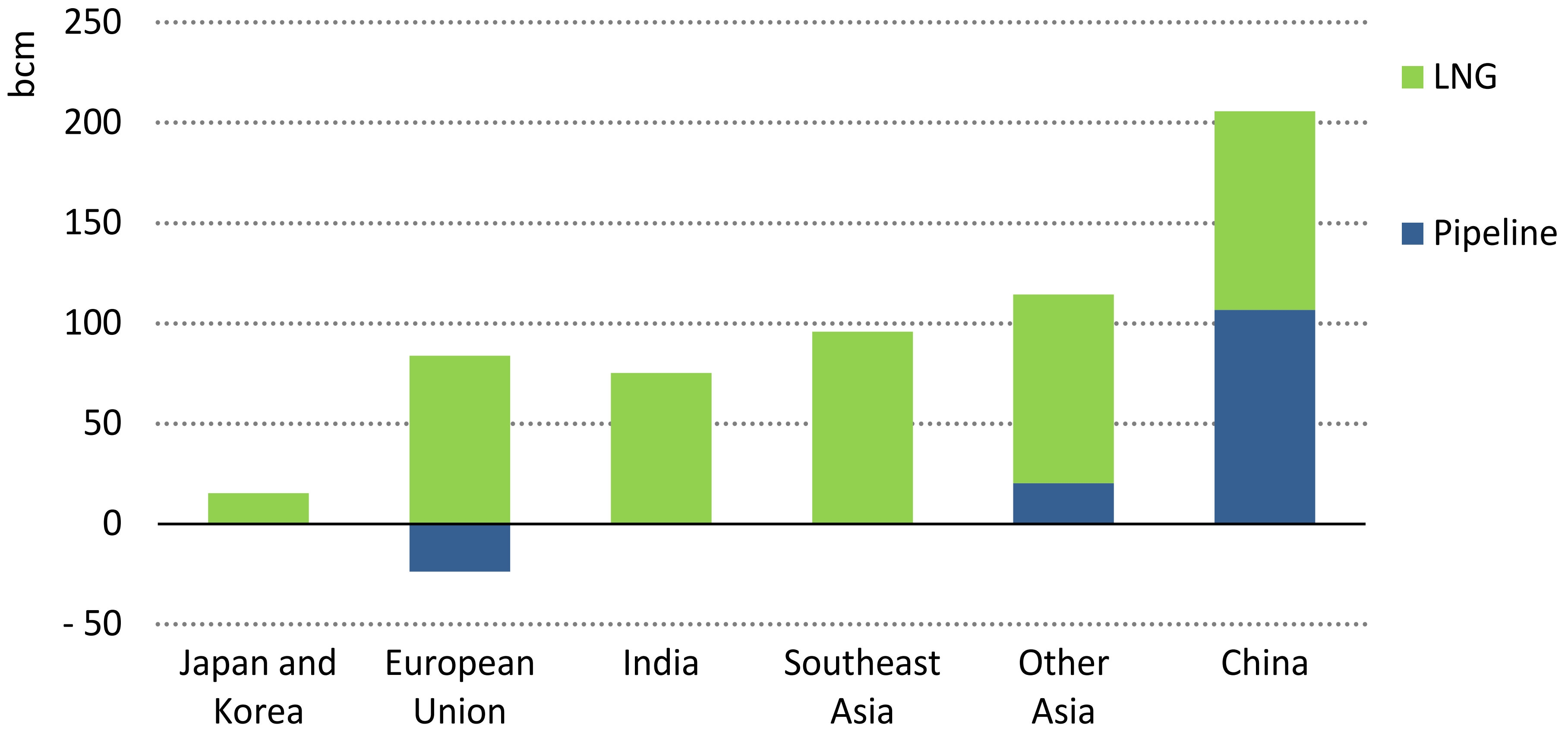
Jonathan Stern

MANY COUNTRIES OUTSIDE EUROPE STILL REGARD GAS AS A LOW CARBON SOURCE OF ENERGY; THE MAIN CHALLENGE TO THE FUTURE OF GAS IS AFFORDABILITY

Affordability = `energy access' (absolute level of income) and competitiveness against alternatives

Affordability of LNG imports will be the key metric for gas demand in many regions

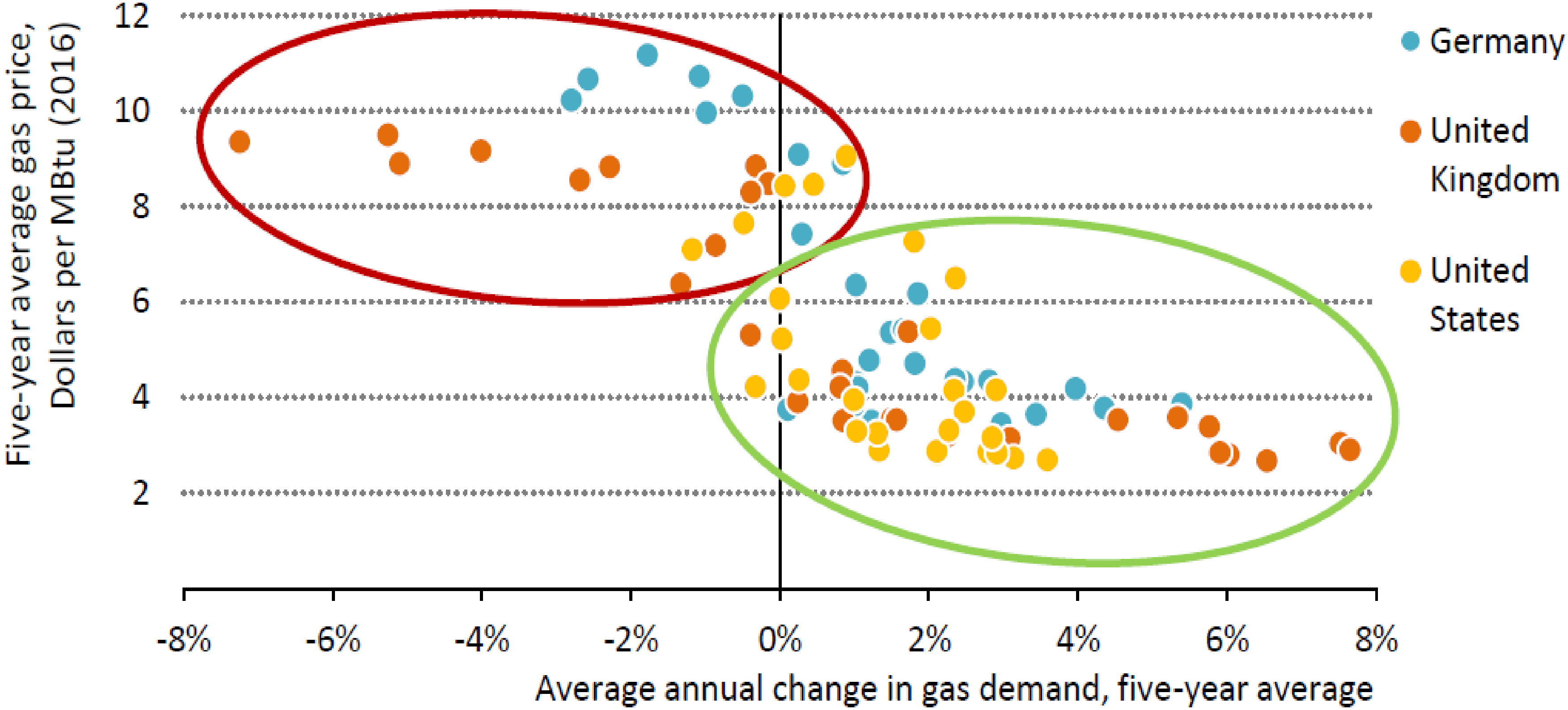
Change in gas imports by selected region and mode in the New Policies Scenario, 2016-2040



Asia leads the growth in global gas trade; outside China, new pipeline trade routes find it hard to advance in a market with LNG readily and flexibly available

Source: IEA, WEO 2017, Figure 8.11, p.362

Historical importance of the $6-8/MMbtu [€16-22/MWh or 42-56p/th] price thresholds

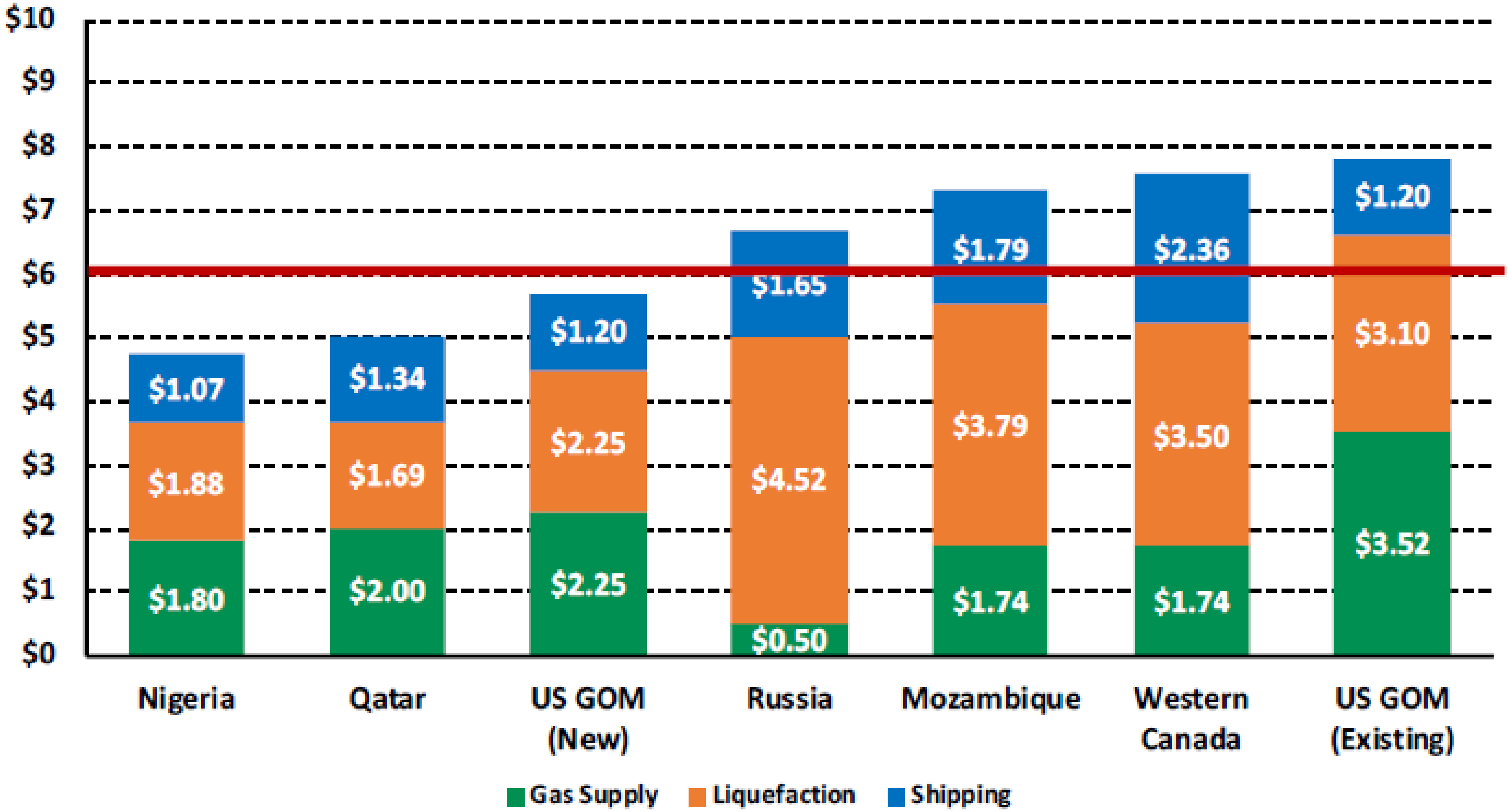


Analysis of historical demand trends in the US, UK and Germany shows that gas use increased at prices below $6/MBtu, but declined at prices above $8/MBtu

Source: IEA, WEO 2017, Figure 8.5, p.342

Estimated Breakeven Market Prices for New LNG Projects in North West Europe 2025

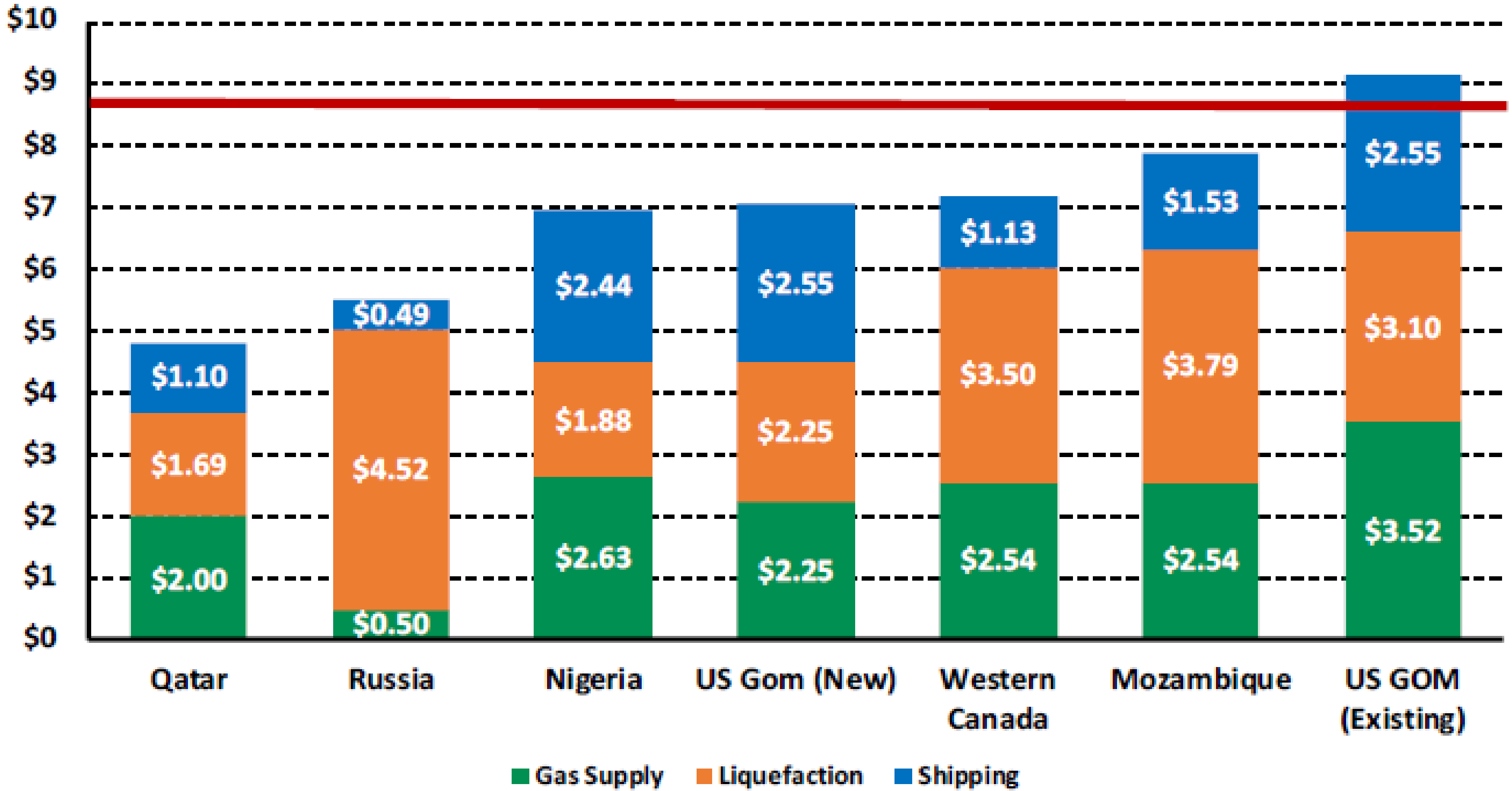
Source: Steuer/OIES



At a $6/mmbtu price, everything except Nigeria, Qatar and new US struggles to break even in NW Europe

Estimated Breakeven Market Prices for New LNG Projects in Asia 2025

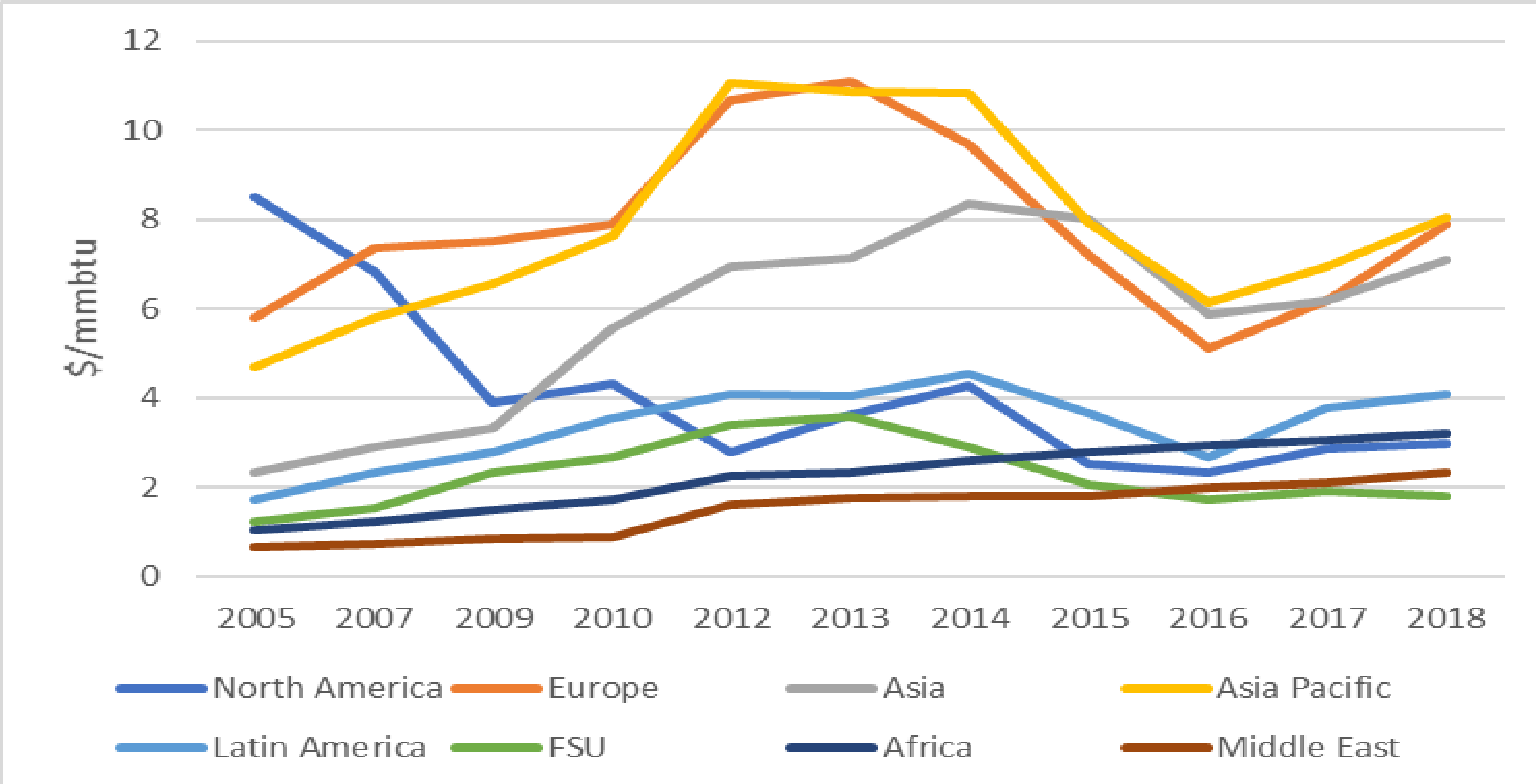
Source: Steuer/OIES



At $8.75/mmbtu price in Asia all projects look viable, but demand may be a problem

Wholesale Gas Prices in Different Regions 2005-18 (real prices in $/mmbtu)

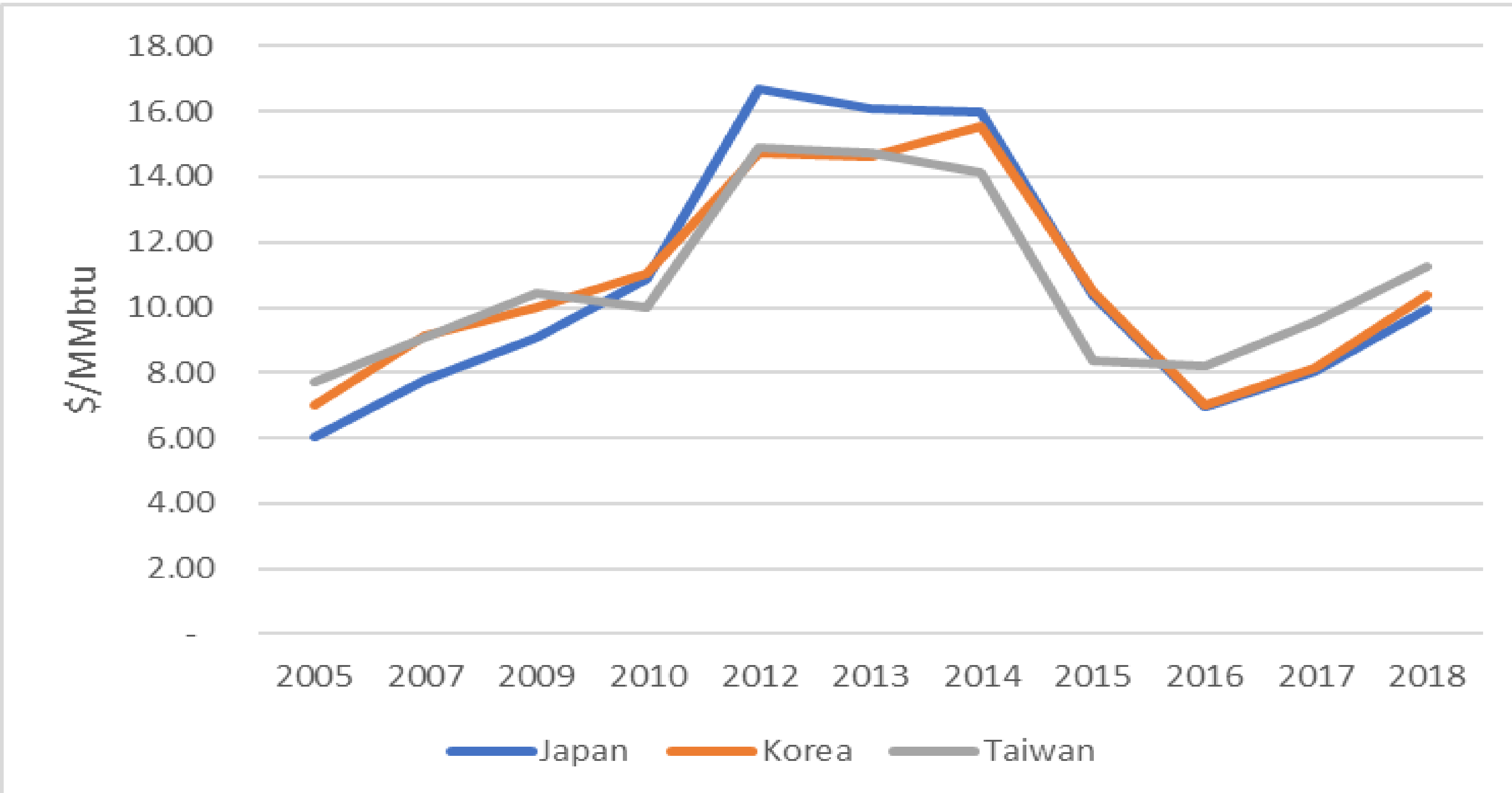
Source: International Gas Union, *Wholesale Gas Price Survey 2019 Edition,* Figure 4.5, p.48



Two groups: OECD+Asia (post-2009) paid $6-11/mmbtu; FSU, Latin America, Africa, Middle East paid less than $4/mmbtu, but country granularity is essential

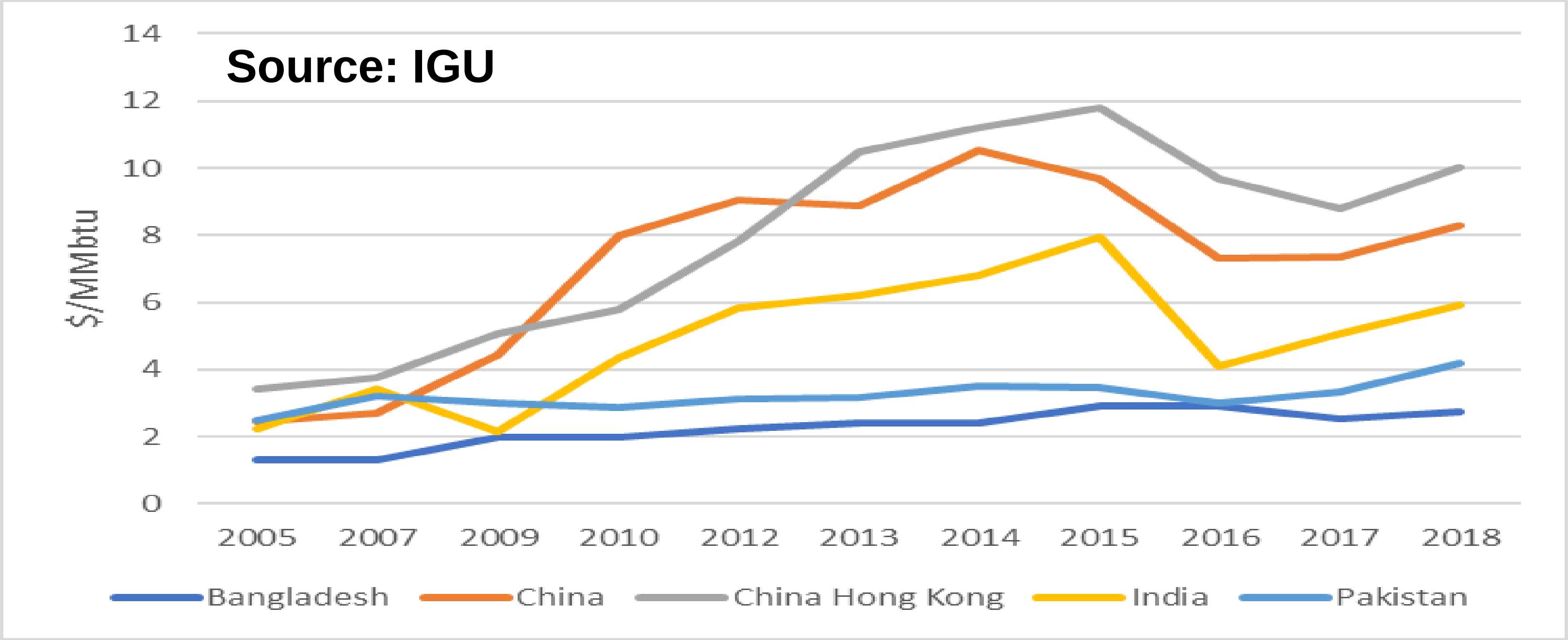
Japan/Korea/Taiwan Prices 2005-18

(Source: IGU)



The big LNG importers: "in a price class of their own"

East and South Asia Wholesale Gas Prices 2005-18

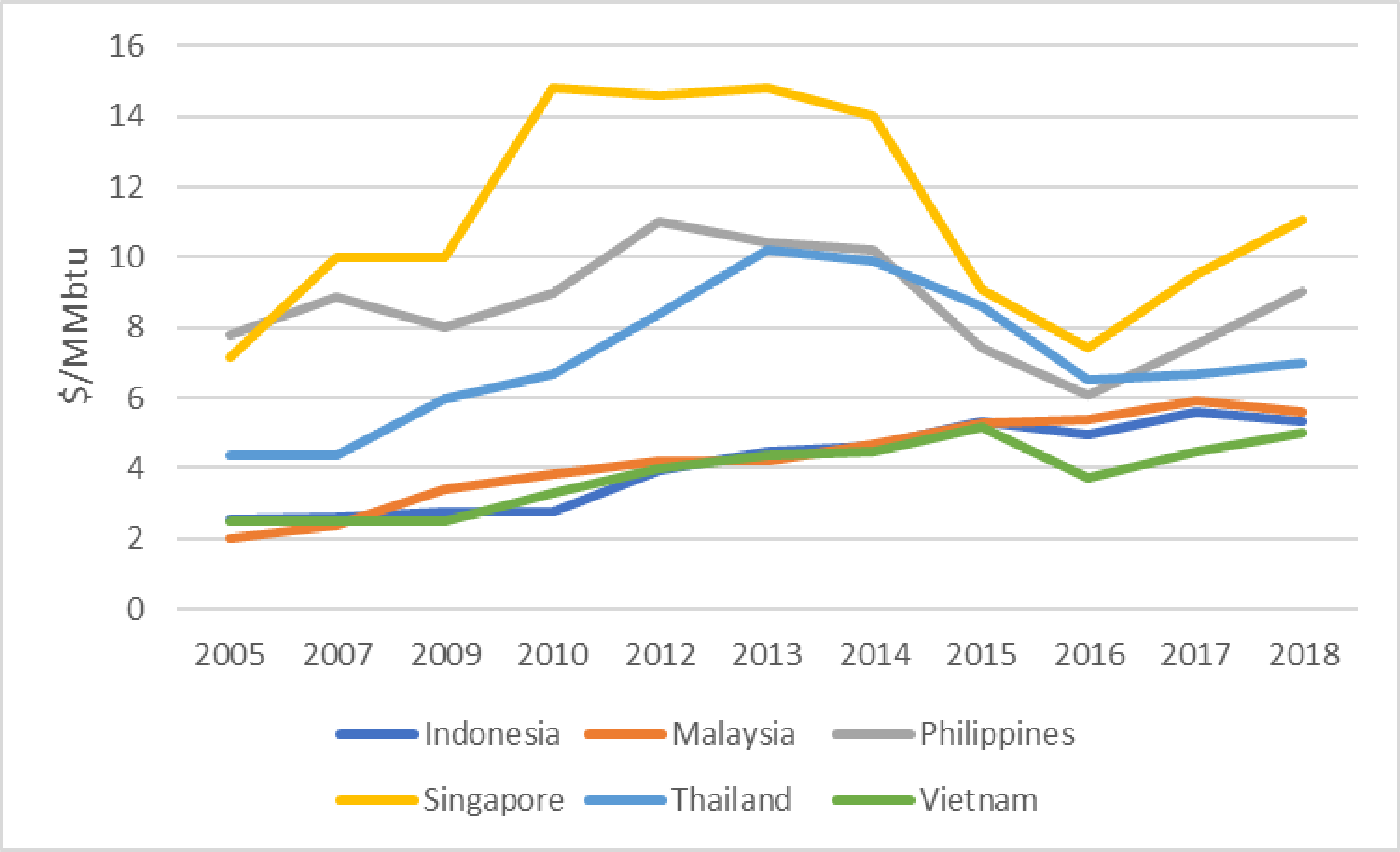


- China and Hong Kong have shown clear capacity to pay $6-10/MMbtu (but even generalisations across one country are difficult eg Chinese provincial prices ranged from $7-10/mmbtu in 2018)
- Pakistan and Bangladesh prices have been below $4/Mmbtu; India is an intermediate case

So how can Bangladesh and Pakistan afford to pay even $6 for LNG? Answers: if customers are currently using oil or with government subsidies. Same for many other countries eg in the Middle East. How sustainable are subsidies at much higher levels of gas imports?

South East Asia Gas Pricing 2005-18

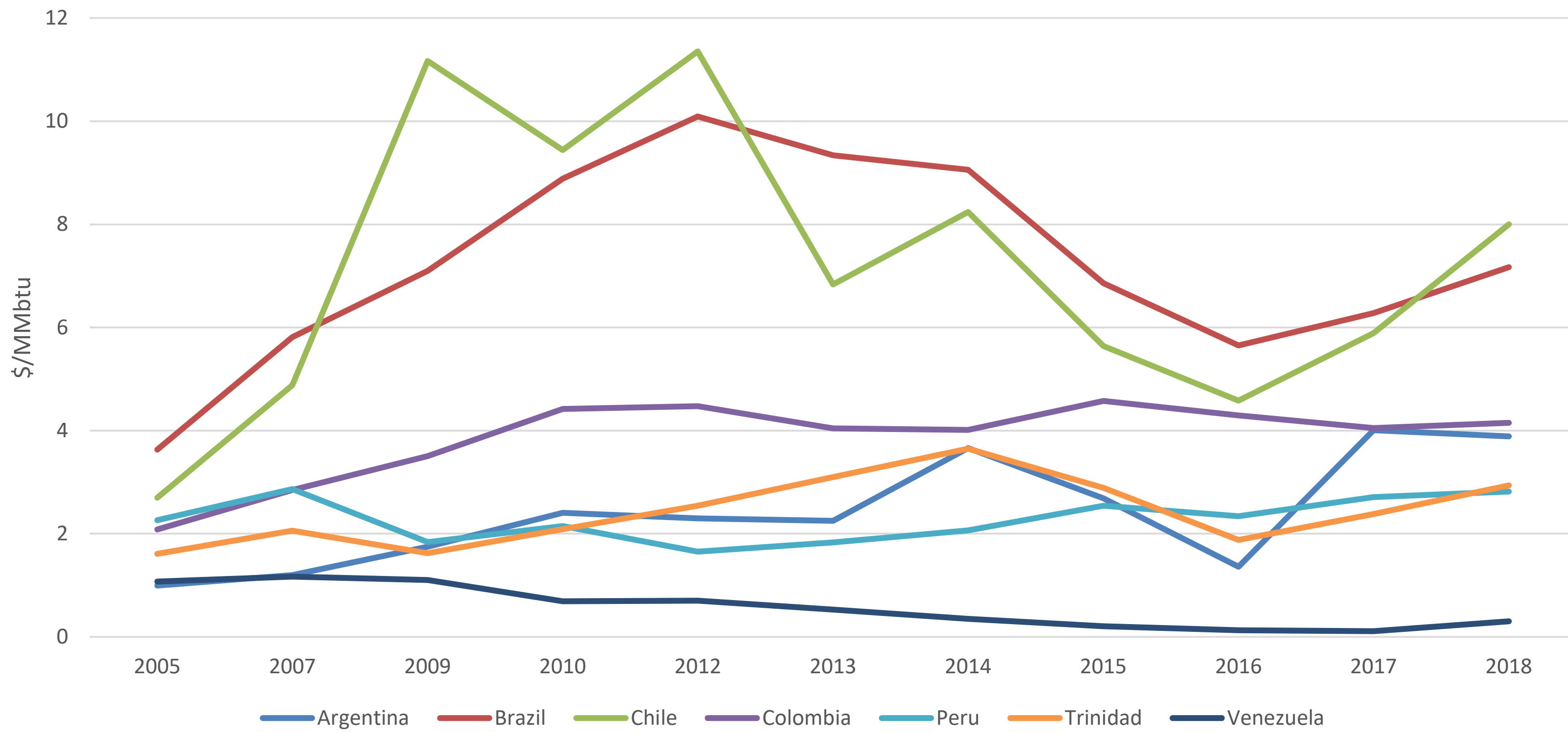
Source: IGU



The Asia Pacific Divide: Singapore, Philippines and (maybe) Thailand versus Indonesia, Malaysia and Vietnam

Latin American Prices 2005-18

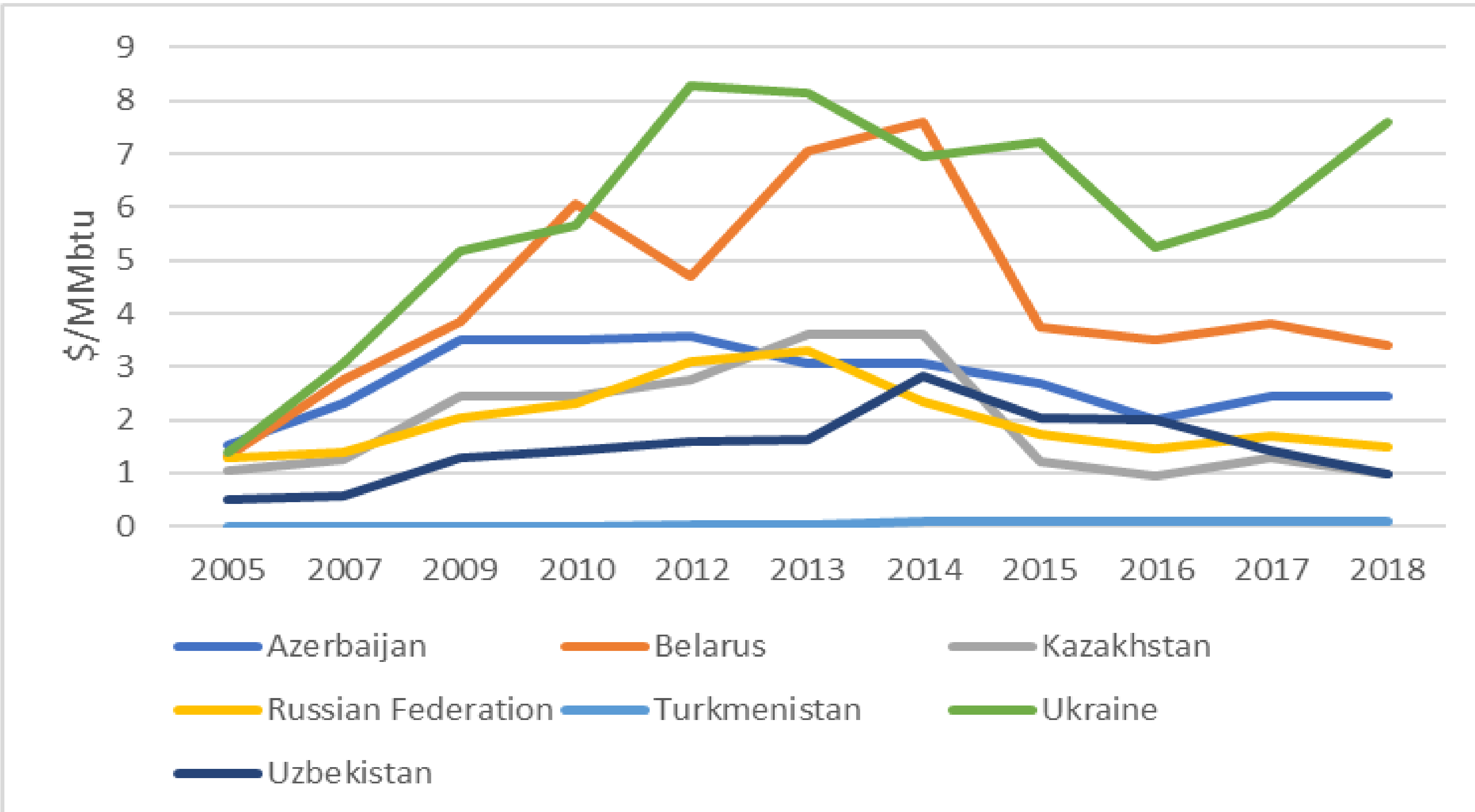
(Source: IGU)



Chile and Brazil have much higher price levels

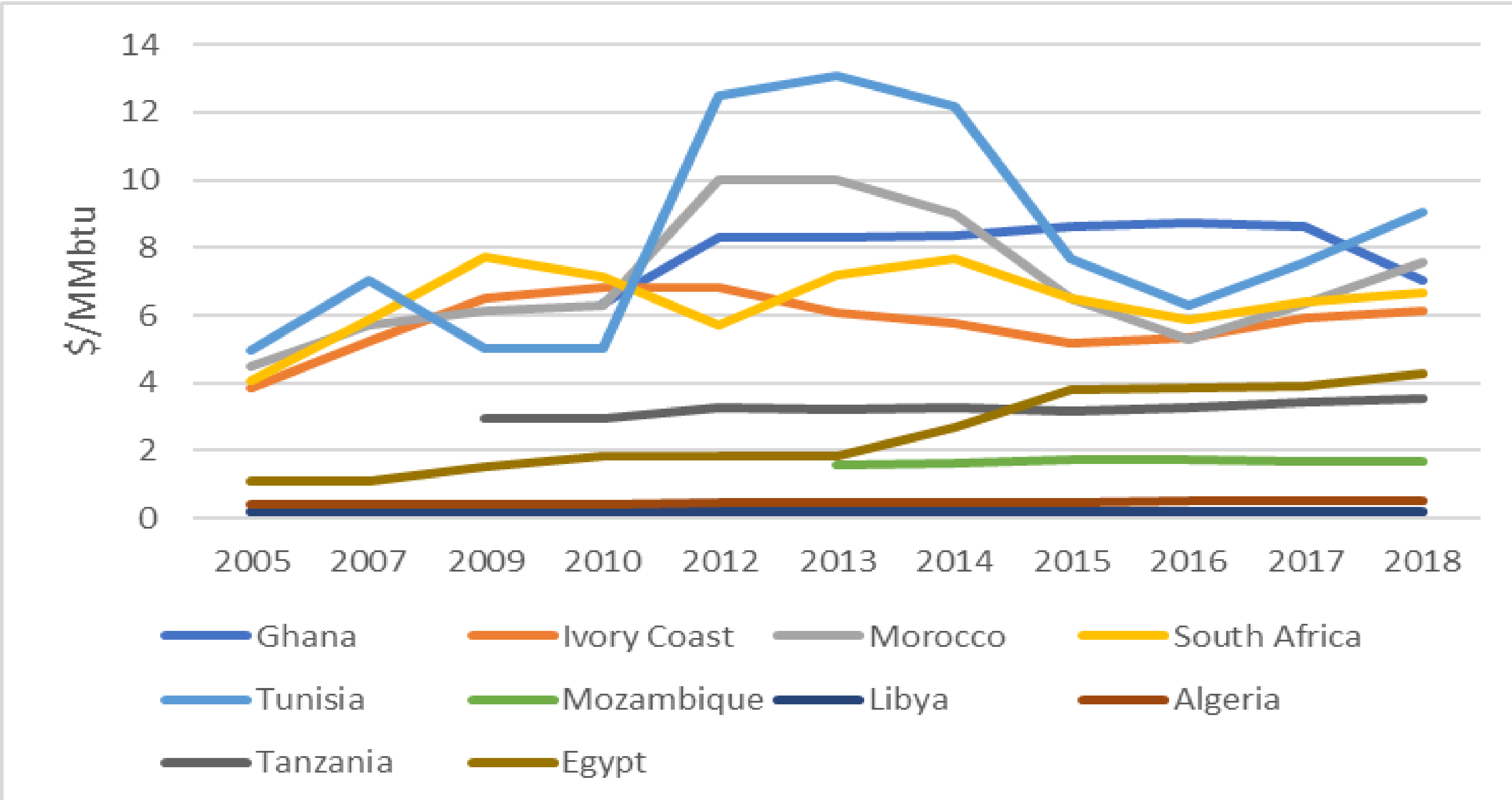
Former Soviet Union Prices 2005-18

(Source: IGU)



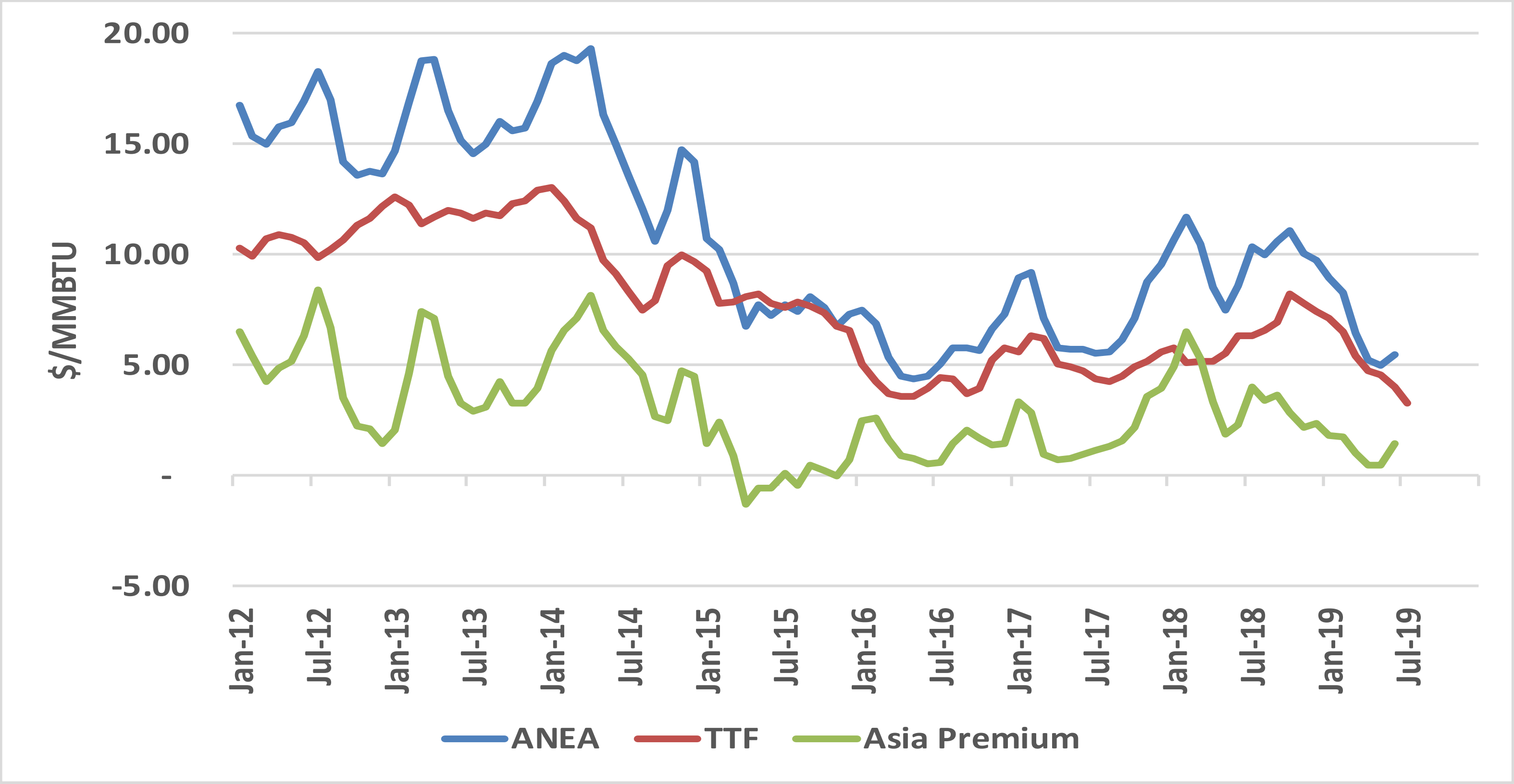
Ukraine and Belarus compared with the big producers and exporters

African Prices 2005-18 (Source: IGU Survey)



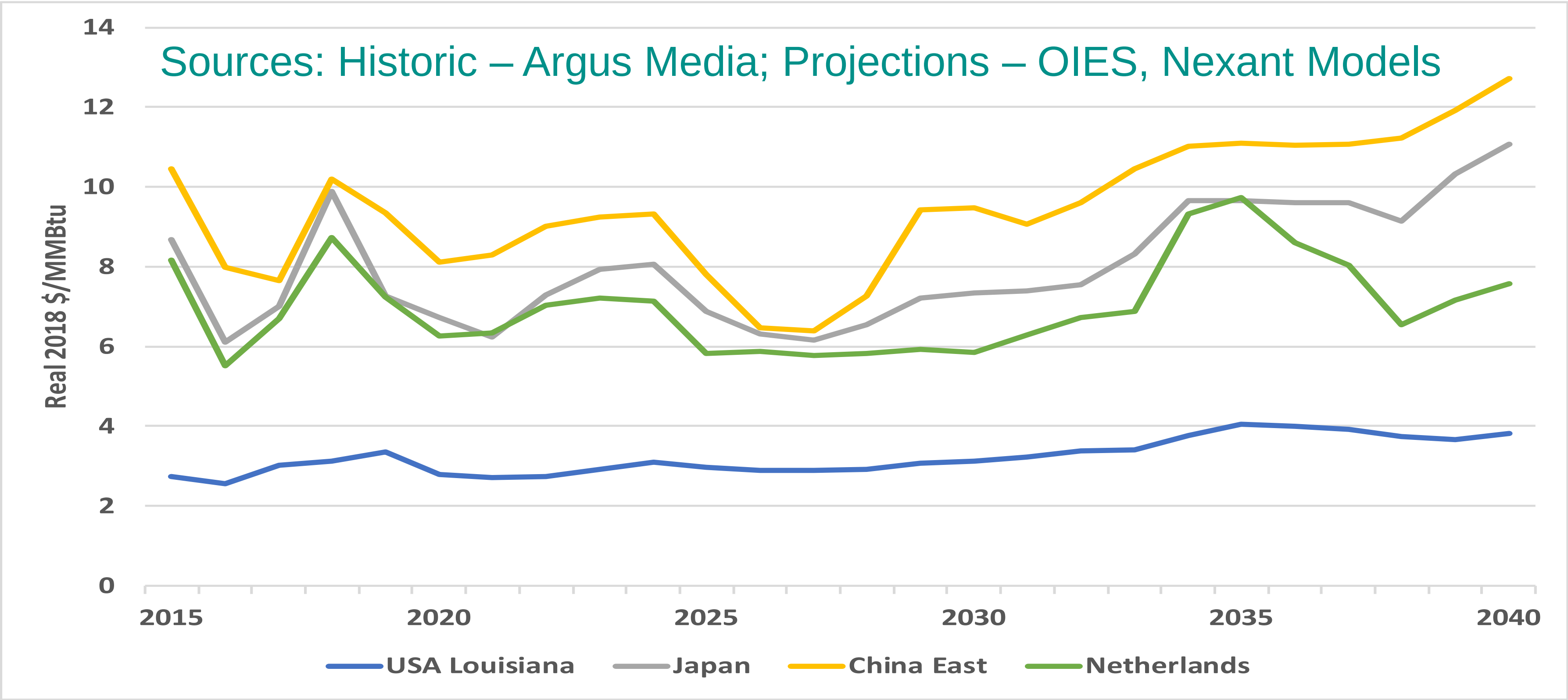
A big diversity: Tunisia, Morocco, Ghana, Ivory Coast, South Africa all above $4.MMbtu, aside from Algeria and Libya reform is visible

Spot Gas/LNG Prices in Europe and Asia: the changing `Asian Premium' 2012-19



- Excess supply has led to converging spot prices – Asia premium has disappeared
- Little to suggest in supply – demand analysis that it will re-emerge soon apart from weather-related seasonality

Spot Gas/LNG Price Projections for US, Europe and Asia 2015-40



- Cyclicality in prices – boom and bust cycle – as new projects (especially LNG) come online in waves
- Henry Hub rises to $4 to 2040; Europe $6 through 2030
- Asia much lower gas/LNG prices to 2030 but still too high for many countries?

SUMMARY AND CONCLUSIONS

Decarbonisation Challenges for Gas Markets in Europe post-2030

- Biogas/biomethane potential is limited
- Hydrogen potential from electrolysis (even from off-grid RES) is relatively small up to 2040 so…
- Large scale hydrogen will initially need to come from reformed methane with CC(U)S but..
- large scale CCS projects are not yet under way and in many country are not possible
- Networks lack uncertainty how to prepare for a mixture of decarbonised gases because…
- technical/regulatory frameworks are lacking

Although each country will have its own narrative, these will be difficult problems to resolve

Affordability/Competitiveness Challenges in Many Lower Income Countries

- Affordability – many non-OECD countries unable to pay prices above $6 to remunerate new gas projects; in OECD prices above $8/MMbtu will destroy demand
- Competitiveness with domestic coal, and increasingly renewables, means gas will need to focus on non-power sectors; or be confined to a back-up role

The affordability/competitiveness challenge is NOW: is it worth developing new gas projects with costs above $6-8/MMbtu and for which markets? How many new projects can be delivered at that cost?

THANK YOU

jonathan.stern@oxfordenergy.org