Gas or Coal to Chemicals – will it ever work in a low oil price environment?

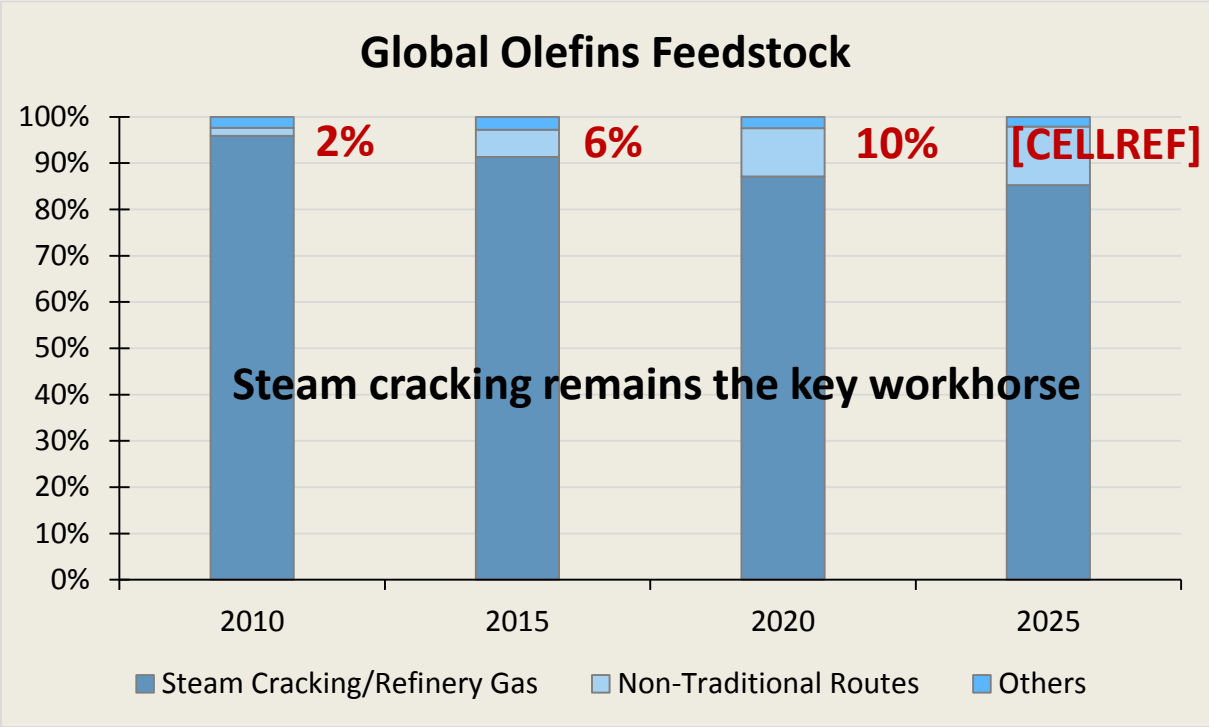
Balasubramaniam Ramani
Senior Consultant
ICIS Analytics & Consulting

Agenda

- Olefin sources as building blocks for Petrochemicals
- Olefin supply from Non-traditional routes and resultant impact
- Impact of Low Oil Price and Shale Gas Boom
- Summary

Olefin sources as building blocks for Petrochemicals

Steam cracking remains the key workhorse for petrochemical production, although non-traditional routes (CTO/MTO and PDH) capacities are expected to gain an important share



Non-traditional sources include CTO, MTO, PDH *(Discussed in next section)*

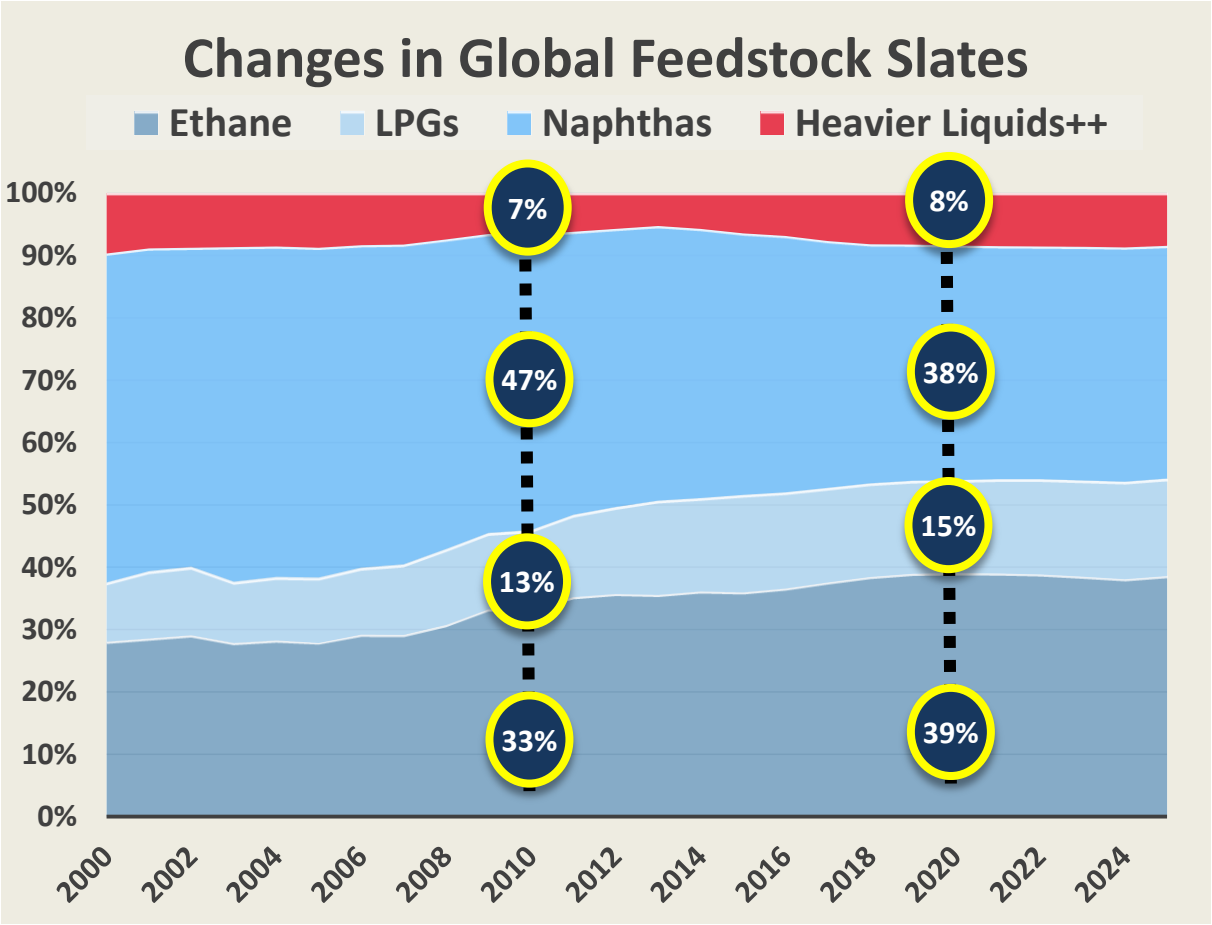
Olefins feedstock via non-traditional routes are expected to make up 13% by 2025

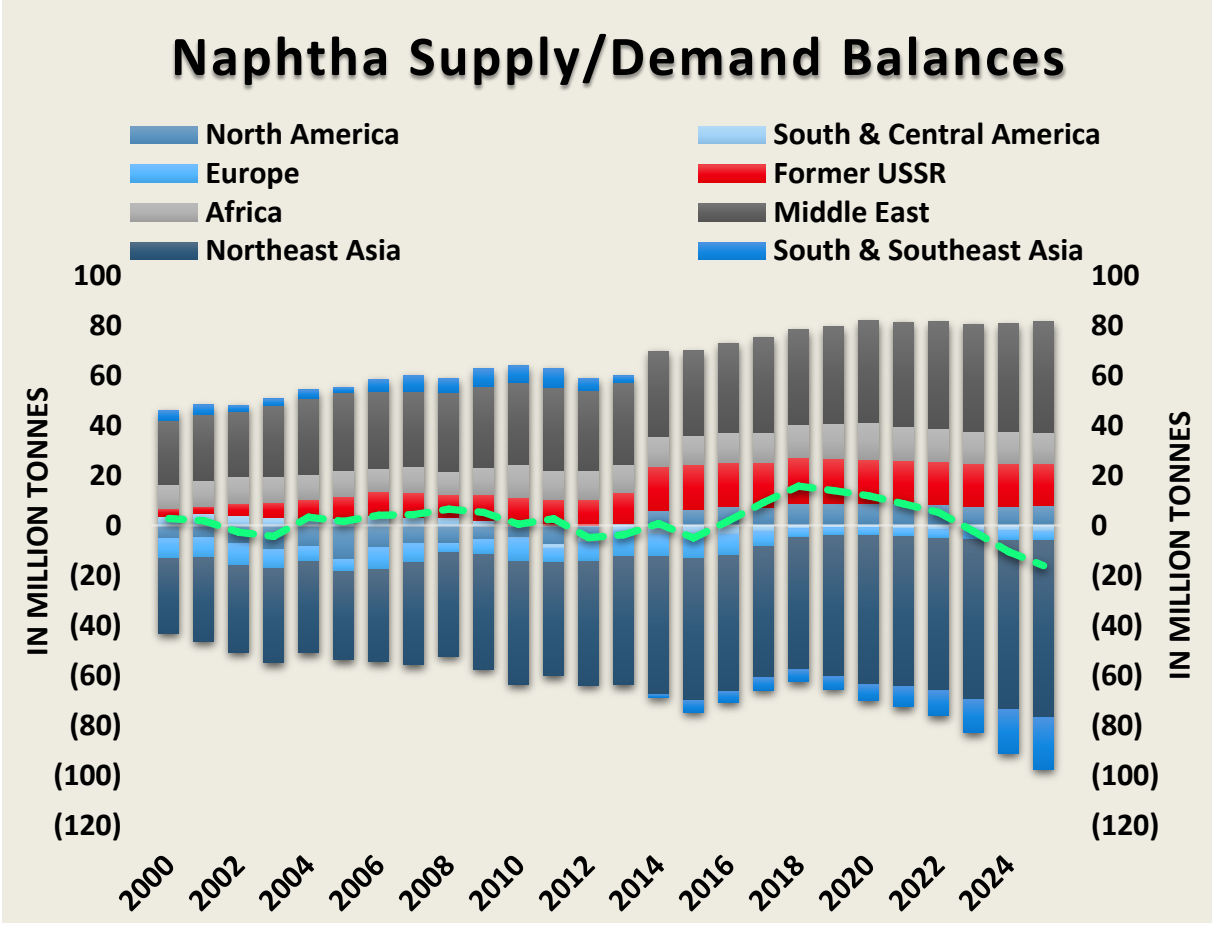
How is this likely to affect pricing of olefin as well as derivatives?

Source: ICIS Supply and Demand Database

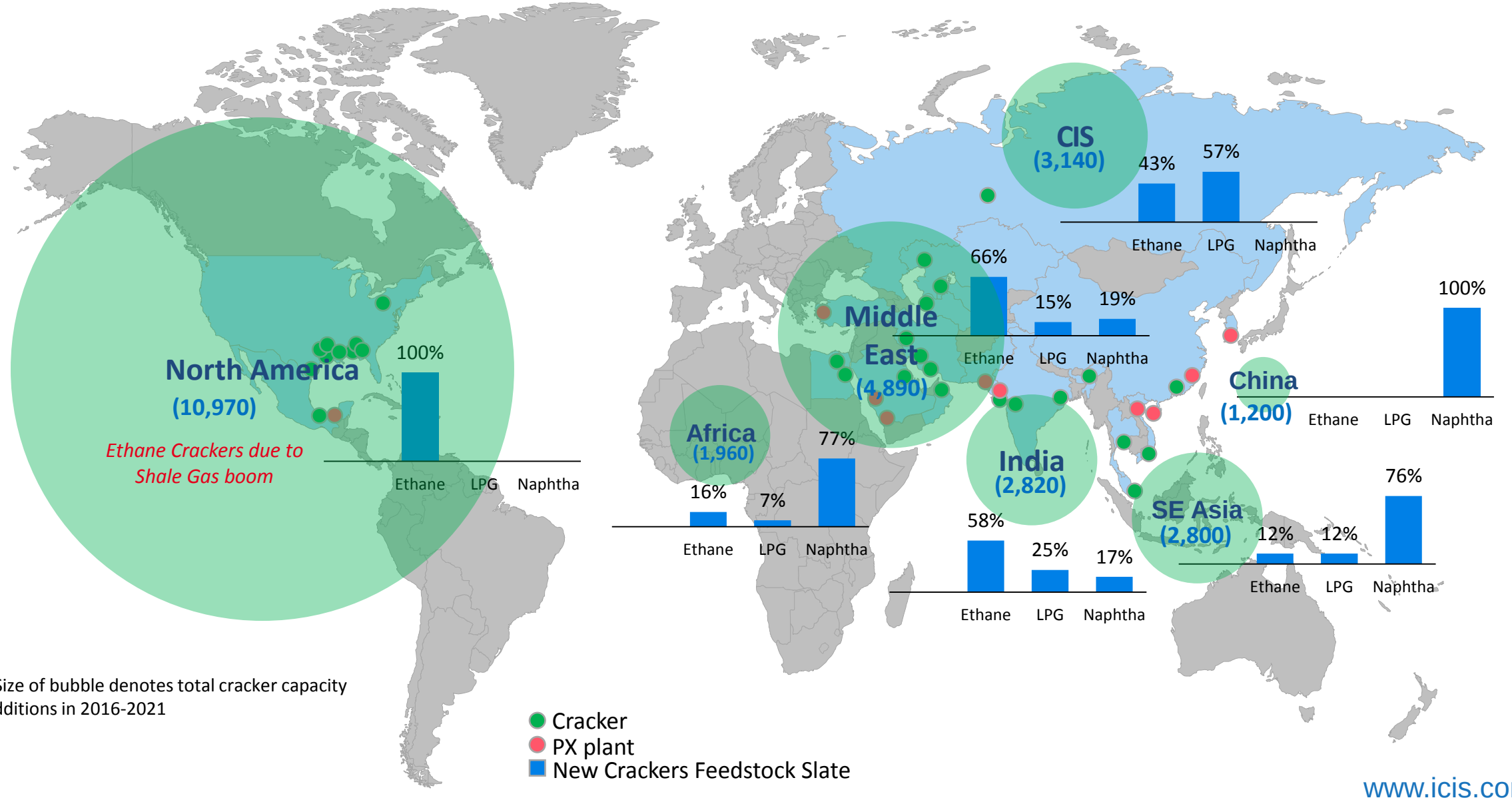
Initially from a Naphtha supply point of view: it will remain more than sufficient to satisfy the rise in demand until early 2020s, after which more refining capacities are likely to be required

- Petrochemicals (both olefins & aromatics) will play a growing part in oil demand via naphtha feedstock, in comparison to naphtha for gasoline blending





North America has the largest upcoming capacity for Steam Cracking between 2016 & 2021, followed by Middle East.



Upcoming Global Steam Crackers (2016-2021)

E – Ethane; L – LPG; N – Naphtha

		2016	2017	2018	2019	2020	2021
NORTH AMERICA	**United States**		**Chevron Phillips Chemical** 1500ktpa (E) **Dow Chemical** 1500ktpa (E) **Exxonmobil Chemical** 1500ktpa (E) **Indorama Ventures** 375ktpa (E) **Ingleside Ethylene** 545ktpa (E)	**Shintech** 500ktpa (E)	**Sasol** 1500ktpa (E)	**LACC – Lotte/Axiall** 1000ktpa (E)	**Shell Chemicals** 1500ktpa (E)
	Mexico	**Braskem Idesa** 1050ktpa (E)					
AFRICA	**Egypt**	**Egypt Ethydco** 460ktpa (E)				**Tahrir Petrochemicals** 1500ktpa (N)	
MIDDLE EAST	**Iran**	**Kavian Petrochemical** 1000ktpa (E)		**Gachsaran Petrochem** 1100ktpa (E) **Ilam Petrochemical** 490ktpa (E/L)			
	Oman					**ORPIC** 800ktpa (N)	
	Saudi Arabia	**Sadara Chemical** 1500ktpa (E/N)					
CIS	**Kazakhstan**						**Kazakhstan PC Industries** 850ktpa (E)
	Russia						**Zapsibneftekhim** 1500ktpa (L)
	Turkmenistan				**Turkmenneftegaz** 390ktpa (L)		
	Uzbekistan	**UZ-KOR Gas Chemical** 400ktpa (L)					

Upcoming Global Steam Crackers (2016-2021)

E – Ethane; L – LPG; N – Naphtha

		2016	2017	2018	2019	2020	2021
NE Asia	**China**			**CNOOC and Shell PC** 1200ktpa (N)			
S & SE Asia	**India**	**BCPL** 220ktpa (E) **GAIL** 400ktpa (E) **OPaL** 1100ktpa (E/N)	**Reliance** 1100ktpa (E/L)				
	Malaysia						**PETRONAS Chemicals Group** 1200ktpa (N)
	Thailand					**PTTGC** 500ktpa (N)	
	Vietnam						**Long Son Petrochemical** 1100ktpa (N)

US Ethane Balances may get tighter, although ethane will not be short…

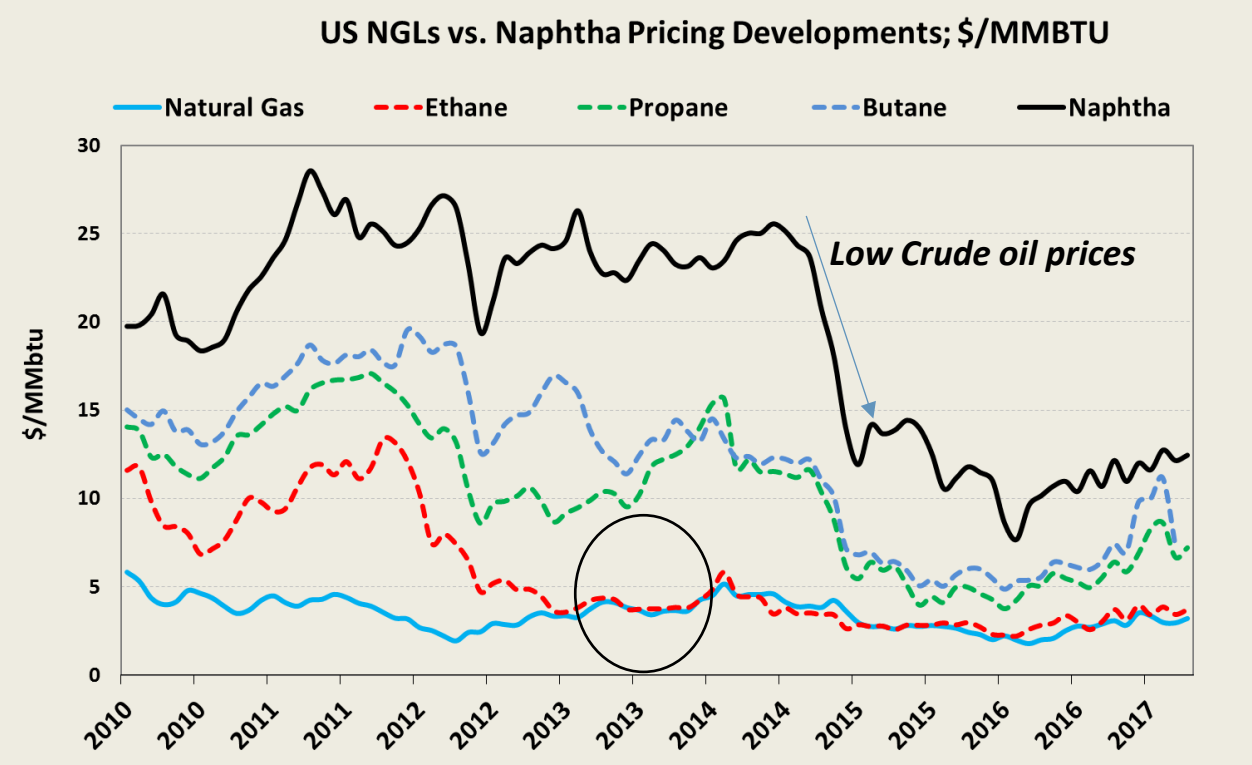
USA Ethane Exports

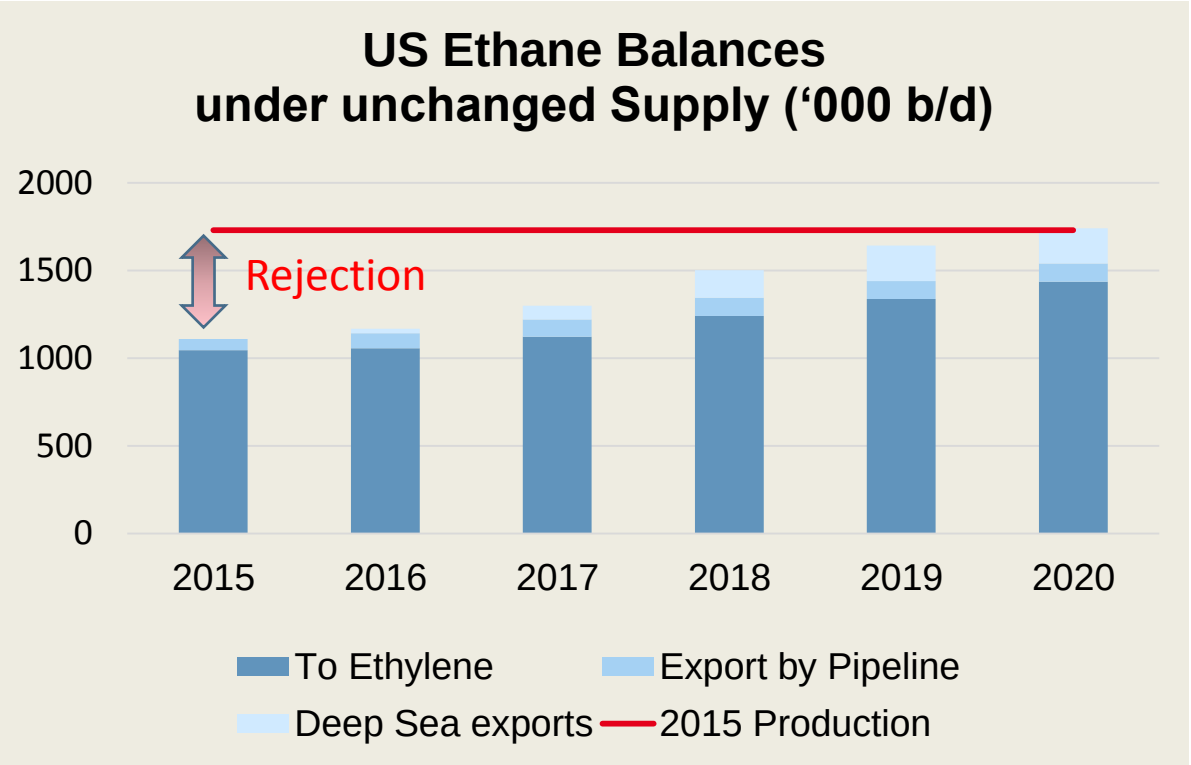
(Million Metric Tonnes)

	2015	2018	2020
Brazil	-	-0.2	-0.2
Canada	-1.5	-1.7	-1.8
India	-	-1.2	-1.6
Sweden	-	-0.6	-0.6
UK	0.0	-0.8	-1.1
Total USA Exports	1.5	4.5	5.3

Source: ICIS Supply and Demand Database

NGLs – primarily ethane, is changing the world of polyolefin manufacture…

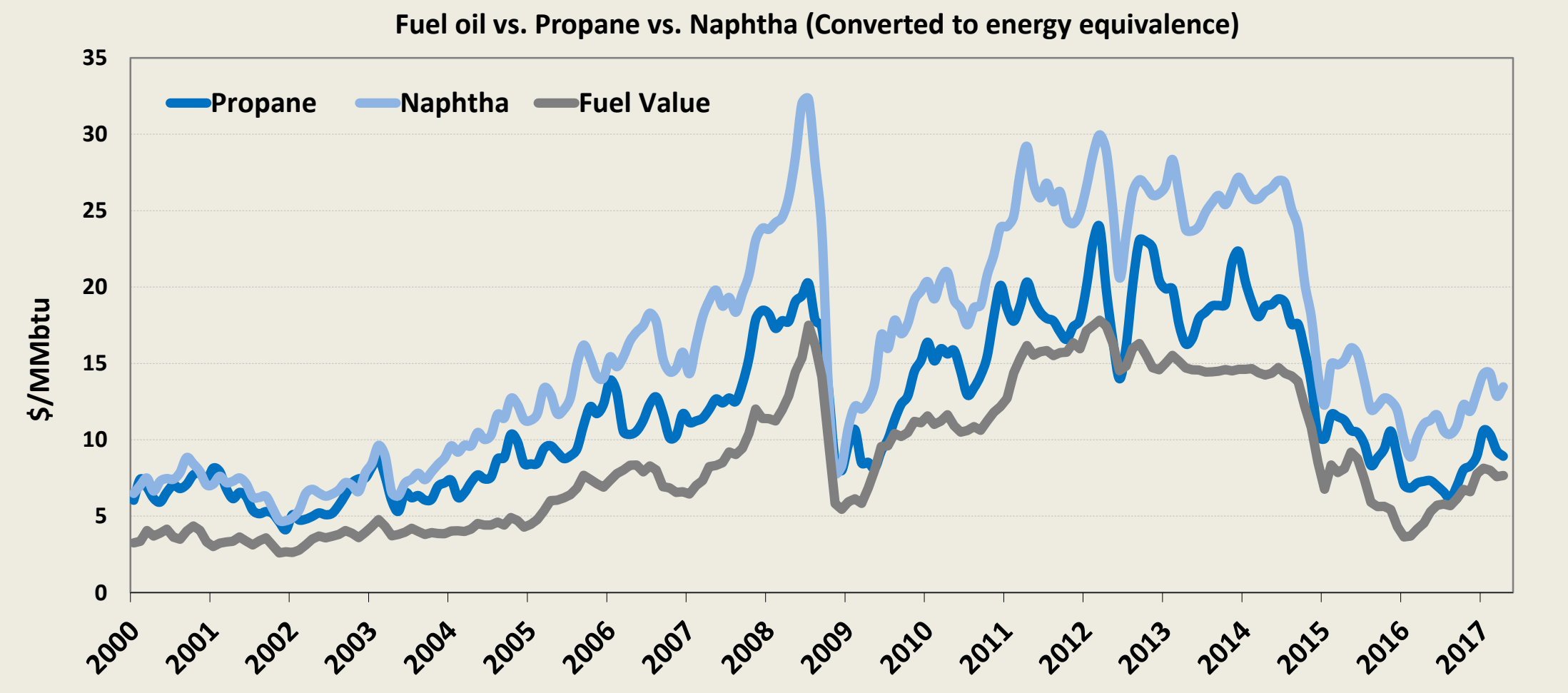




Source: ICIS Consulting & ICIS Pricing

- Ethane price is influenced by growth of USA shale production - A large amount of ethane remains "rejected", waiting for the new demand. But once demand arrives, more production will be required and transport costs featured…
- Propane availability suggests ample supply is available, but seasonal factors remain in place. Steam-crackers' with feedstock flexibility will have a substantial competitive advantage
- Developments in LPG price setting mechanisms, inline with naphtha cracking economics, could reward flexible crackers with seasonally cheaper, imported feedstocks

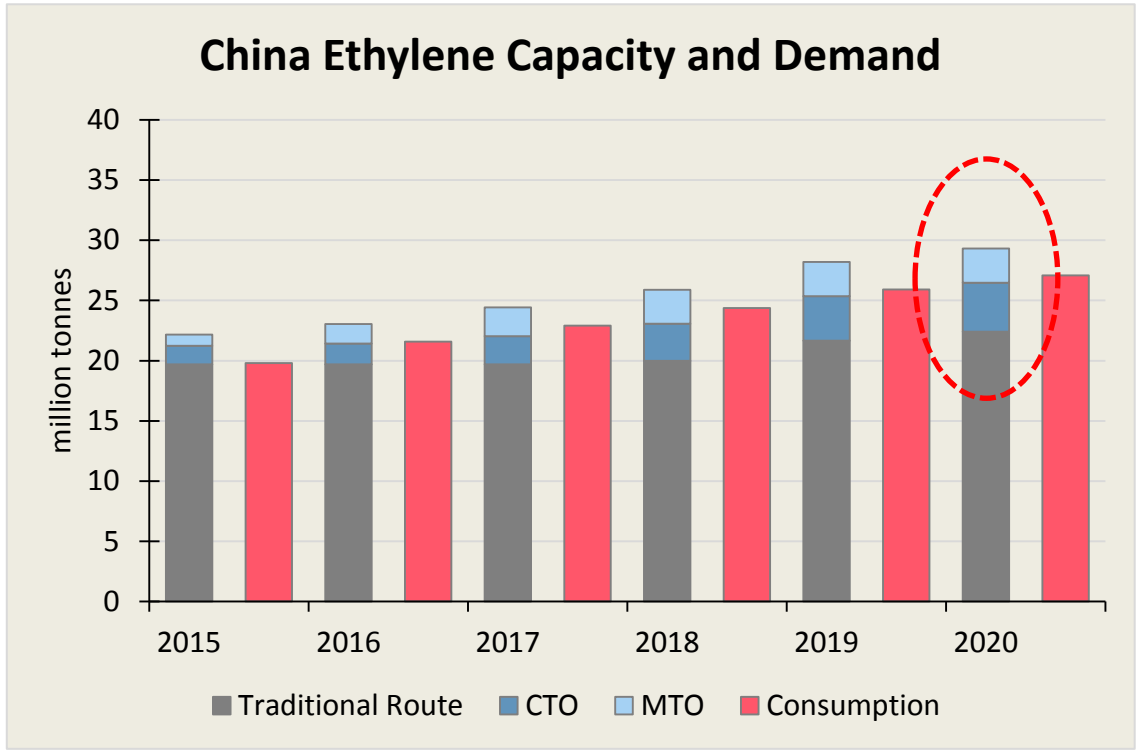
Asian Pricing for Propane, Naphtha and fuel oil.

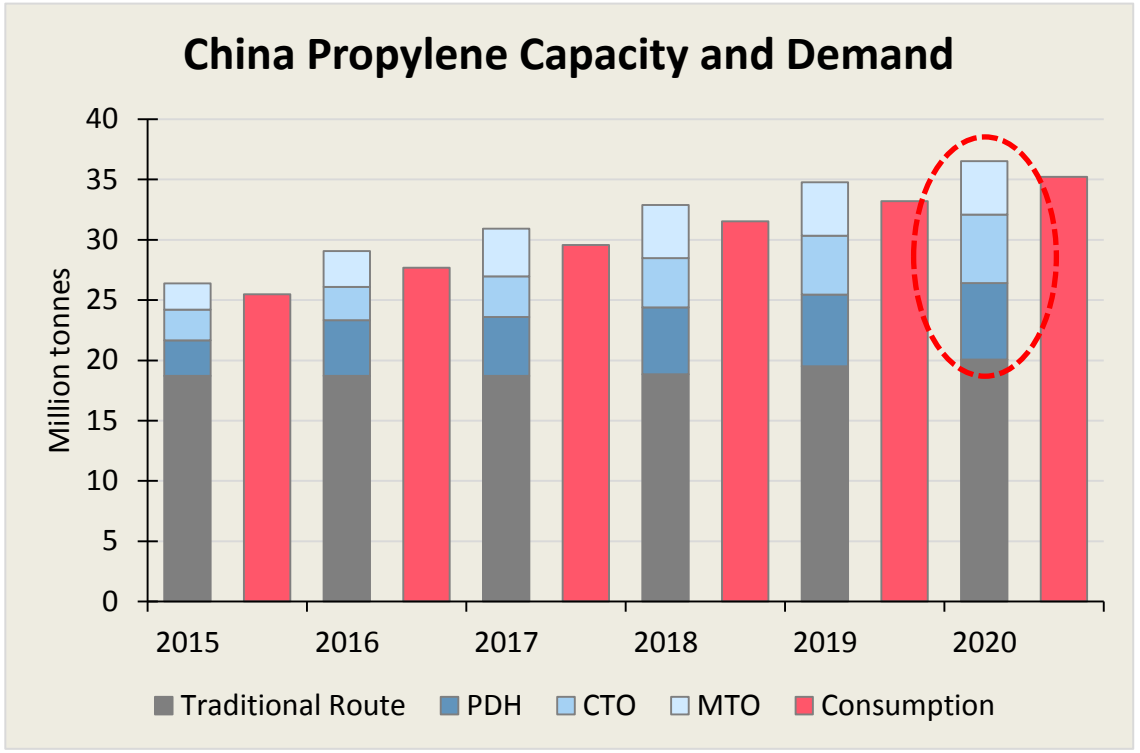


Source: ICIS Consulting & ICIS Pricing

Olefin supply from Non-traditional routes and resultant impact

In the case of China, non-traditional routes (CTO/MTO and PDH) fill a considerable demand gap

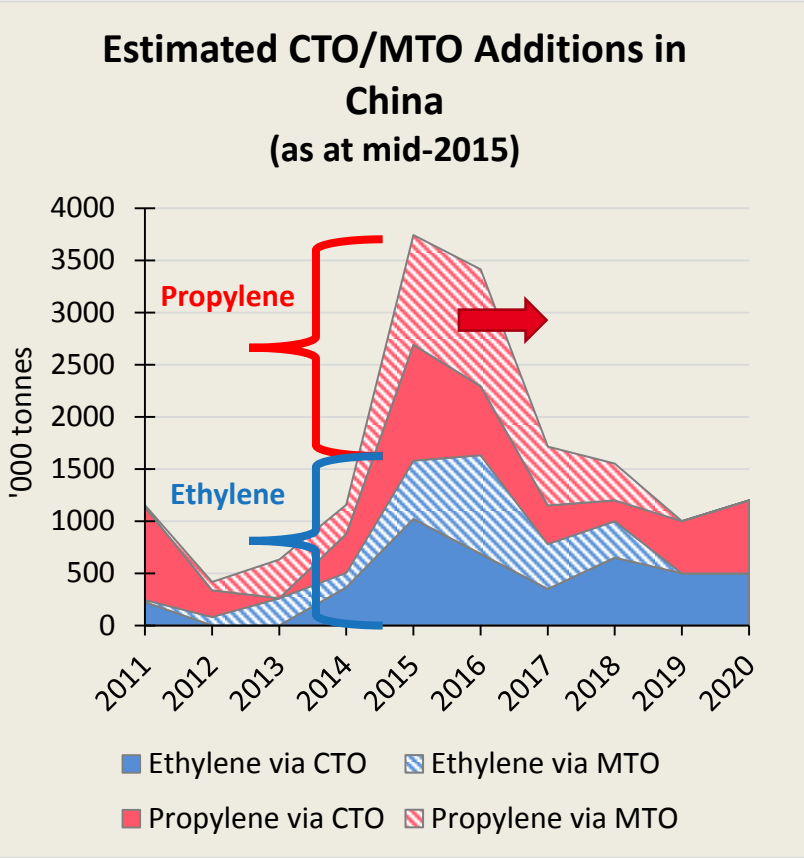


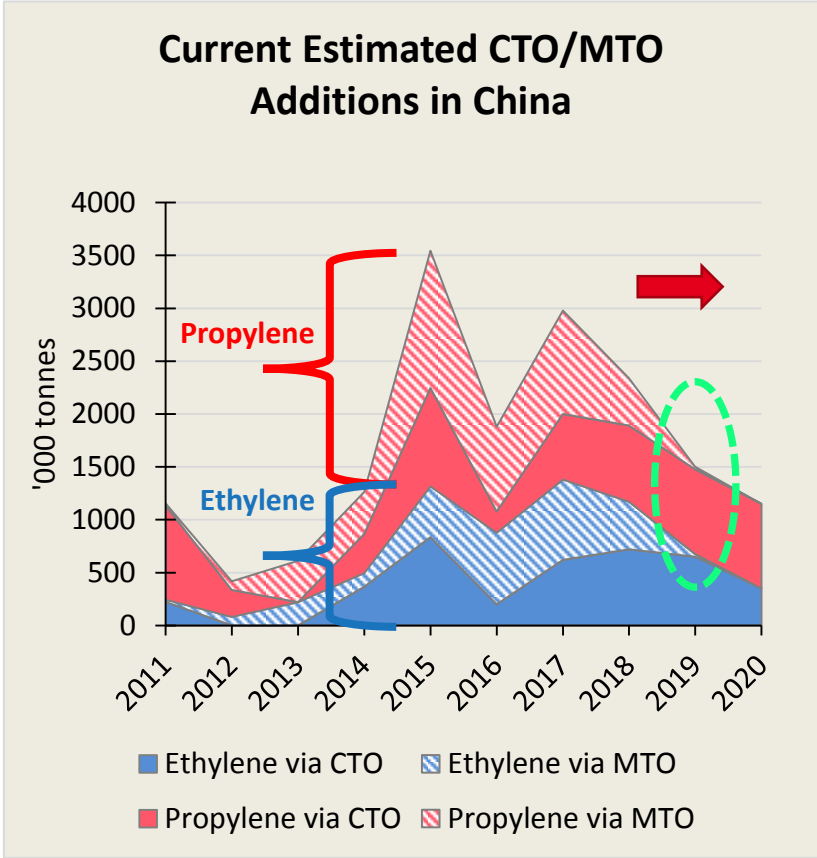


- Close to 7m tonnes/year of ethylene capacity is expected to be via CTO/MTO by 2020
- Above 16m tonnes/year of propylene capacity is expected to be via PDH and CTO/MTO by 2020

Source: ICIS Supply and Demand Database

Several CTO/MTO start-ups have been delayed with the current low oil environment





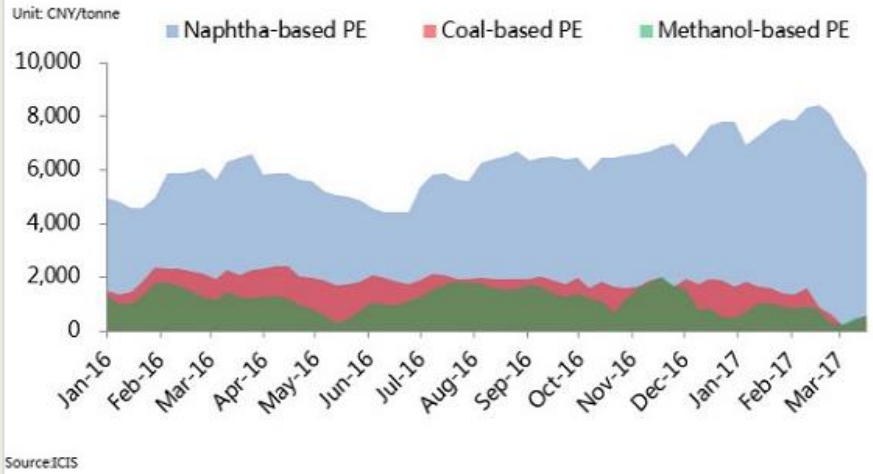
Source
ICIS News

China PE start-ups from CTO may be hindered by poor margins

11 April 2017 05:05

"Shanxi Coking Group, for example, has postponed its start-up schedule from 2014 to 2017."

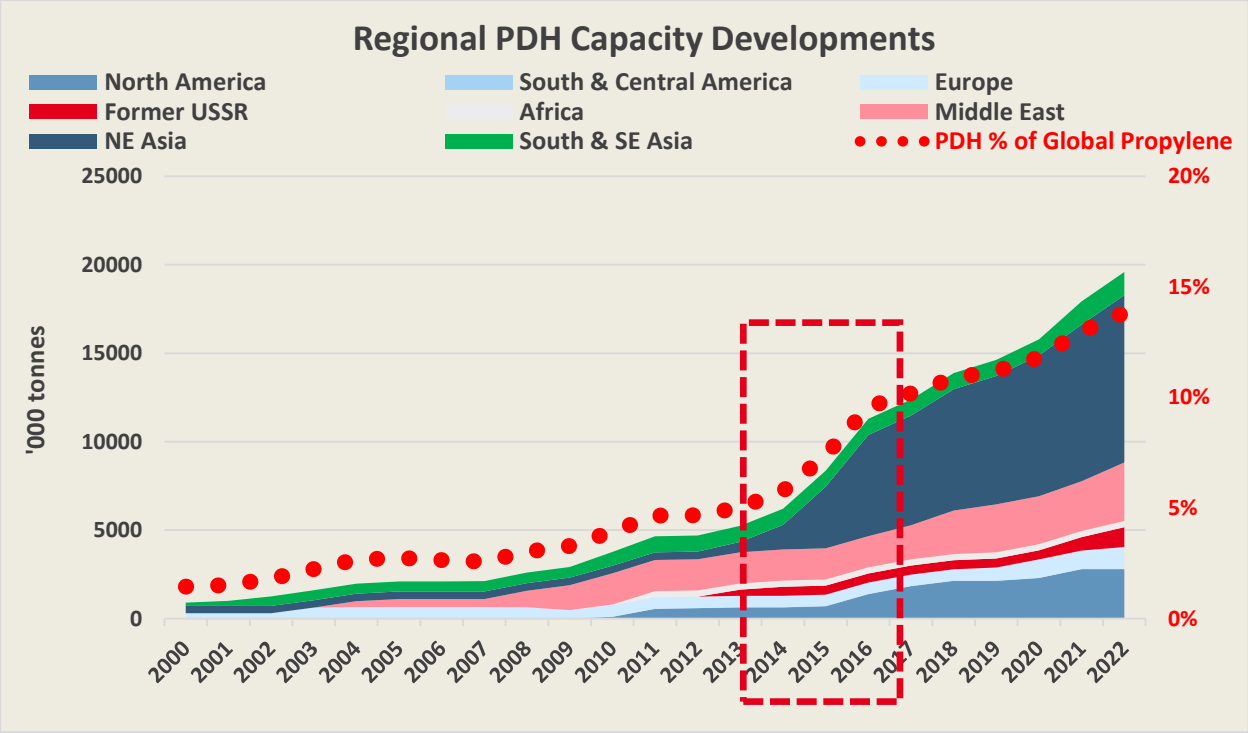
"Jiutai Energy has put off indefinitely the start-up of its 250,000 tonne/year high density polyethylene (HDPE)/LLDPE swing plant via the CTO route."

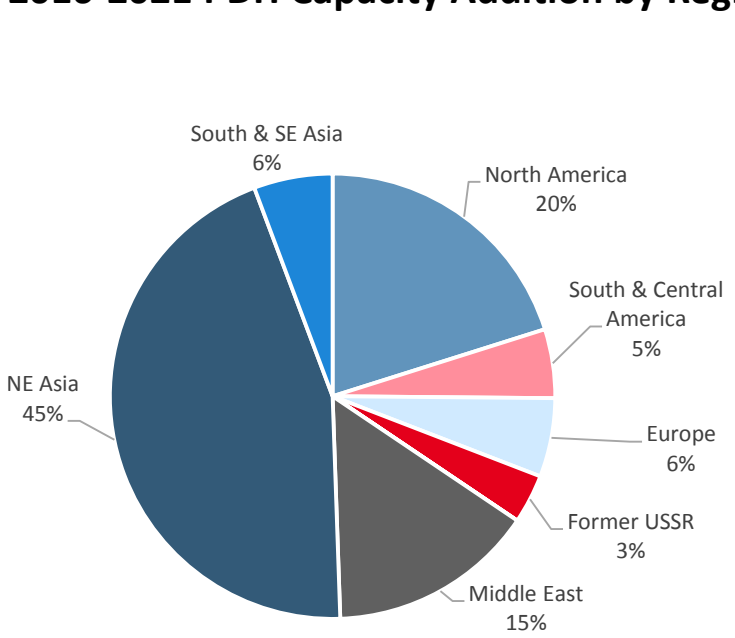


- Several planned start-ups have lapsed; expected delay about 1-2 years
- Further out, development of methanol to olefins is expected to fizzle out, although investments in coal to olefins will remain.

Source: ICIS Supply and Demand Database

PDH is fast growing as a more common propylene supply mechanism in order to balance the market

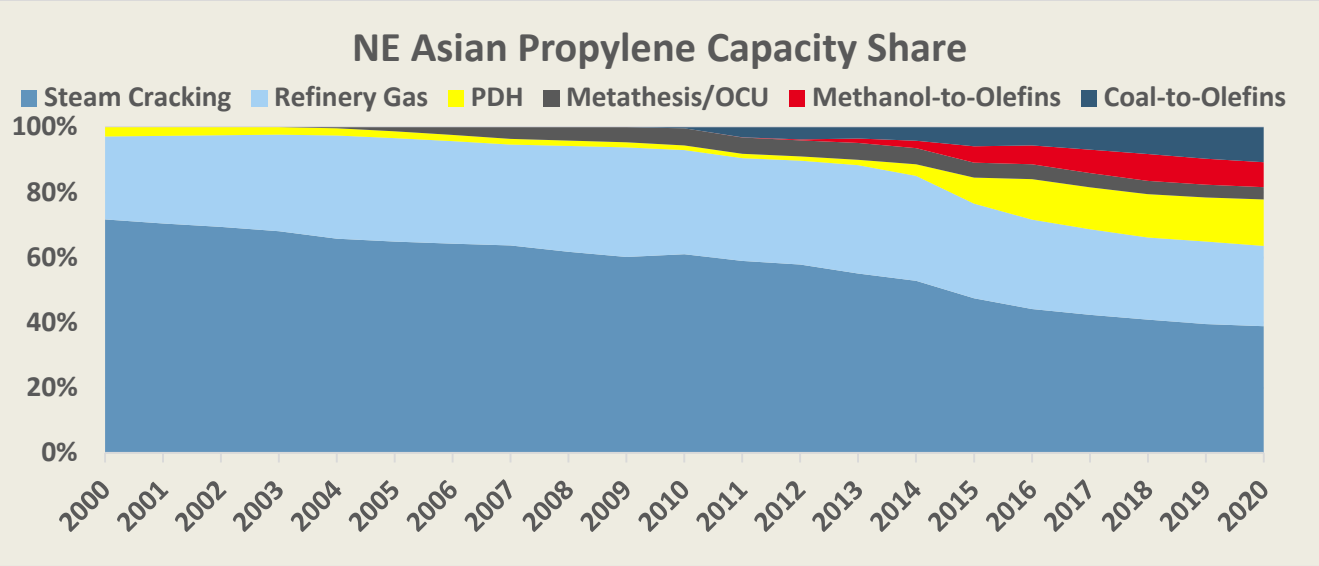


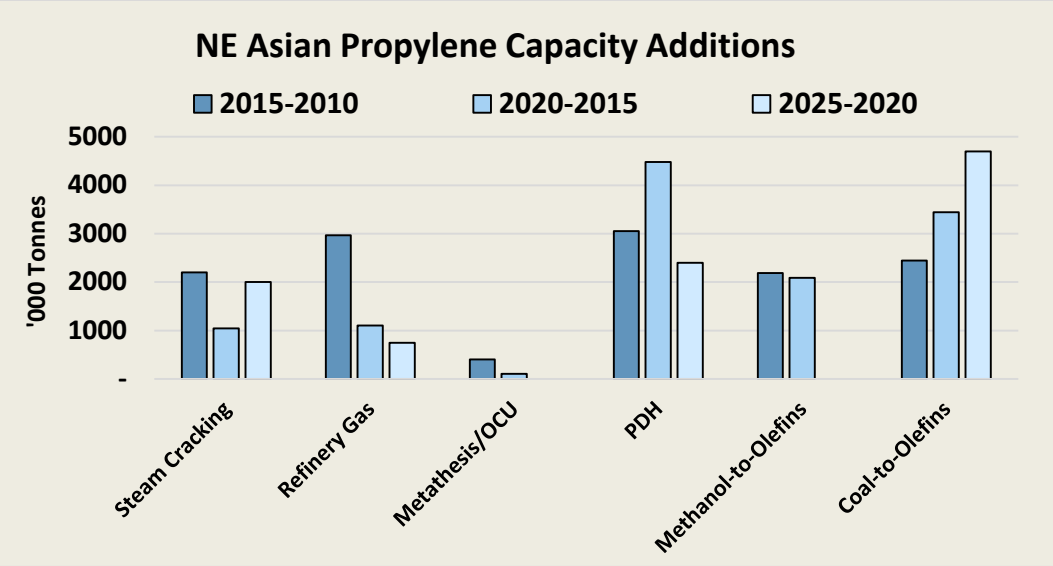


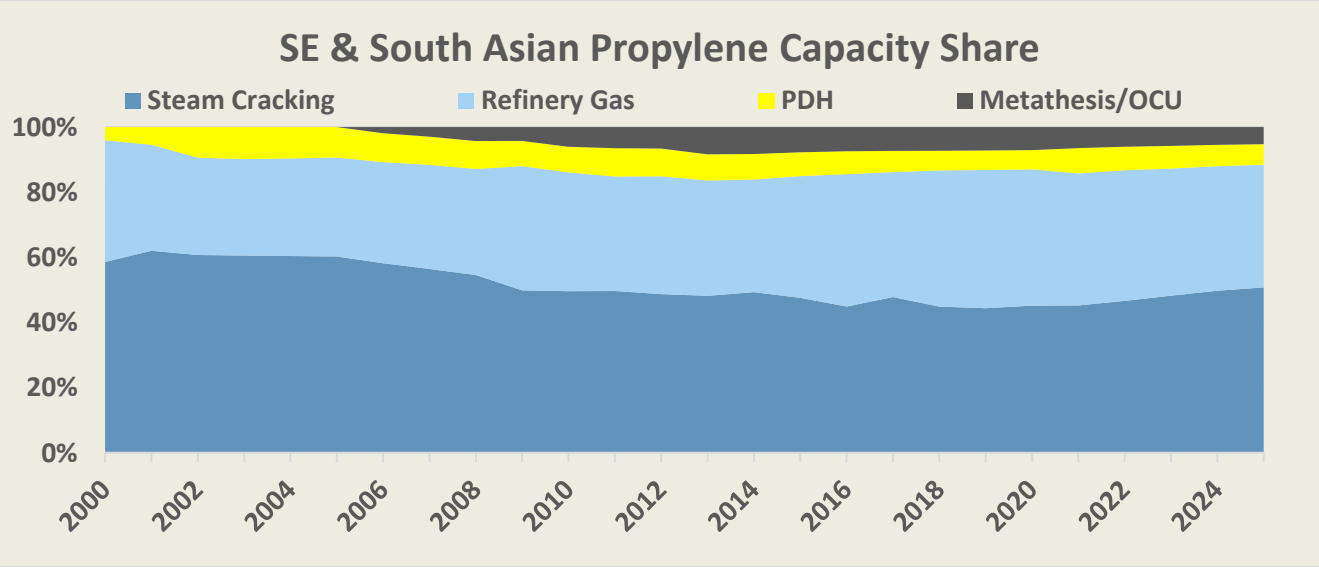
- Past few years saw the peak of PDH capacity addition, with more than 6 million tonnes/year of capacity added in 2014-16.
- 1.1m expected in 2017.
- More than 60% of PDH capacity addition in the future will come from the US and NE Asia.

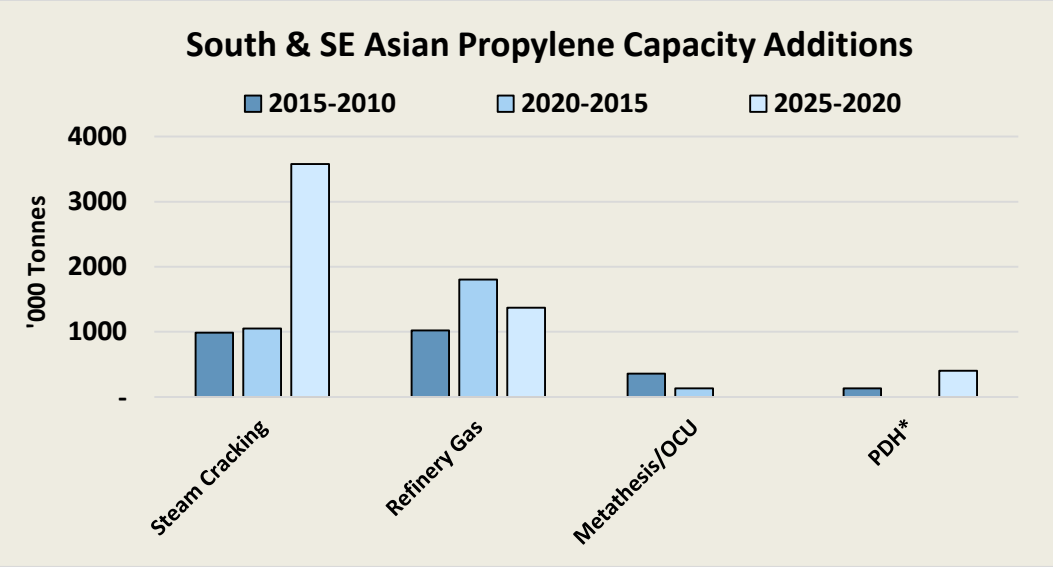
Source: ICIS Supply and Demand Database

Firm supply-demand fundamentals + Availability of imported NGLs (both planned & fortuitous) promote investments in on-purpose PDH-based propylene production especially in NE Asia





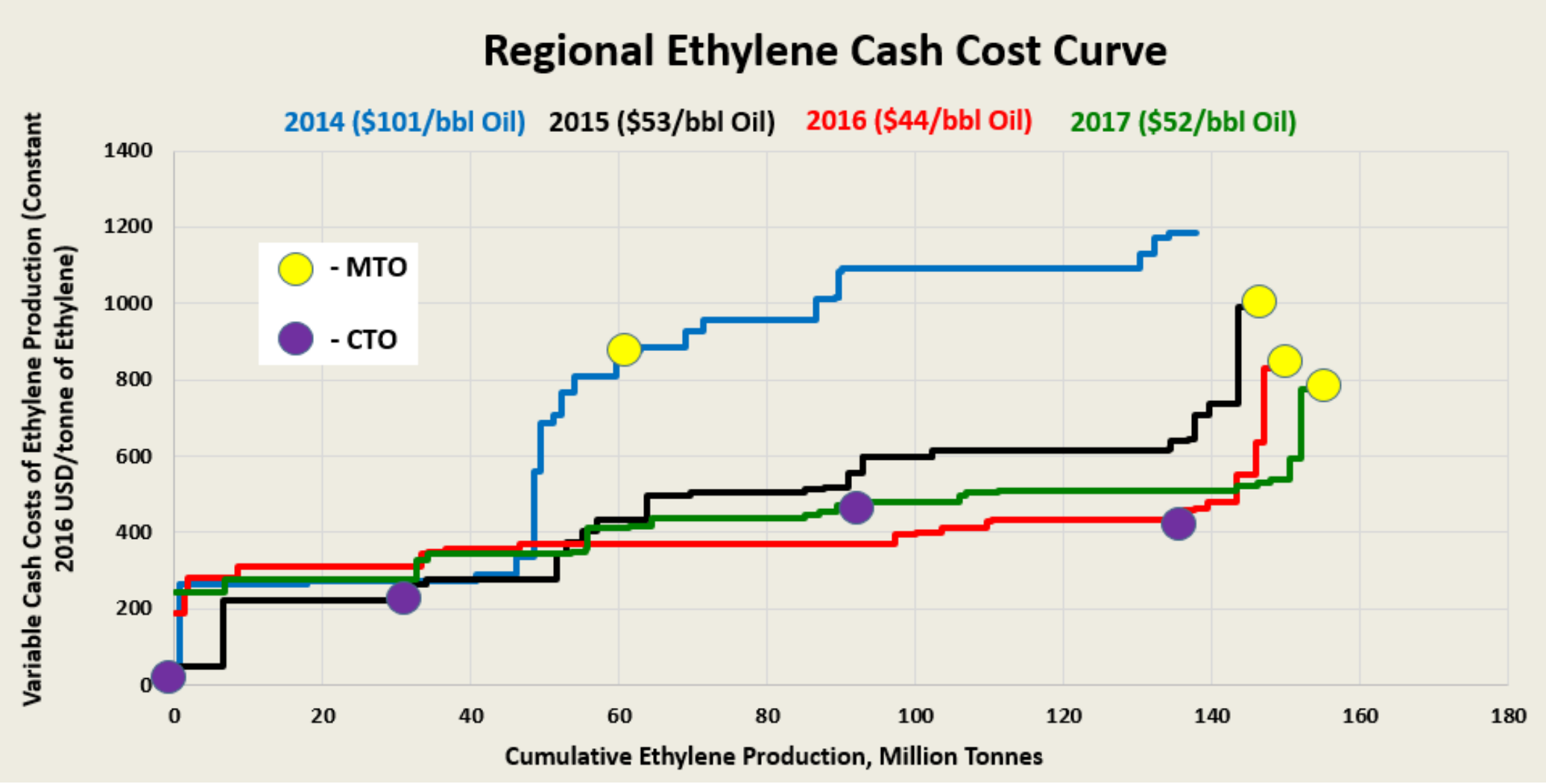




Source: ICIS Supply and Demand Database

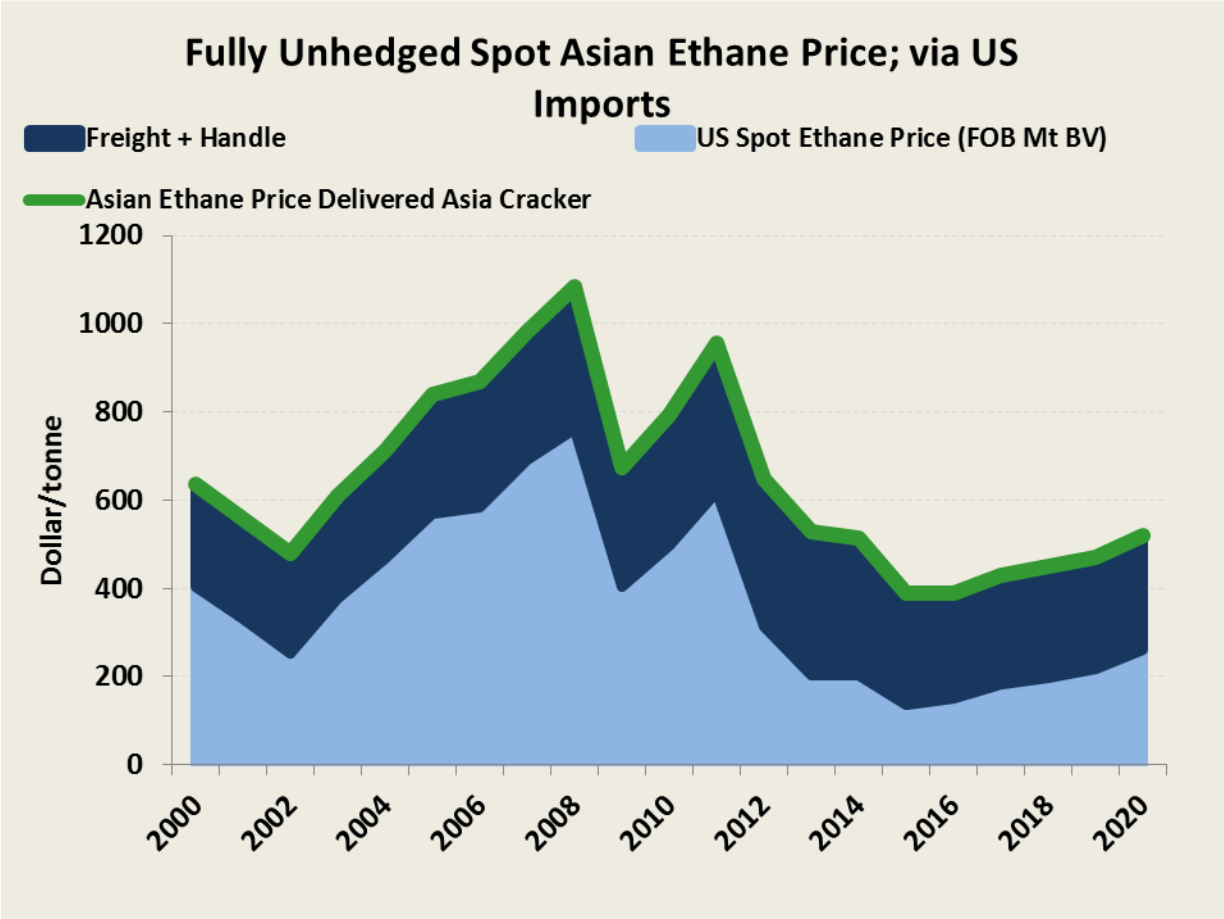
Impact of Low Oil Price and Shale Gas Boom

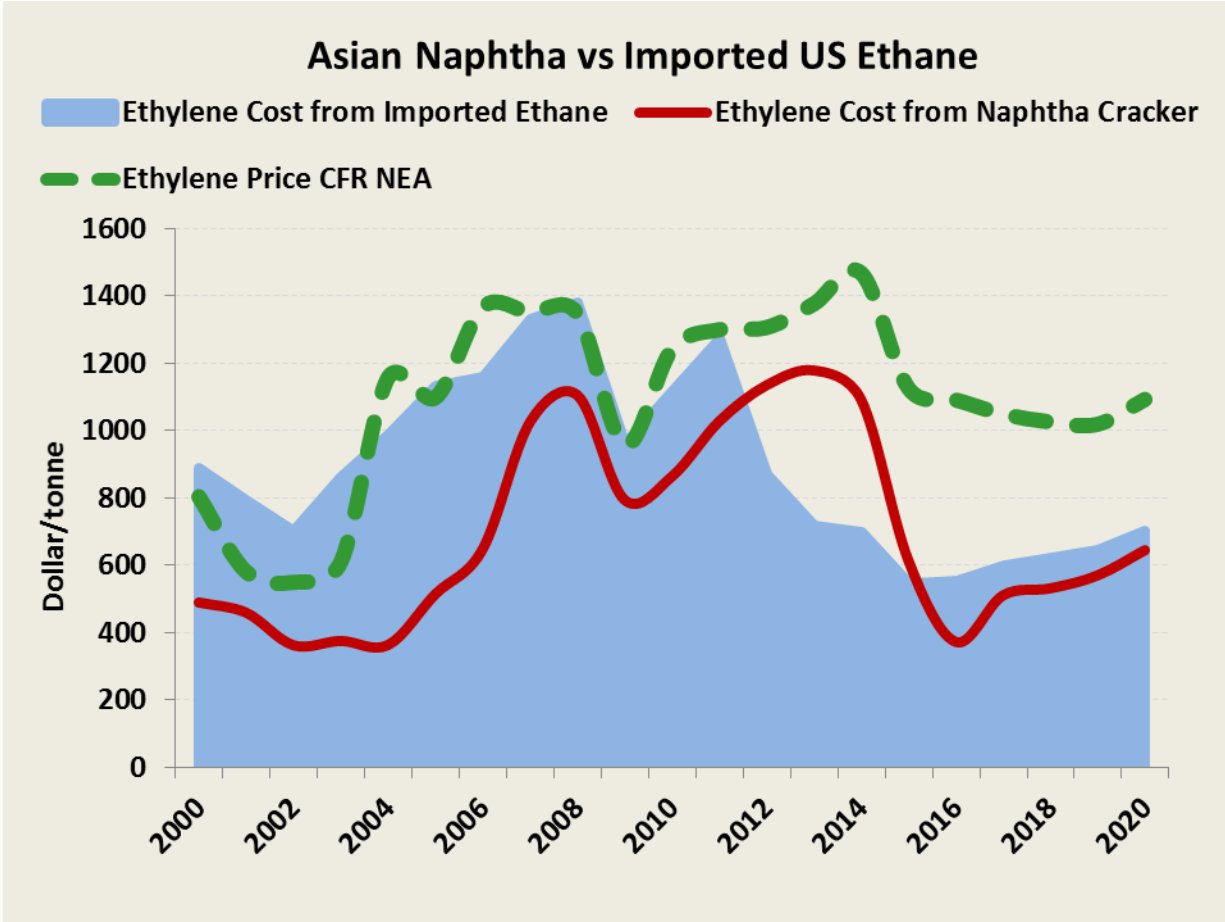
With the fall in oil prices, the ethylene cost curve flattened dramatically, reducing the ingrained competitive advantage of ethane crackers in North America or the Middle East. From a C2 perspective, CTO loses it's cost advantage in a lower oil scenario



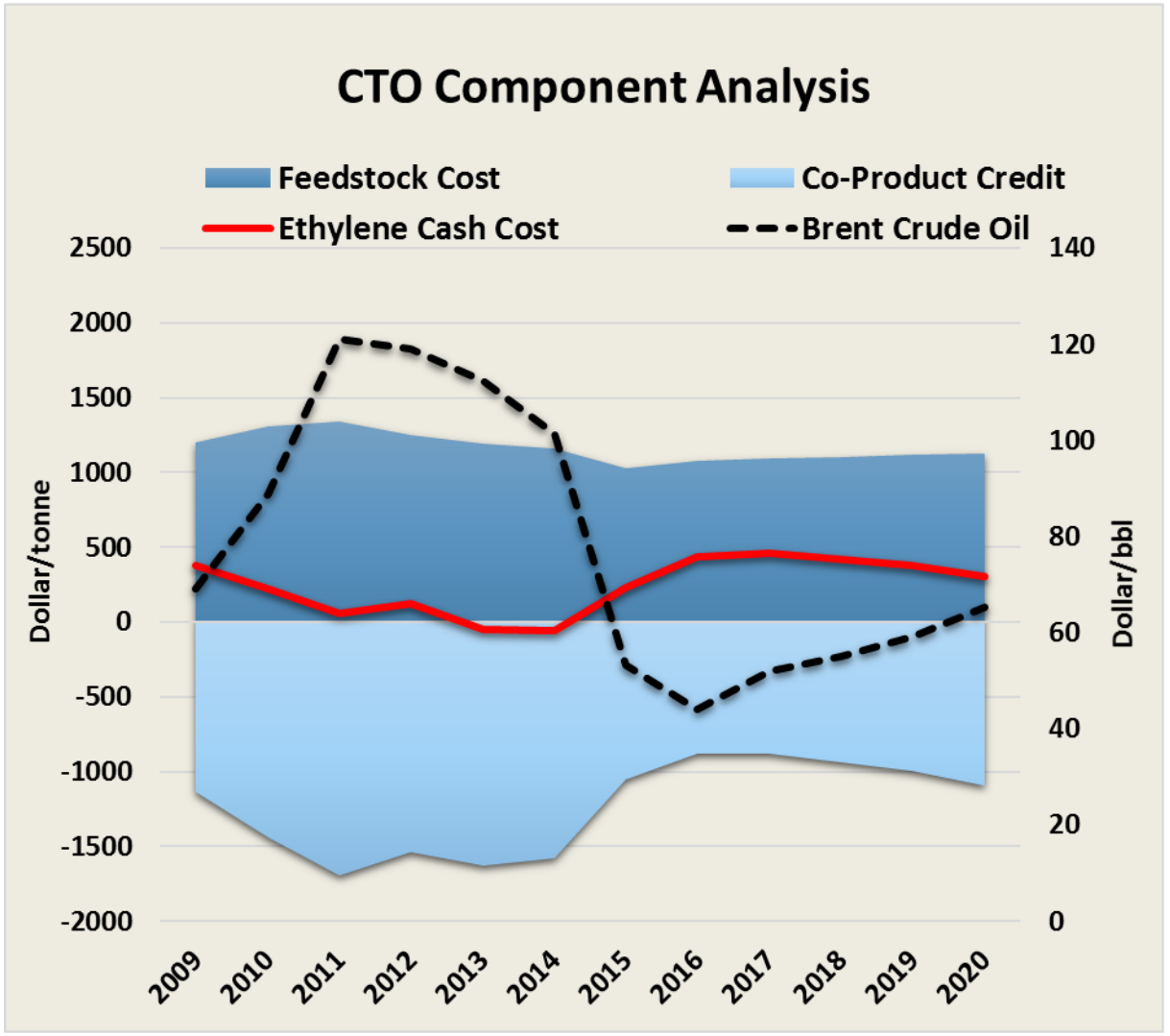
Asian Cost Comparisons: Imported Ethane vs Traditional Naphtha

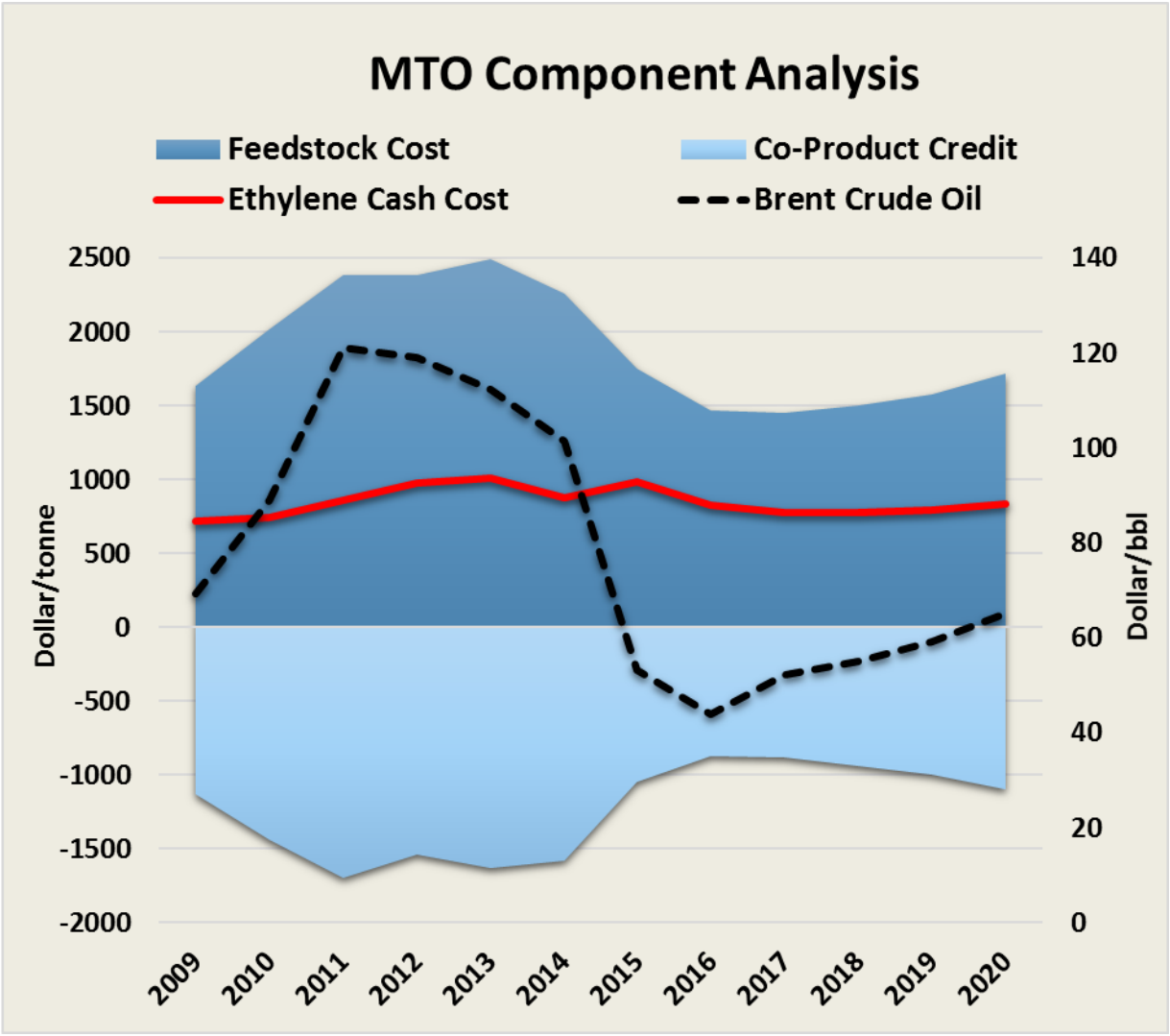
- The ‘easy decision’ window on ethane imports from the US has closed
- Risk appetite, any hedging opportunities & infrastructure will be important considerations





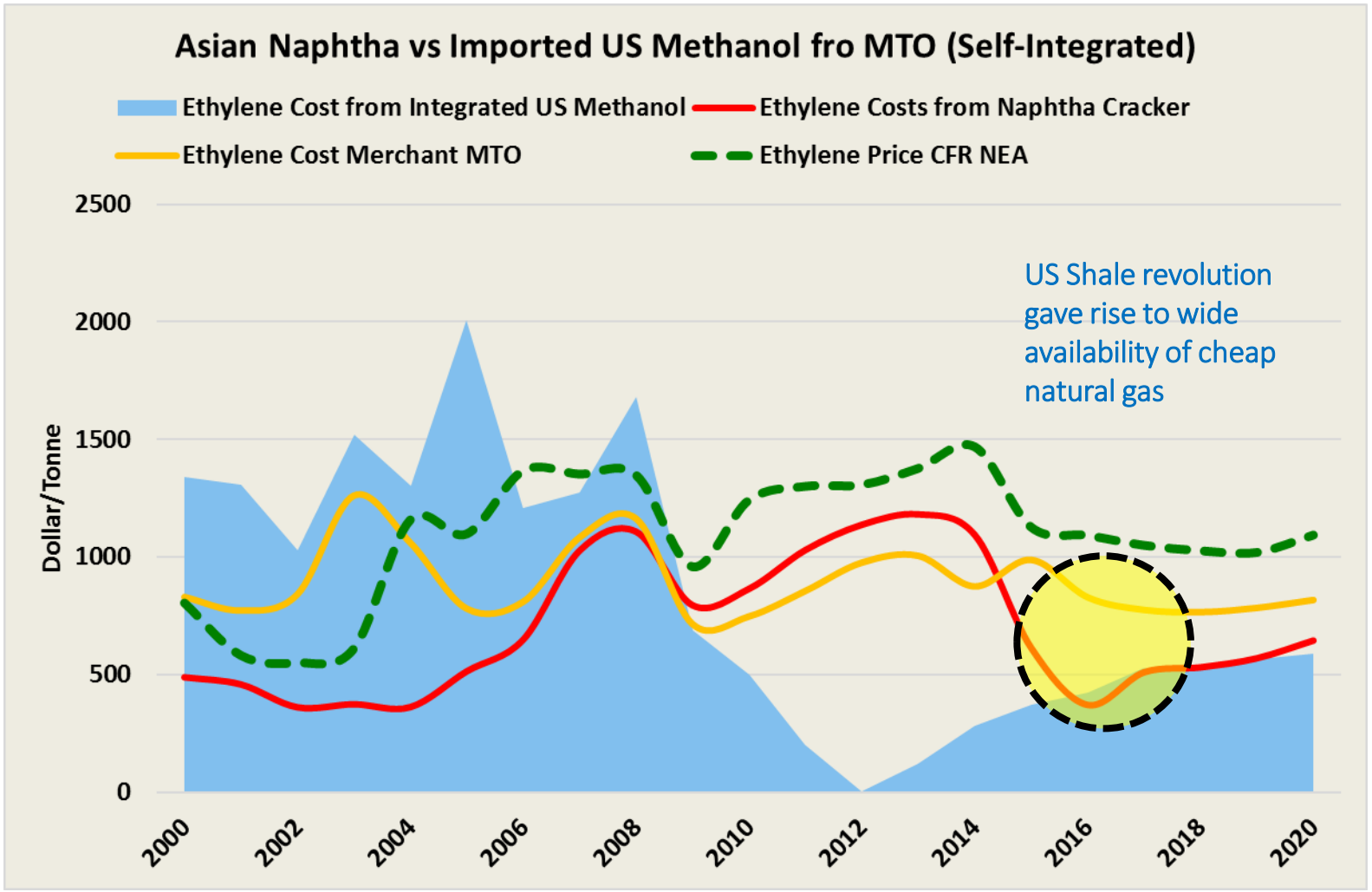
Although generally lower cost, CTO costs are highly leveraged to oil prices via a ‘round-about’ mechanism. MTO costs are higher, but less volatile.





Source: ICIS Supply and Demand Database

Lower oil closes window for MTO projects “integrated” to US methanol -- ‘Poor Man’s LNG’



- Chinese companies have plans to invest in methanol production in the US and ship to China, riding on the cheap natural gas
- The advantage, however, has disappeared in the low oil environment
- Assume ~$60/bbl Brent oil in 2020

Source: ICIS Consulting

In Summary

In Summary – the Impact of Low Oil

- Non-traditional routes (PDH/CTO/MTO) are not as attractive as an option in lower oil scenarios
  - Much lower Naphtha prices and fairly healthy co-product demand have helped to lower naphtha cracking costs while demands of polyolefins remain strong
- However, non-traditional capacity additions have helped to satisfy supply – demand balances – and will be required in the future, especially for C3 chains.
- Current slimmer margins will make it more difficult to justify new non-traditional route methanol-based investments, especially in market priced methanol-to-olefin projects.
- CTO & PDH investments will play a part of future olefin supply, as easier a market balancing requirement or a ‘strategic’ development.

Contact us

Balasubramaniam Ramani

Senior Consultant
ICIS Analytics & Consulting
Tel: +65-6780-4853
Mob: +65-8233-7305
Email: bala.ramani@icis.com

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Events Shaping Future Energy Demands

In Summary – Traditional vs. Non-traditional routes

Traditional Route

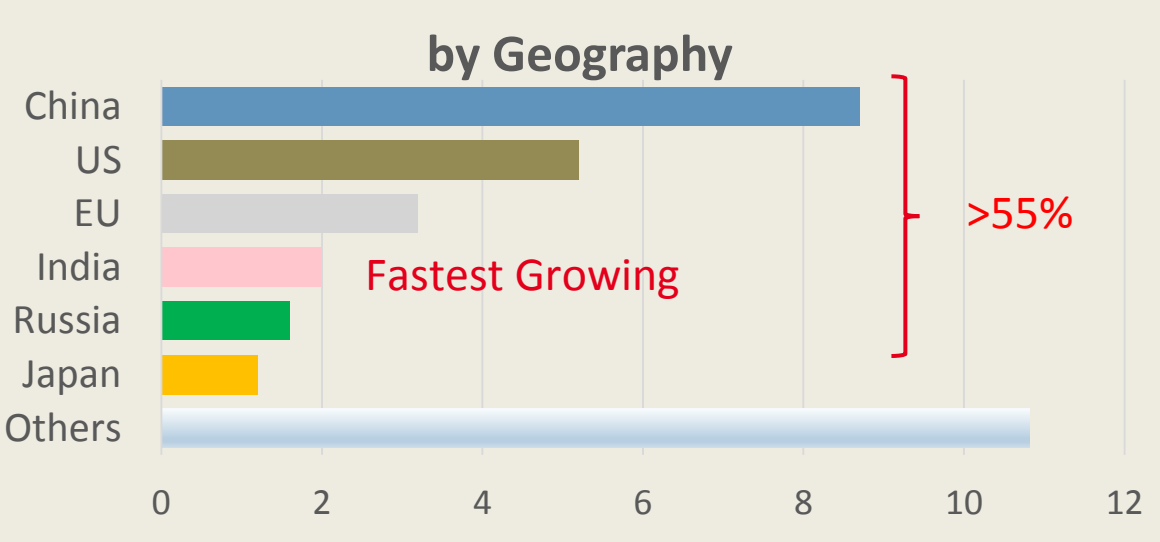
- Low oil price has lead to improved margins for Naphtha-based producers
- US ethane-based ethylene derivatives exports still viable albeit narrower spread against Asia market
- Projects based on imported Ethane into Asia might not be viable solely from an economic standpoint

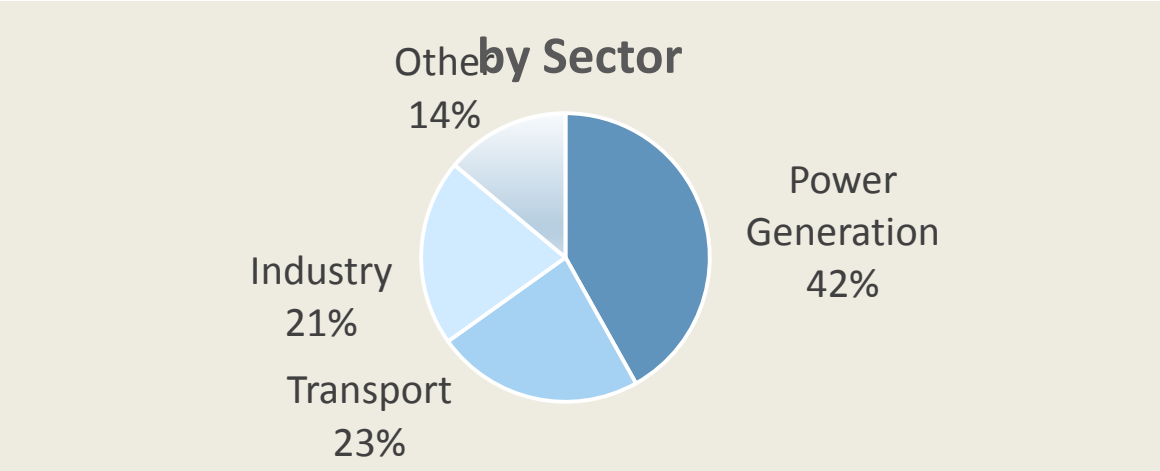
Non-Traditional Route

- Among non-traditional routes, PDH remains most viable
- CTO moves to the far right in the ethylene cost curve
- MTO based on merchant methanol shifts to the top of cost curve
- Advantage of MTO project "integrated" to US methanol eroded

2015 Paris Climate Conference (COP21) aims to limit increase of global temperature to well below 2°C above pre-industrial levels

Energy Related CO2 Emissions (*)



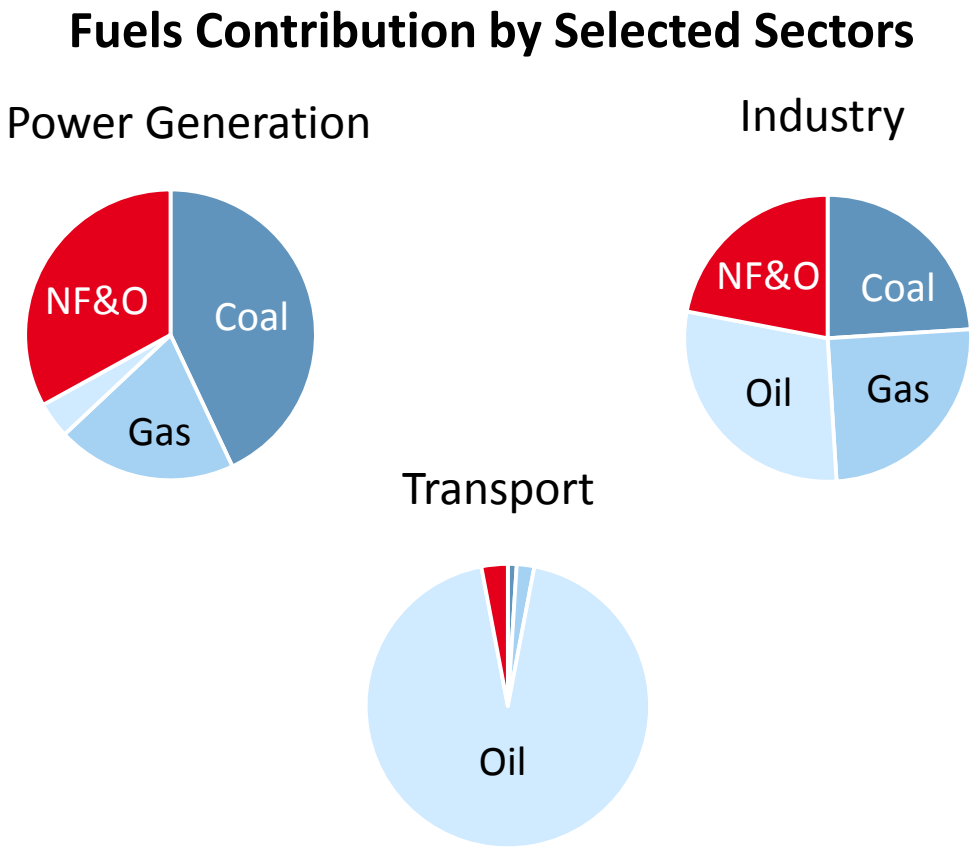


- **Why especially important this time?**
  - United States and China are in the game
  - Multinational oil & gas companies are in favour of introducing prices on GHG emissions.
- **Key Implications**
  - **It will take time...**The **5 largest emitting geographies account for over 55% of global emissions**, and political, social and economic issues could be inadvertent roadblocks. This is despite strong local support and the introduction of Emission Trading Scheme (ETS). Ratification will need to be extended to more parties.
  - **Power Generation, Transport and Industry sectors make up 86% of CO2 emission**

(*) CO2 represents the majority of GHG, and energy related accounts for 2/3 of it

Source: ICIS Elaboration from IEA, BP, ExxonMobil, Industry data

Demand growth for Coal, Oil and Gas will be affected

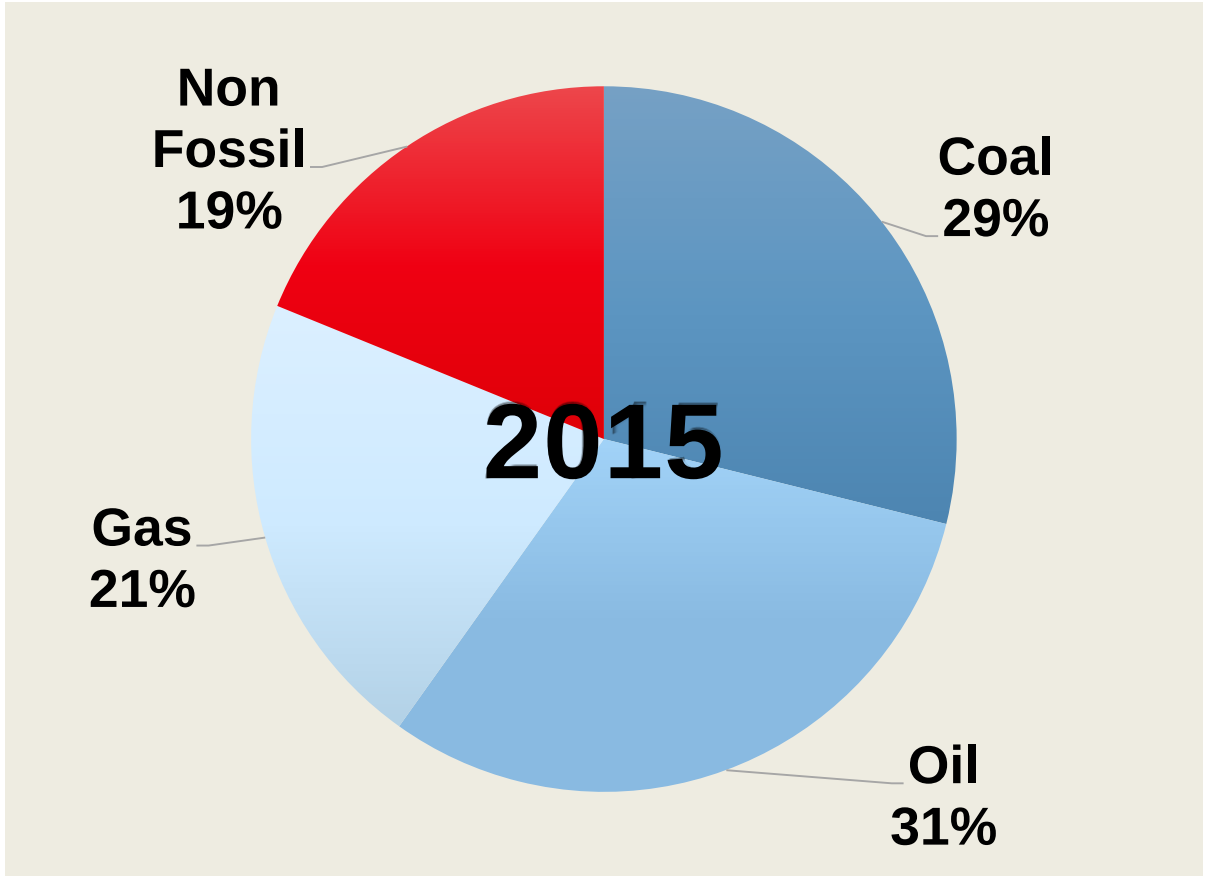


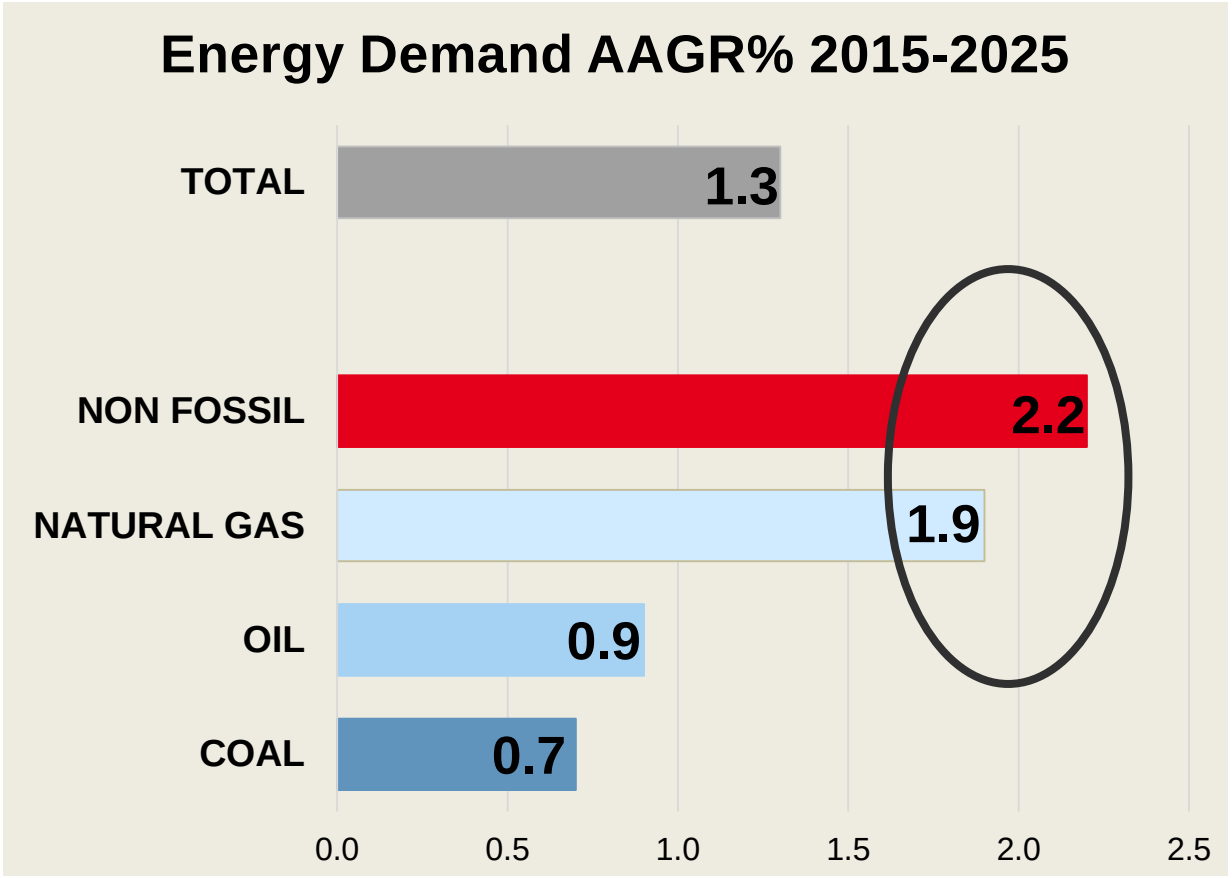
Note: NF&O: "Non Fossil, & Others" cover renewables like solar & wind powers, nuclear and bioenergy

- **Power Sector**
  - Coal is the largest source of electricity, and the largest emission contributor (up to 70% more than natural gas per unit of power)
  - Continued substitution is likely from incremental gas and non fossil fuels
- **Industry Sector**
  - Increased "electrification" and natural gas use, at the expense of coal, will be pursued.
  - Oil use will primarily be for transformation in chemicals (feedstock), and less so as fuel.
- **Transportation Sector**
  - Oil dominates the transportation fuels
  - Vehicles' efficiency gains and further substitution with alternatives fuels will be implemented to mitigate the impact of an increasing fleet

Source: ICIS Supply and Demand Database, ICIS Elaborations from IEA, BP, ExxonMobil, Industry data

Growth of global energy demand slows into the future
- but natural gas and non-fossil sources will lead the growth





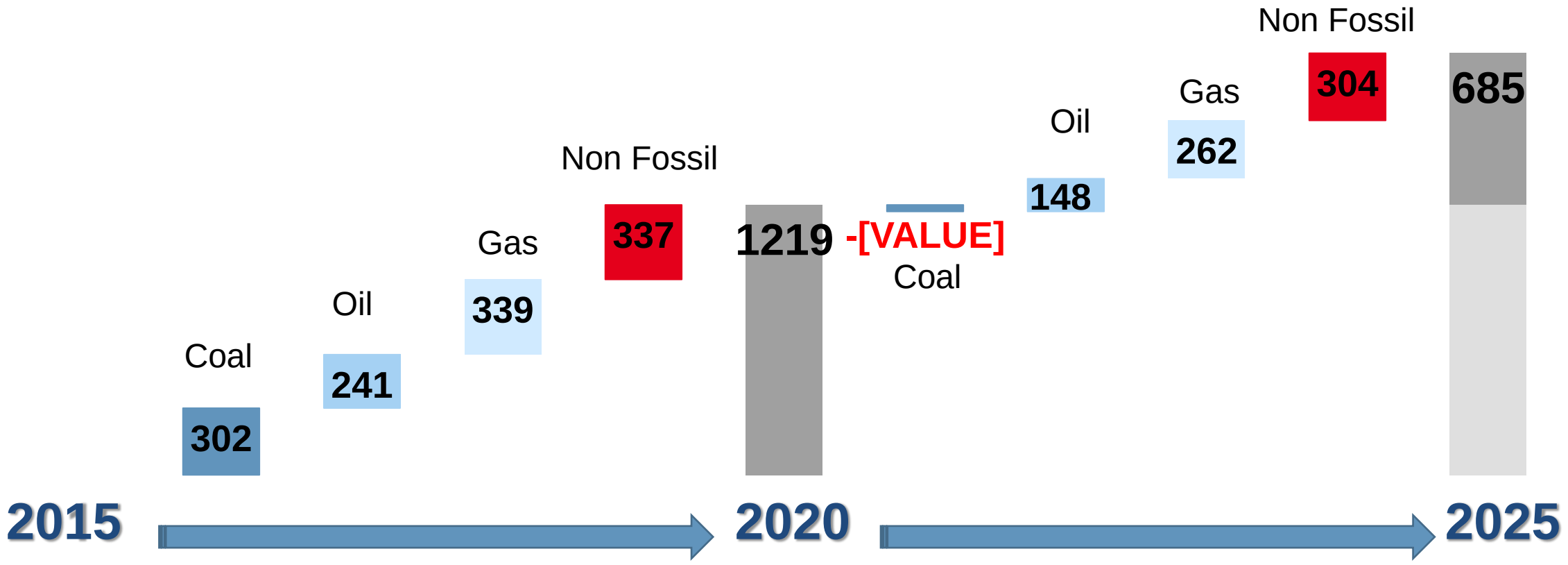
Note: "Non Fossil" includes renewables like solar & wind powers, nuclear and bioenergy

Source: ICIS Supply and Demand Database

Improved energy efficiency and lower carbon emission drive lower future demand for fuels

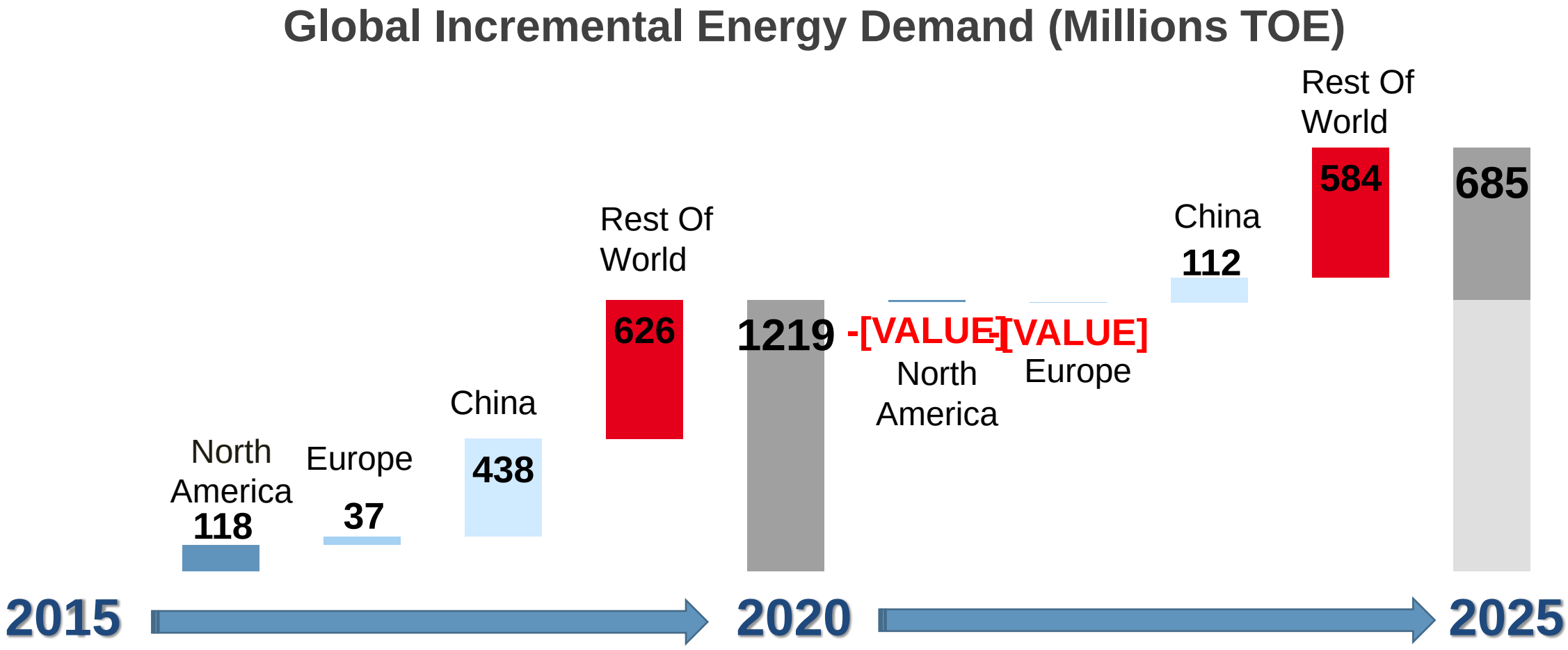
Peak Coal Approaching, Peak Oil not yet but growth is declining…

Global Incremental Energy Demand (Millions TOE)



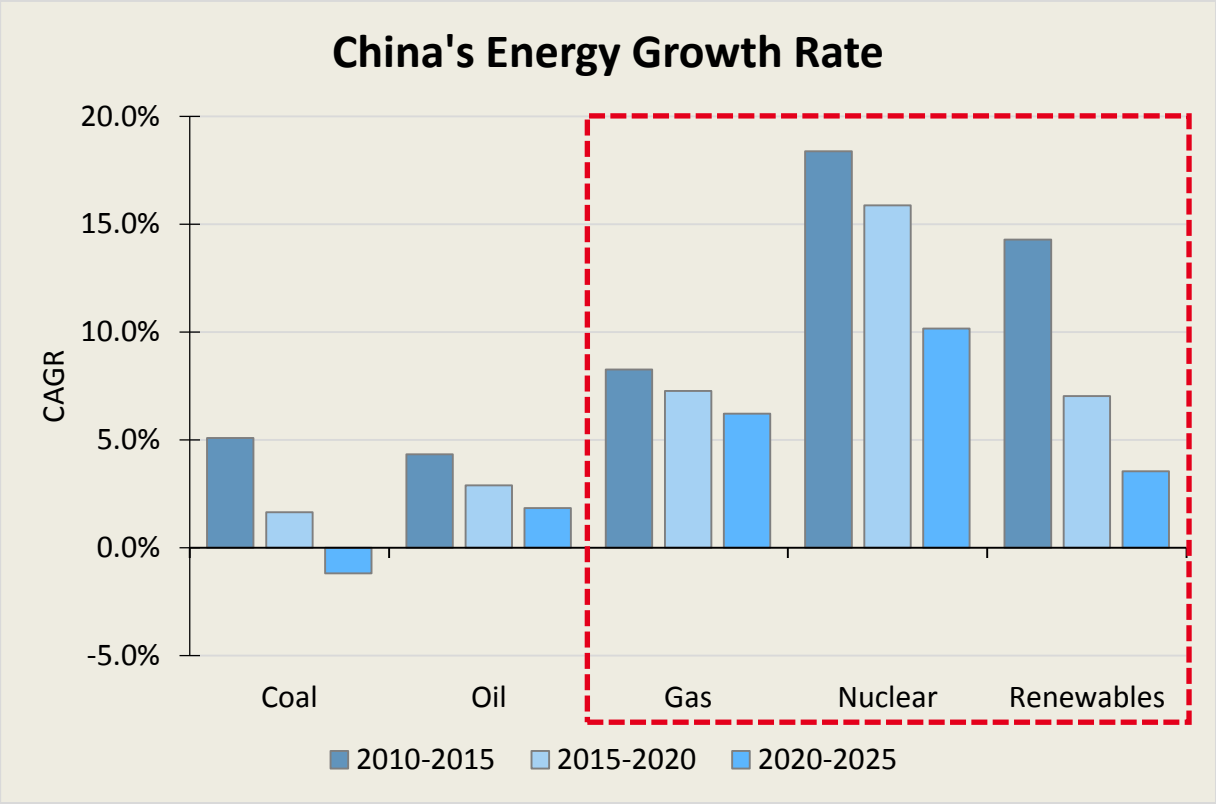
Source: ICIS Supply and Demand Database

China’s energy demand growth is anticipated to shrink… coal moves to surplus



Source: ICIS Supply and Demand Database

Energy sector transformation is underway in China, and it will have to pursue lower carbon emission….



- Gas – a cleaner fuel
- Nuclear and renewables will lead the growth from smaller base
- Coal has reached its peak demand and inefficient coal mining will be shut
  - China has set a target to cut its coal mining capacity by 500 million tonnes/year by 2020

Coal for energy use will be less important in future

Are coal-based petrochemicals a way out? Or is this peculiar only for China?

Source: ICIS Supply and Demand Database