

# Can the US Remain Competitive in Chemicals?

Rice Global E&C Forum

18 May 2018

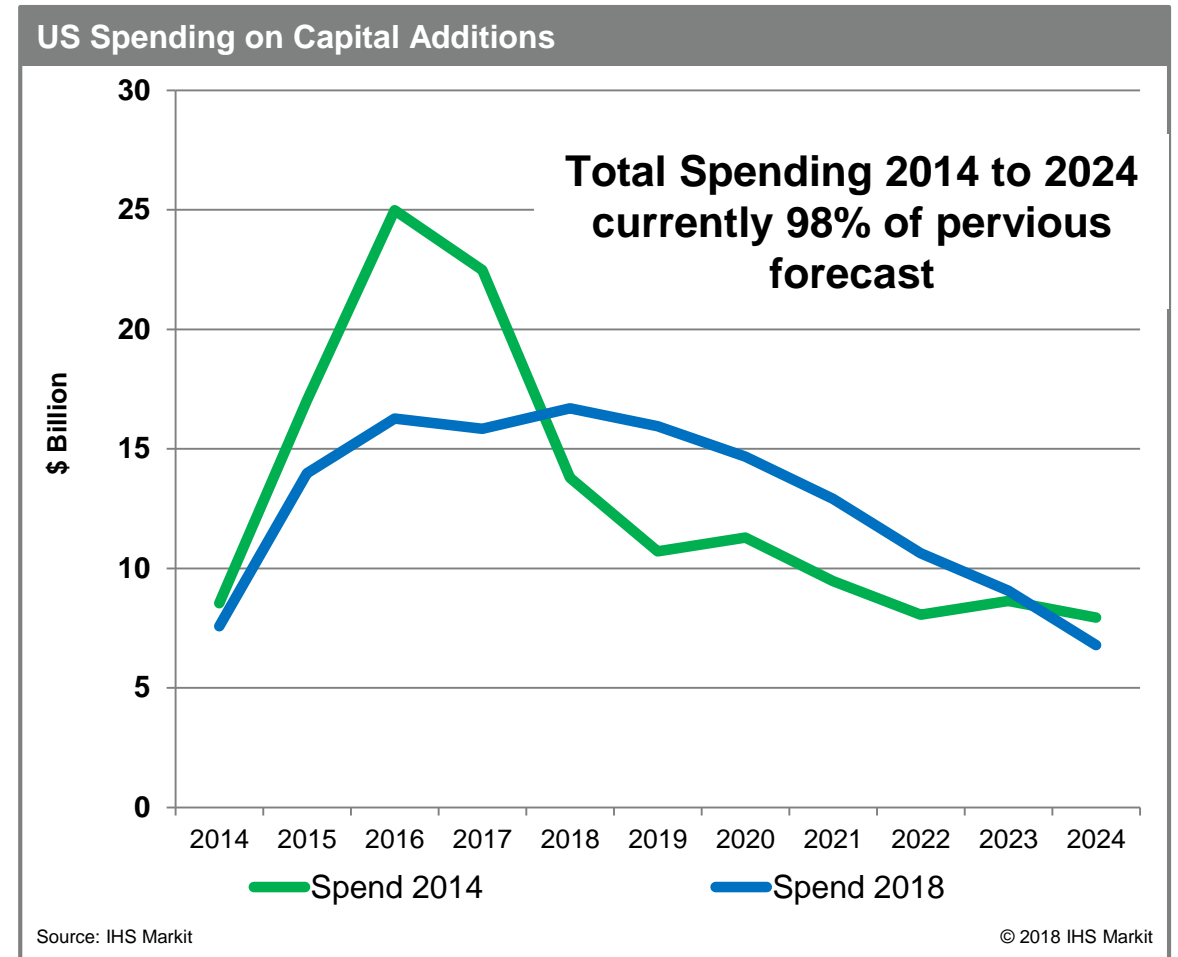
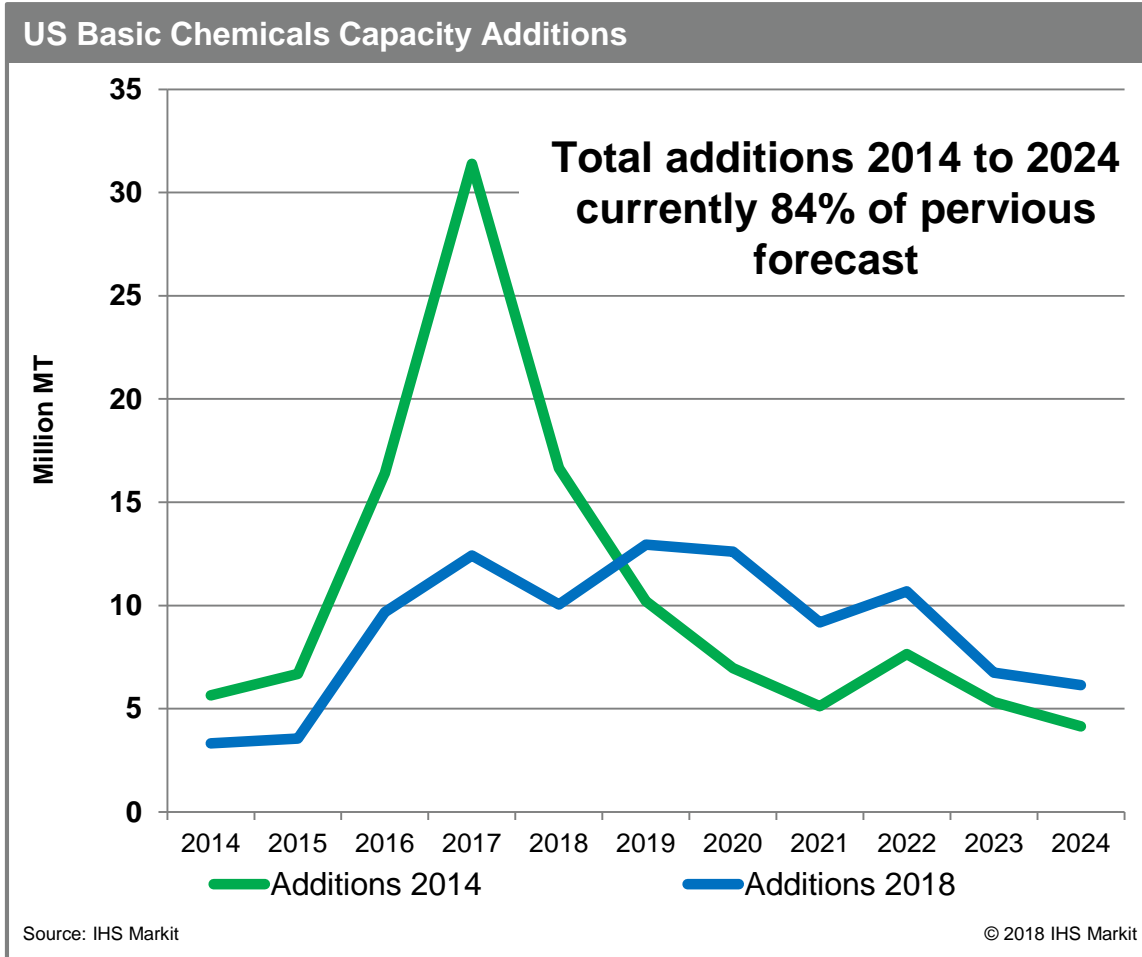
Rice University | Houston, TX, US



## Summary

- Shale is the resource that just keeps giving.
- Capacity additions globally are down from their peak but expected to remain strong through 2022
- US project costs remain a concern as previous projects were more expensive than expected.
- Current differential between US and China on costs may result in feedstocks instead of products being exported

## Expansions did not happen as anticipated in 2014, but...



# Agenda



## Shale Update

Factors Impacting where new capacity gets built

Updated Global and US outlook

Ethylene Example

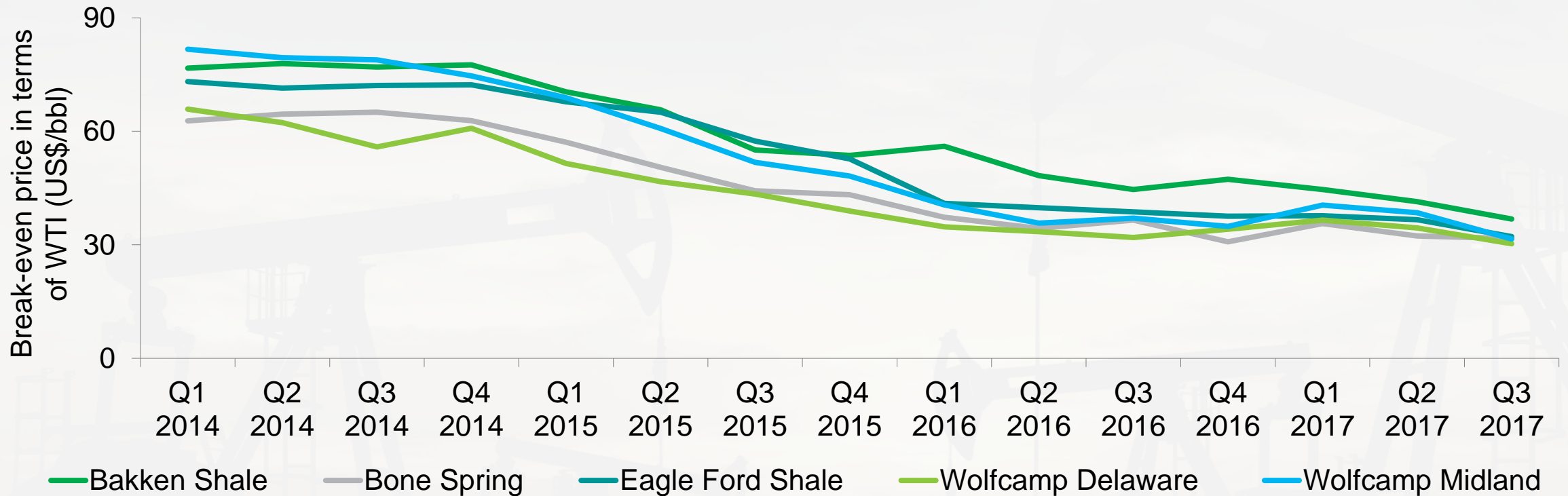
A silhouette of an oil drilling rig stands against a dramatic sunset sky. The rig's derrick is the central focus, with its complex lattice structure clearly visible. The sky transitions from a deep orange near the horizon to a lighter, hazy yellow at the top. In the foreground, the dark silhouettes of various industrial components, including pipes, tanks, and smaller structures, are scattered across the lower half of the frame. A semi-transparent teal banner is positioned horizontally across the middle of the image, containing the title text.

# North American Shale



## Innovation found tight oil, now ingenuity is lowering cost per barrel

Median break-even prices for five key US oil plays, 2014–17

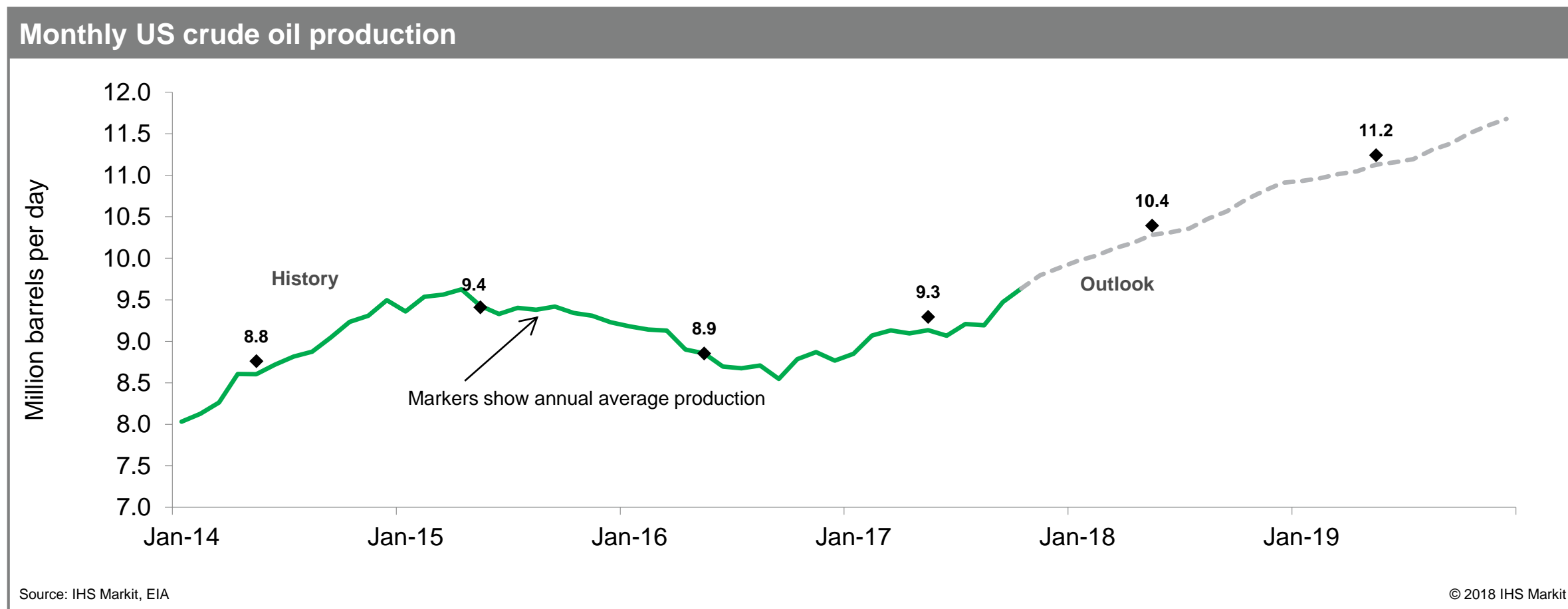


Notes: The break-even price is the WTI crude oil price required for the project to cover all of its estimated well capital and operating costs and generate a 10% rate of return. Data are through 3Q 2017.

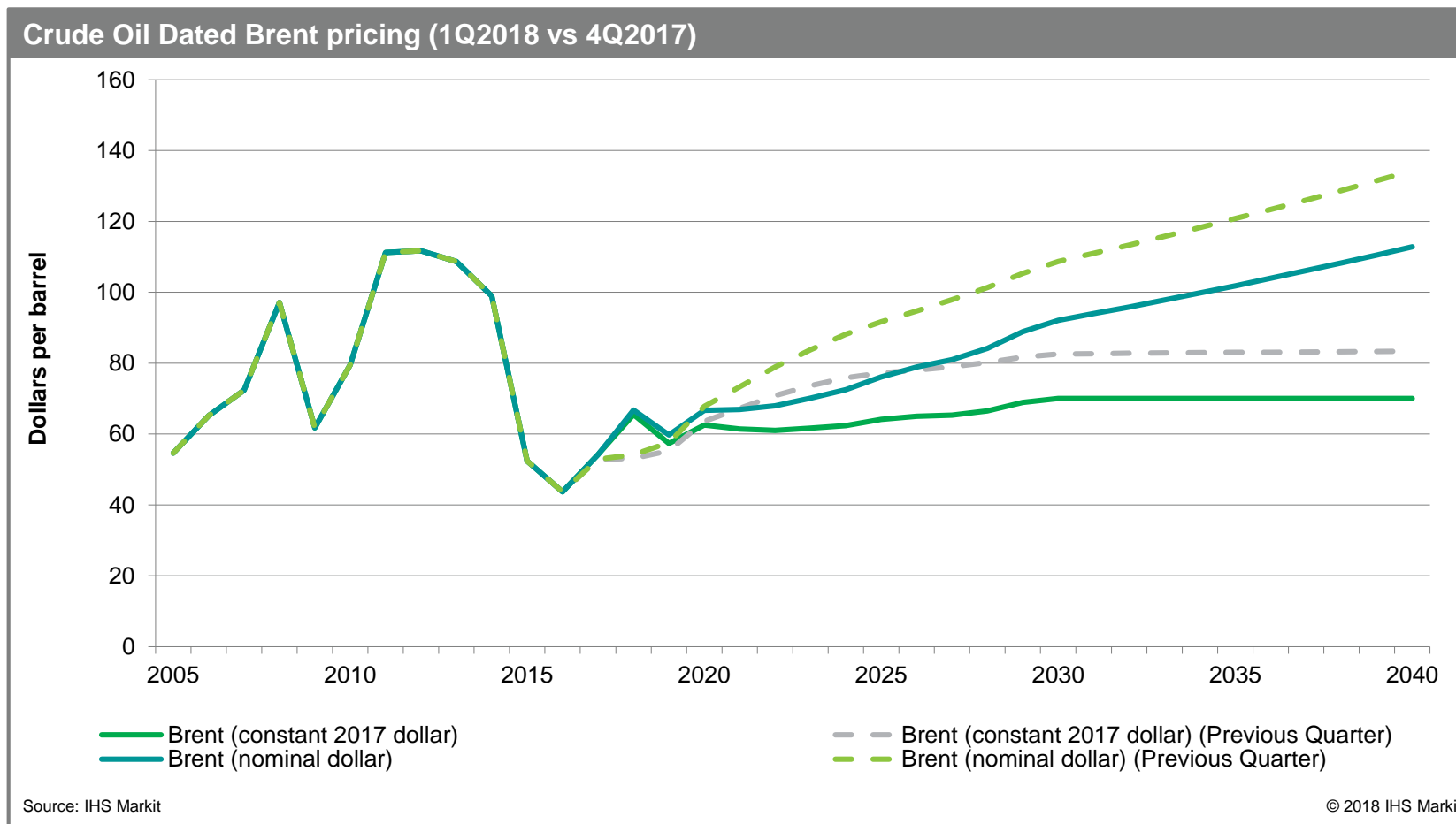
Source: IHS Markit Performance Evaluator

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# Productivity improvements provide launch pad for new supply wave



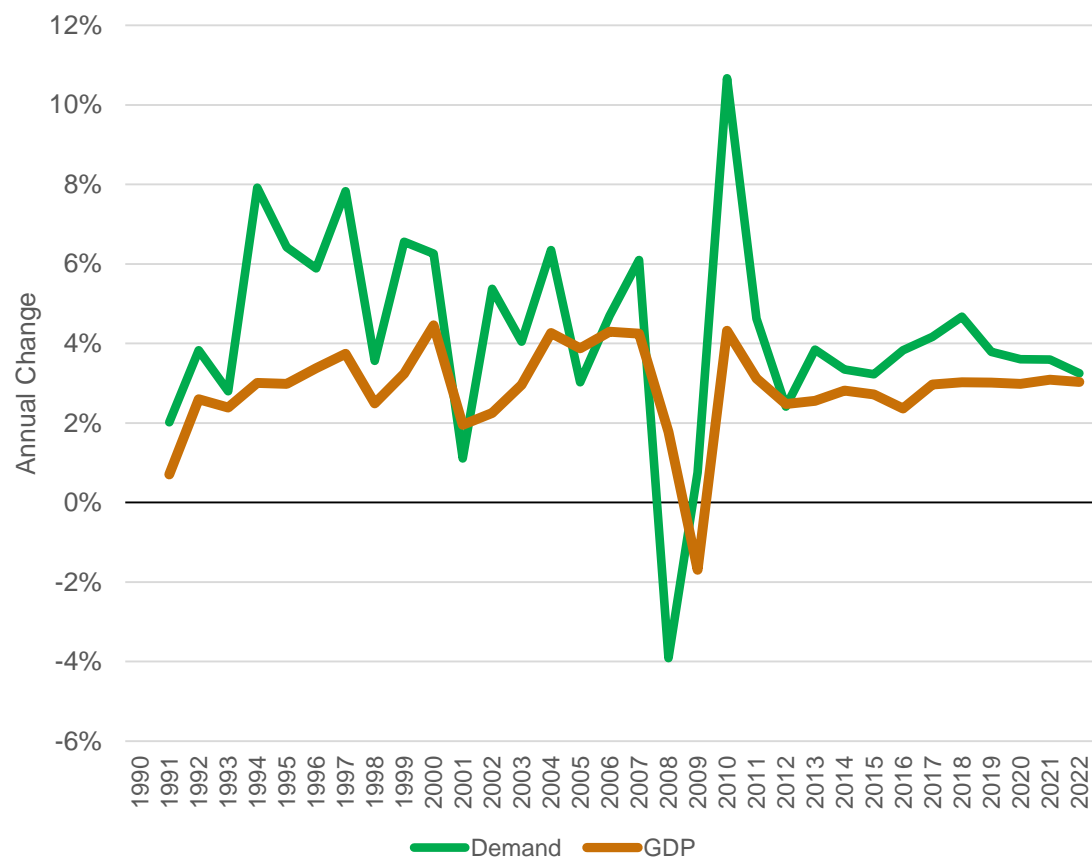
# Long term Brent price environment now expected to average around \$70 per barrel (in constant dollars)



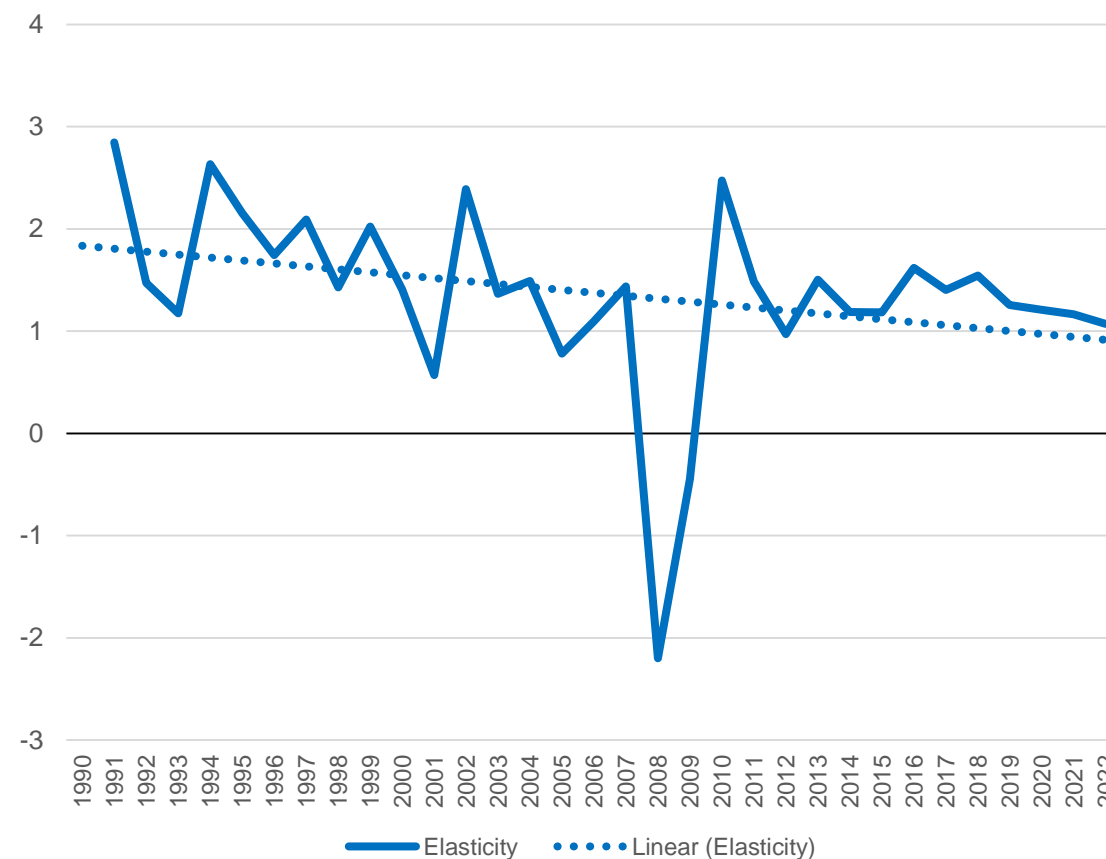


# Chemical Demand's Linkage to Economic Activity

## Basic Chemicals



## Elasticity



# Capital investments seek to maximize returns – preferably with a sustainable competitive advantage

## Investment “Drivers”

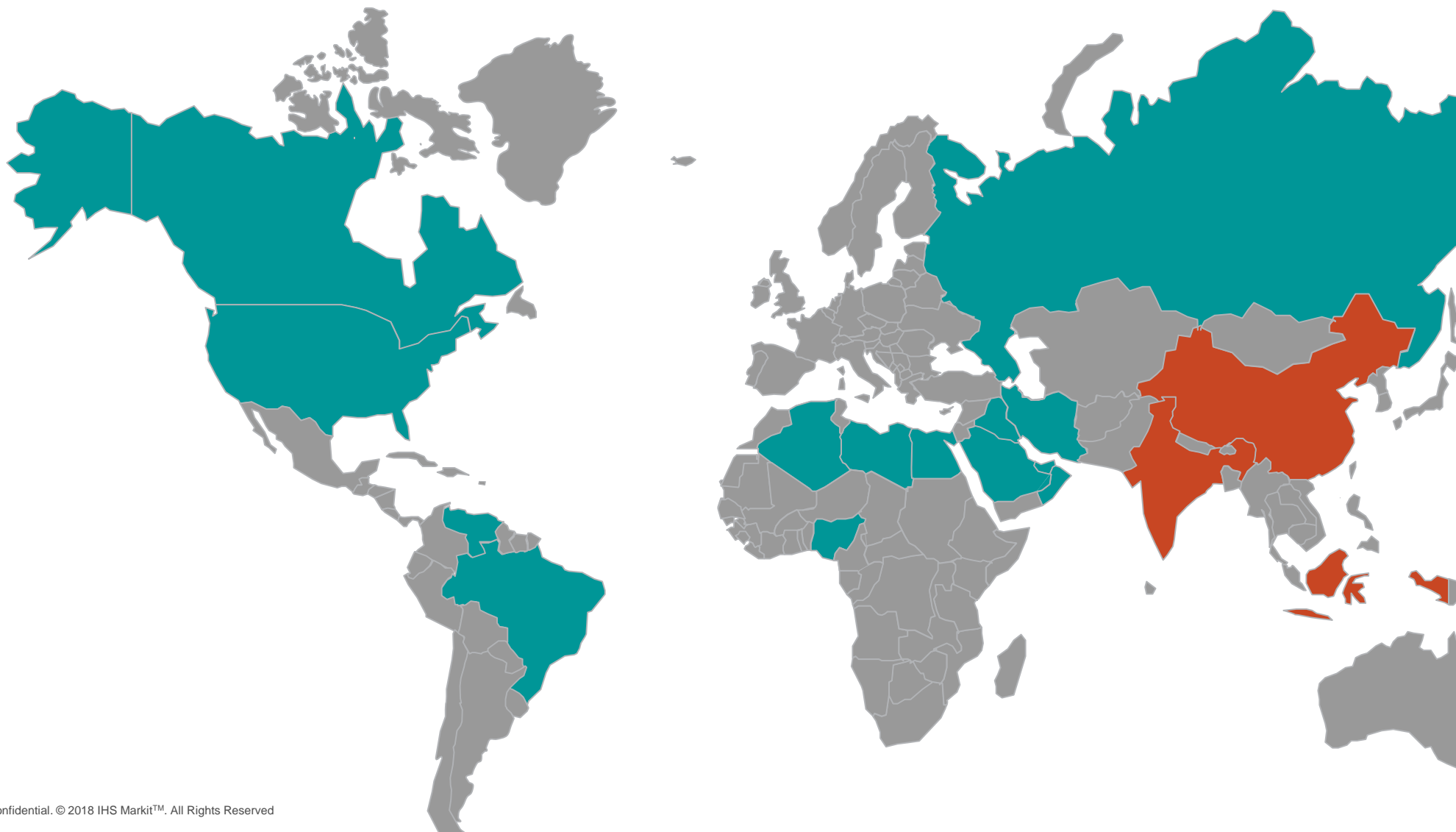
- ✓ Secure an energy & feedstock advantage
- ✓ Leverage current technology and build world-scale for maximum capital efficiency
- ✓ Invest with proximity to local markets and/or access to trade routes
- ✓ Build to leverage an upstream and/or downstream integrated position



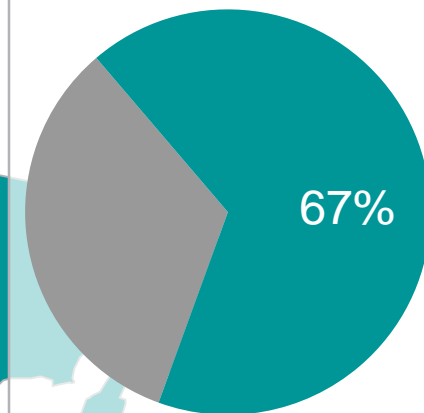
Chemicals are illustrative of the energy supply chain. Global chemical demand is concentrated in developing world with more than 50% of demand growth in China...



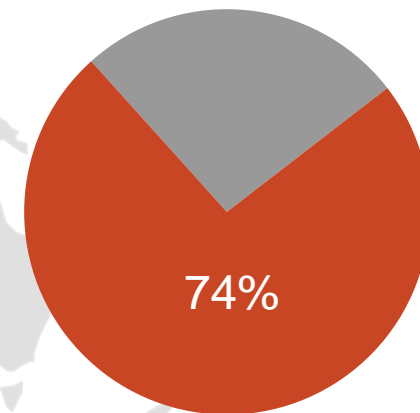
...But petroleum supply is concentrated elsewhere



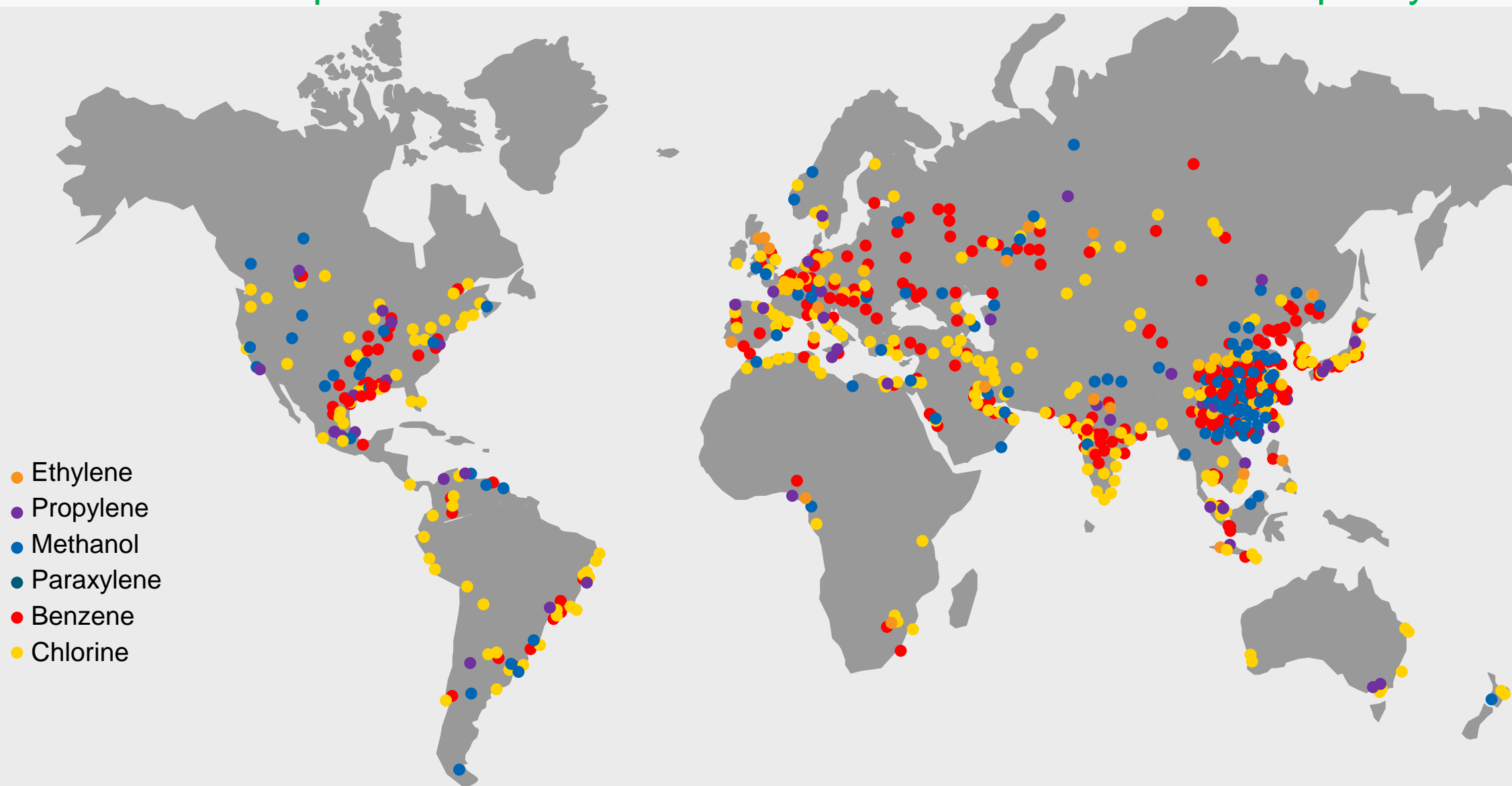
SUPPLY



DEMAND



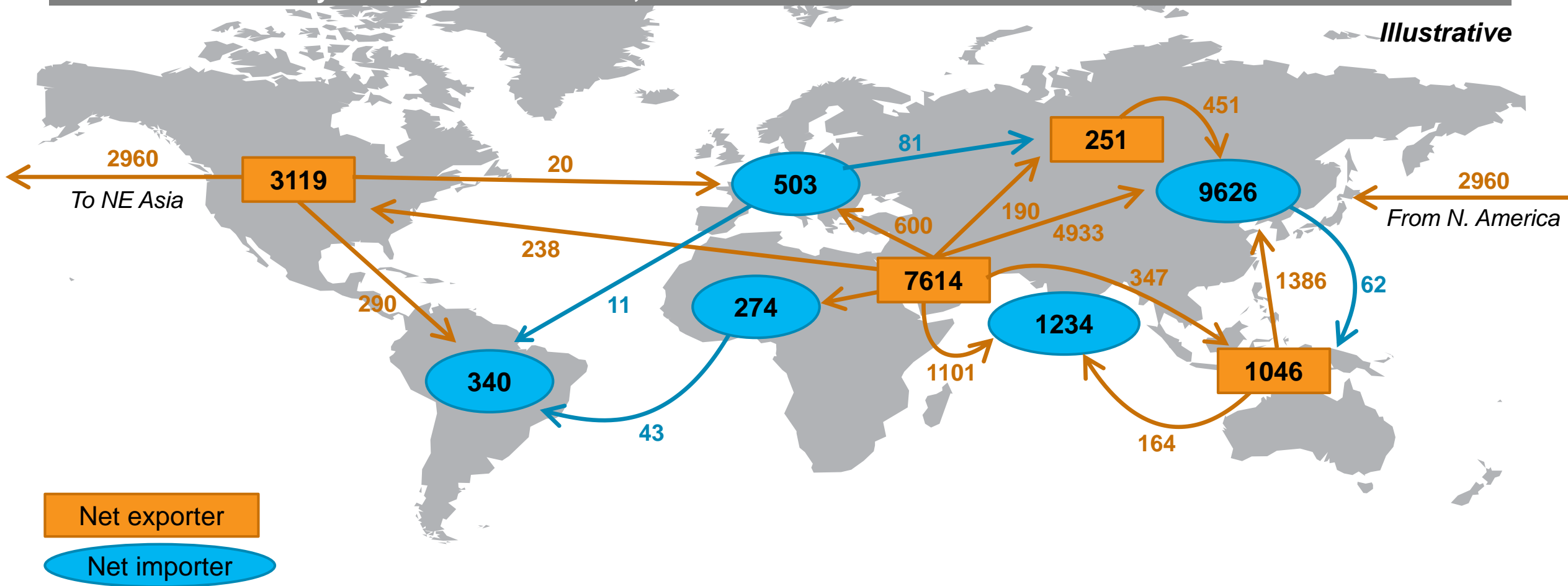
Base chemicals produced 492 million tons from 610 million tons of capacity in 2017



Trade from advantaged hydrocarbon regions fills the demand gap – typically at the first value chain node with reasonable logistic costs and product market liquidity

### 2026 World Monoethylene Glycol Trade Flows, Kilotons

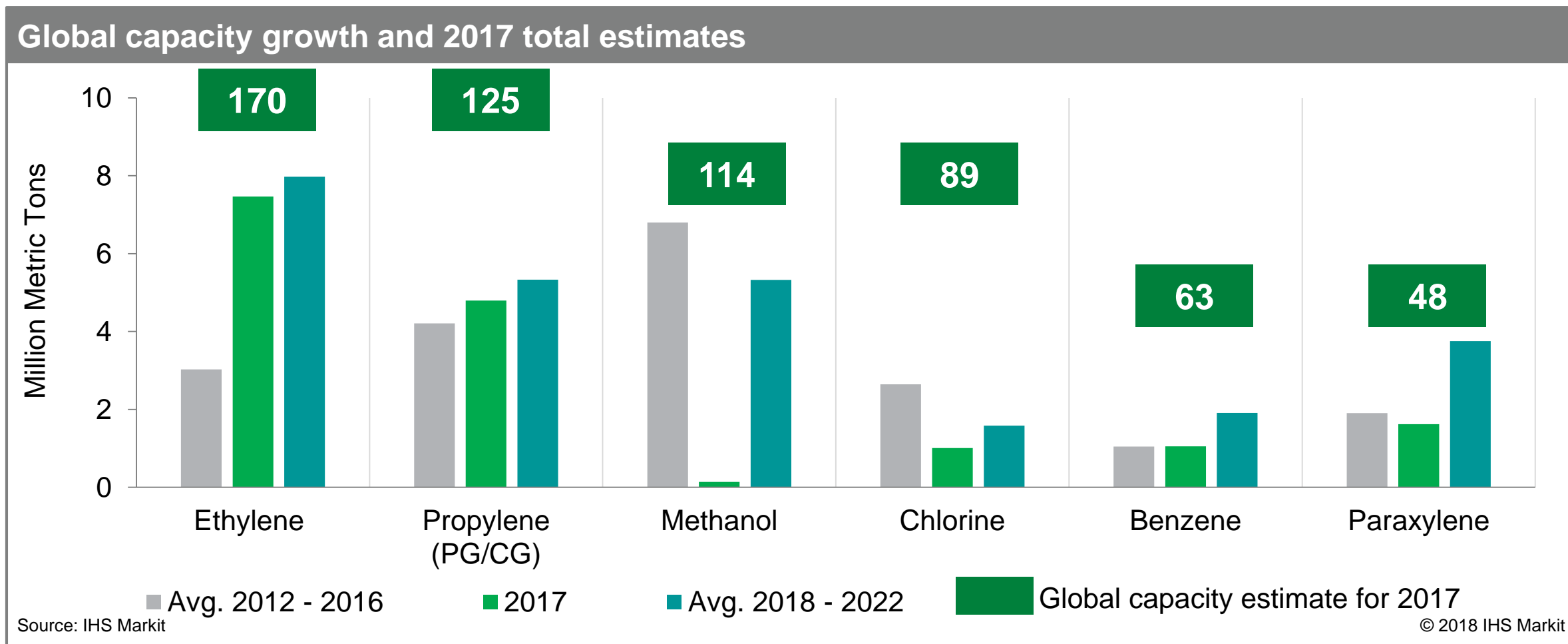
*Illustrative*



Volumes greater than 5,000 metric tons noted; intra-regional trade excluded.

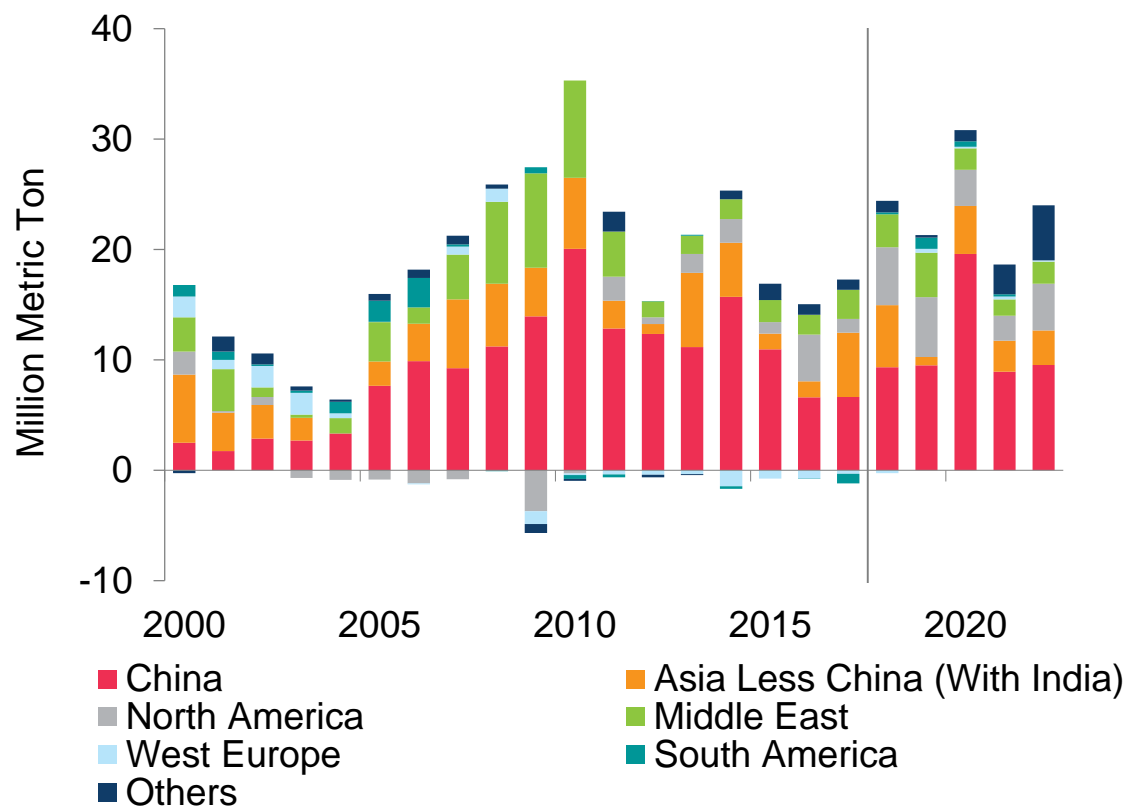


# All base chemical value-chains are actively adding new capacity on a global basis



Global base chemical capacity will increase by 118+ million tons, 2018 – 2022  
 Asia-Pacific (led by China) will add 60%; N. America – 20%; Middle East – 10%

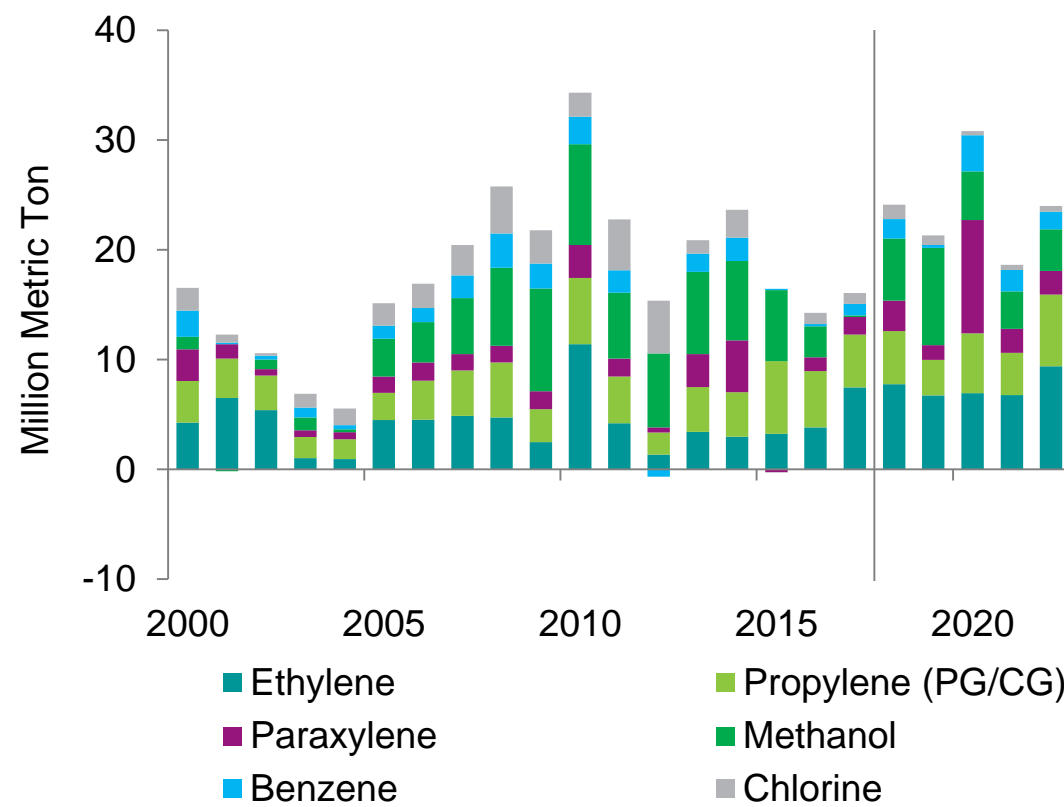
World base chemical annual capacity growth **by location**



Source: IHS Markit

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World base chemical annual capacity growth **by market**

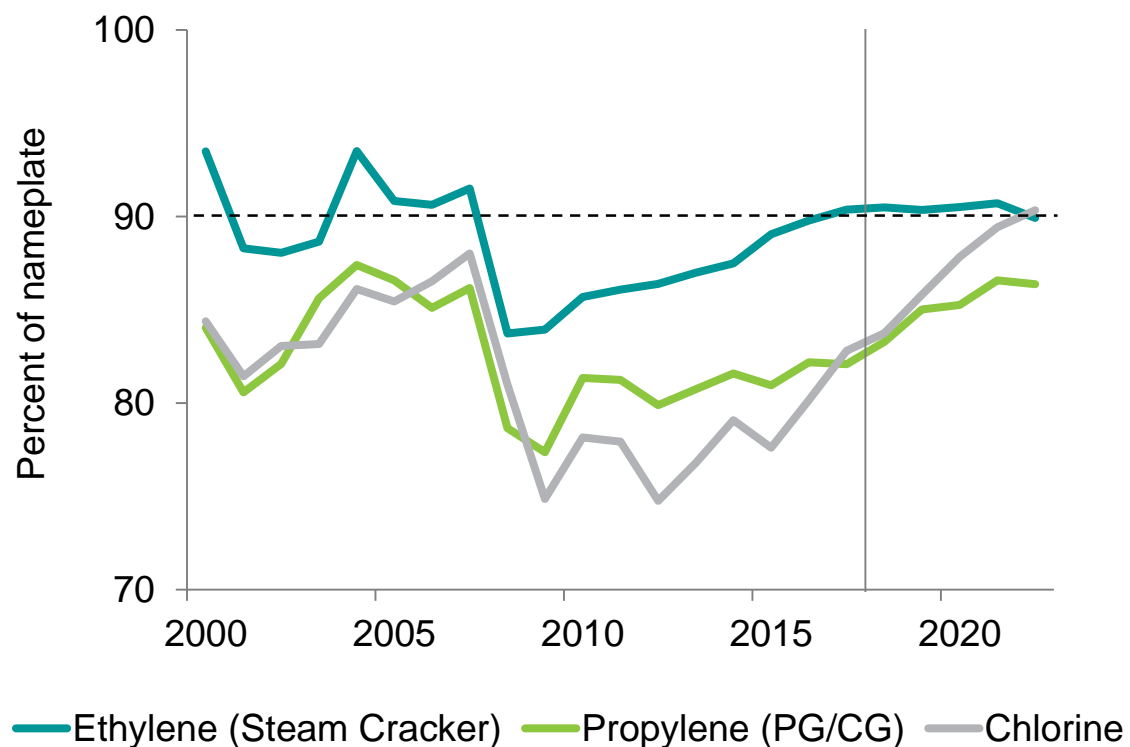


Source: IHS Markit

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By all measures, ethylene / propylene / chlor-alkali , will be supply-constrained

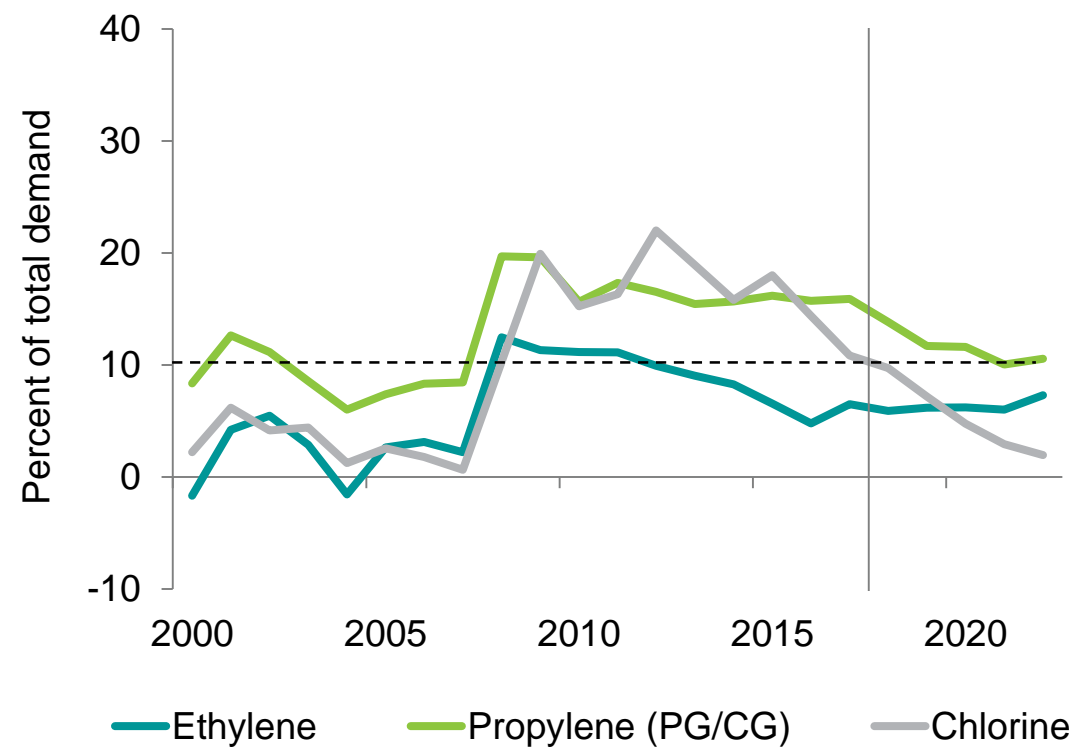
World capacity utilization



Source: IHS Markit

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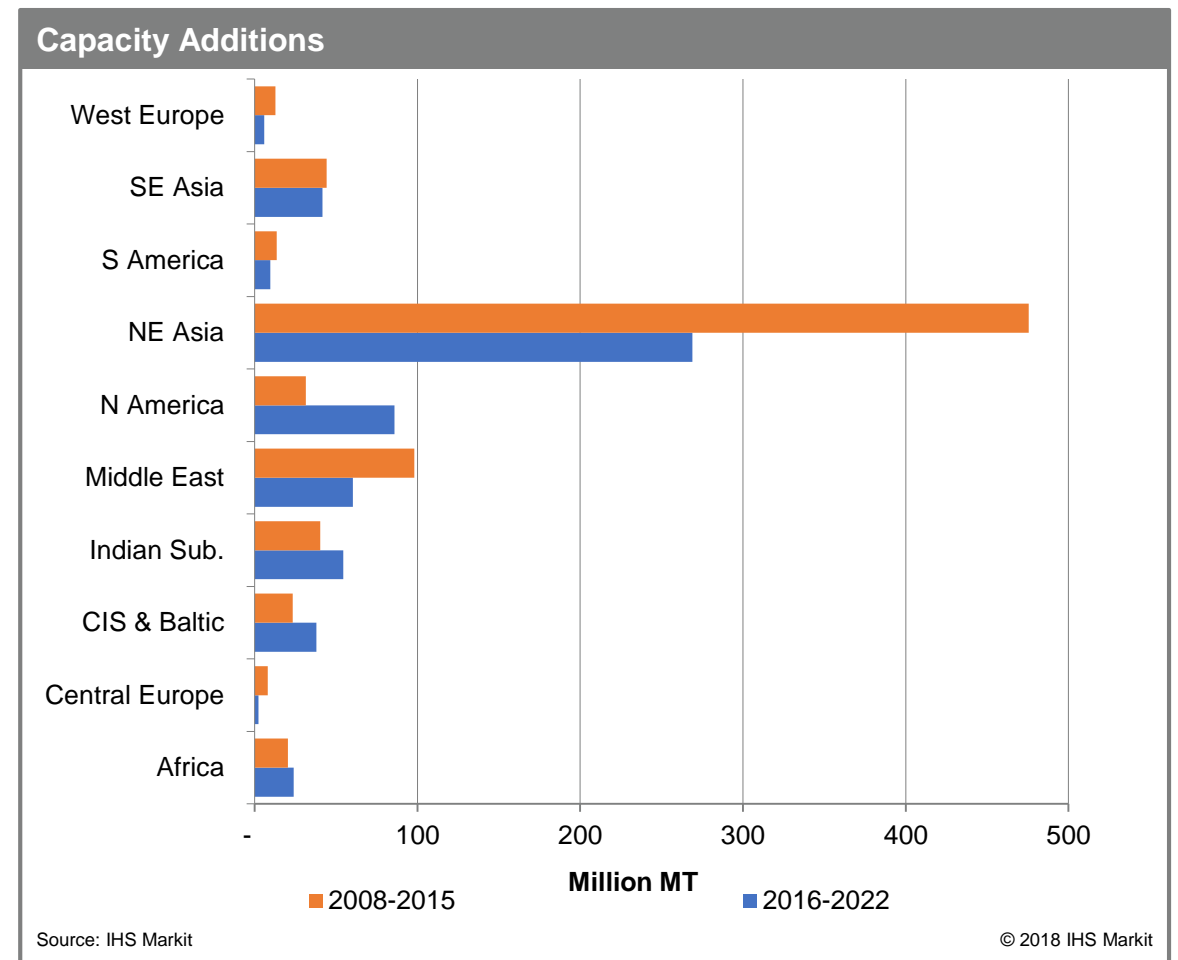
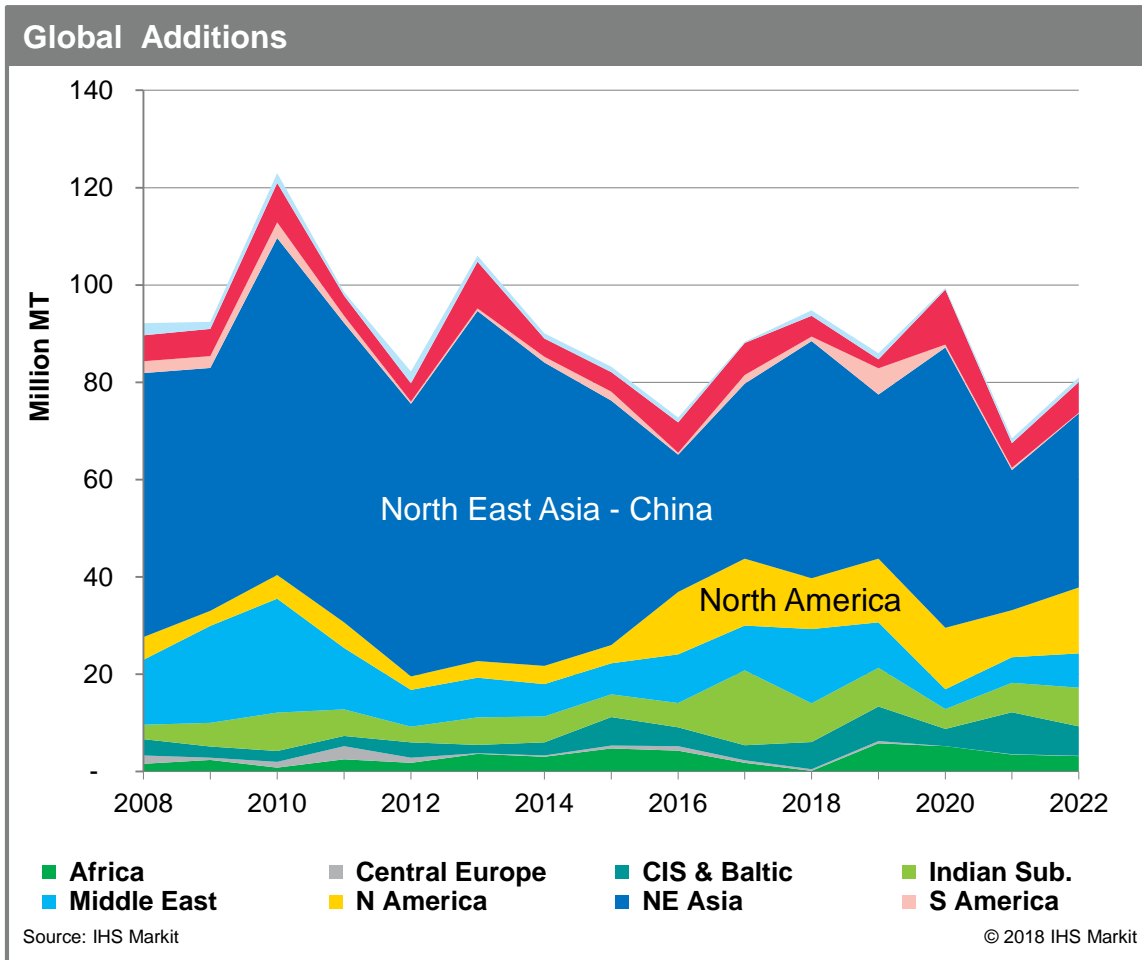
World surplus capacity as % of total demand



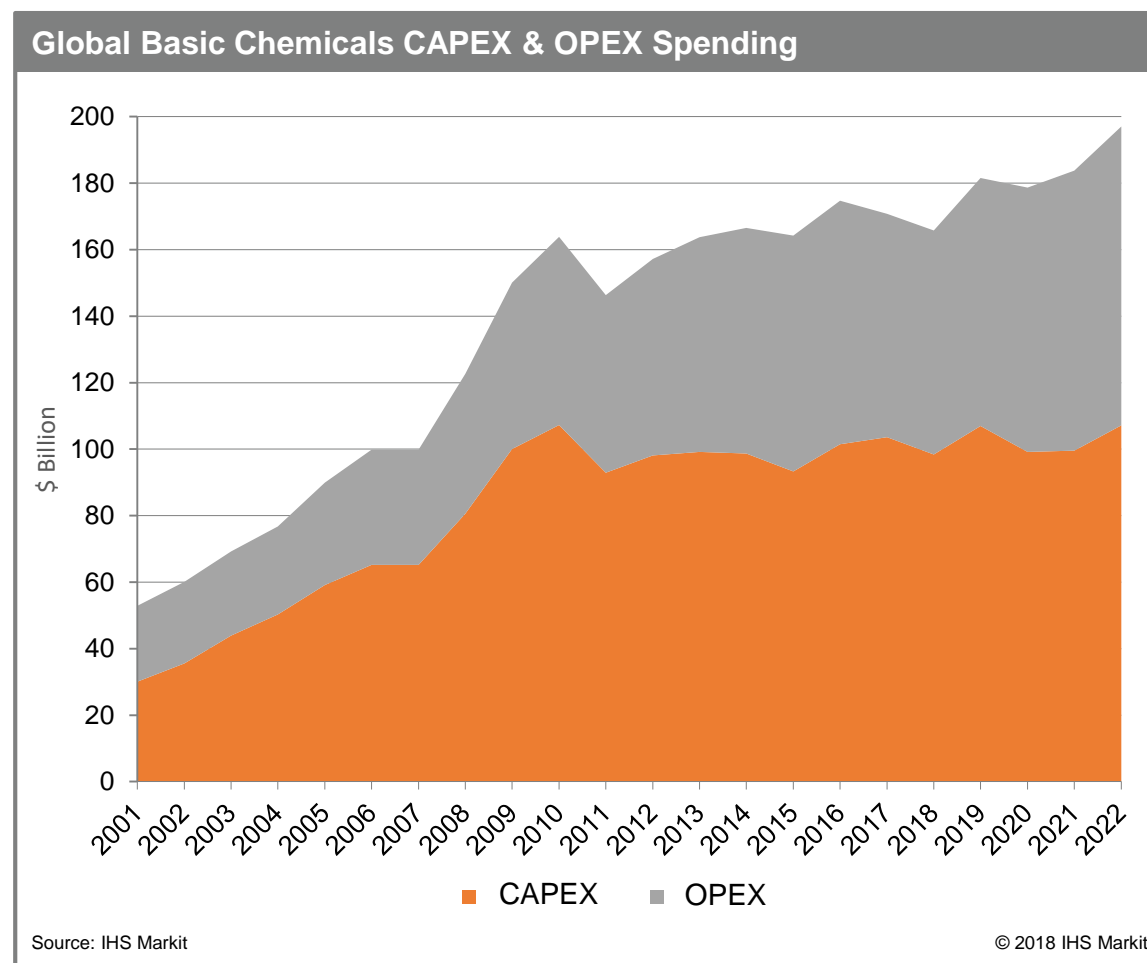
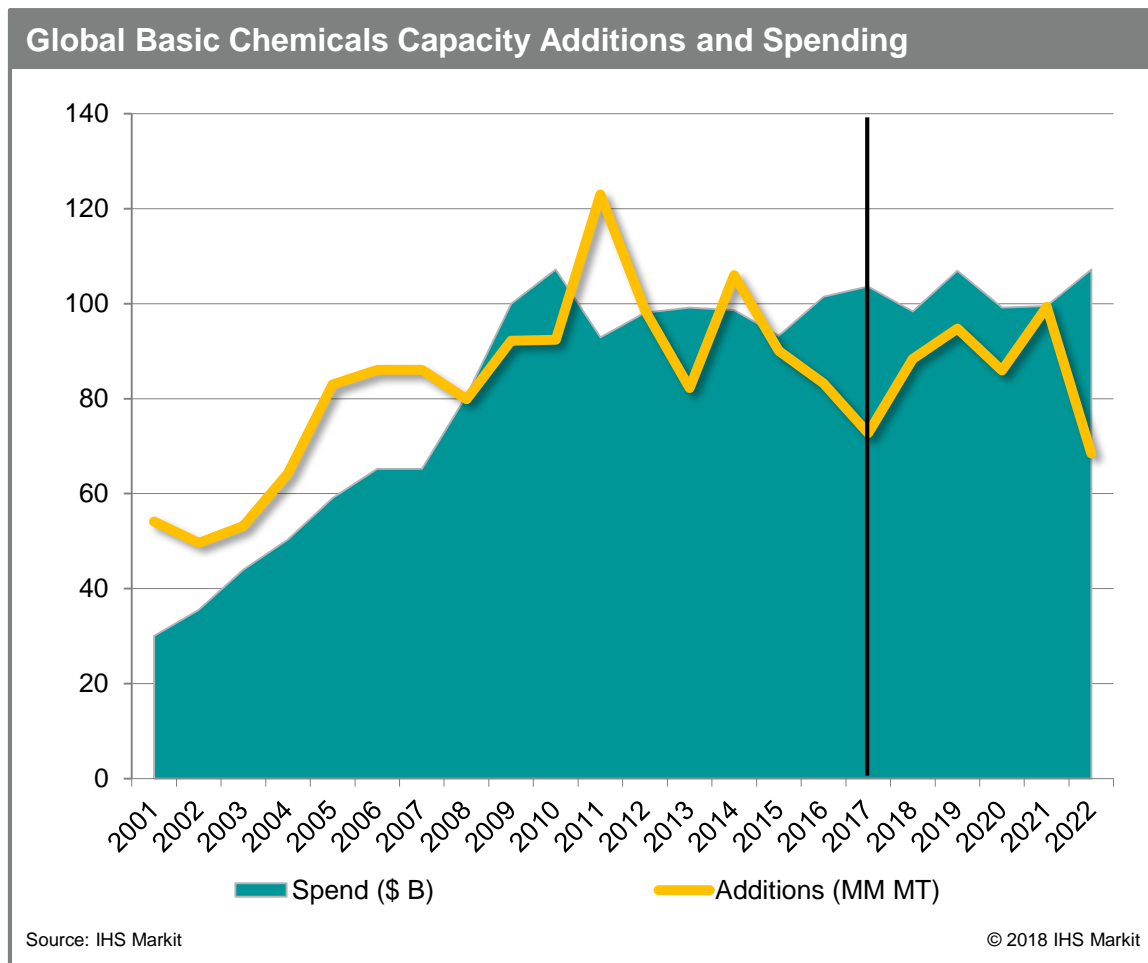
Source: IHS Markit

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# Capacity additions are moving to take advantage of feedstock availability

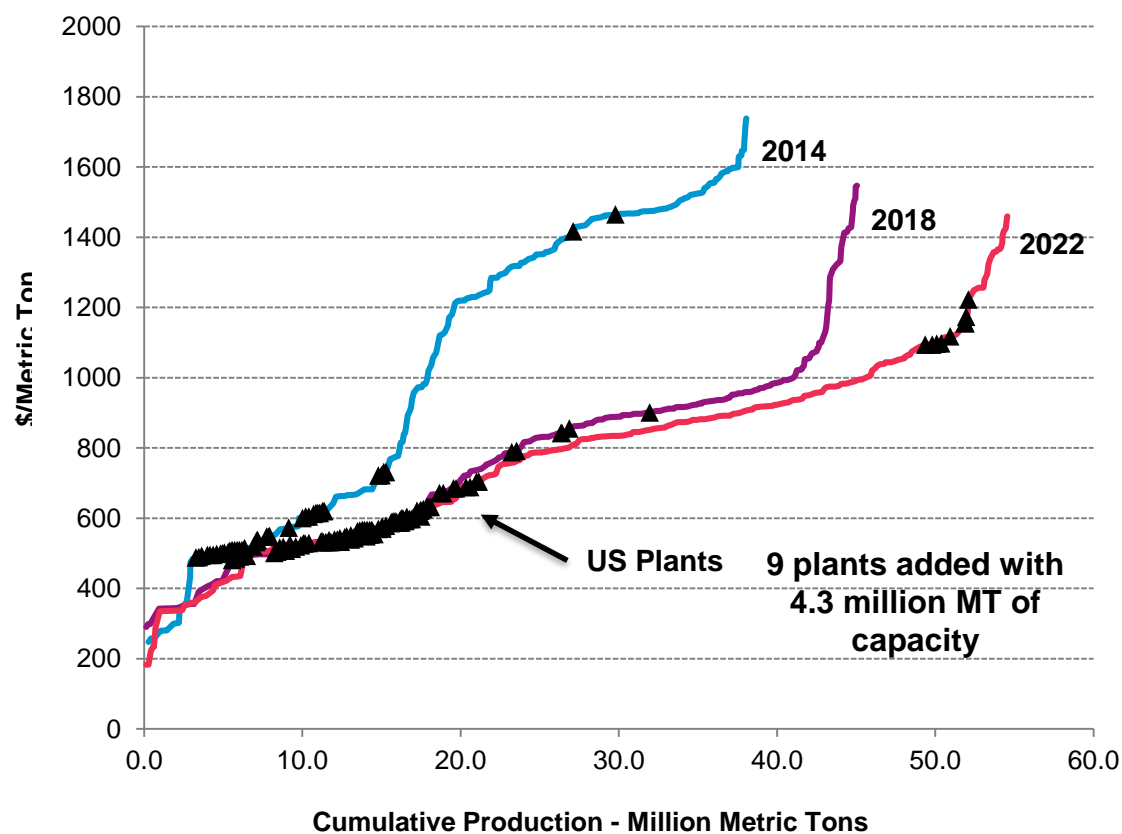


# Global Capacity Additions Spending

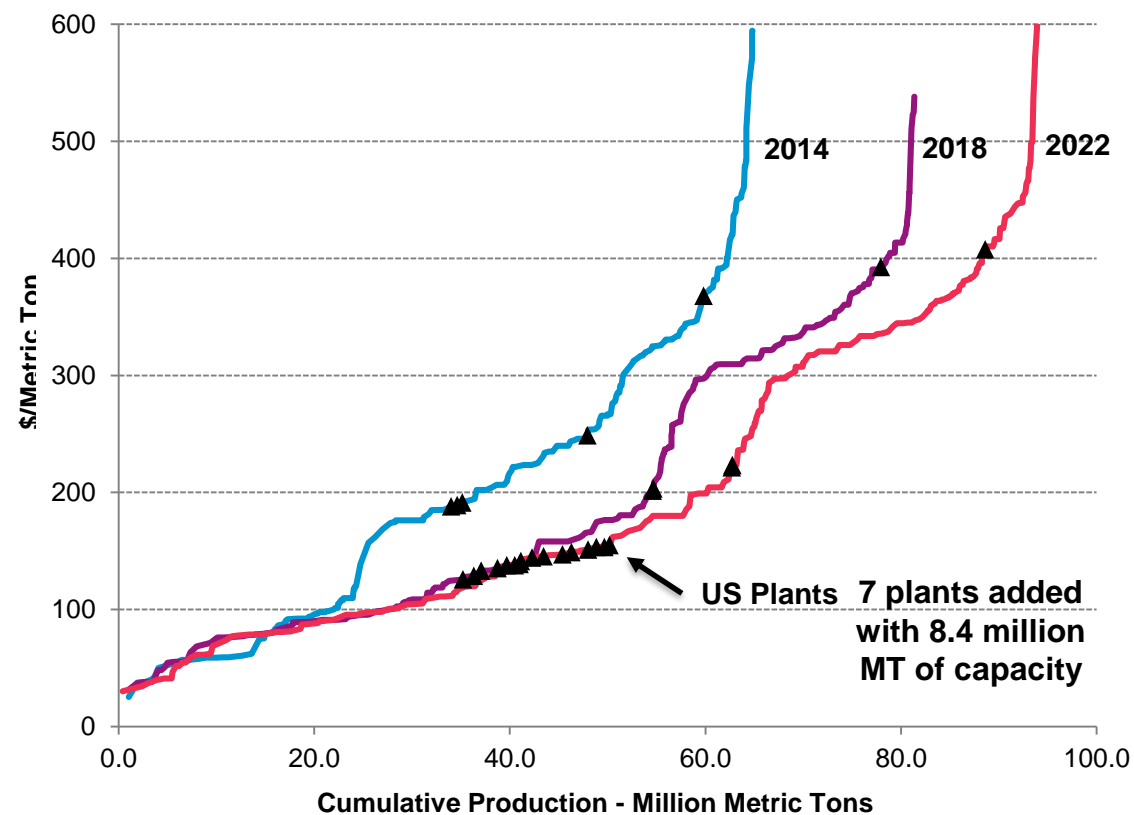


# US Competitive Advantage Improves as Oil Prices Rise

World Cost Curve: Polyethylene - HDPE

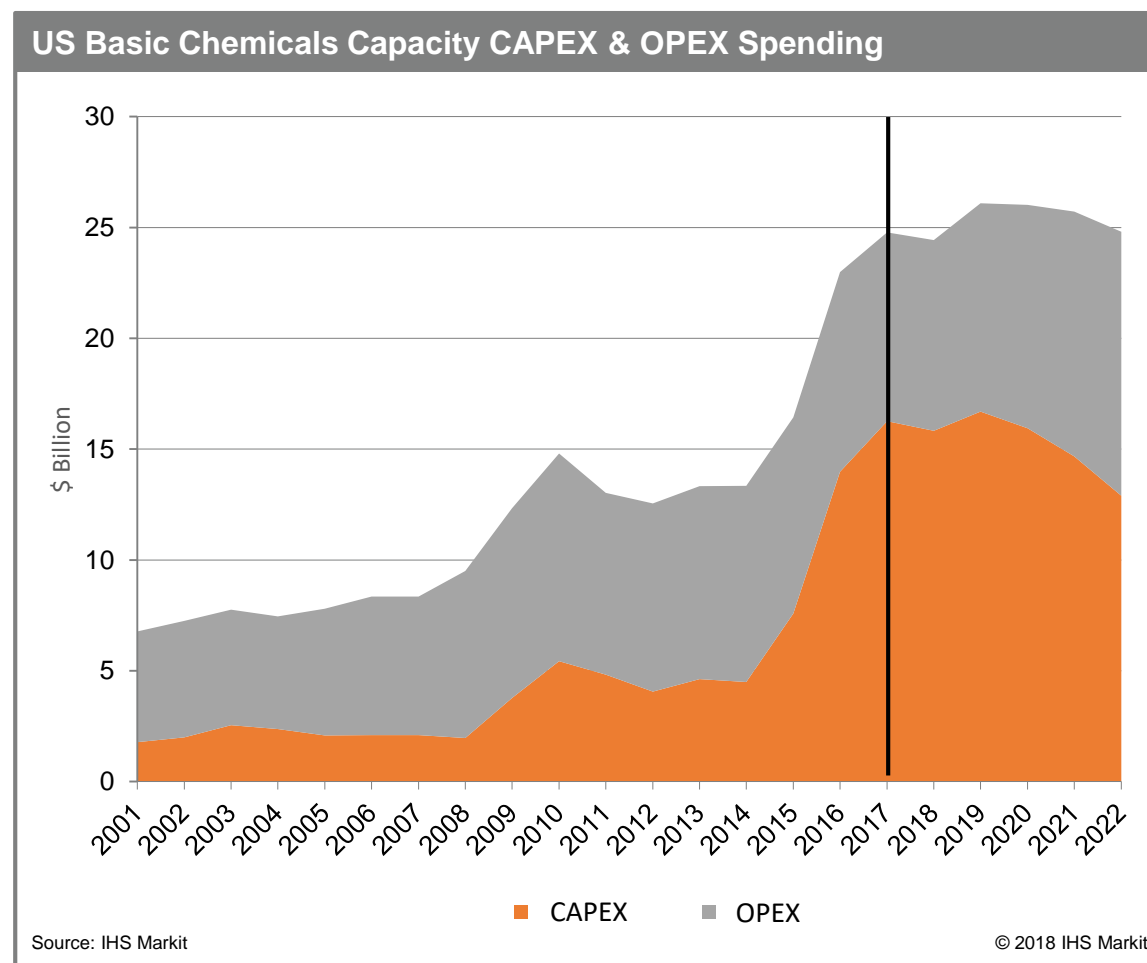
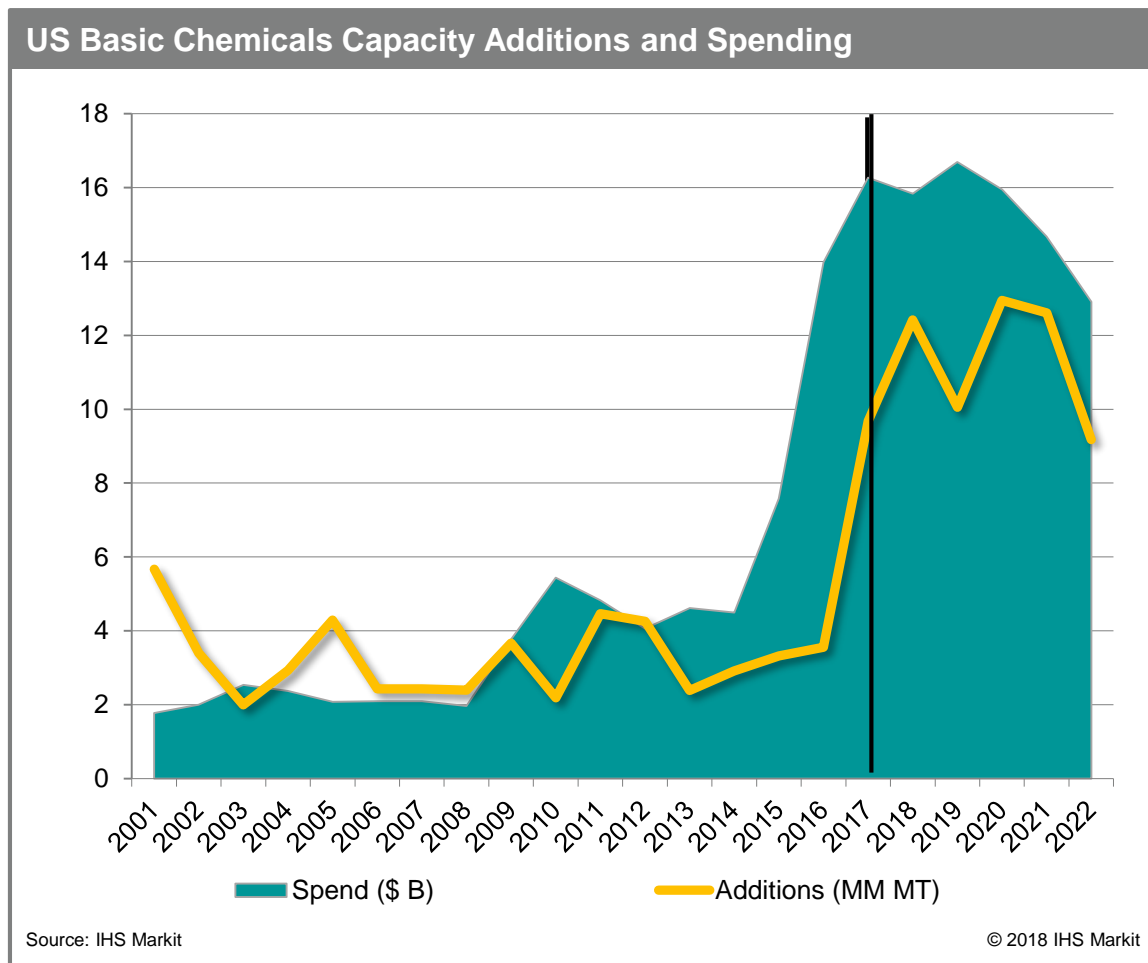


World Cost Curve: Methanol

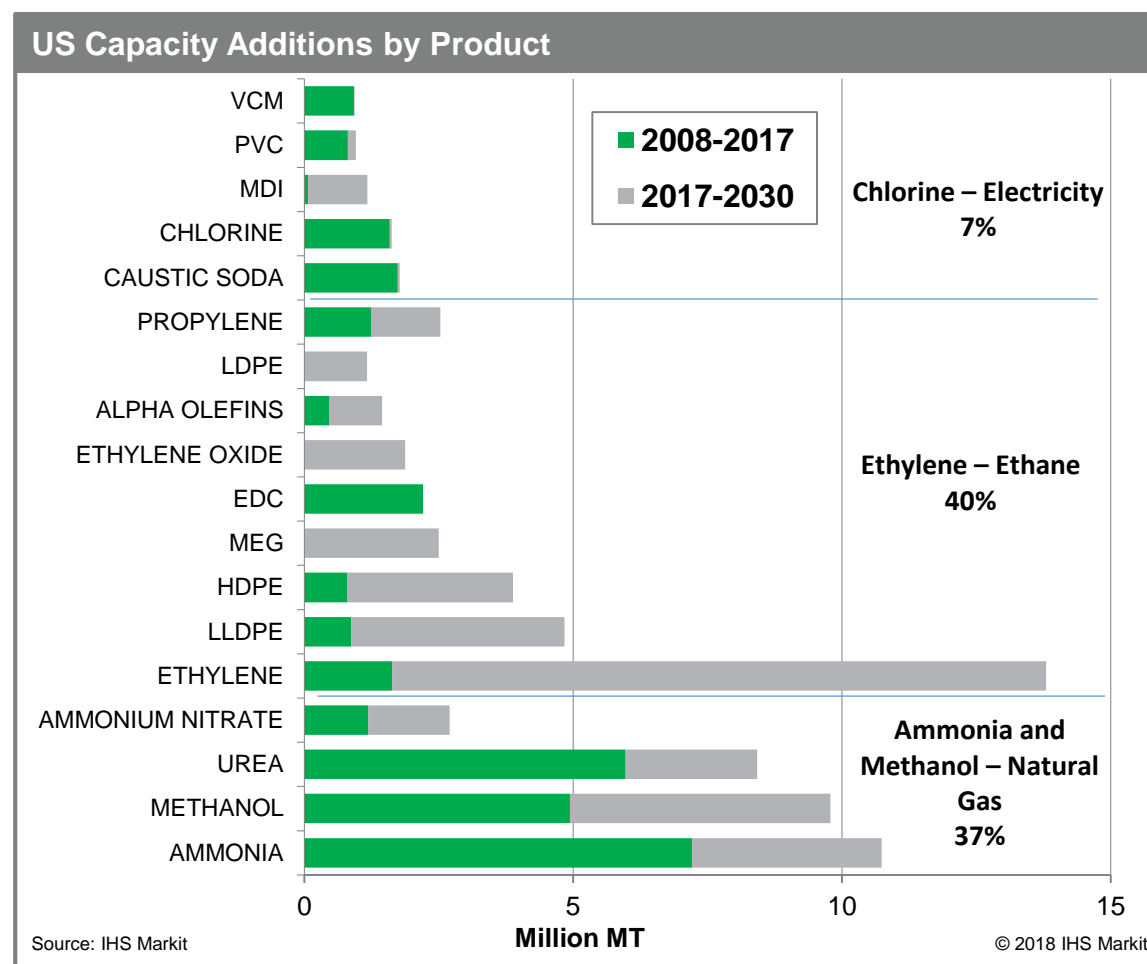
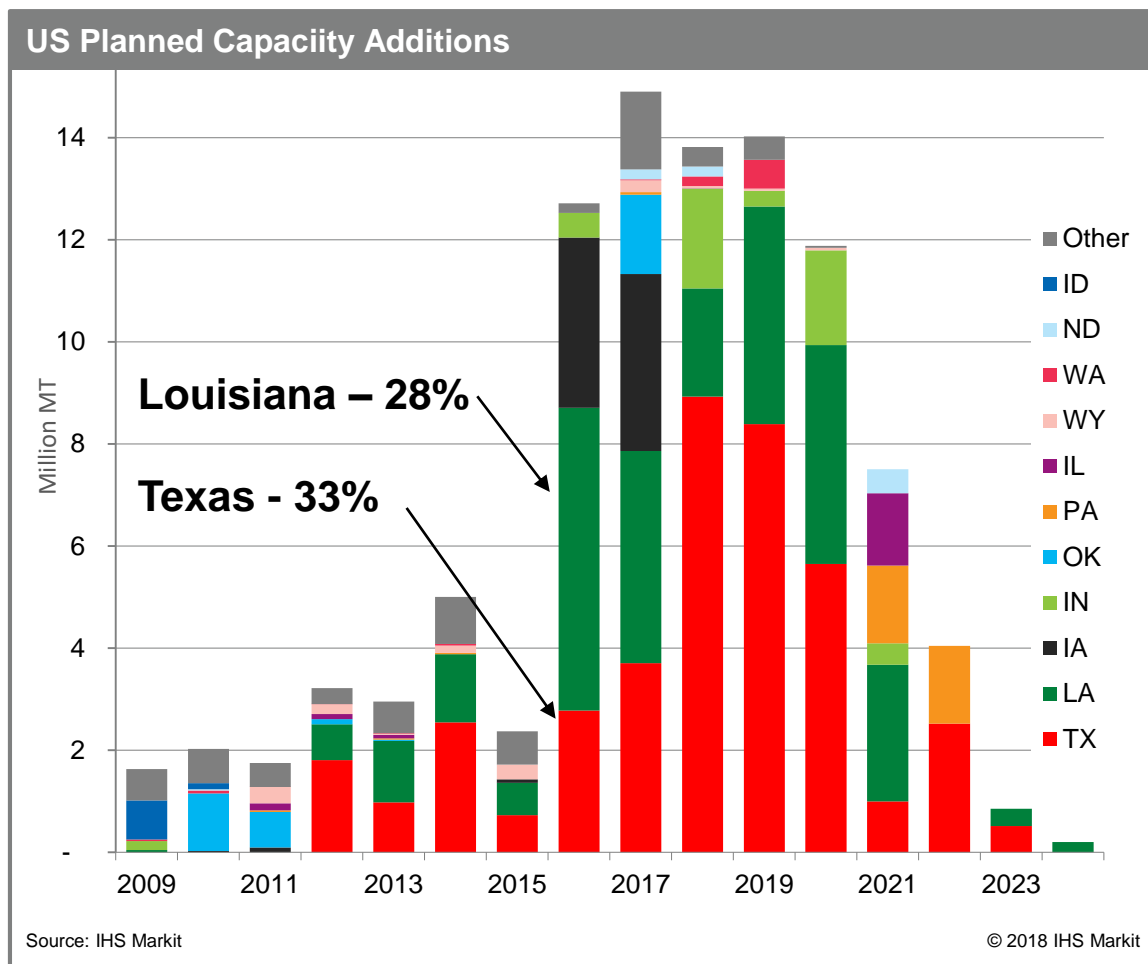




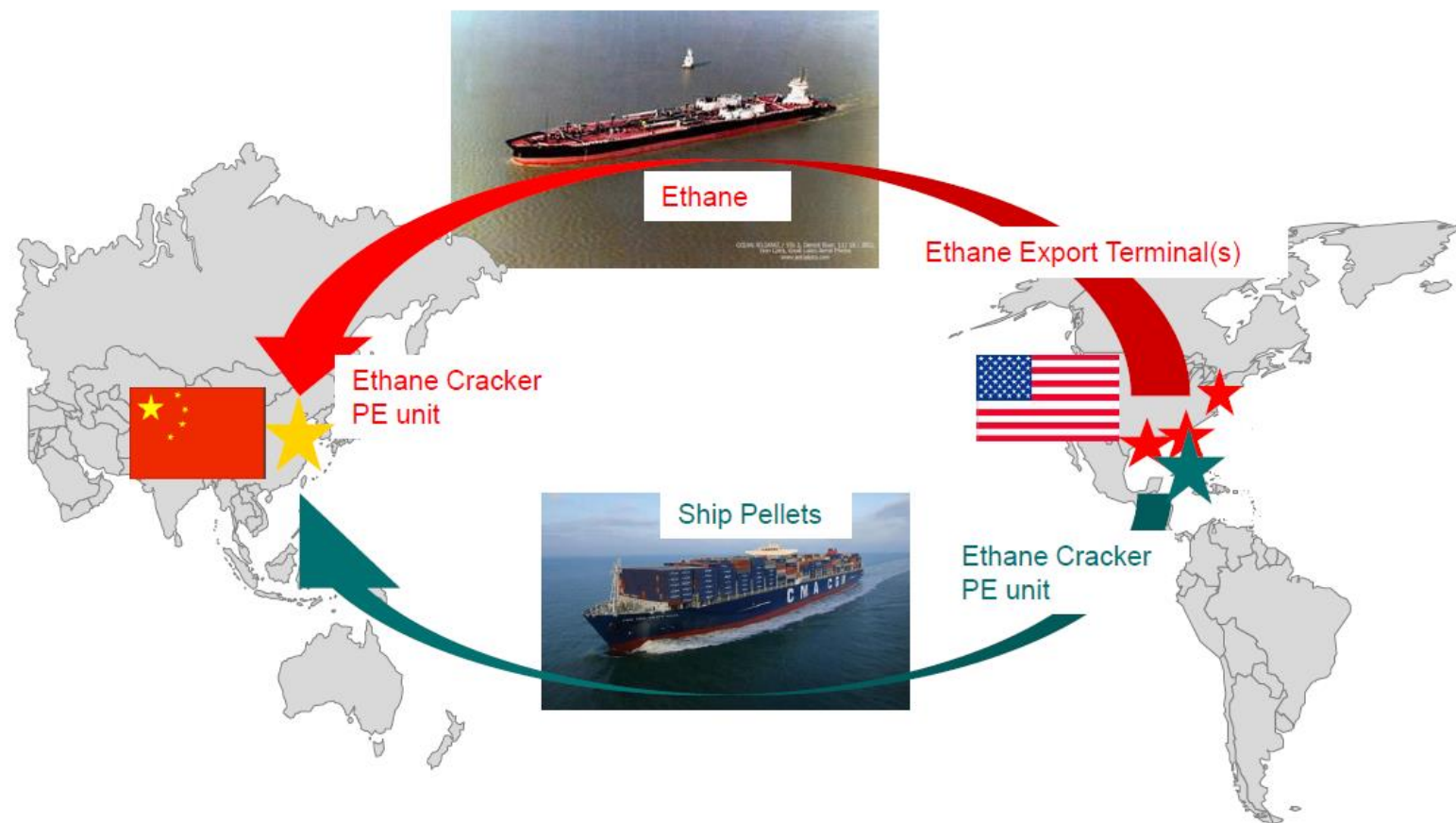
# US Capacity Additions and Spending



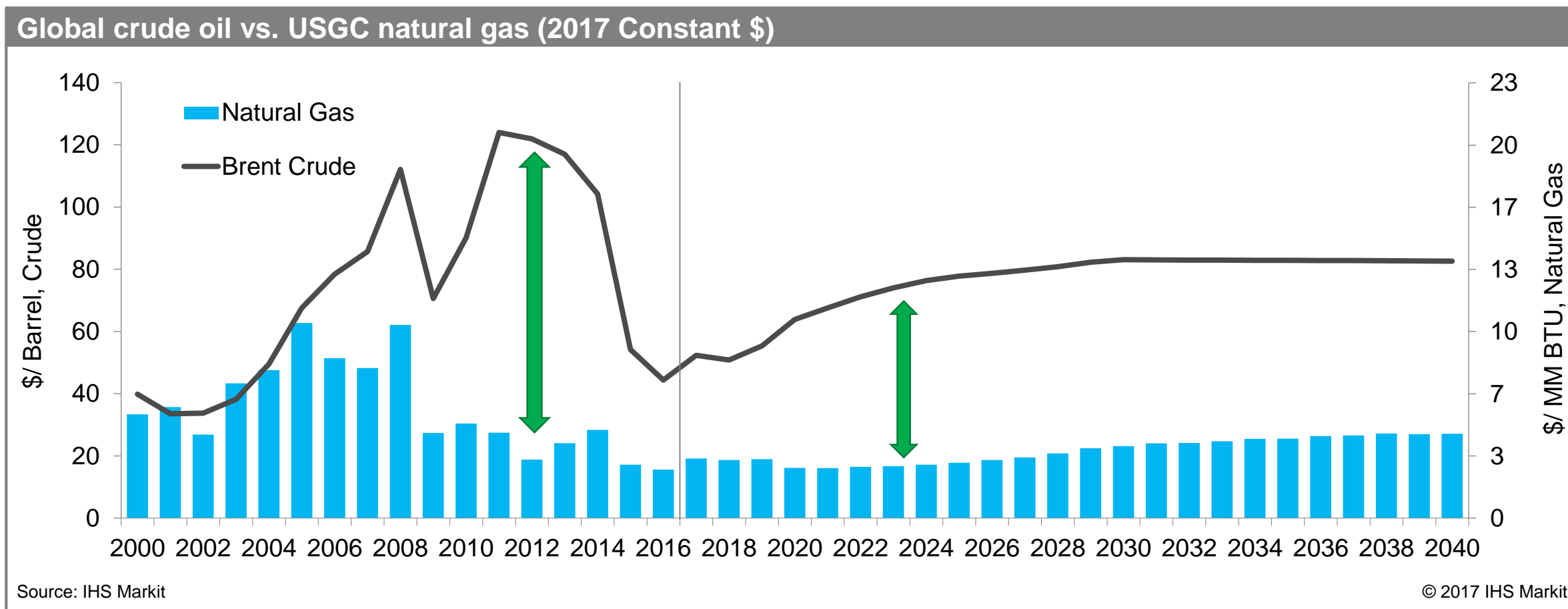
## US Activity has peaked and remains high through 2020



## Concept – Refrigerated liquid versus Pellets

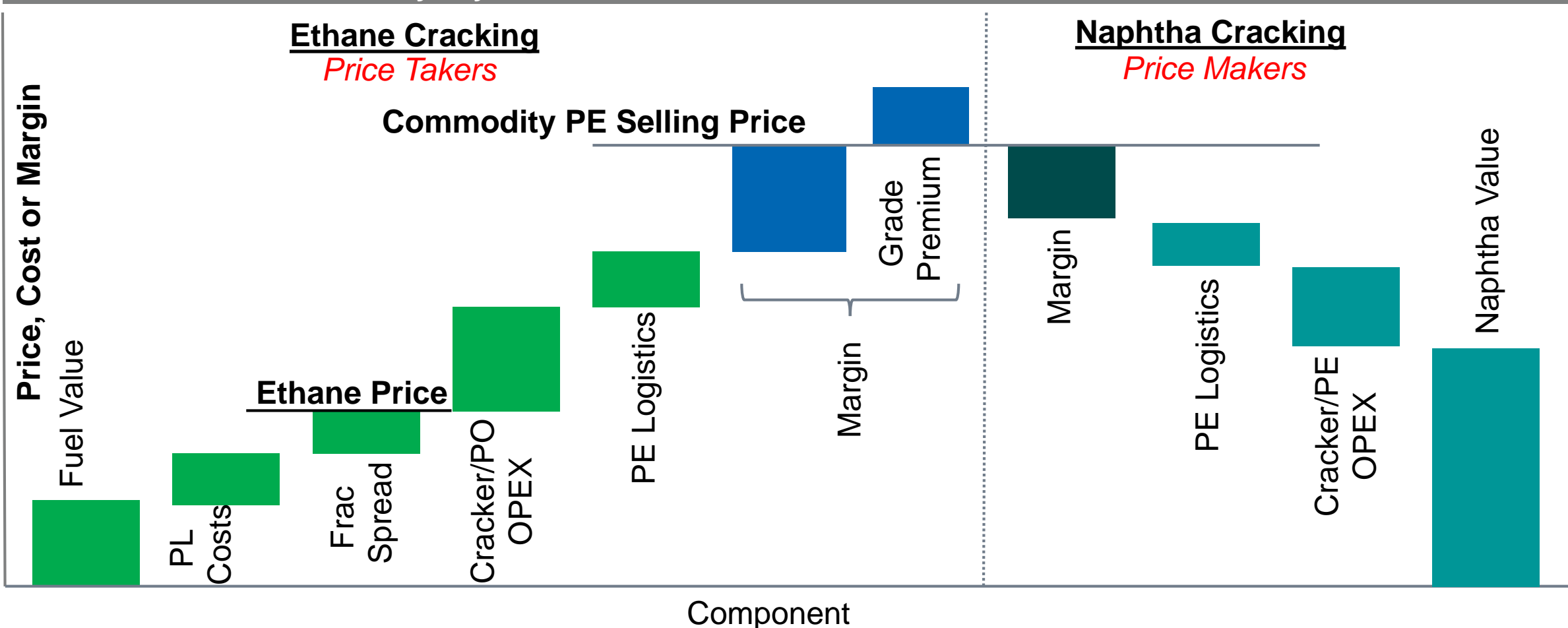


## Combination of high crude prices and stable gas is attractive for those North America investments based on natural gas and natural gas liquids

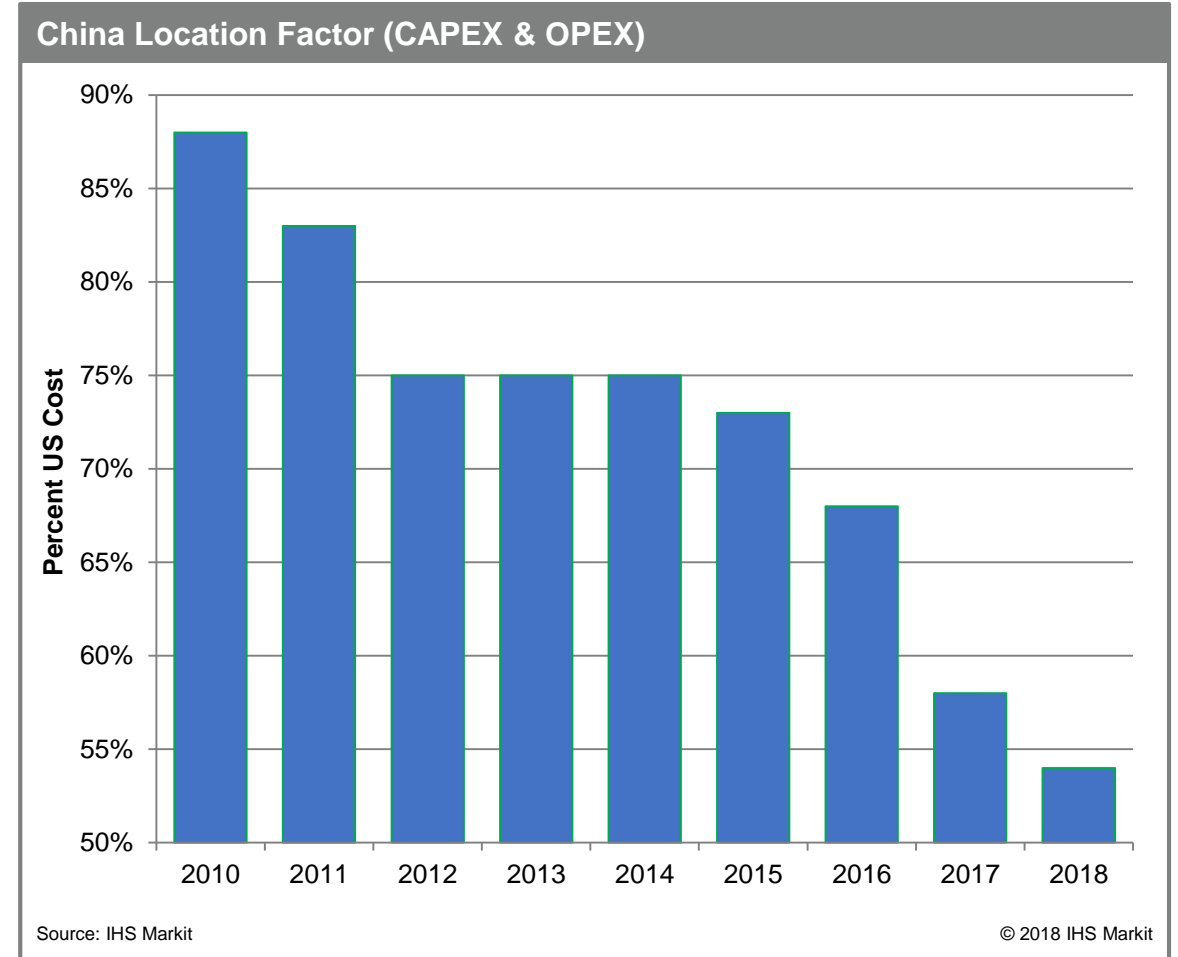
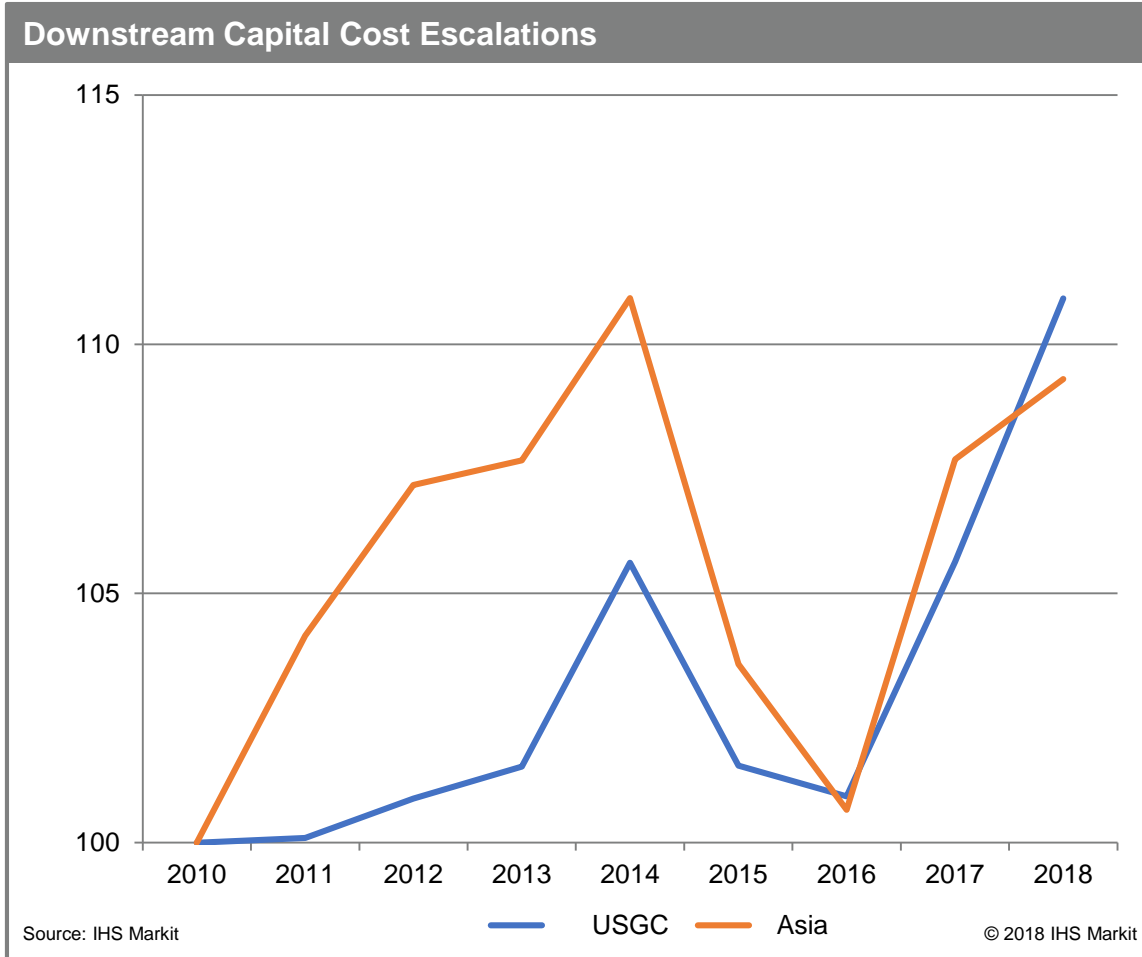


# Example of value creation hydrocarbon to polyethylene: a host of market and cost drivers influence ultimate margin realization and value creation

## Cost and Value Drivers for Polyethylene



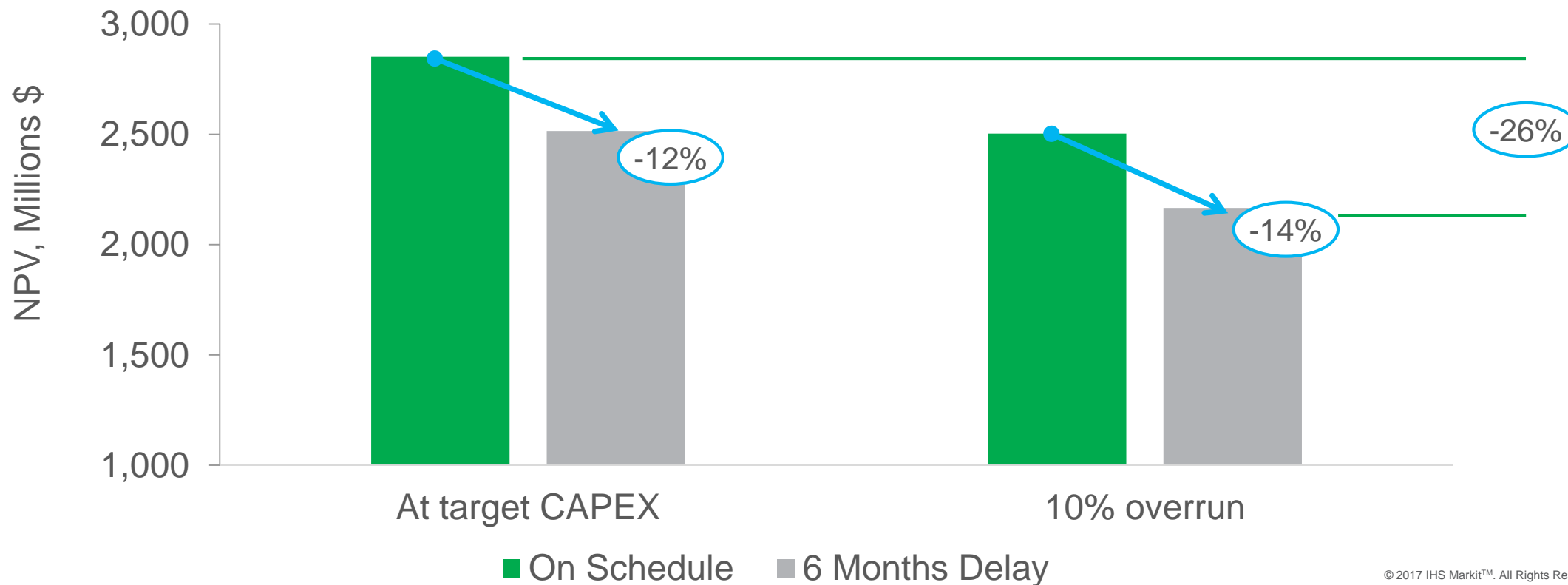
## Increase in China's local content is driving costs down





## Plenty of value creation available for US investment, but high execution risk as delays and overruns destroy value

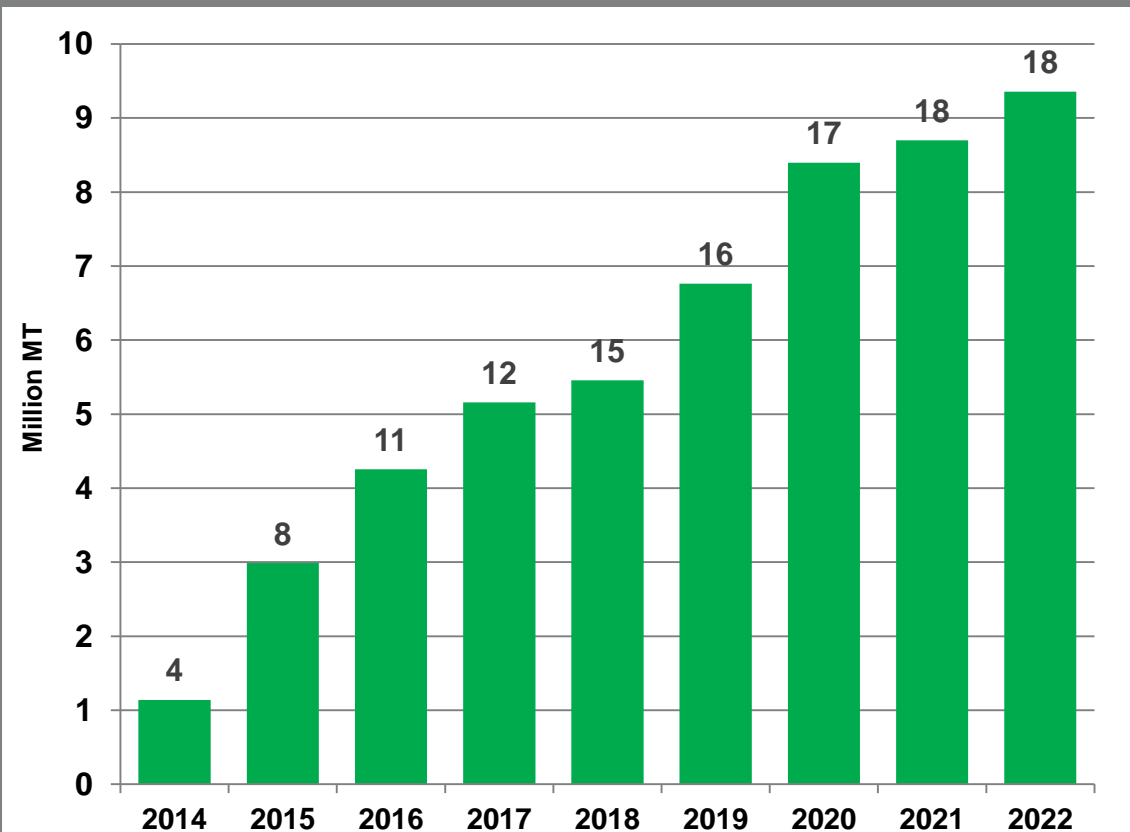
Impact of Project Underperformance on Base US Ethane Cracking NPV



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# Exports of Propane to China to Produce Propylene is Expanding Rapidly

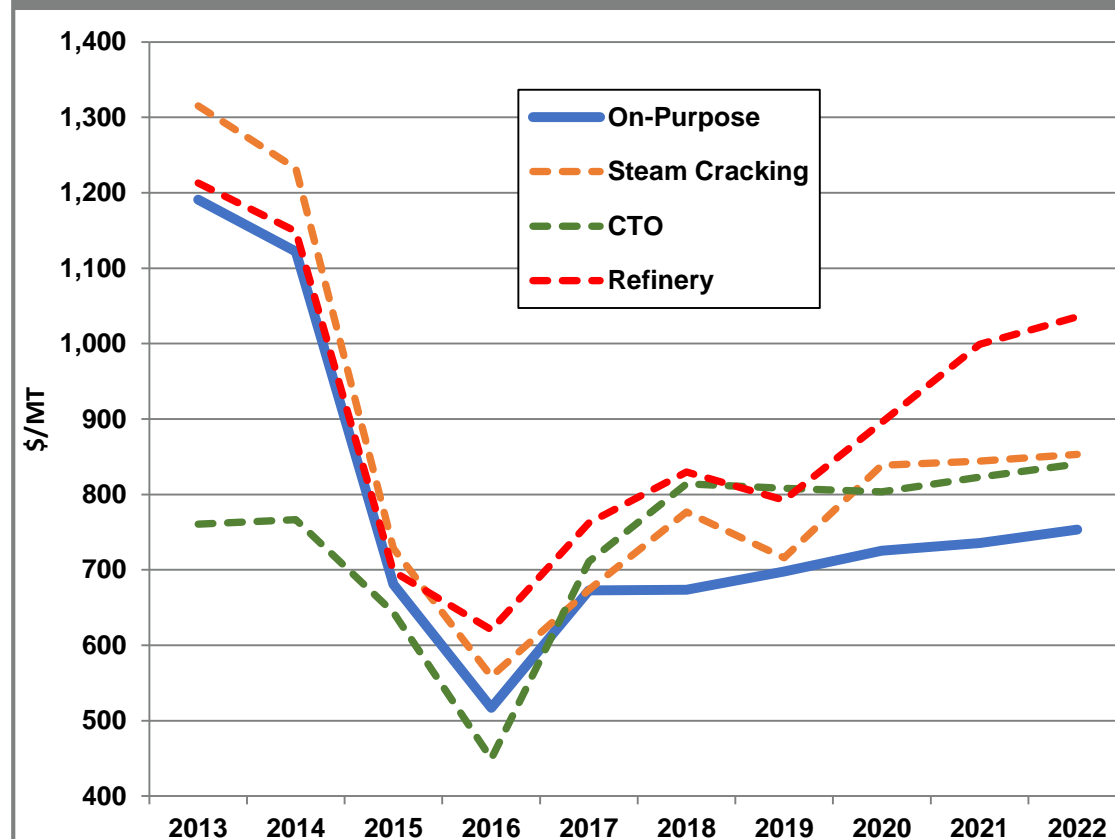
China Propylene from Imported LPG



Source: IHS Markit

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Propylene Production Costs - China



Source: IHS Markit

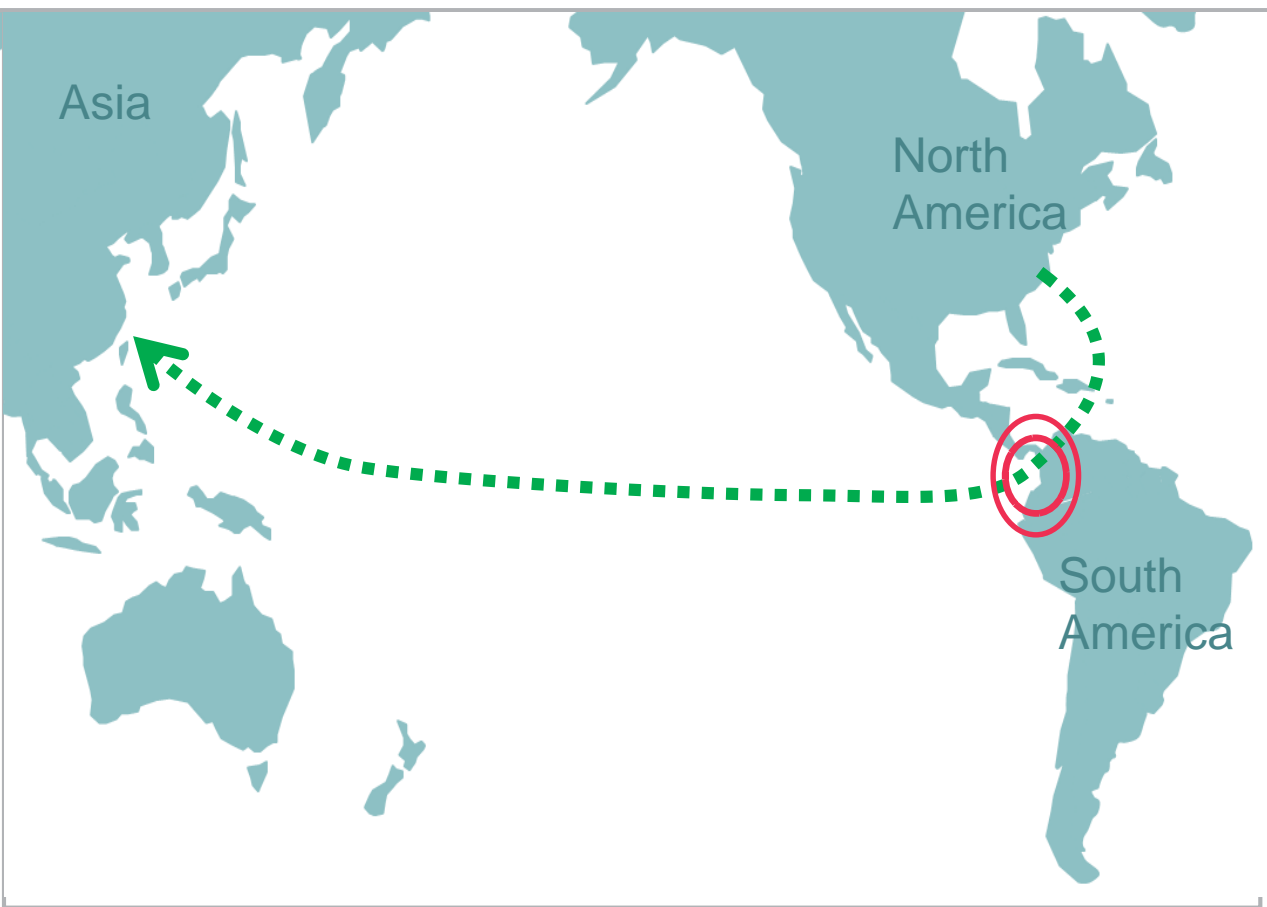
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## Case study - Multiple models for investment exist to satisfy Chinese demand growth

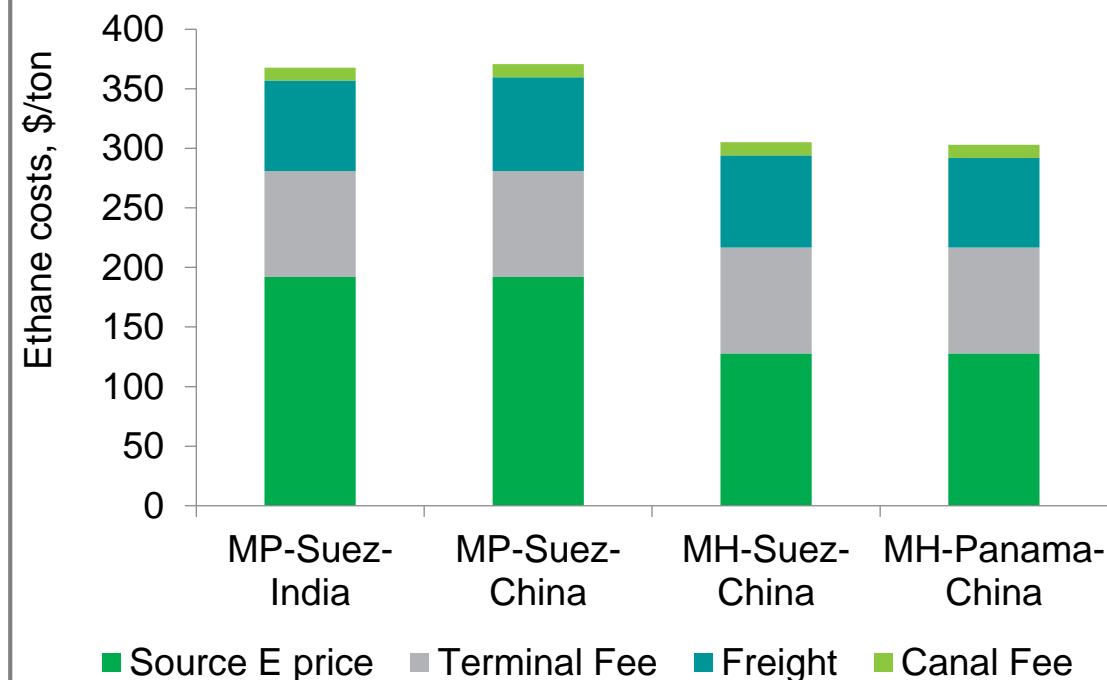


Option	Cash Cost	Capital	Market Risk
Export ethane, build cracking in China	Highest	Lowest	Lowest
Build US methanol, export to MTO in China	Lowest	Moderate	Medium
Build ethane cracker in US, export product	Moderate	Highest	Highest

Logistics costs are significant part of cost of imported ethane feedstock in Asia – roughly half of delivered cost to India



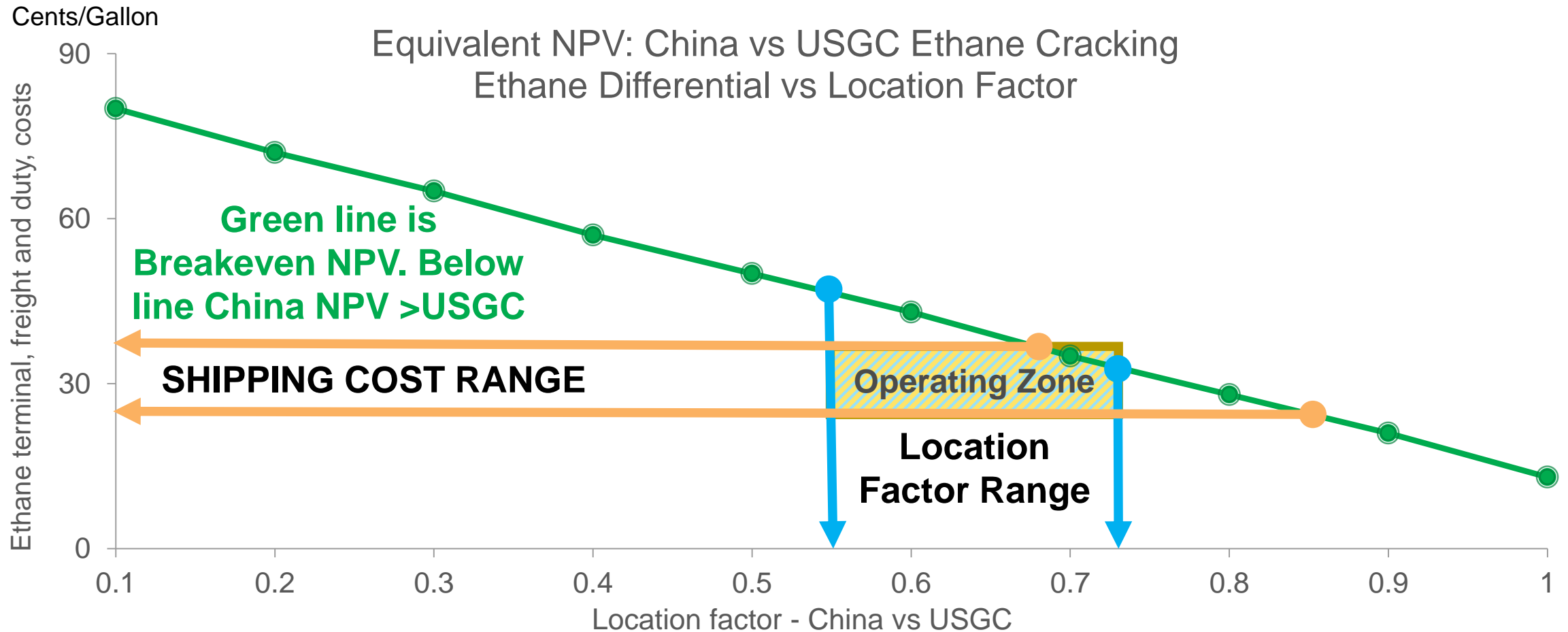
Ethane delivered cost build up



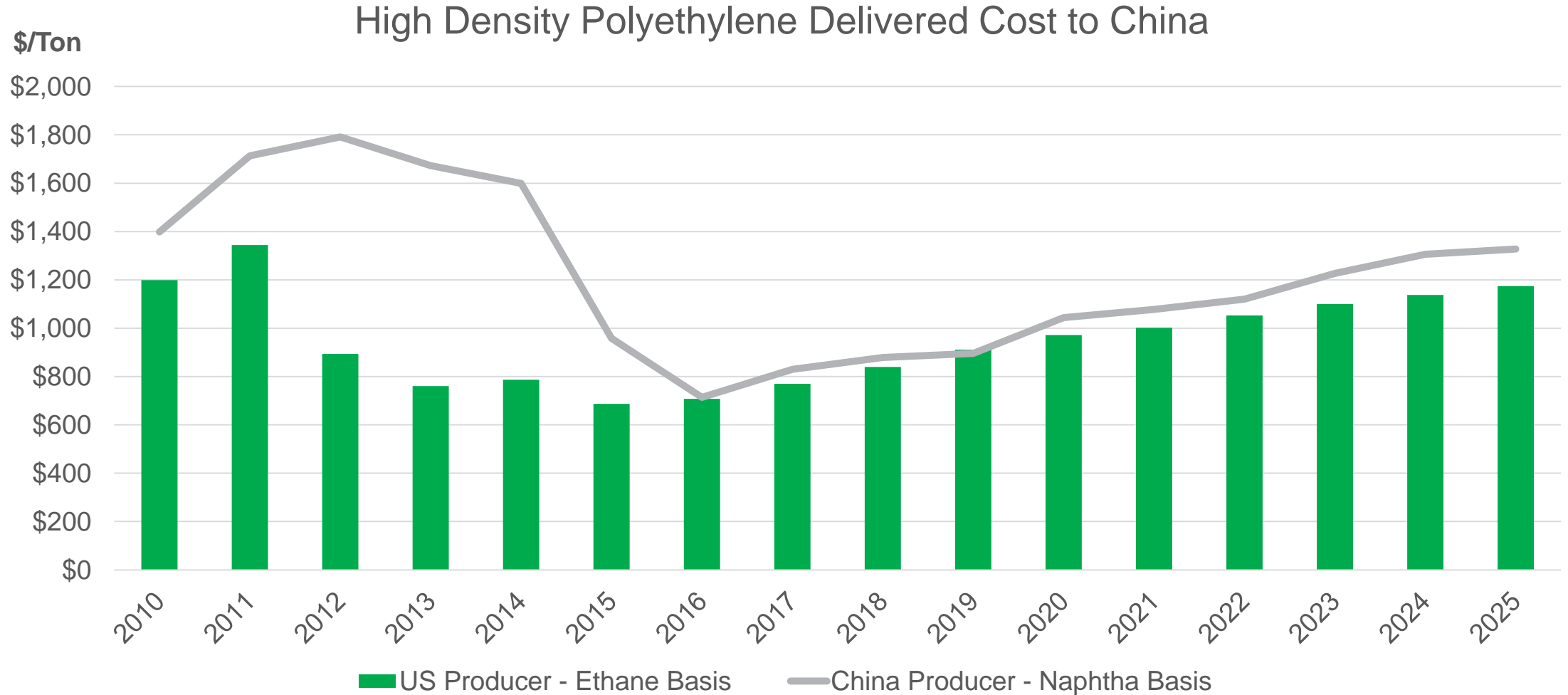
Source: IHS Markit

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Low-cost Chinese and high US capital costs means Chinese investment beats US returns even after accounting for high feedstock shipping costs

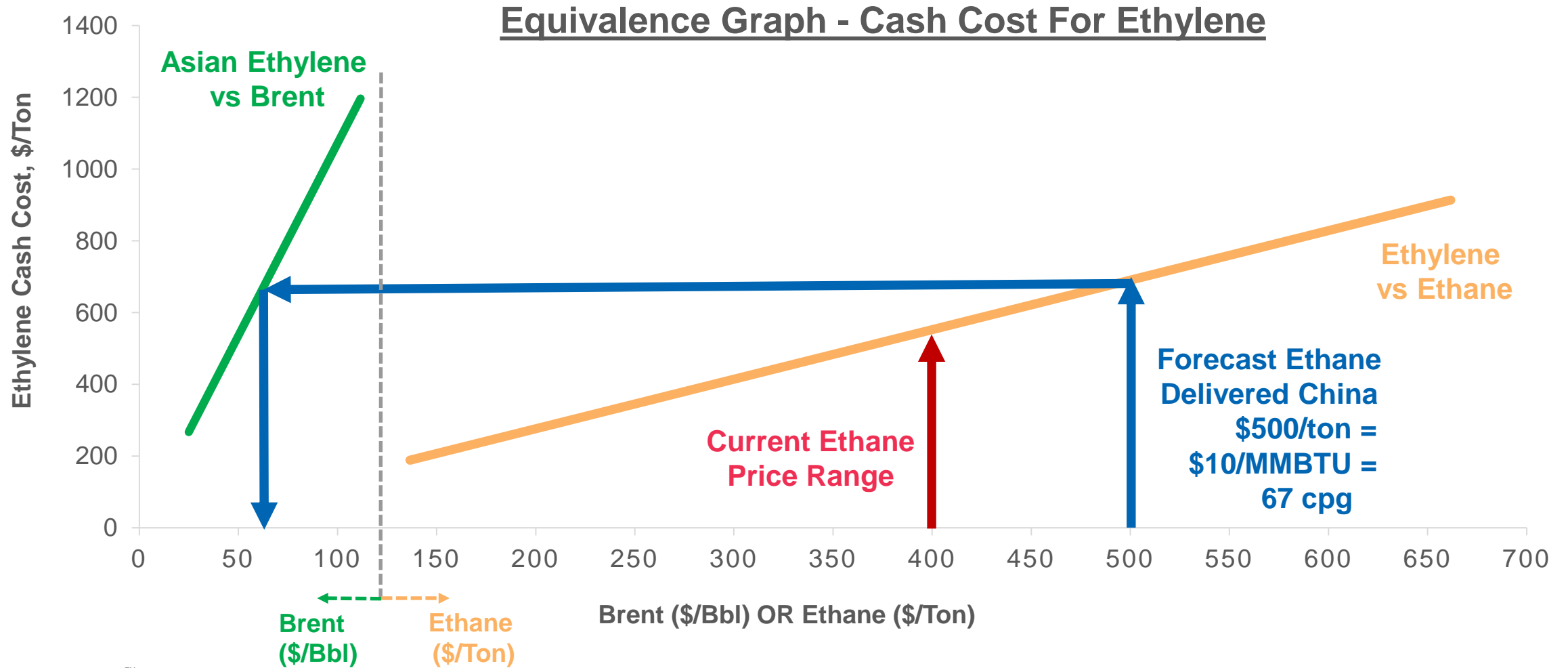


The US still wins on a delivered to customer cash cost basis (and has to or it won't be able to clear ethane)

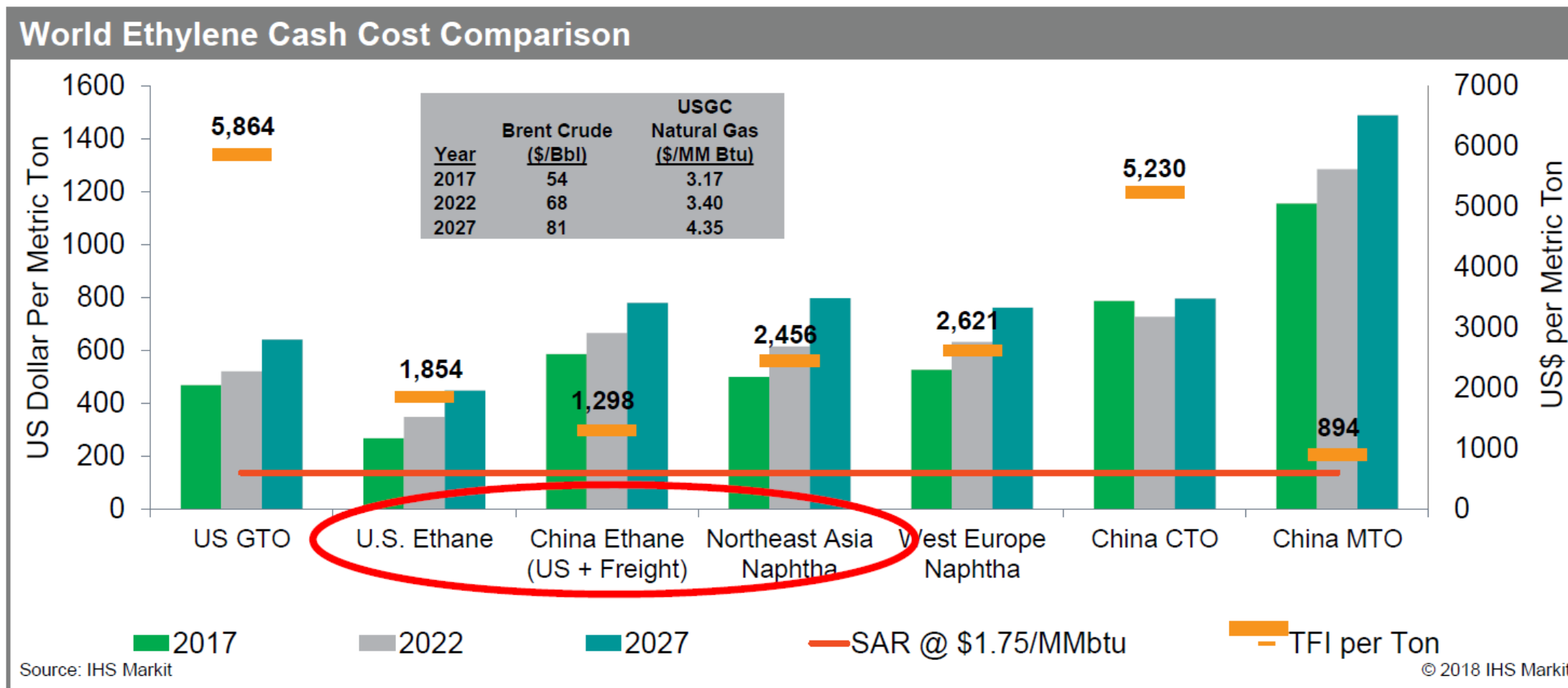




At expected ethane prices, cash costs favor naphtha at crude prices below \$60/Bbl.  
Will crude to ethane spreads be low enough for Chinese ethane to beat naphtha?



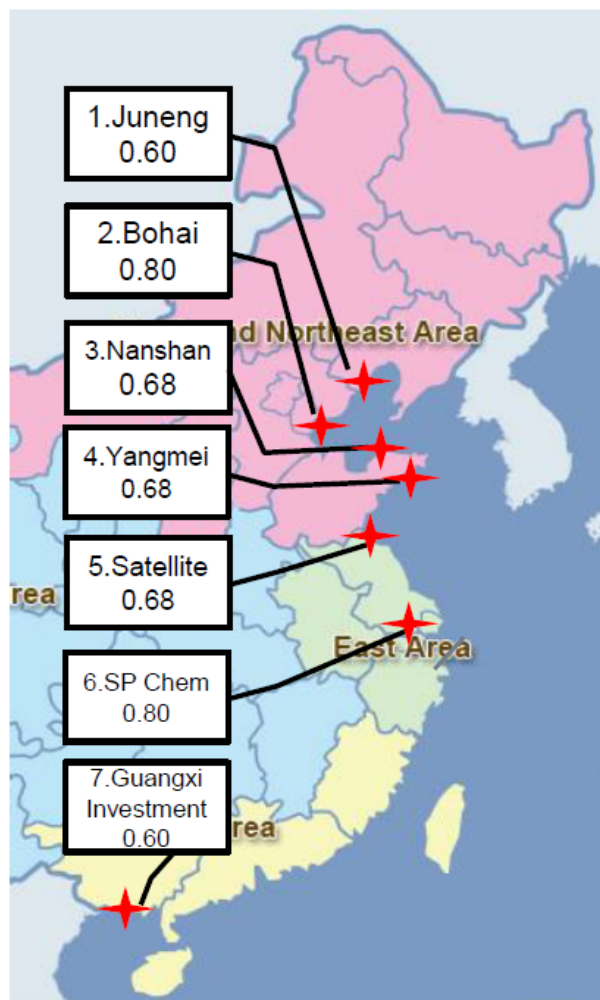
## Ethylene Cash cost, capital cost and returns part of the message



(Cash cost = Feed + VC + FC – co-product)

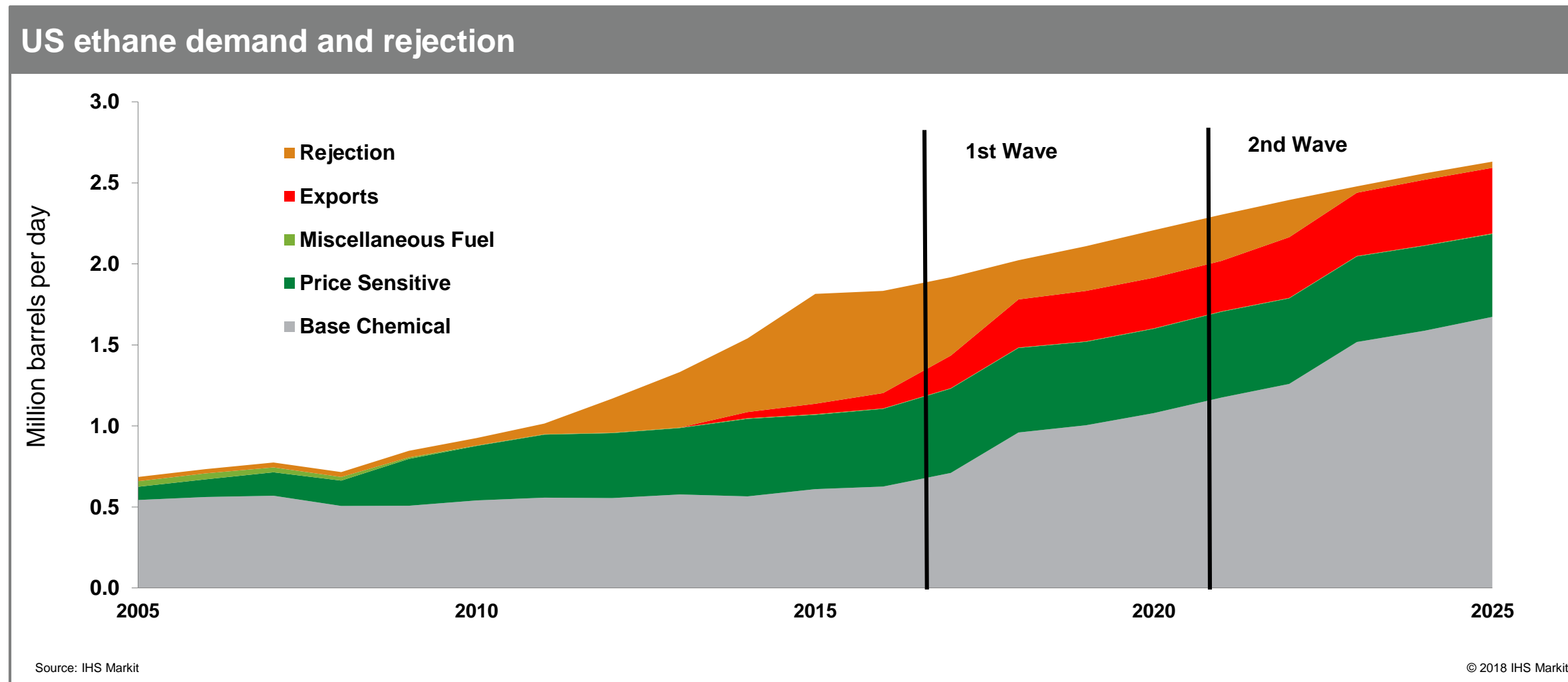
GTO = Gas-to-Olefins; CTO = Coal-to-Olefins; MTO = Methanol-to-Olefins

## Announced list of Ethane Crackers Are Under Planning, But How Many Will Come?

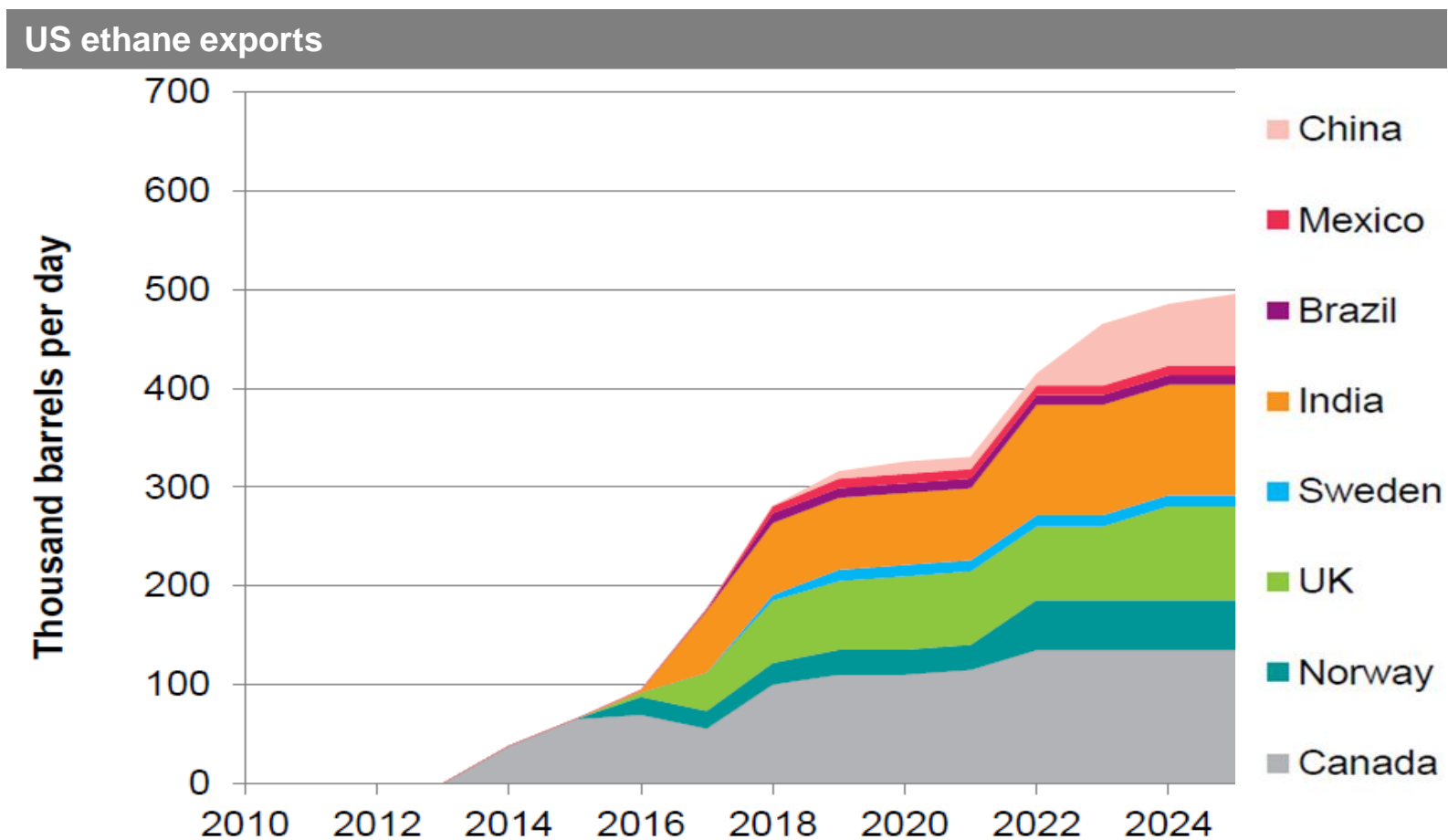


No.	Company	Location	Major Business	Ethylene Cap/KTA	Consume Ethane/KTA	Investment Billion RMB	Derivatives	Supplier	Status
1	Juneng Heavy Industry	Jinzhou, Liaoning	Machinery	2,000	2,600	26.1	NA	American Ethane Company	EIA
2	Bohai Chemical	Tianjin	Chemical	1,000	1,300	NA	SM, PE	/	FS
3	Nanshan Group	Yantai, Shandong	Metal	2,000	2,600	26.9	MEG, EVA, PE	American Ethane Company	EIA
4	Yangmei Hengyuan	Qingdao, Shandong	Coal	1,500	2,000	NA	EDC, SM, PE	American Ethane Company	FS
5	Satellite PC	Lianyungang, Jiangsu	Chemical	2,500	3,250	30.0	EOEG, PE, EVA	JV with SUNOCO	FS Financing
6	SP Chemicals	Taixing, Jiangsu	Chemical	650	270	5.5	EDC, SM	E/P, Ineos, one VLEC	Constructing
7	Guangxi Investment	Qinzhou, Guangxi	Power	1,000	1,300	4.5	EOEG, PE, EVA	/	FS
		<b>TOTAL</b>		<b>9,150</b>	<b>13,320</b>				

# Exports of NGL Feedstocks to China is Already a Reality



## Volume and pace of ethane exports depends on terminal capacity and cracker timing





## Conclusions

- **Demand growth concentrated** in developing world **and dislocated** from hydrocarbon supply
- **Shale has unlocked huge amounts of competitive supply** supporting investment growth in Energy and Chemicals
- Poor US project performance is **eroding feedstock advantages**
- Future expansion of industry in the US **may be at risk.**

