



State of the US Chemical Industry

Is the resurgence in growth sustainable?

A look at the ramp up in US chemical industry capital investment as a result of US Shale Oil & Gas

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Mark Eramo, Vice President – Global Business Development
Oil Markets / Midstream / Downstream / Chemicals

mark.eramo@ihsmarkit.com

Addressing strategic challenges with interconnected capabilities

IHS Markit provides leaders from multiple industries with the perspectives, analysis and insights they need to make informed business decisions that help them succeed and stay ahead of their competition.

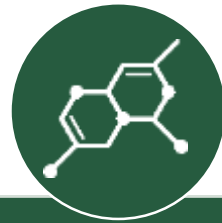


State of the US Chemical Industry AGENDA

- **Industry fundamentals**
 - > Consistent & Emerging Issues & Drivers
- **Basic chemical outlook: Global & US**
 - > Energy (crude oil) assumptions are important
 - > Capital investments and trends in global chemicals trade
 - > Industry cycle / Earnings outlook
- **Top global issues**
 - > Mobility, Refinery integration returns, Plastics Waste, China
- **Final Thoughts**



The Chemical Industry Enables Modern Living



Natural resources

Refined products & natural gas liquids

Base chemicals

Chemical intermediates

Formulated products / performance materials

Consumer products

- Oil
- Gas
- Coal
- Renewable

- NGLs
- Naphtha
- Fuel Oils
- Gasoline
- Diesel

- Olefins
- Aromatics
- Chlor-alkali
- Others

- Commodities
- Differentiated commodities
- Technical specialties

- Transportation • Packaging
- Construction • Recreation
- Industrial • Medical
- Pharmaceutical • Personal care
- Textiles • Electronics
- Aerospace • Business equipment

Multi-billion dollar investment decisions rest on key market fundamentals and emerging mega-trends

Basics: Unchanged over time

Building blocks for consumer goods

Economic growth drives demand

Low cost position endures & thrives

Market access & logistics are critical

Emerging trends: Continue evolving

Energy market fundamentals

Social license to operate

Technology & world scale

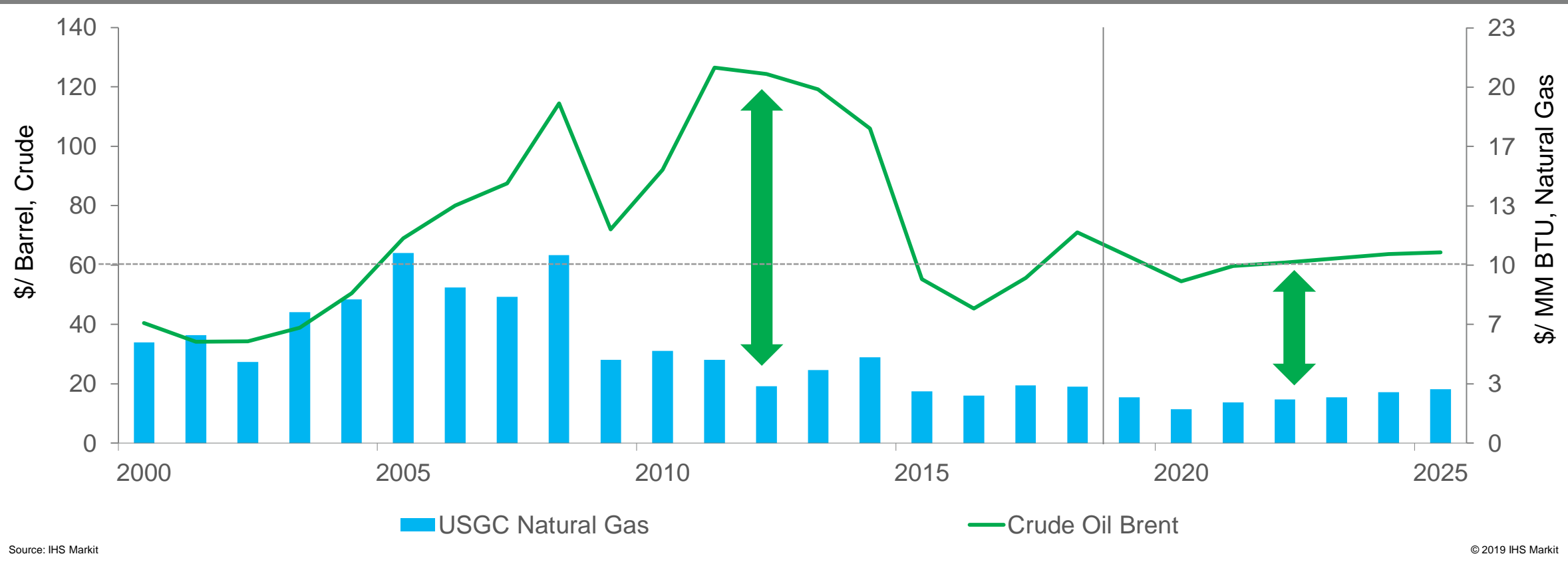
Use of digital technology

Energy outlook drives capital decisions

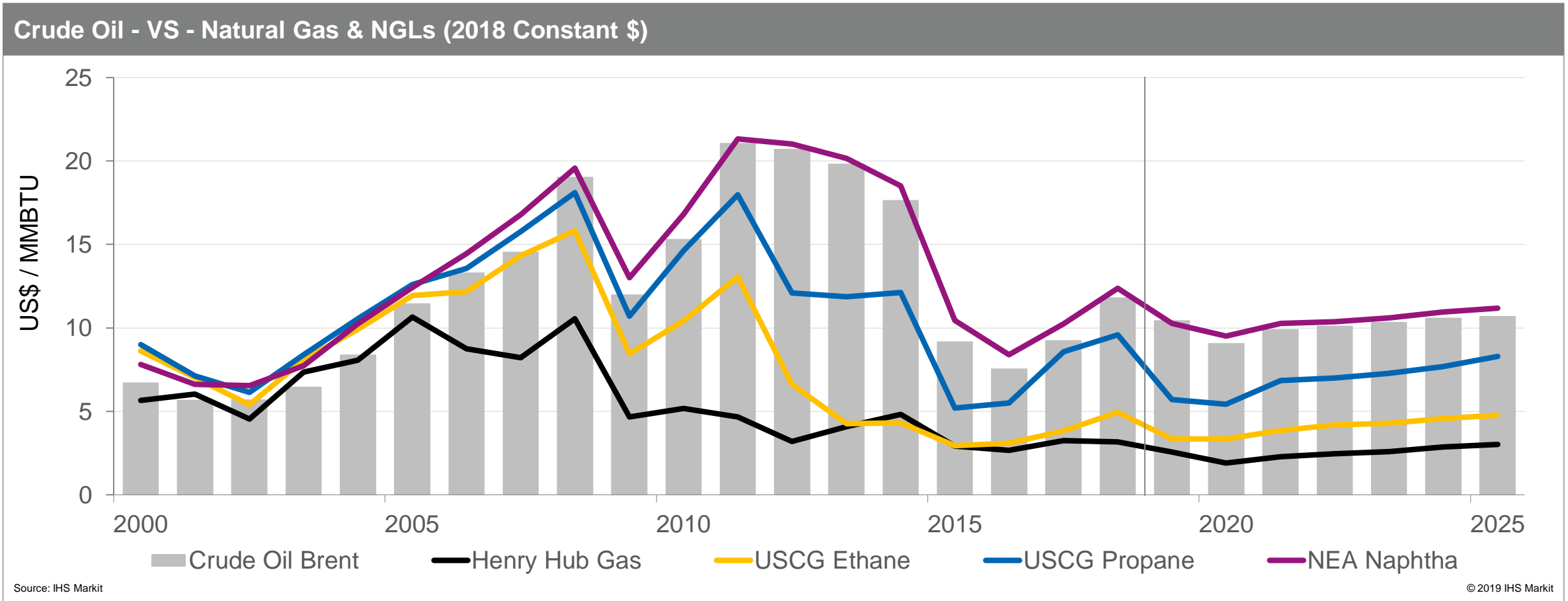
High global crude oil prices & low gas prices in North America drive gas based investments

Combination of high crude prices and stable natural gas is attractive for North America gas-based chemical investments

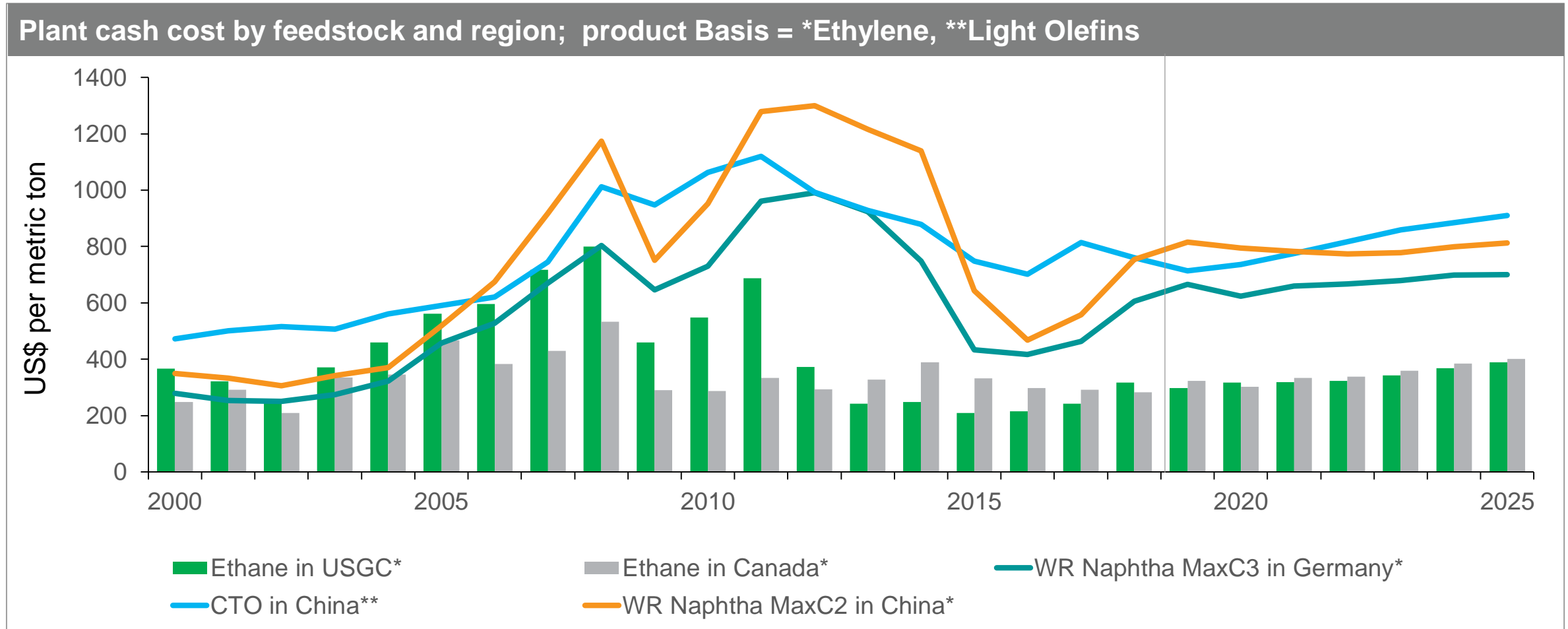
Global crude oil vs. USGC natural gas (2018 Constant \$)



Sustained higher crude oil pricing creates sustainable advantage for ethane and propane feedstocks versus naphtha



Energy scenario with higher crude oil pricing versus natural gas, provides for a sustainable ethane cracking advantage in light olefins production



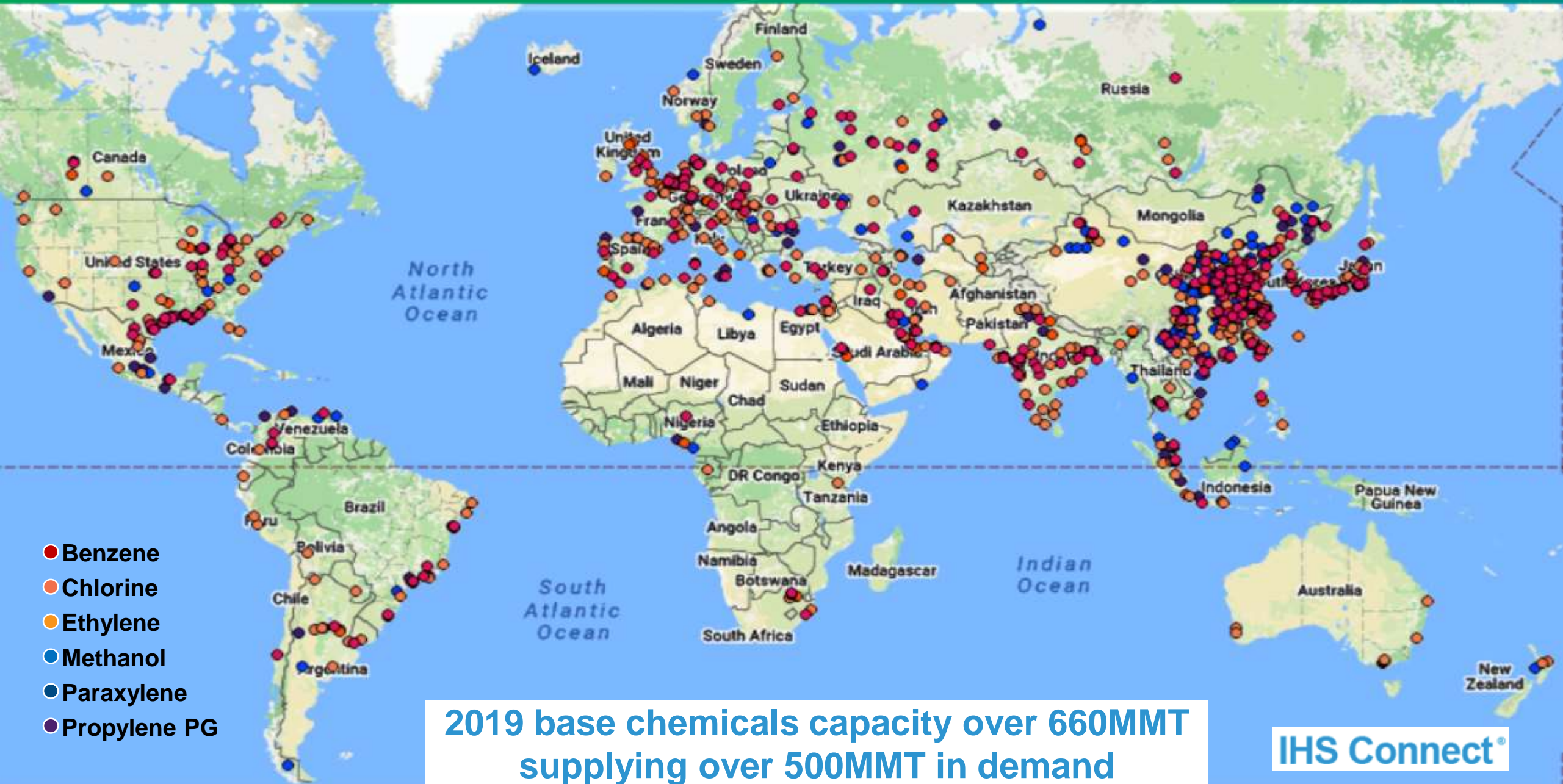
Capital investments seek a sustainable advantage

Chemical Investment “Drivers”

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

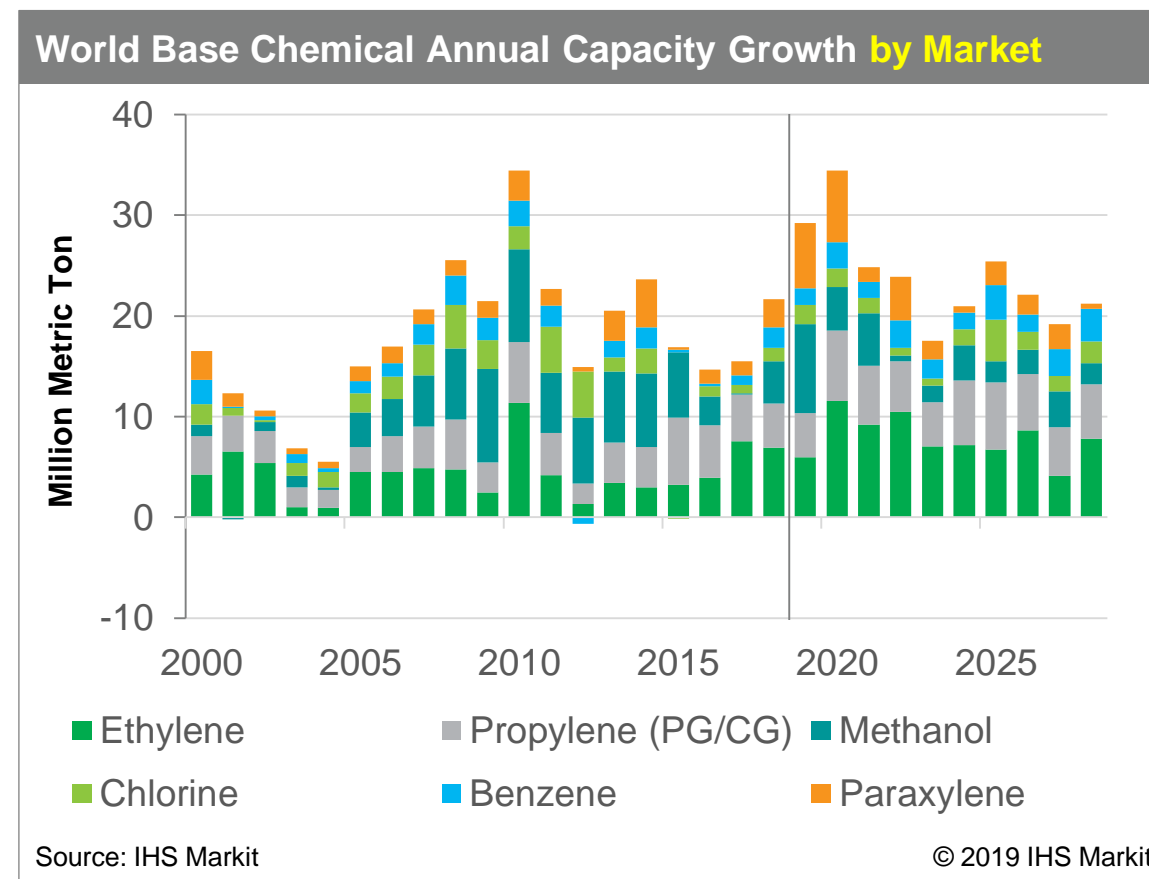
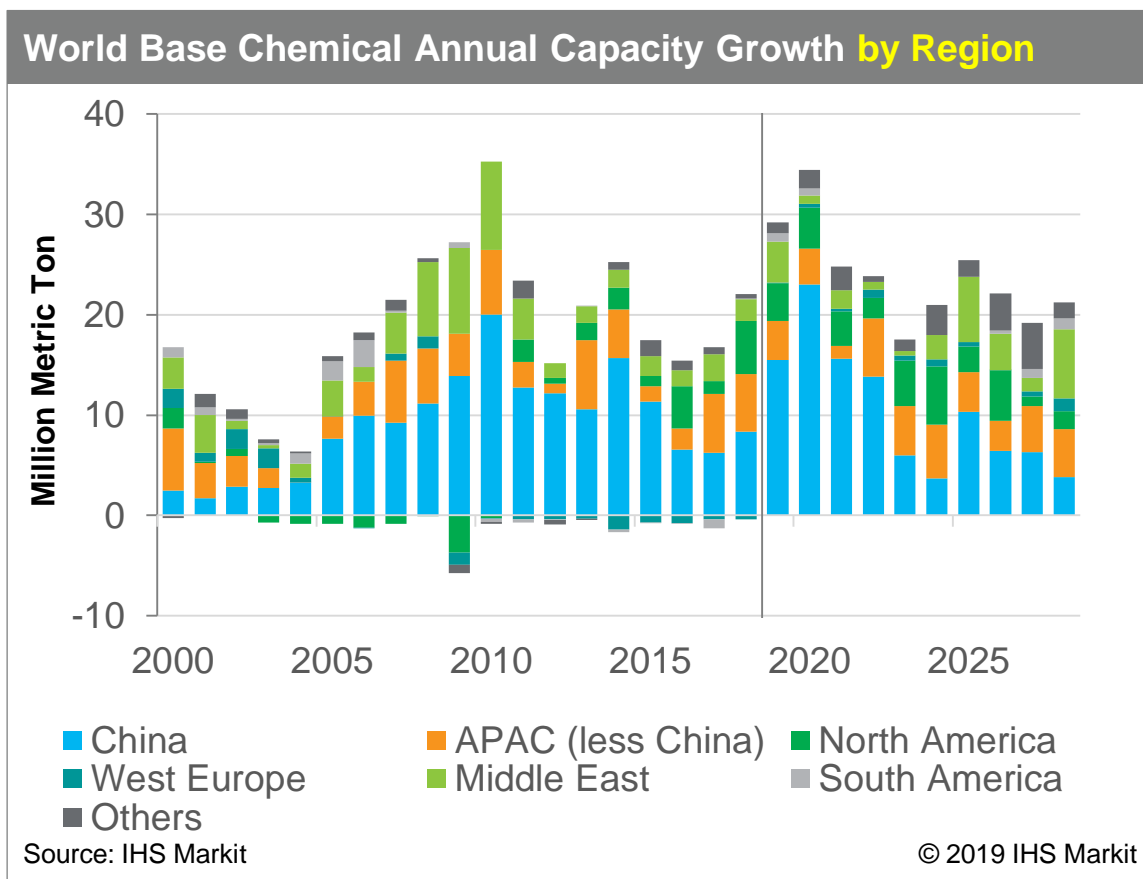


Shell Chemical Appalachia, LLC
Pennsylvania Petrochemical Complex
Ethylene & Polyethylene

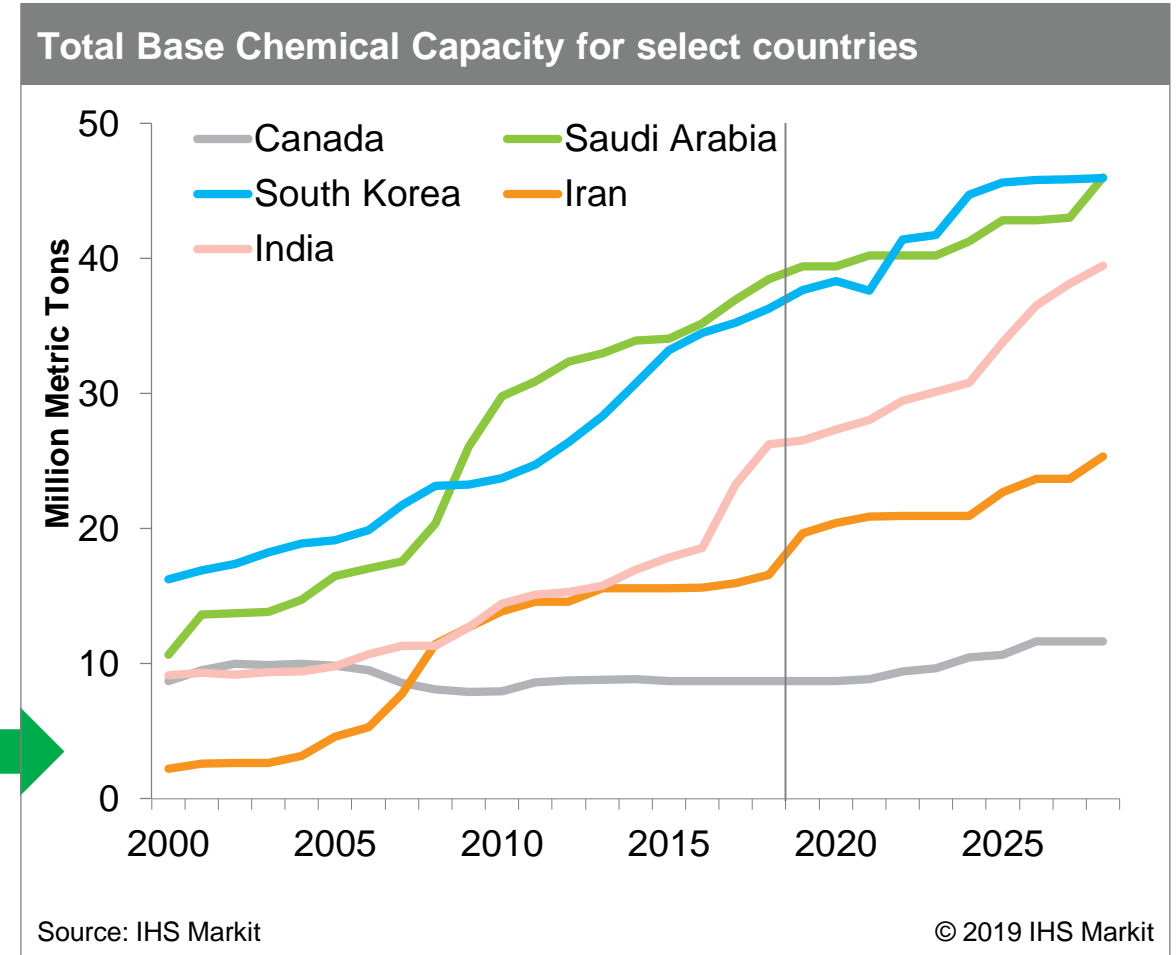
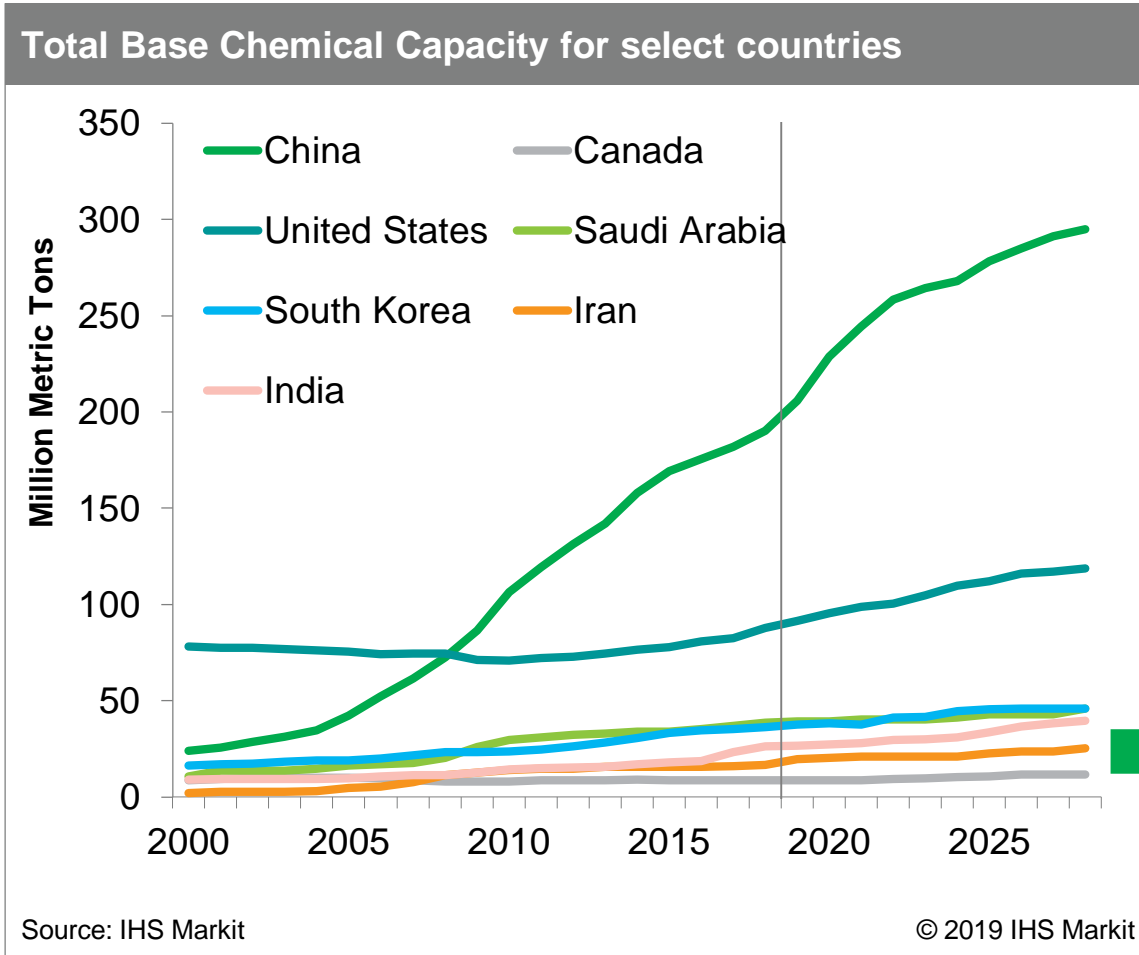


**2019 base chemicals capacity over 660MMT
supplying over 500MMT in demand**

Led by China, APAC is adding more than 50% of new capacity followed by North America and Middle East as surplus capacity emerges in many value-chains



China and North America investment continues at rapid pace along with more modest growth in other locations

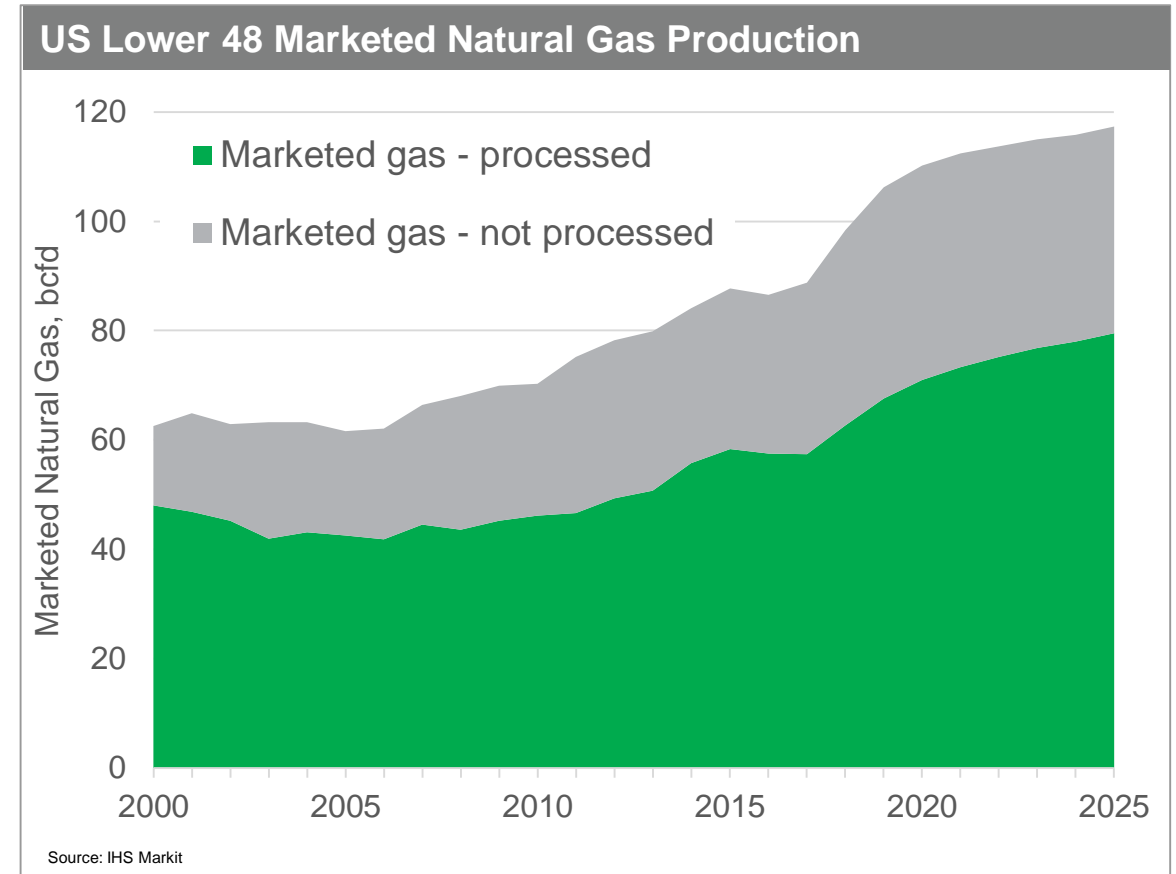
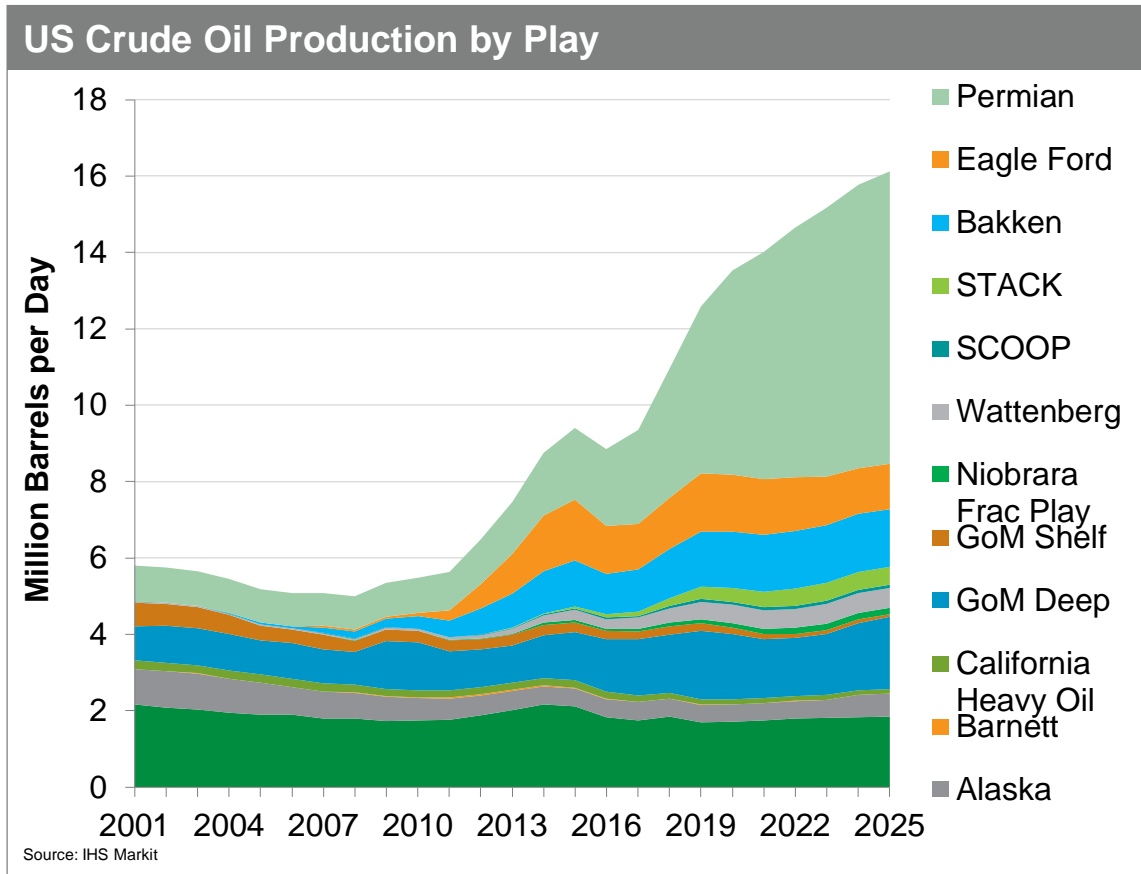


Total base chemical capacity includes: ethylene, propylene (PG,CG), methanol, chlorine, benzene, paraxylene

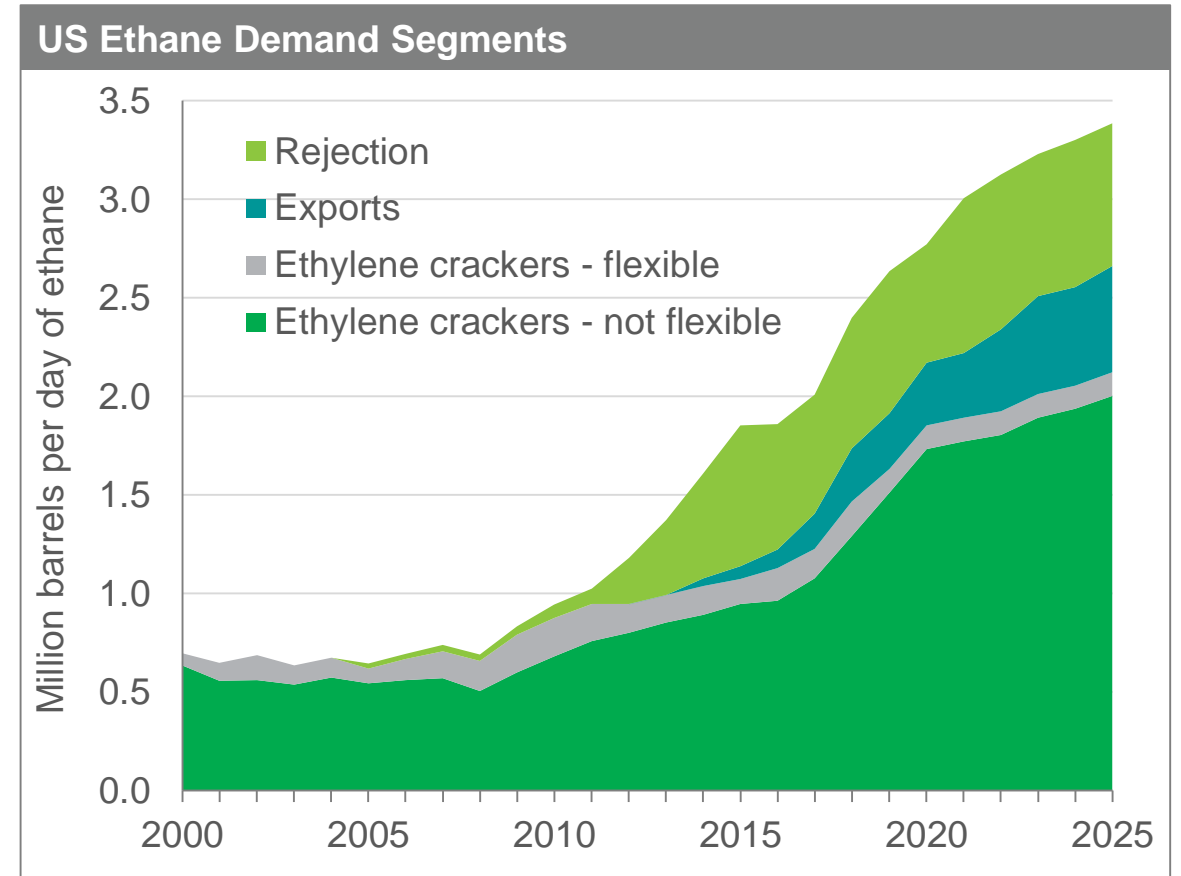
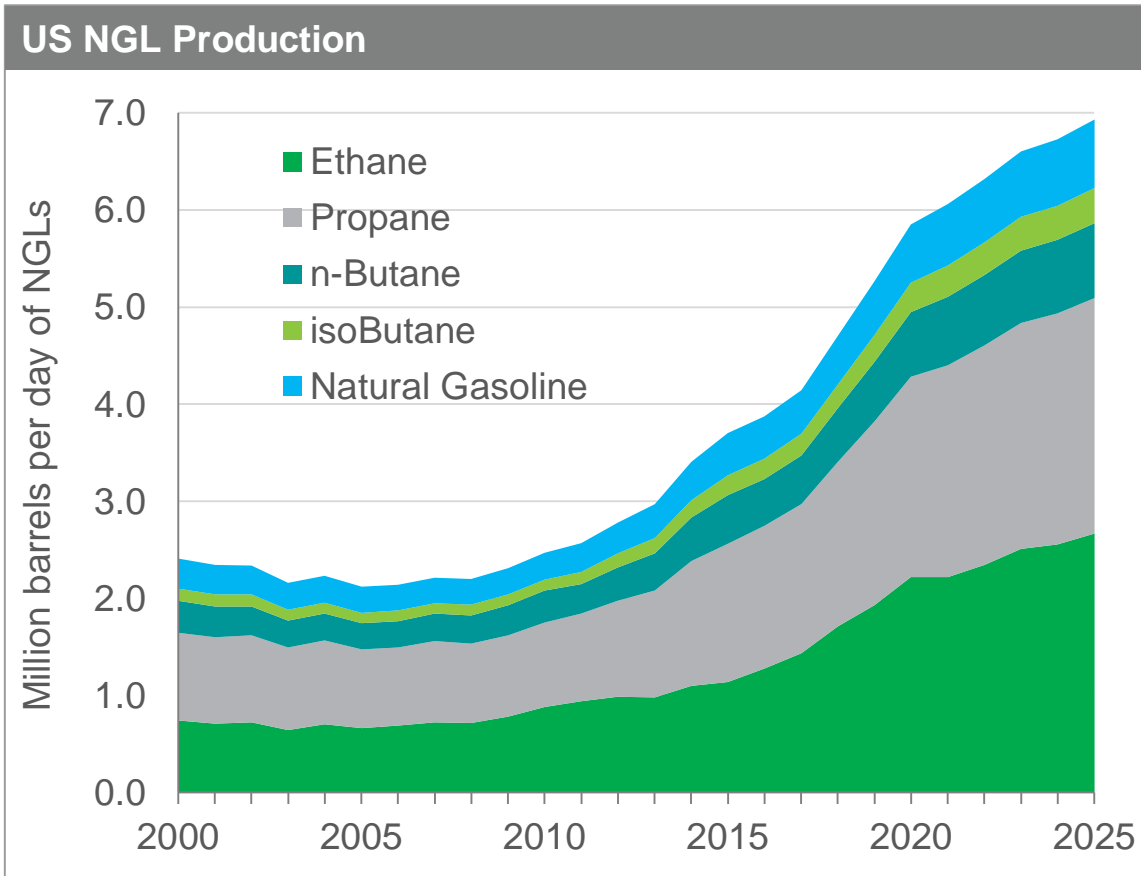
US outlook for energy supports continued investments

Domestic & foreign capital continues to flow into the US and Canada for chemicals and energy

Led by the Permian basin, US crude oil production approaches peak output by the mid-2020's; lower prices near term could slow production

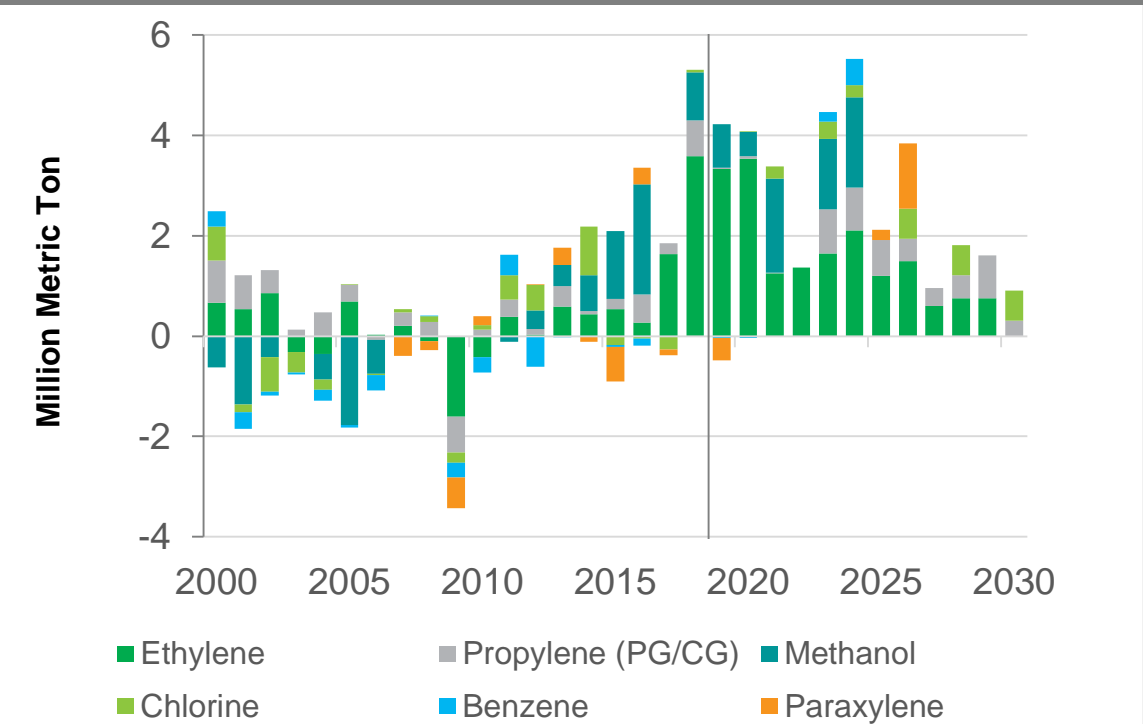


US NGL production nearly triples from 2010, with significant growth in ethane and propane; exports required to balance the market



Increase in US chemical industry capital investment as a result of US Shale Oil & Gas started post-2010 following a series of closures in various markets

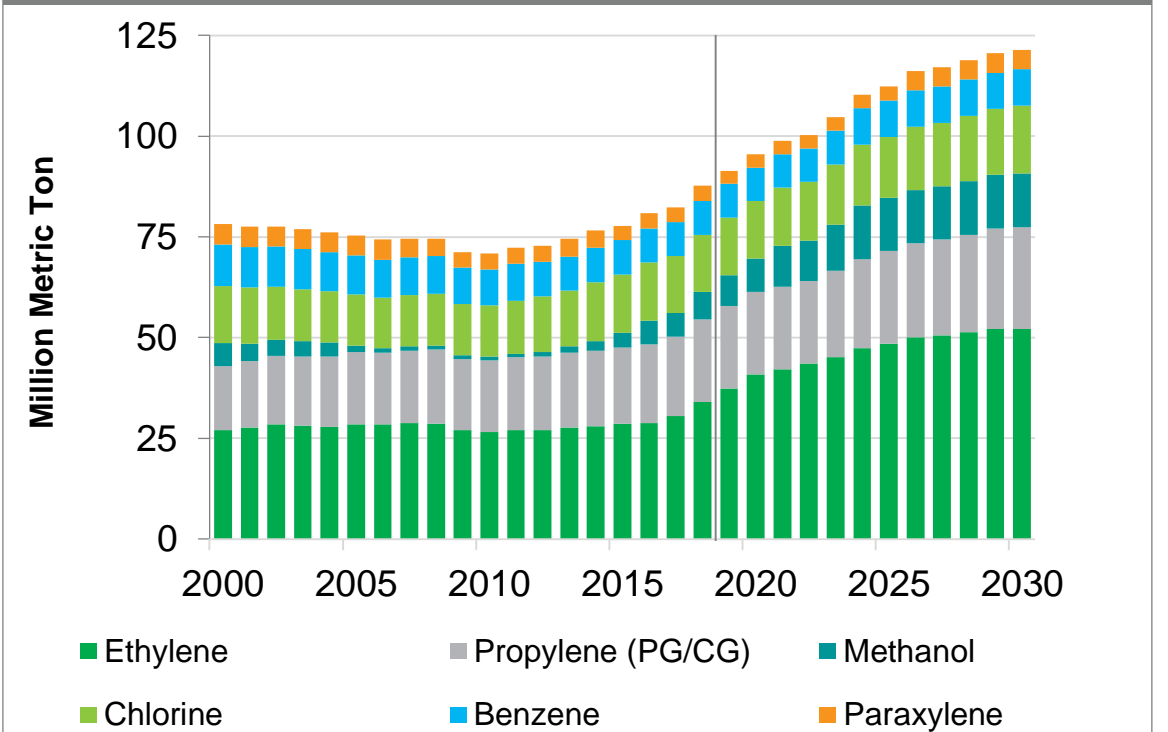
United States basic chemical capacity **annual growth(closure)**



Source: IHS Markit

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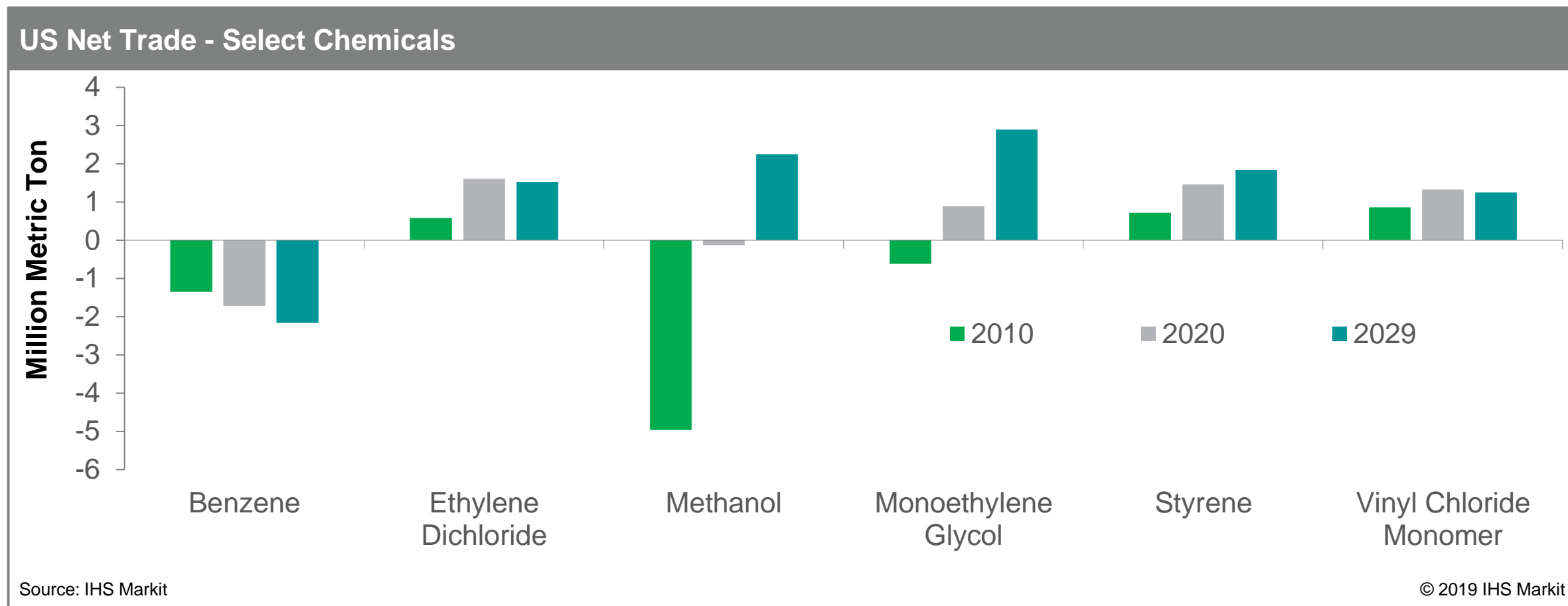
United States base chemical **total capacity**



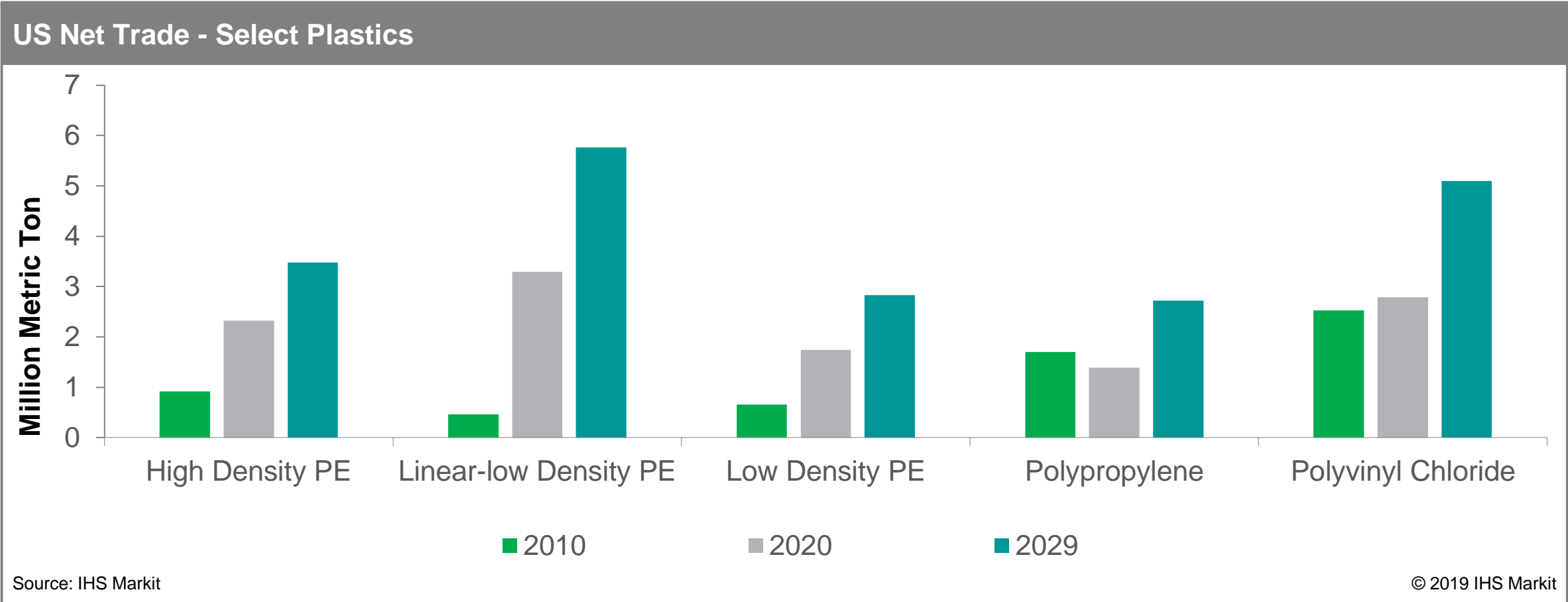
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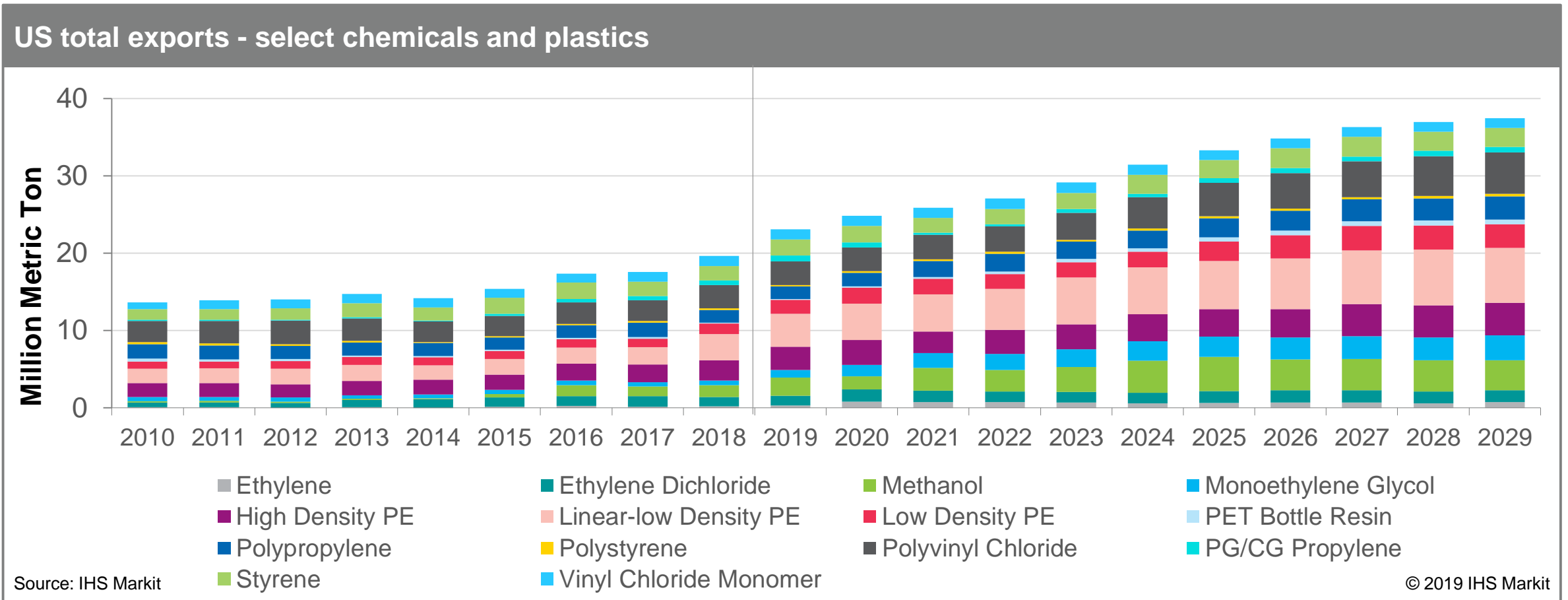
The net trade of most US gas based chemicals and intermediates are forecast to increase over time based on competitive costs; exception is benzene



The net trade of most US gas based plastics are forecast to increase over time based on competitive costs and slow-growth in the domestic market



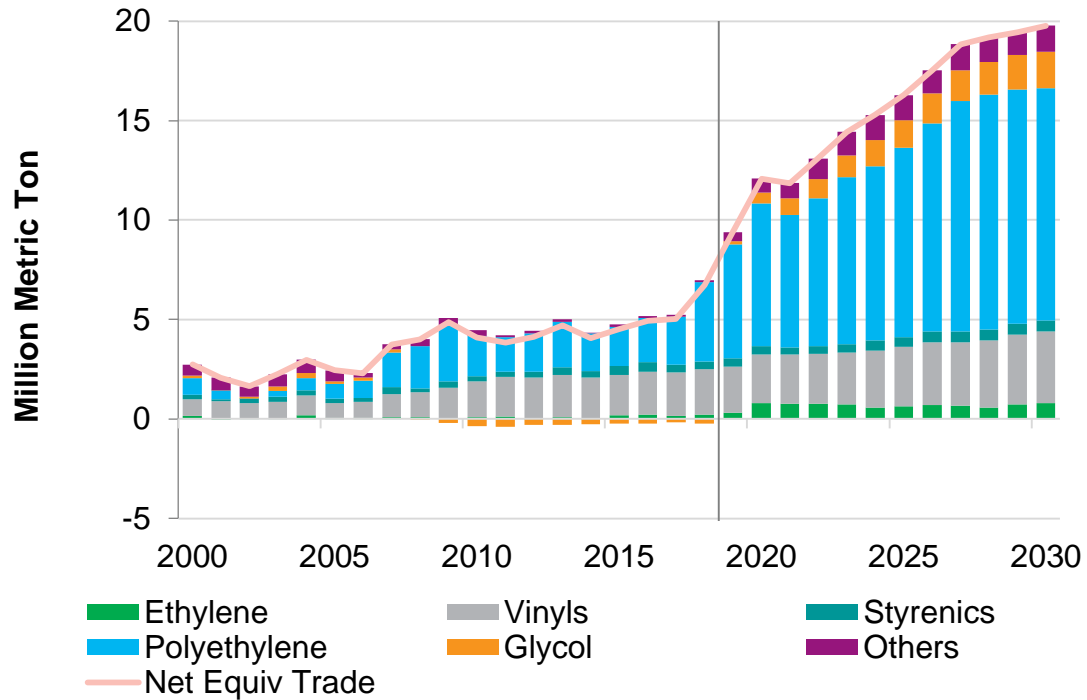
Given slow growth in the domestic market, total exports of chemicals and plastics from the US are forecast to approach 40 million metric tons



Net equivalent trade shows divergent trends on ethylene and propylene investment strategies

Low cost ethane and propane support US investments with targeted sales into export markets / domestic growth cannot support new capacity additions

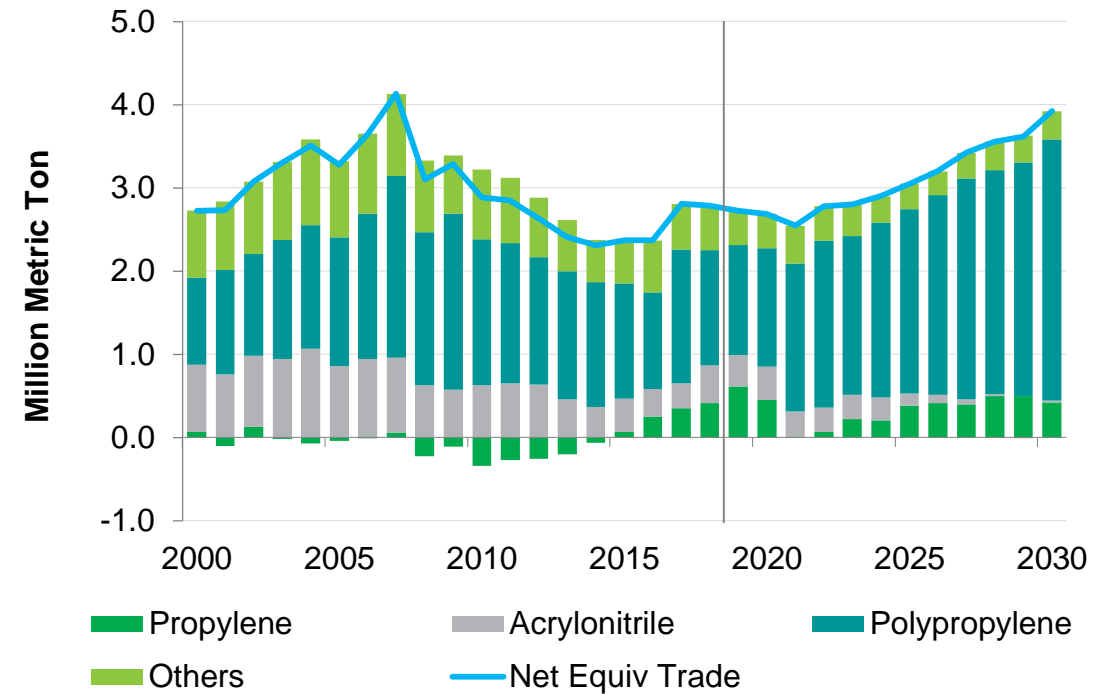
USA Ethylene Net Equivalent Trade



Source: IHS Markit

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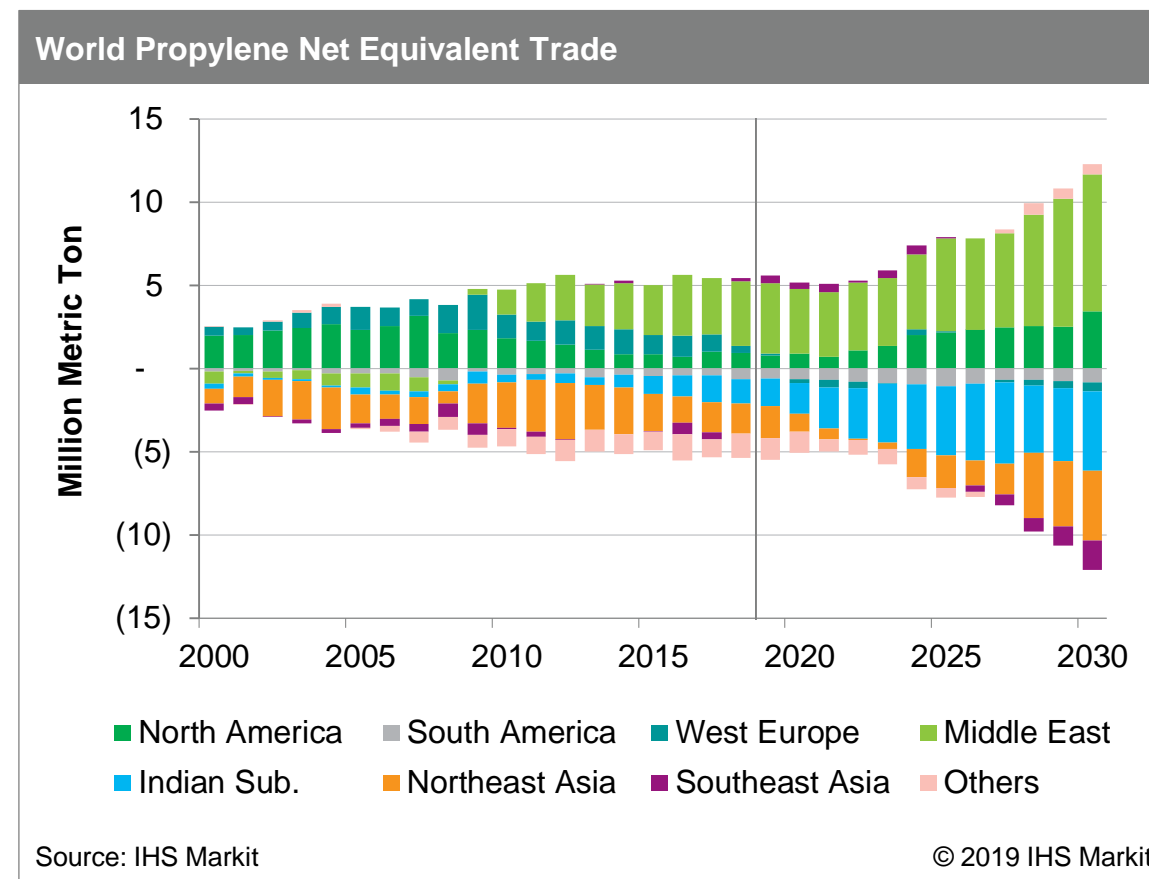
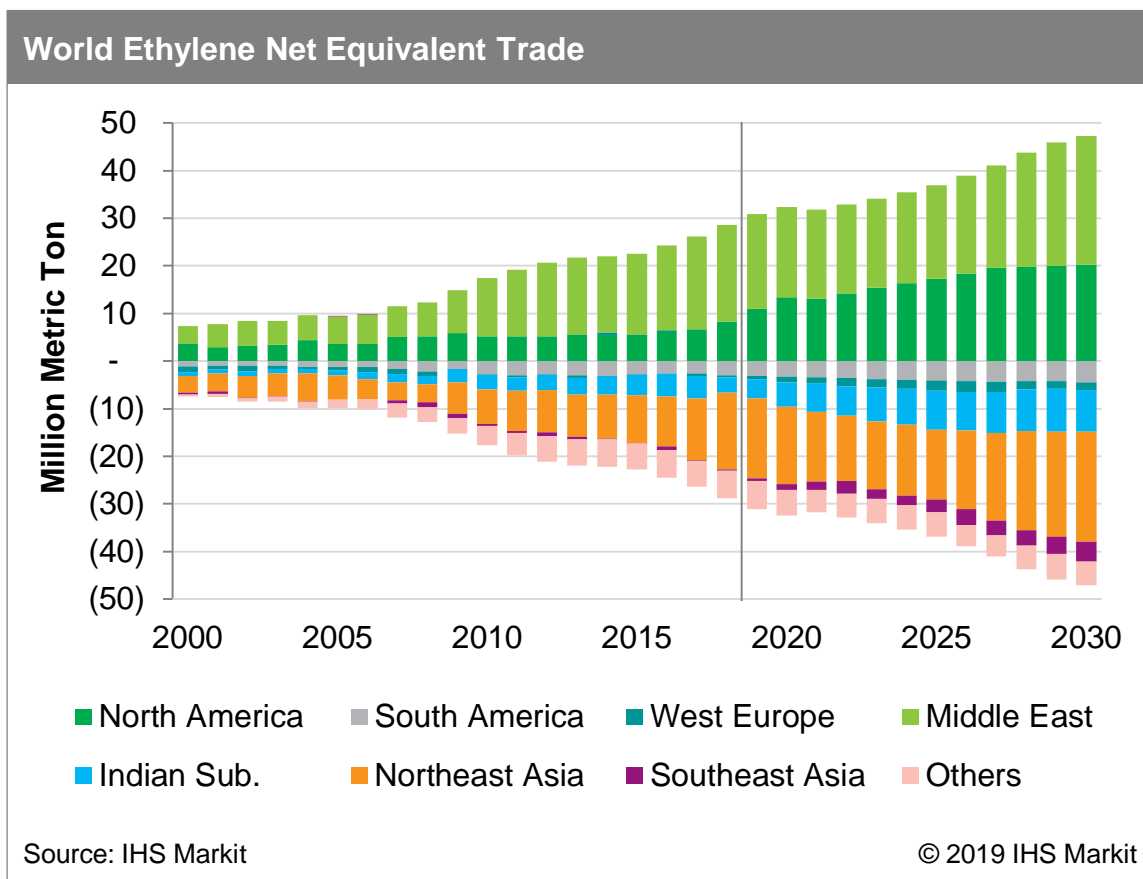
USA Propylene Net Equivalent Trade



Source: IHS Markit

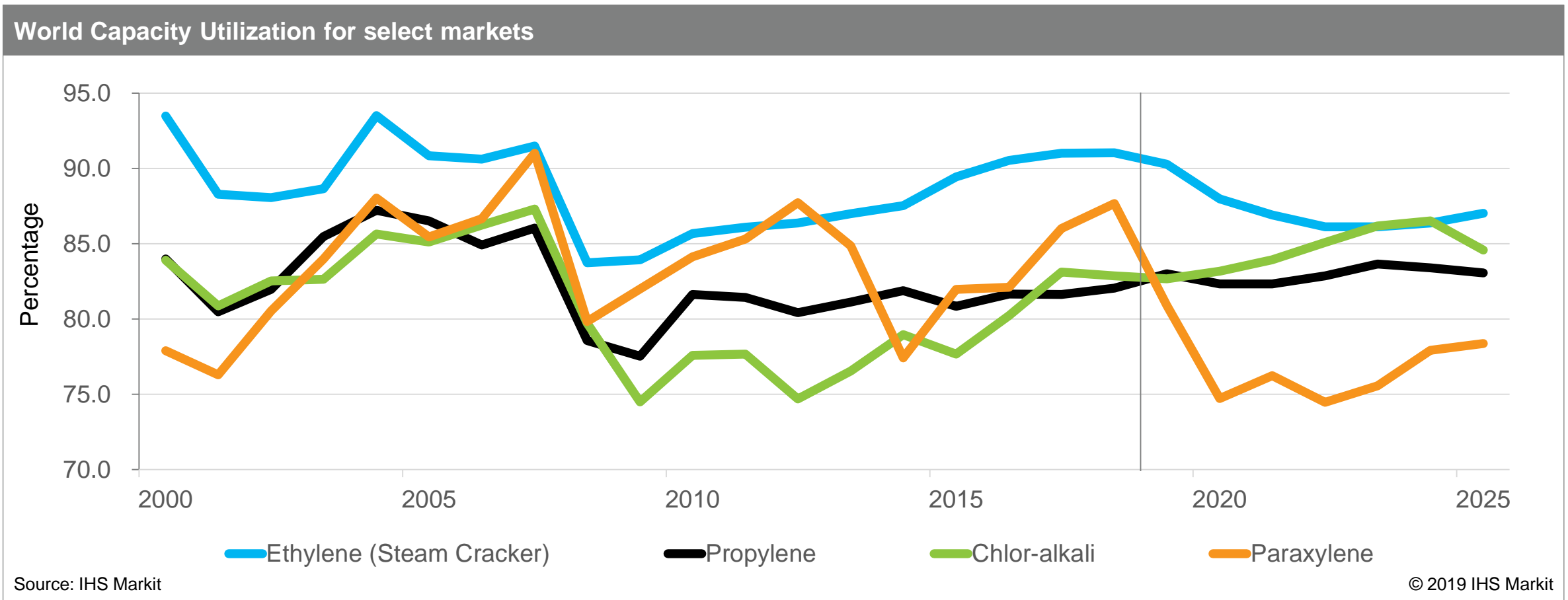
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Ethylene net equivalent trade analysis suggests “build low-cost and ship to high demand growth, while propylene trends show a “build-in-place” strategy



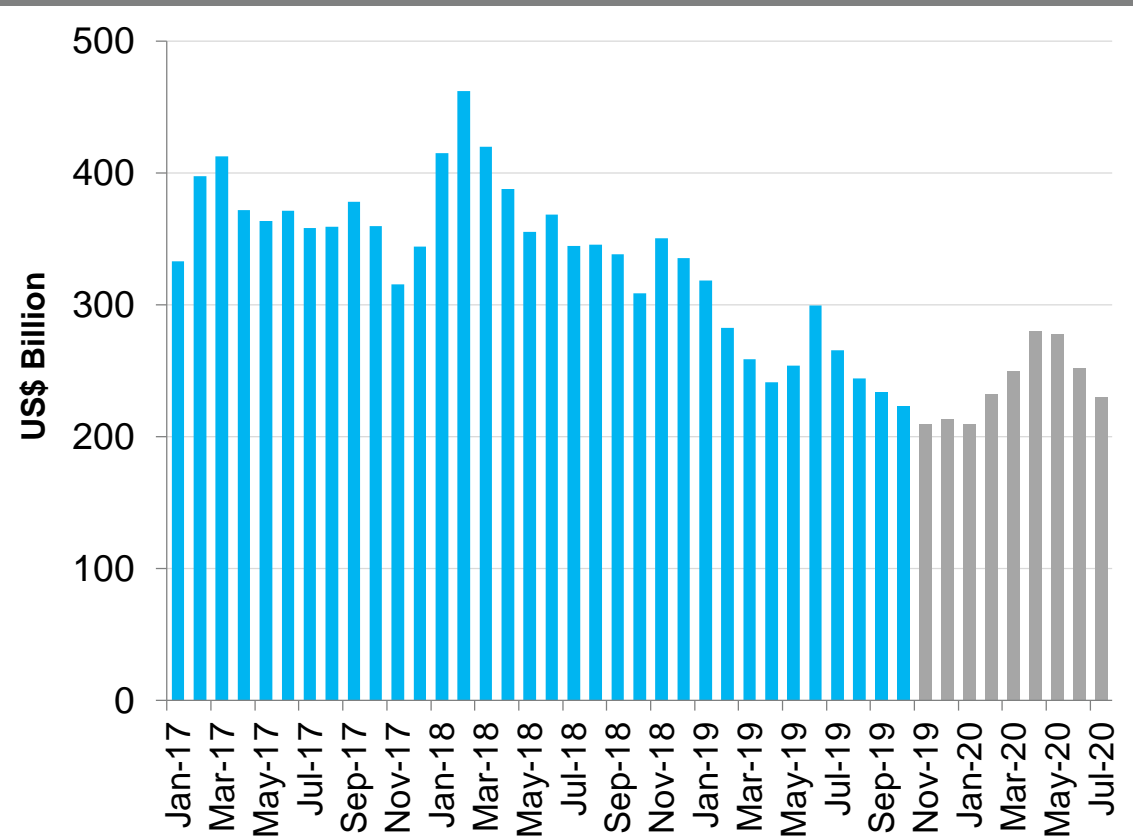
Surge in new capacity and slowing demand growth driving the next down-cycle for petrochemical earnings

Strong headwinds and surge in build-cycle will soften outlook for ethylene and propylene; chlor-alkali strengthens, and paraxylene faces significant over-supply



Global base chemicals and derivatives earnings trend is lower in 2019 due to slower demand combined with new supply; greatest impact felt in Asia markets

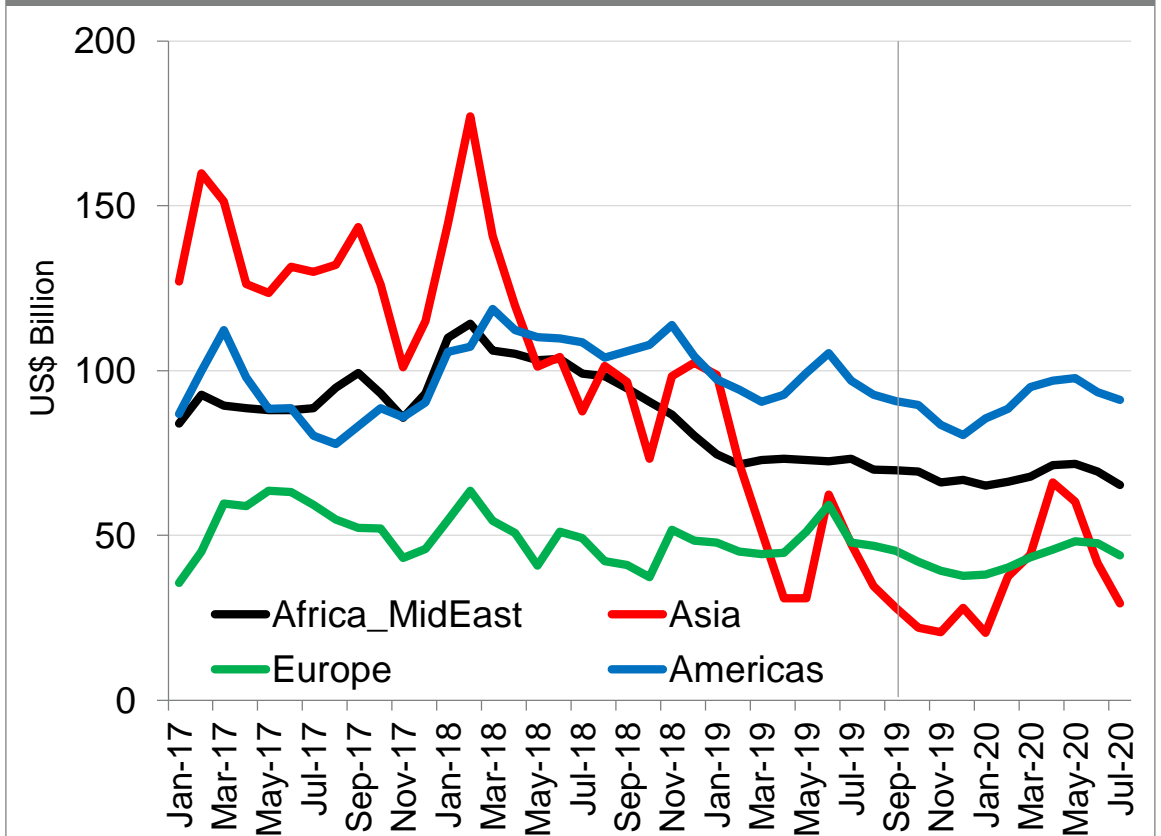
Global Basic Chemicals & Plastics monthly cash earnings



Source: IHS Markit

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Regional Cash Earnings by month, base chems & plastics



Source: IHS Markit

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MEGA-TRENDS IMPACTING THE 2020S



**Impact
on energy
transformation
by mobility**



**Crude to
chemicals
and refinery
integration**



**Light vs
heavy
feedstocks**

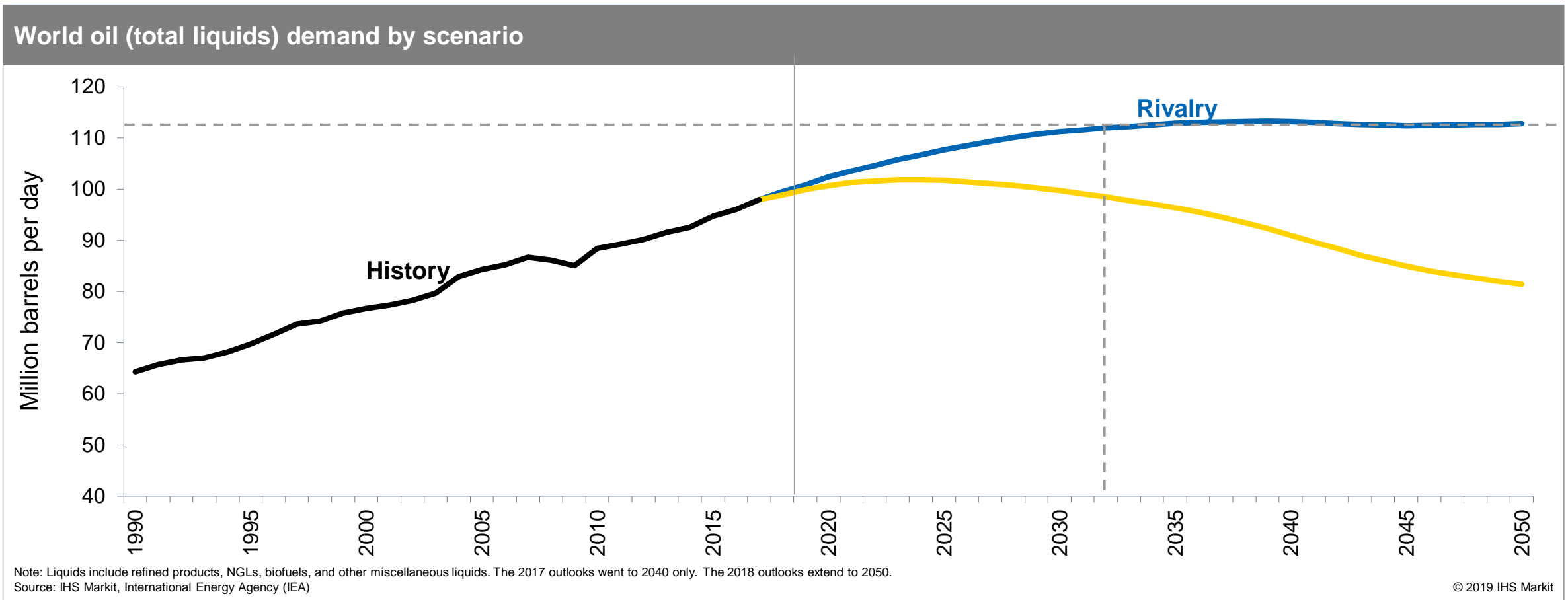


**Impact of
plastics waste
on demand**



**Global
impact on
petrochemicals
by China**

Efficiency gains create peak oil demand despite underlying growth in GDP, population, transportation demand and petrochemical feedstock growth



Progression of refining & petrochemical operations integration



Pre-1990s

1990 – 2000s

2010 – 2020


2020+

Recovery aromatics & FCC olefins

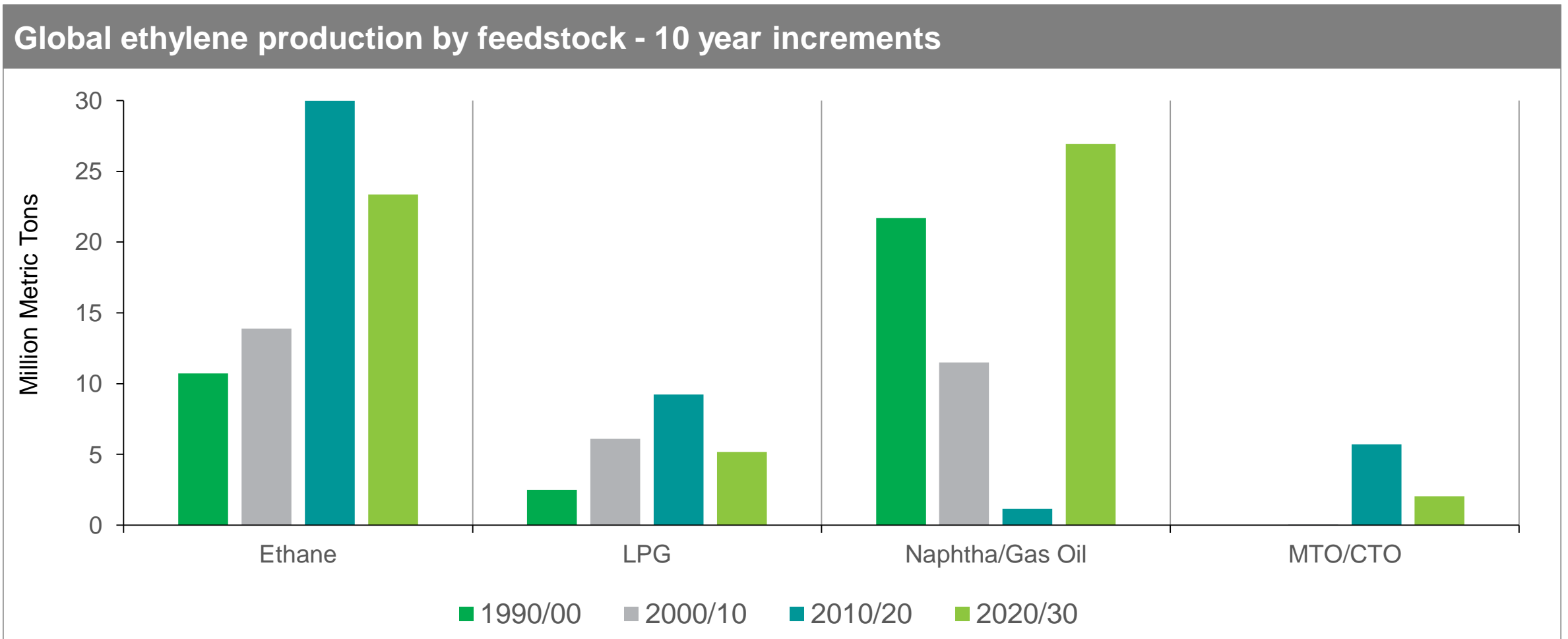
Steam cracker site integration plus commodity derivatives

Increase scale of chemical integration & derivatives complexity

Development of COTC technology

 Yield of chemicals / barrel of crude oil processed

Heavy feedstocks (naphtha's) needed to meet incremental ethylene production during the 2020's

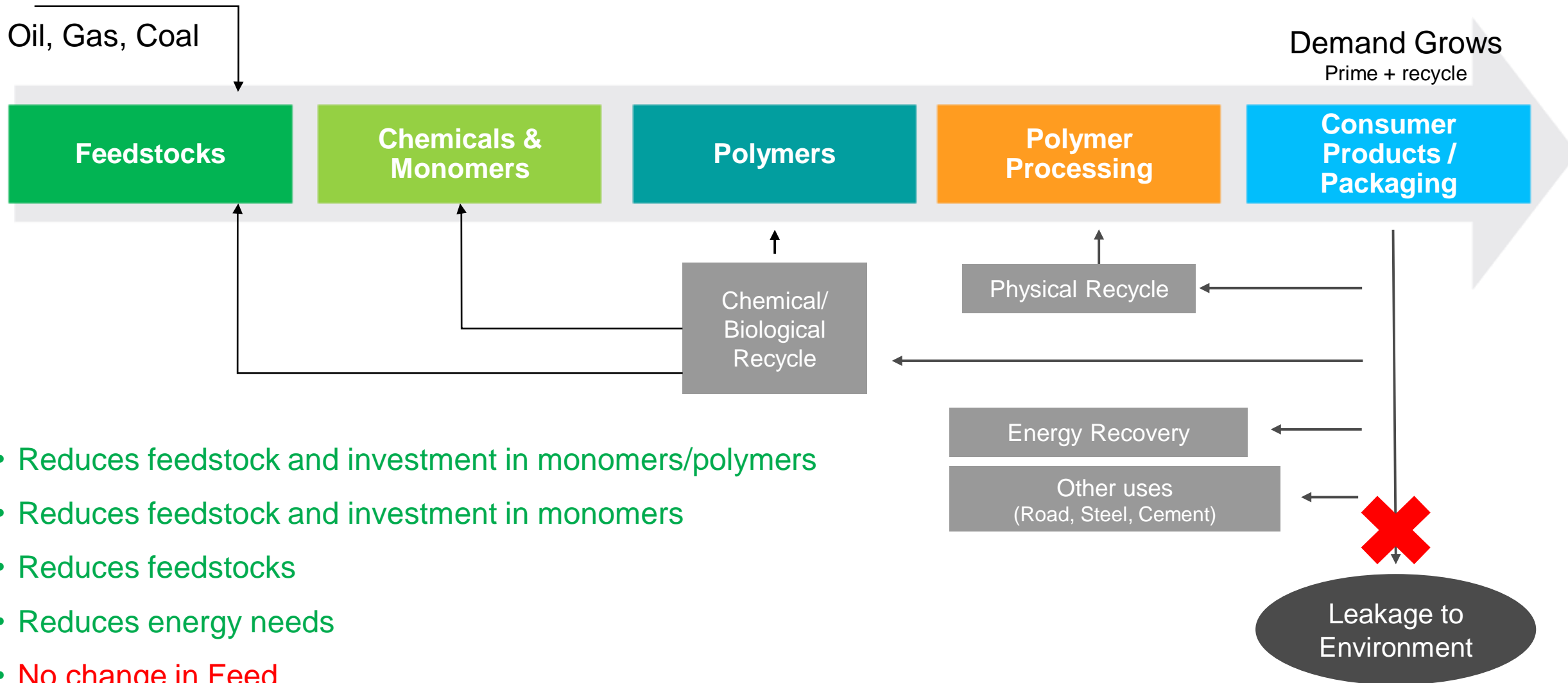




The Plastics Waste Challenge

A strong headwind or an opportunity? The industry mobilizes to take on both.

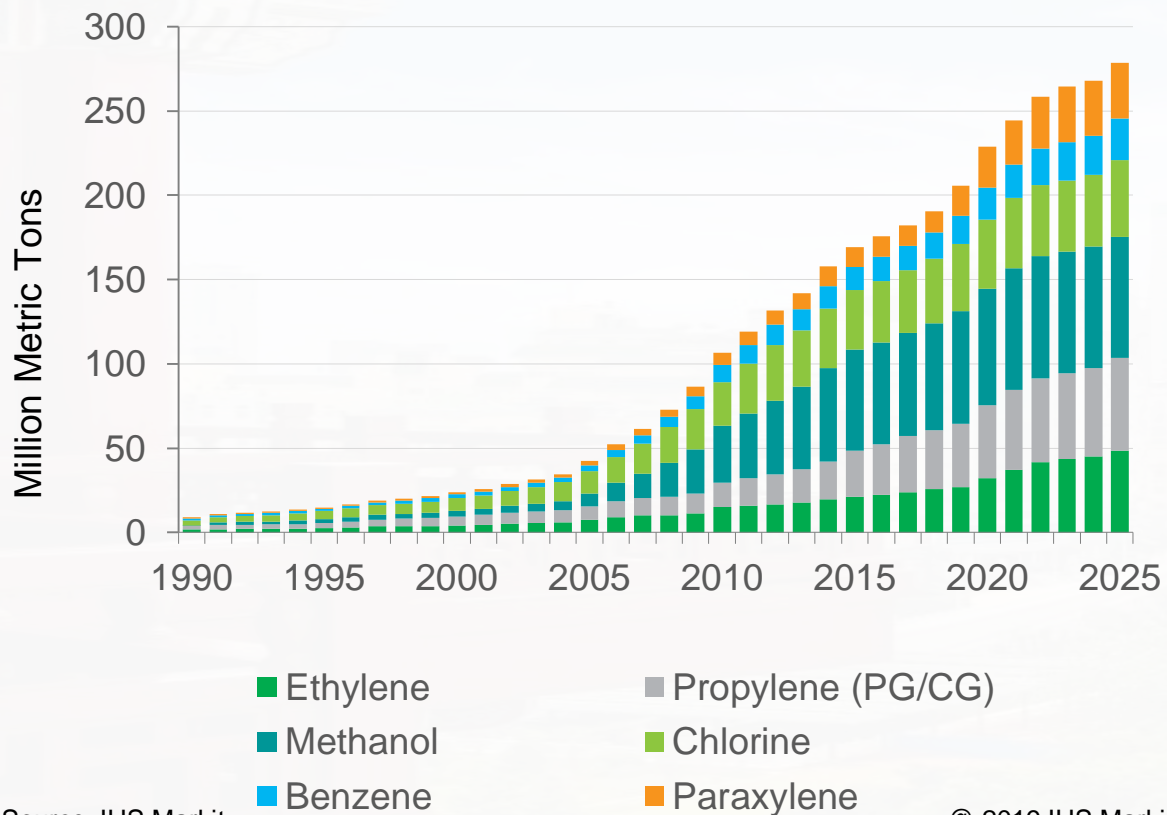
Progression to a circular economy – Polymers remain for global de-Carbonization



- Reduces feedstock and investment in monomers/polymers
- Reduces feedstock and investment in monomers
- Reduces feedstocks
- Reduces energy needs
- **No change in Feed**

China's chemical industry has substantial size and global impact

China – Base Chemical Total Capacity



Source: IHS Markit

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Significant changes are underway that require close monitoring and analysis

- **Economy transition** to high-value manufacturing and services.
- Stricter **environmental protection** policies and new fuel efficiency standards.
- Balance of chemical **company ownership** between central government and the private sector.
- Value-chain integration; **self-sufficiency** objectives; specialty chemical development.
- **Technology** development & conventional/non-conventional capacity
- Significant **capital cost** and capital execution **advantage** over the USGC.
- **International trade ambitions** – One Belt/One Road; establish RMB as recognized trading currency
- Chinese **outbound M&A** remains very active

Final thoughts

- US shale oil & gas developments have fueled the recent surge in petrochemical investments
 - > Low cash cost is key driver despite high CAPEX
 - > Plentiful supply of US oil and gas will enable continued investments in chemicals
- Industry cycles continue, as 2019 earnings have slowed; the outlook has become more cautious with a slowing economy and wave of new capacity
- Assess forecast risks and opportunities
 - > Plastics sustainability risk assessment is essential to long term planning
 - > Understand the return to refinery-petchem integration in Asia, India, Saudi Arabia
 - > Evolving role of China in base chemicals



IHS Markit Customer Care

CustomerCare@ihsmarkit.com

Americas: +1 800 IHS CARE (+1 800 447 2273)

Europe, Middle East, and Africa: +44 (0) 1344 328 300

Asia and the Pacific Rim: +604 291 3600

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