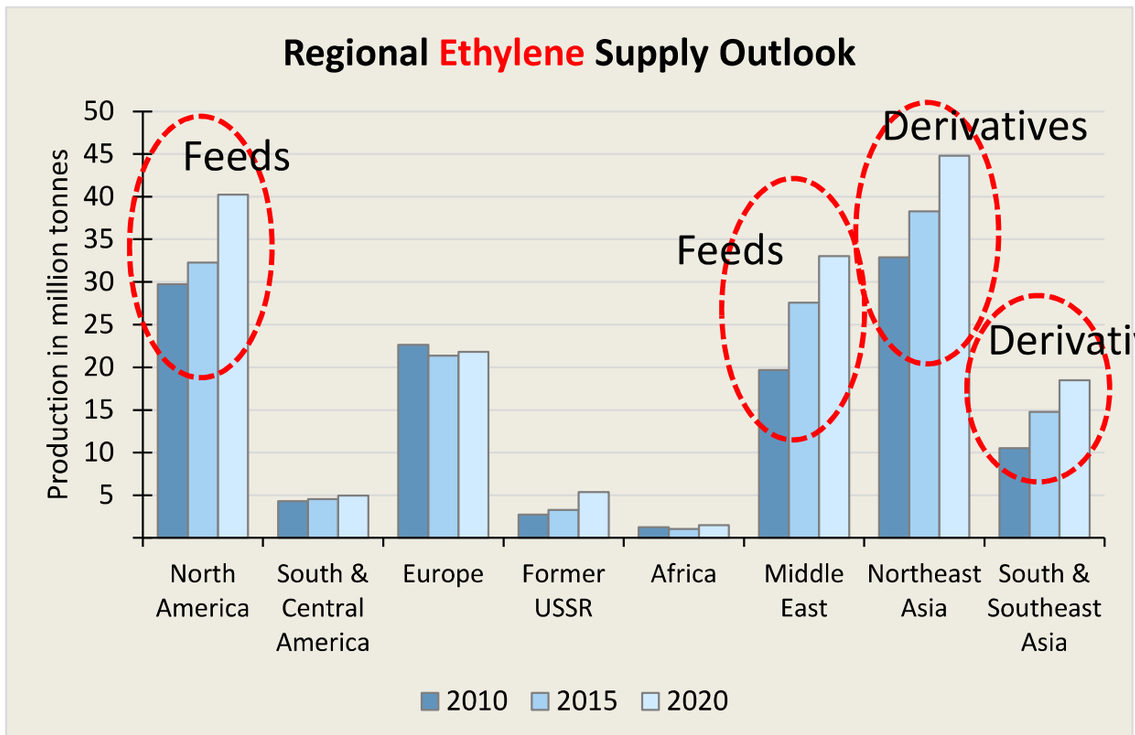
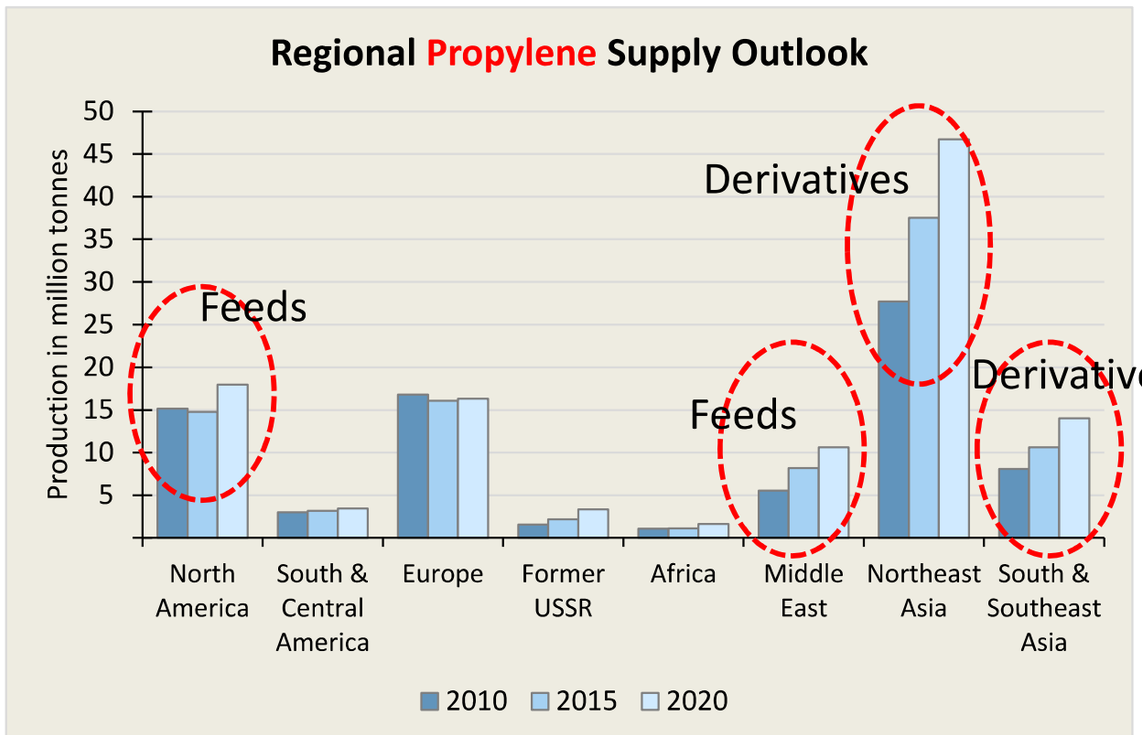
Fundamentals Shift in the Basic Chemicals Industry

Agenda

- Any Major Shift in Supply, Demand and Trade for Olefins/Polyolefins?
- Impact of Low Oil Prices on Olefins Industry
- Any Major Shift in Supply, Demand and Trade for Aromatics?
- Impact of Low Oil Prices on Aromatics Industry
- In Summary - Have Industry Fundamentals Changed?

Olefins supply growth primarily driven by US and Middle East, Asia to fuel demand

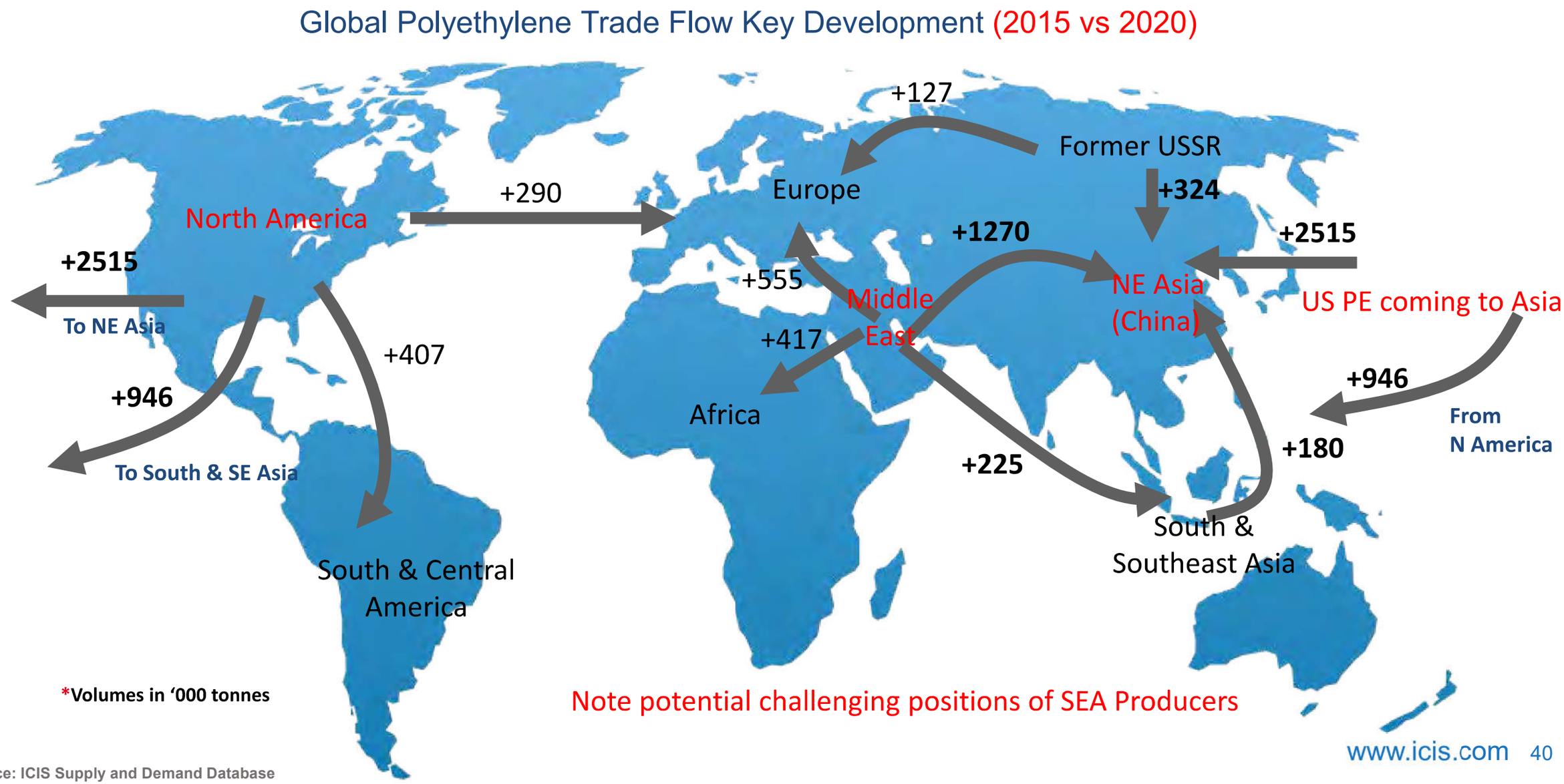




- Export-oriented ethylene derivatives projects are expected in the US and Middle East
- Strong PP demand growth, especially in NE Asia (China), drives dedicated propylene capacity additions

Source: ICIS Supply and Demand Database

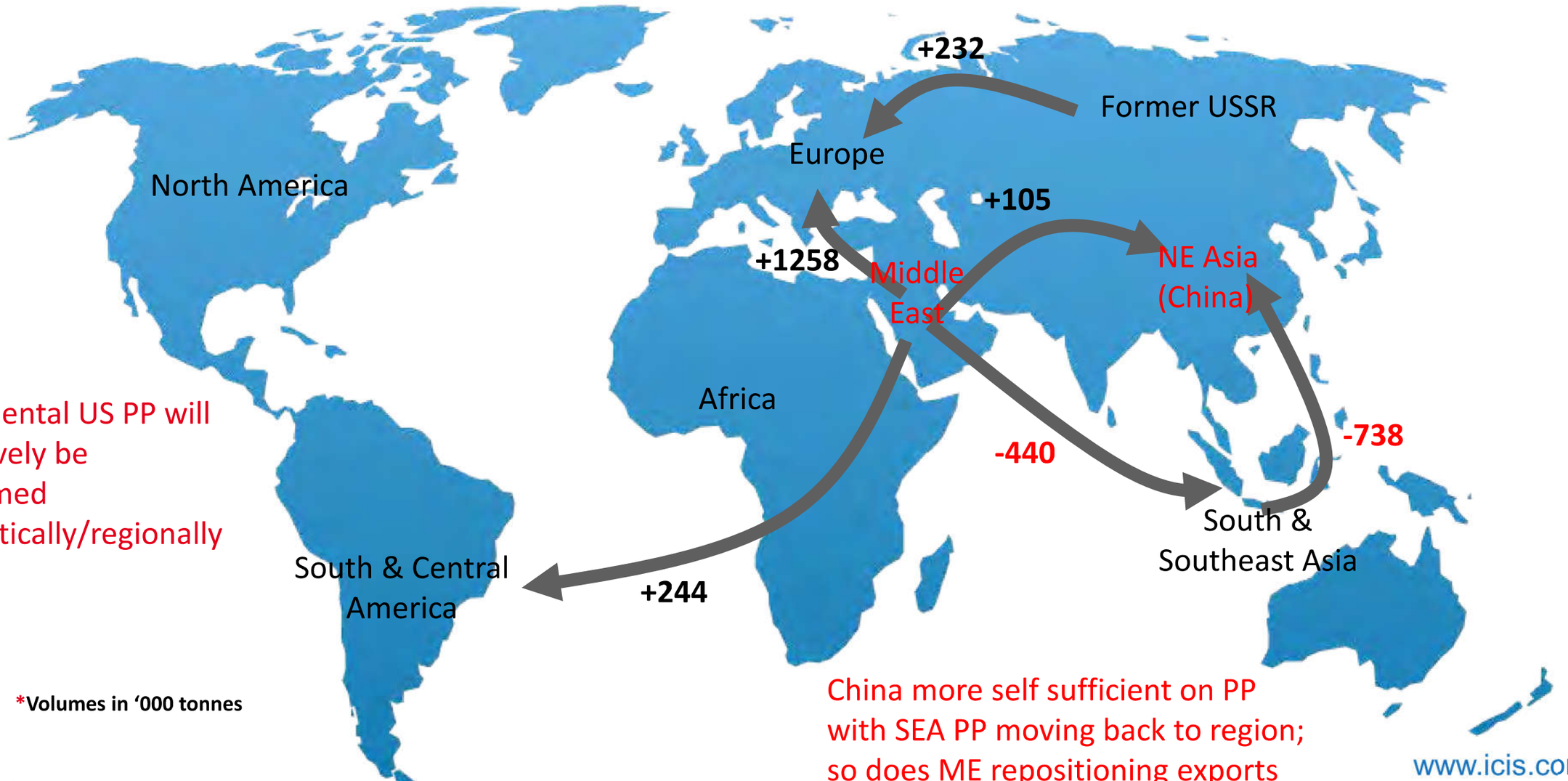
Additional 2.5 million tonnes of US Polyethylene heading to China



Source: ICIS Supply and Demand Database

China PP imports to fall with local PDH, CTO & MTO S/Us

Global Polypropylene Trade Flow Key Development (2015 vs 2020)



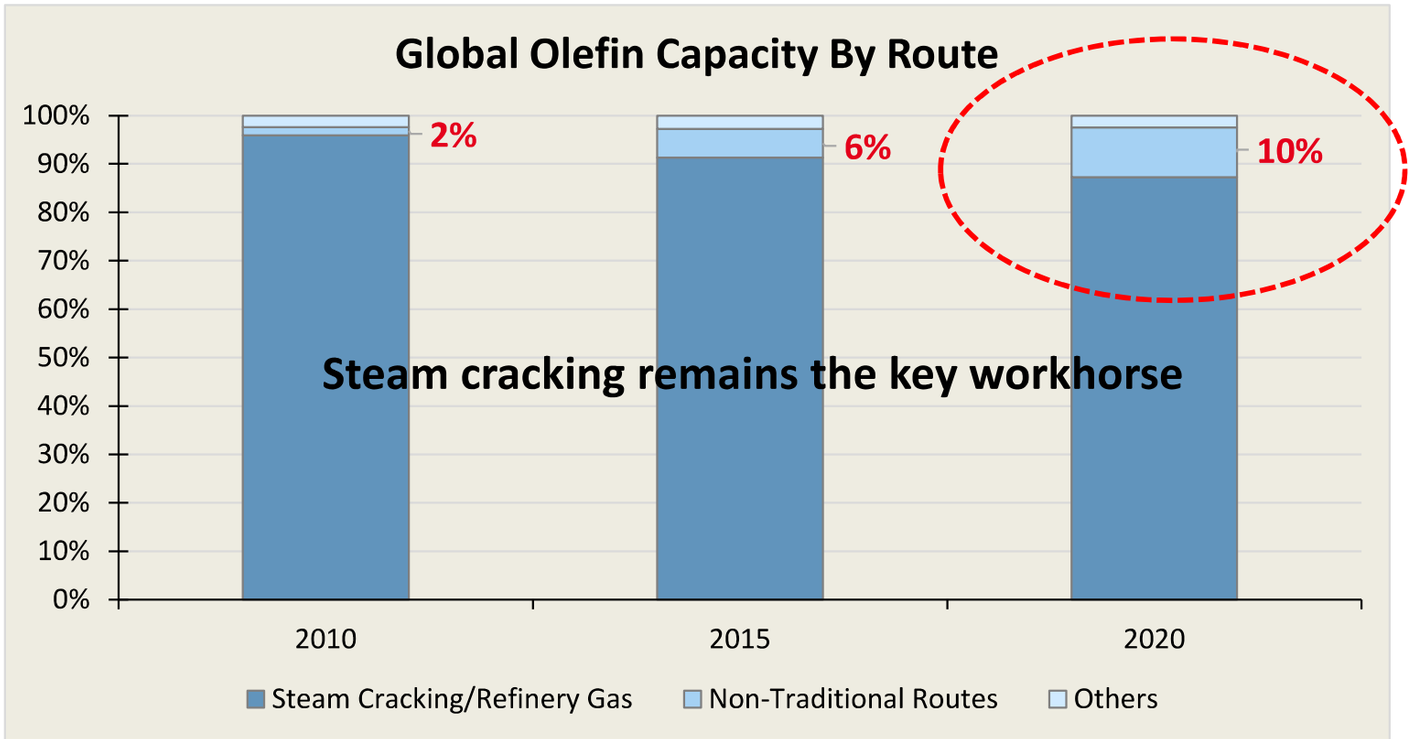
Incremental US PP will effectively be consumed domestically/regionally

*Volumes in '000 tonnes

China more self sufficient on PP with SEA PP moving back to region; so does ME repositioning exports

Source: ICIS Supply and Demand Database

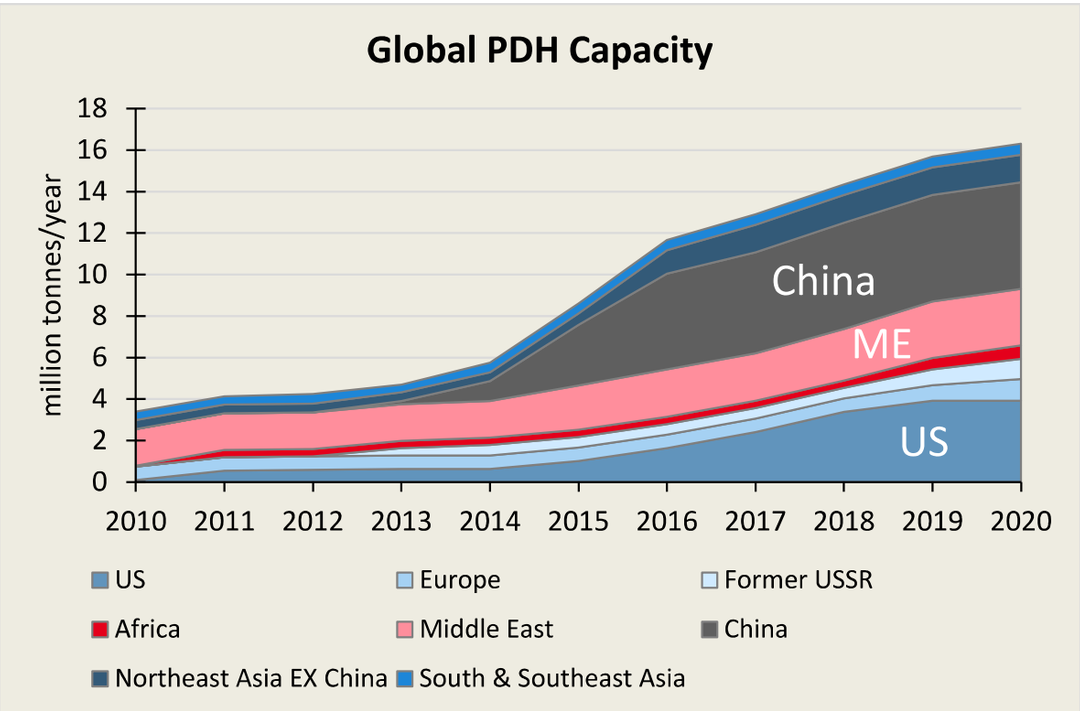
Non-traditional routes (CTO/MTO and PDH) capacity to grow to 10% of global olefins capacity by 2020

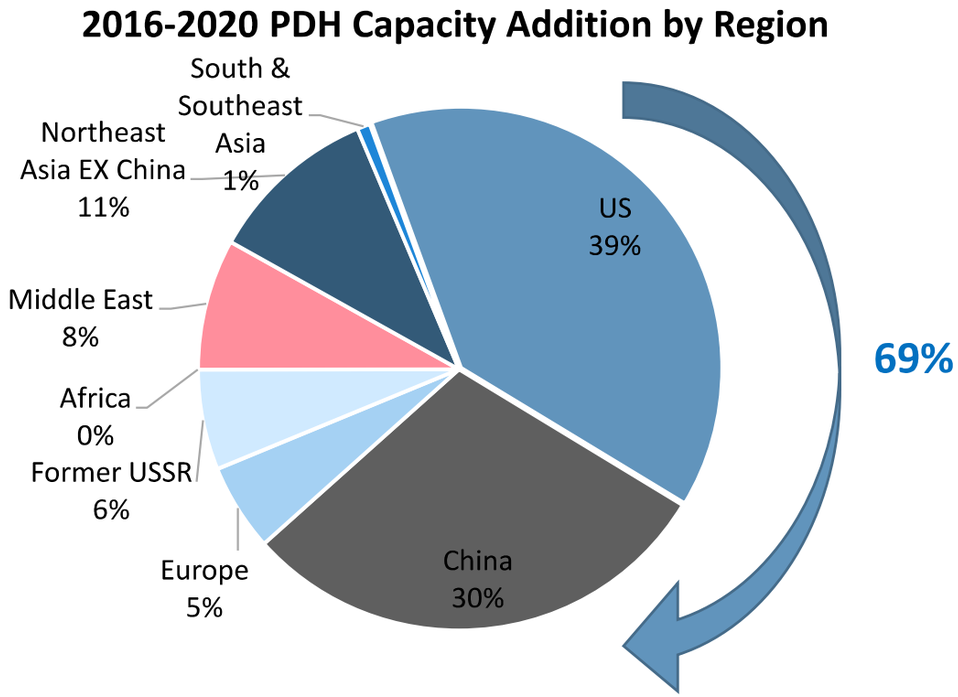


How are these non-traditional routes changing the olefin industry dynamics?

Source: ICIS Supply and Demand Database

Propylene demand outstrips supply (as a co-product from refineries & crackers), fueling investment in on-purpose **propylene** production

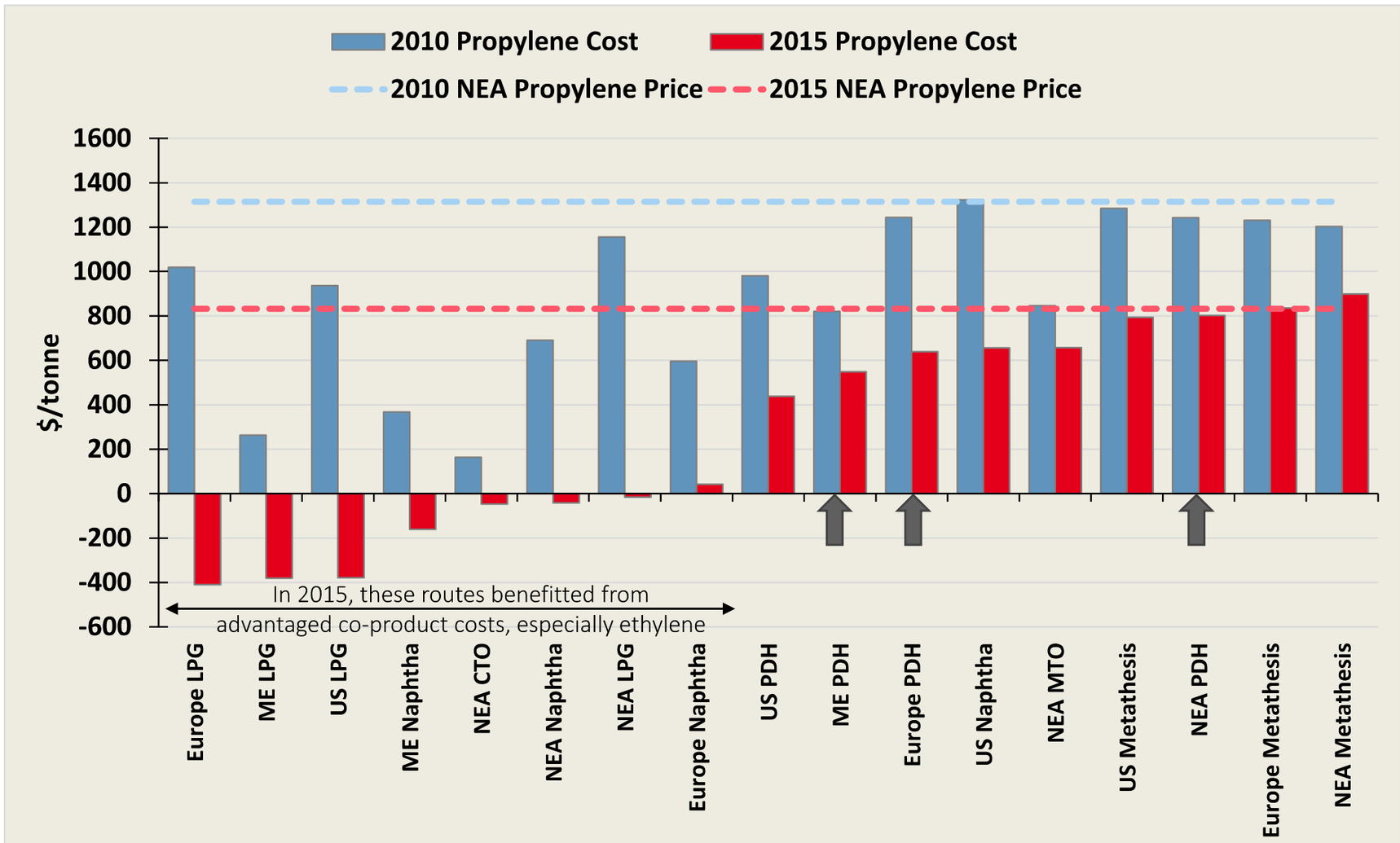




- PDH capacity is expected to almost double to reach over 16m tonnes/year by 2020
- Close to 70% of PDH capacity addition in the next five years will come from the US and China

Source: ICIS Supply and Demand Database

NE Asian PDH and Metathesis units face margins pressure

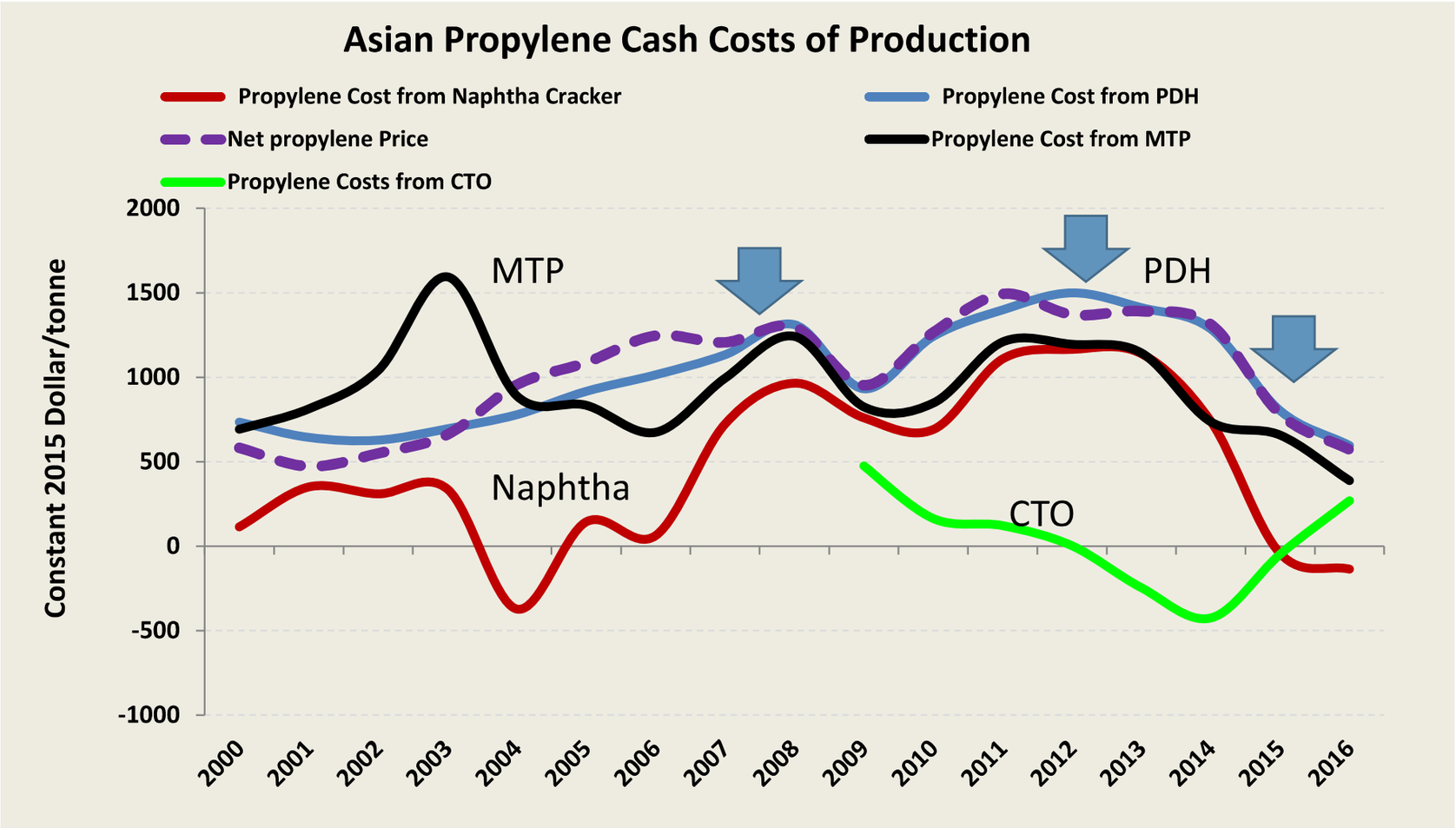


Volume contribution of Metathesis remains small

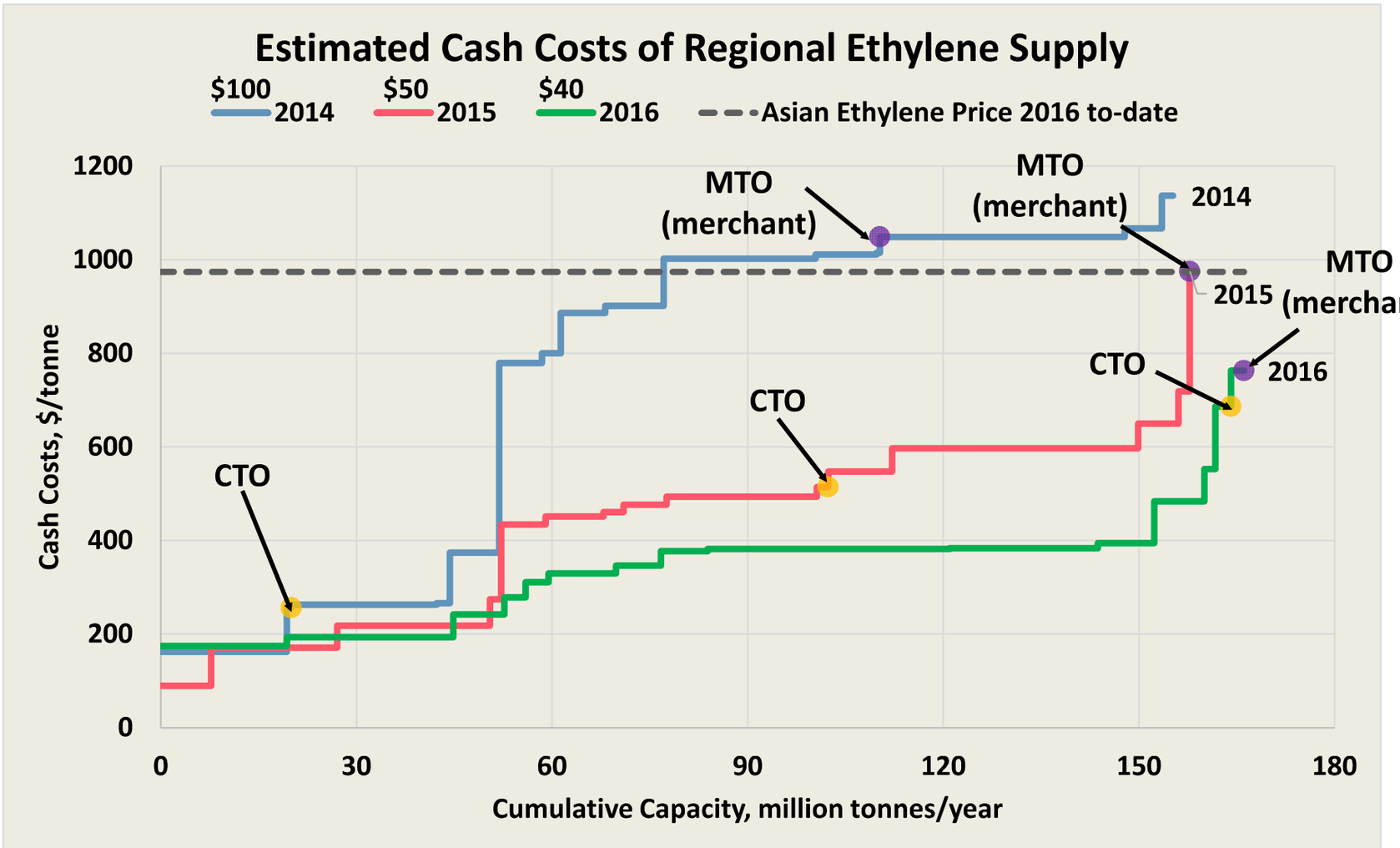
C3 cost from PDH effectively the price setter

C3= from US naphtha at higher cost due low C2= price, a result of abundant ethane

Propylene price tracks closely with propylene cost from PDH

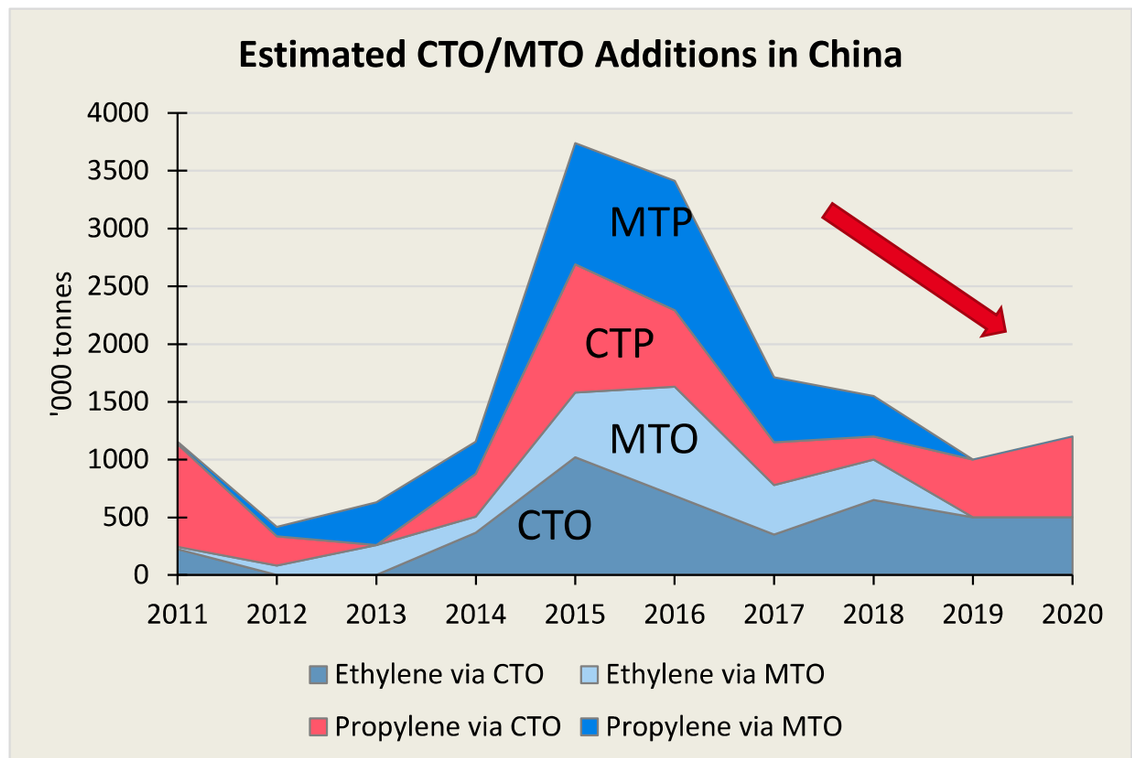


CTO and MTO move up the cost curve when oil prices drop



Source: ICIS Consulting; 2016 to-date

CTO/MTO capacity development slowing down after the first wave of additions, with likely delays and cancellations



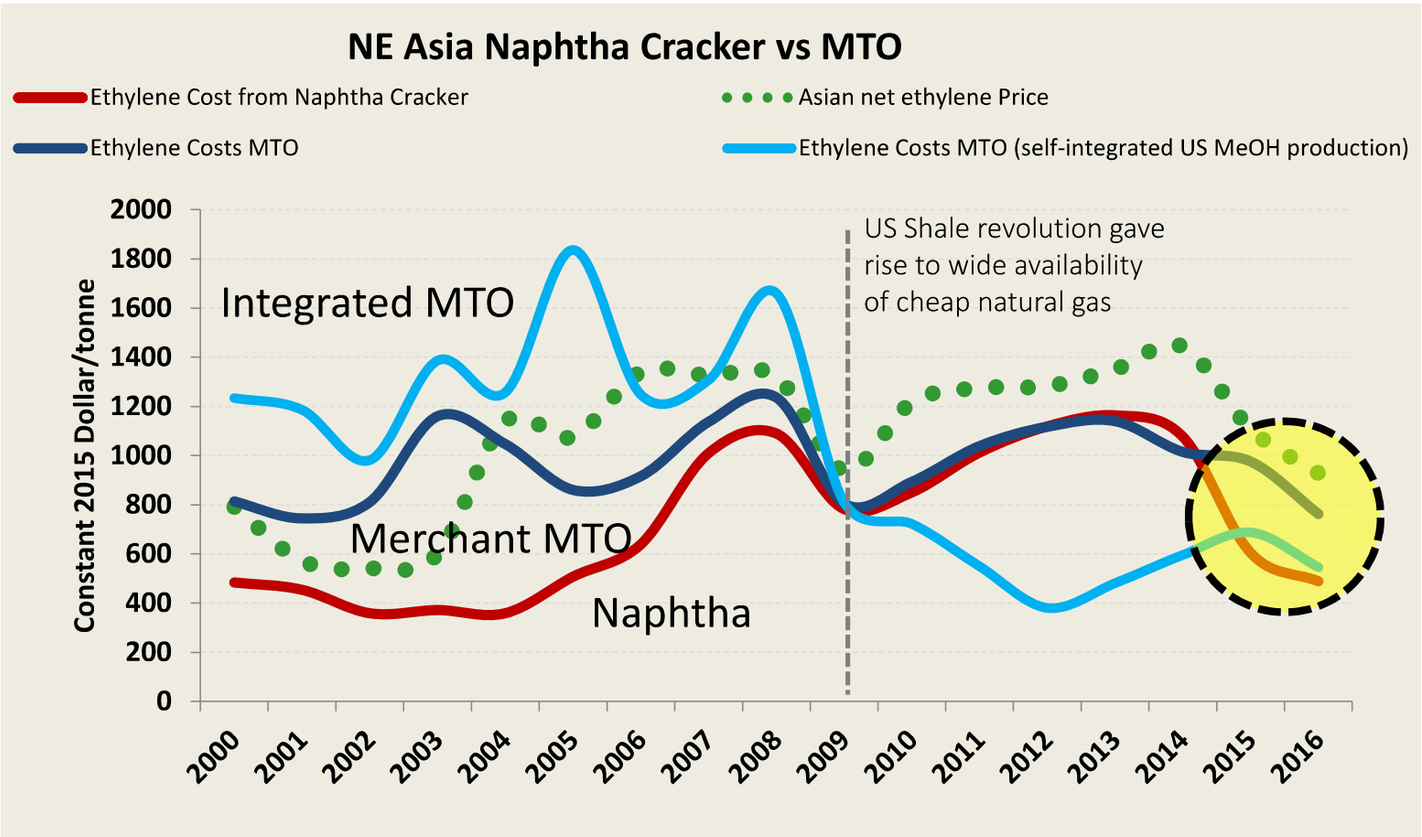
Number of Facilities

CTO	10
CTO (Future)	9
MTO	10
MTO (Future)	3

- Re CTO & MTO, 20 are operating; 12 are likely to happen out of 53 that had had planning approvals

Source: ICIS Supply and Demand Database

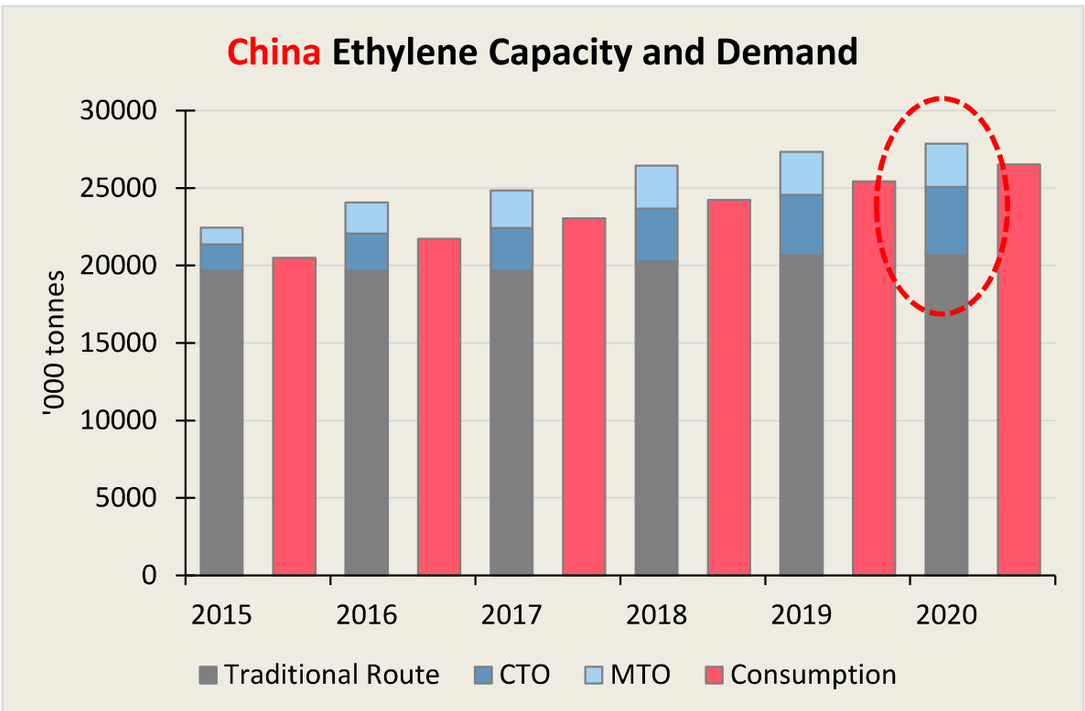
Lower oil prices close window for MTO projects “integrated” back to US methanol

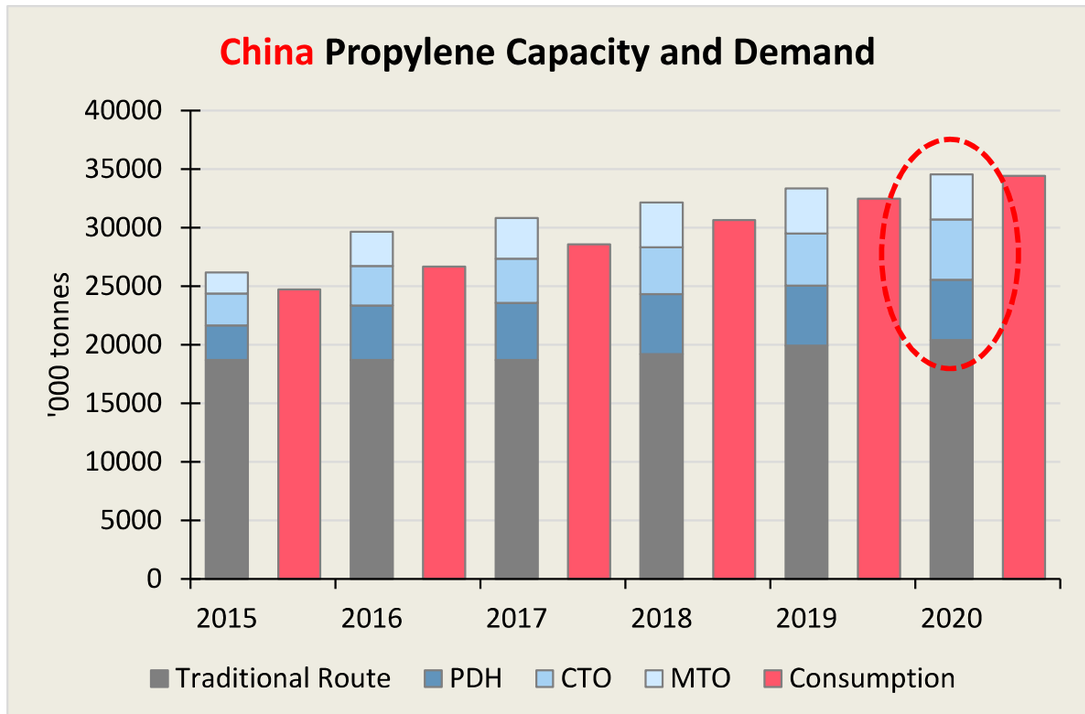


- Some companies have plans to invest in methanol production in the US and ship to China, riding on the “cheap” natural gas
- The advantage, though remaining viable versus merchant MTO investment, has disappeared considerably in the low oil price environment against that from naphtha

Source: ICIS Consulting

CTO/MTO olefin additions fill the considerable demand gap



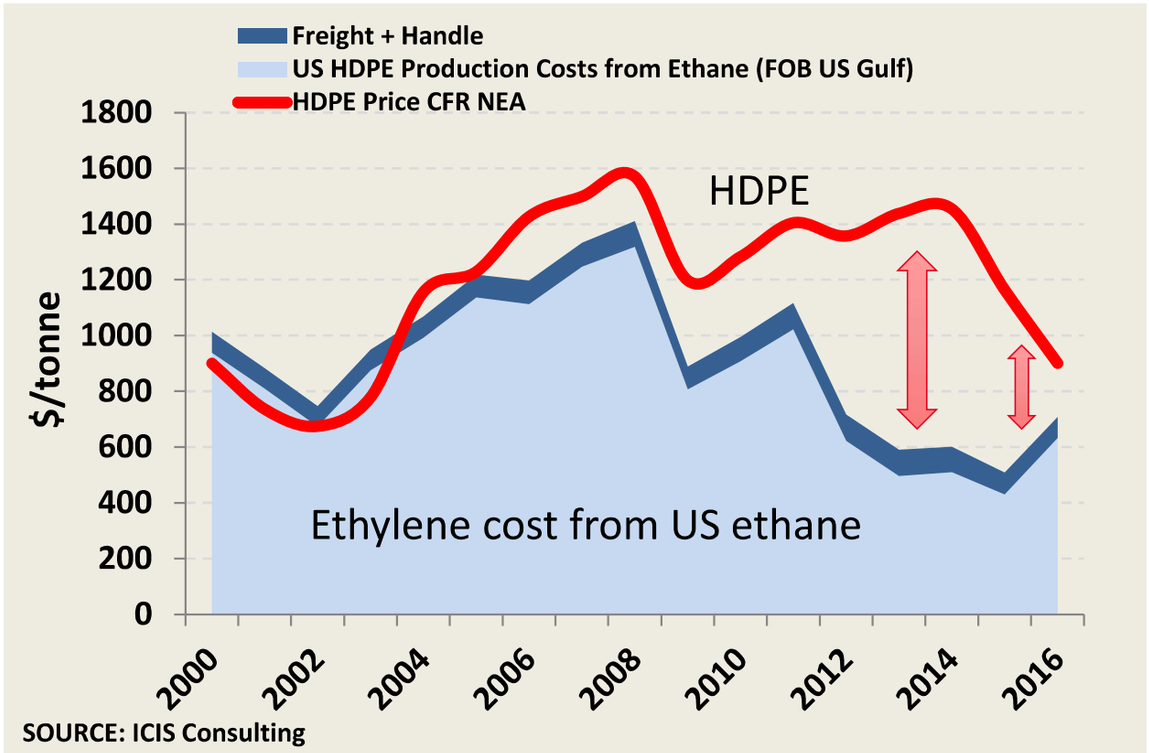


- Above 7m tonnes/year of ethylene capacity is expected to be via CTO/MTO by 2020

- Above 14m tonnes/year of propylene capacity is expected to be via PDH and CTO/MTO by 2020

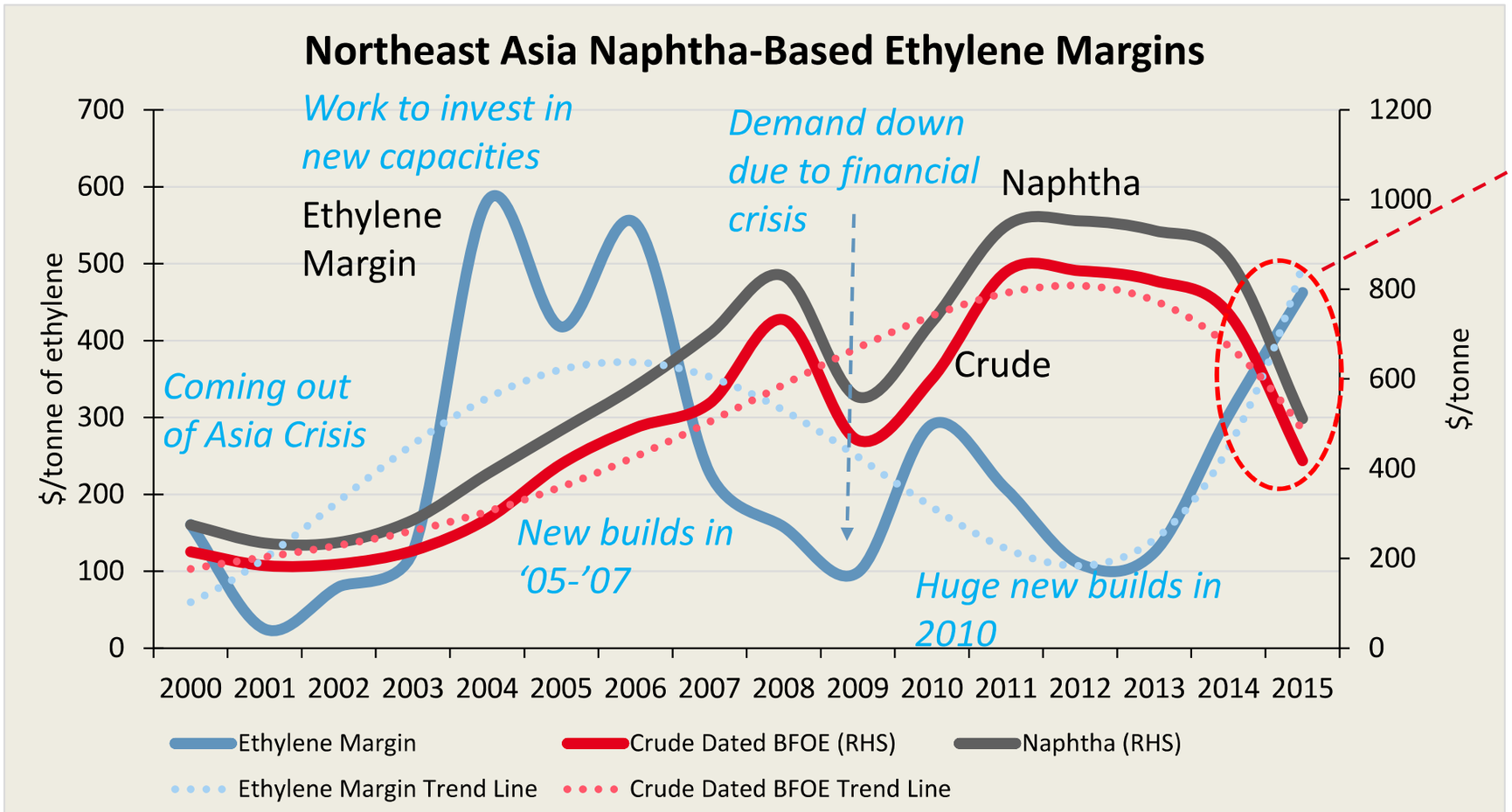
Source: ICIS Supply and Demand Database

US export-oriented projects still make sense…



- Ethylene derivatives exports still have a considerable buffer – though narrower – in a low oil price environment
- Strong growth in export-oriented projects may see North American feedstocks being ‘re-linked’ with Asian prices
- Lower ROI will lead to longer CAPEX payback and will slow down future waves of ethylene derivative investments

Are we to see the investment cycle repeat itself?



Planning for more new capacities again?

S/D drives utilisation which drives prices and in turn, margins – a stronger influencing factor vis-à-vis feedstock prices

Source: ICIS Consulting

In Summary

Traditional Route (Steam Cracker)

- Naphtha-based producers seeing improved margins
- US ethane-based ethylene derivatives exports still viable albeit narrower spread against Asia market
- Advantage for Asian (imported) ethane cracker is driven by concurrent strategic reasons

Non-Traditional Route (PDH, CTO, MTO)

- PDH remains a viable high-cost route
- 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

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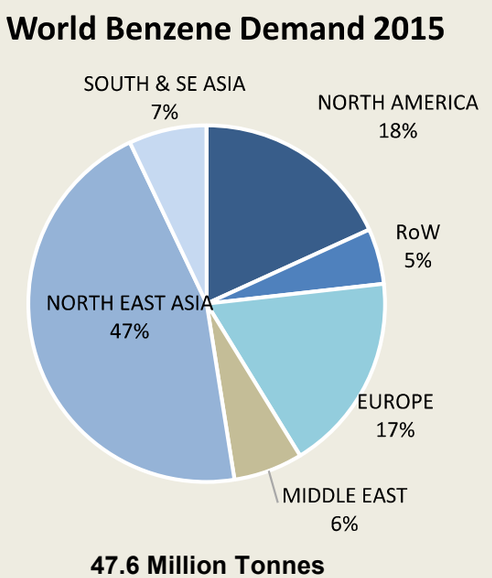
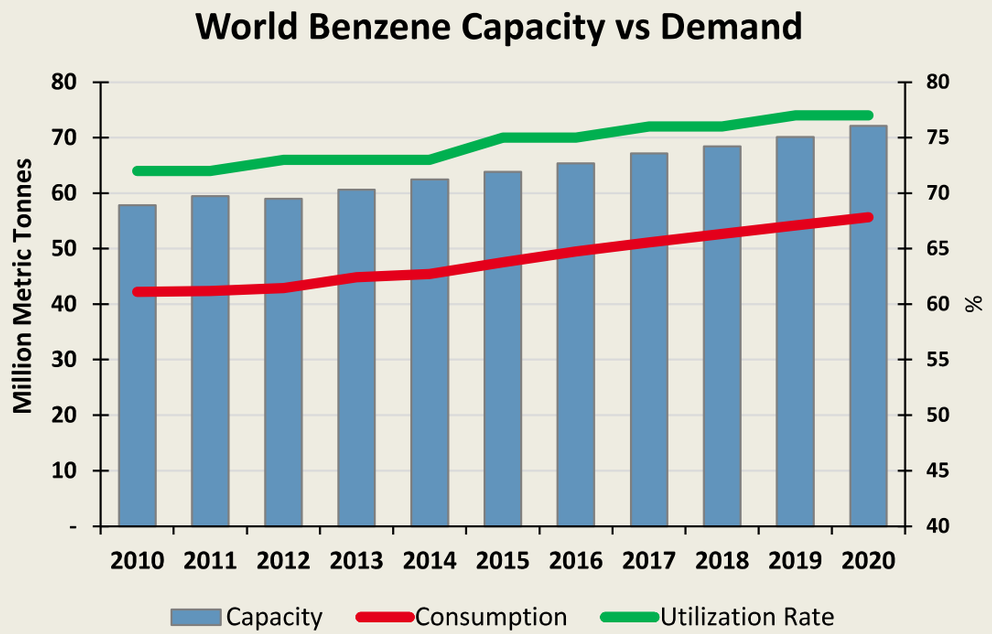
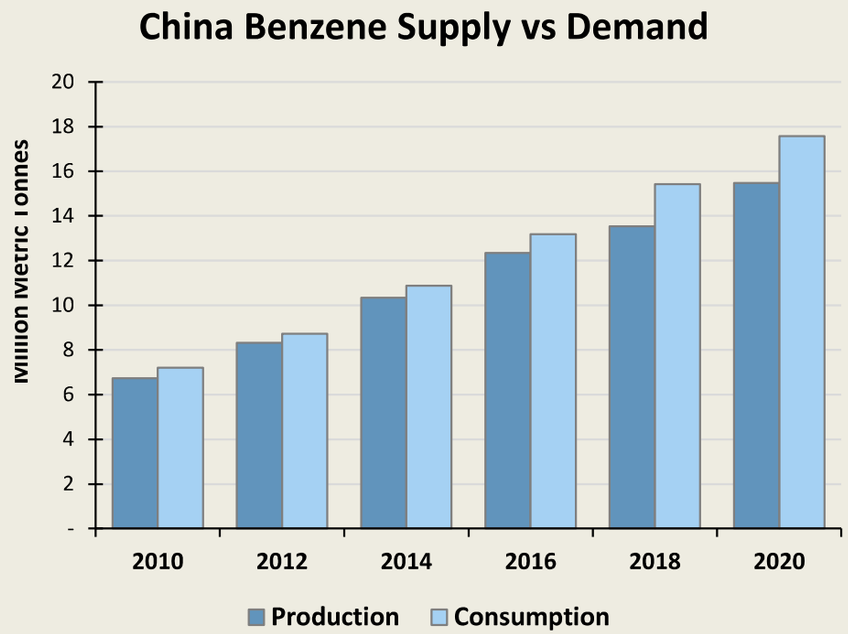
Growing (Chinese) benzene demands take up co-product benzene supply…



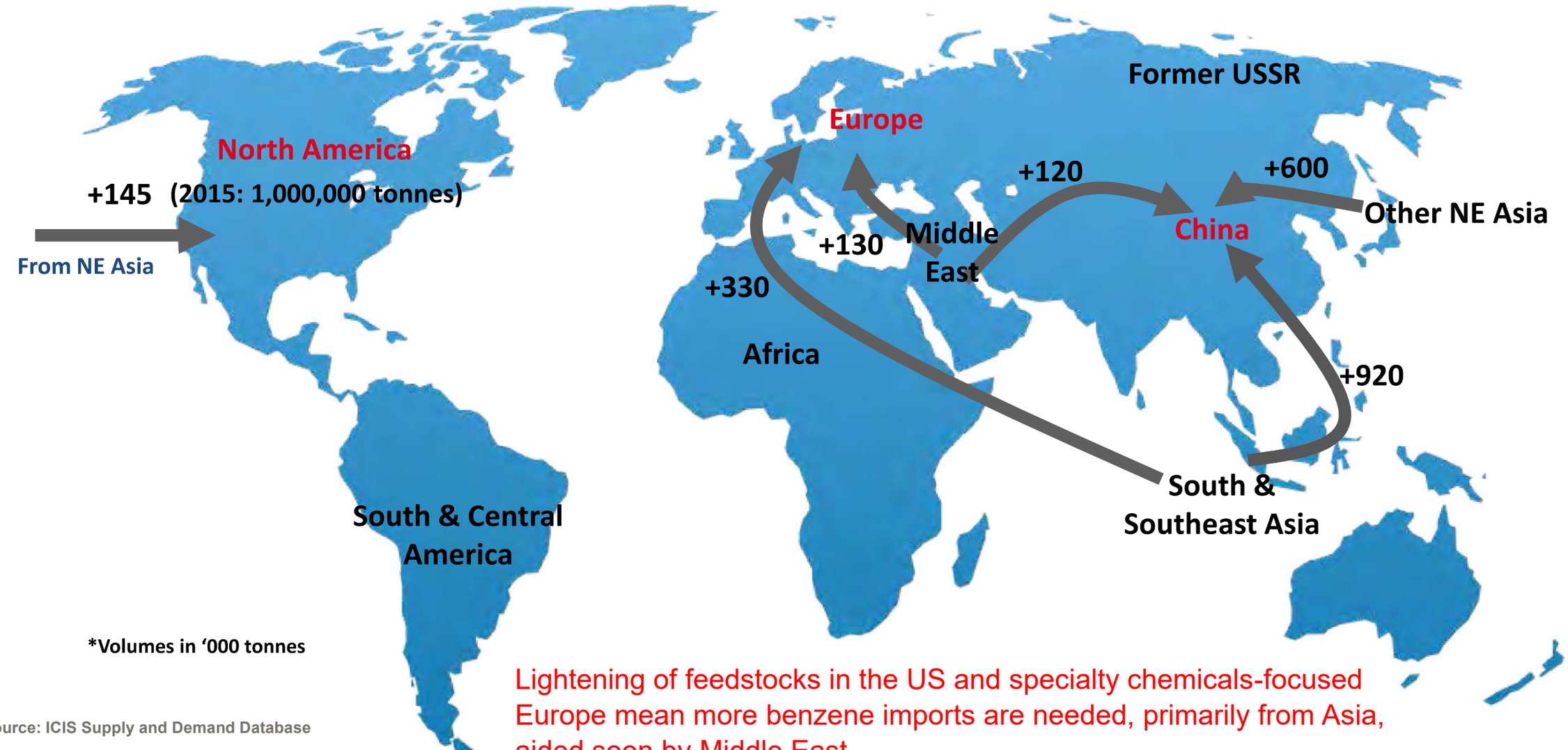




- Benzene is a co-product from steam cracking or aromatic plants
- Start-up delays at Jurong Aromatics, OPaL India and Dragon Aromatics prevented supply overhang
- Lack of new benzene supply in Europe and US continues to increase their benzene trade deficits

Source: ICIS Supply and Demand Database

Global benzene trade flows status quo (2015 vs 2020)

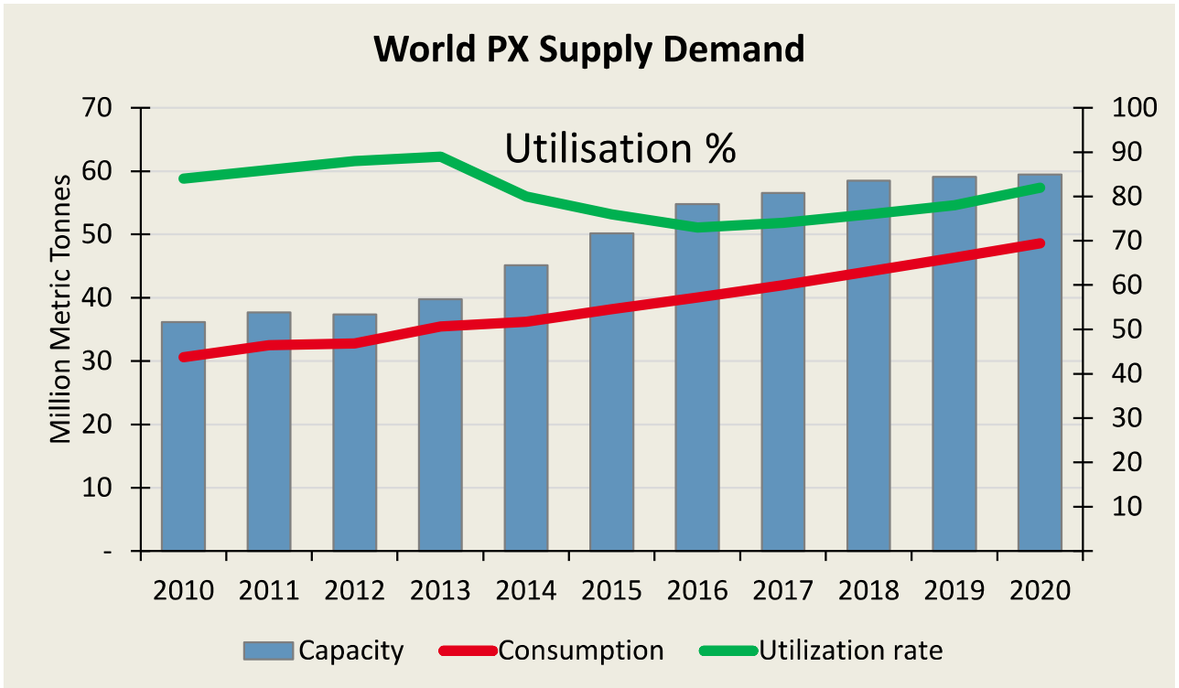


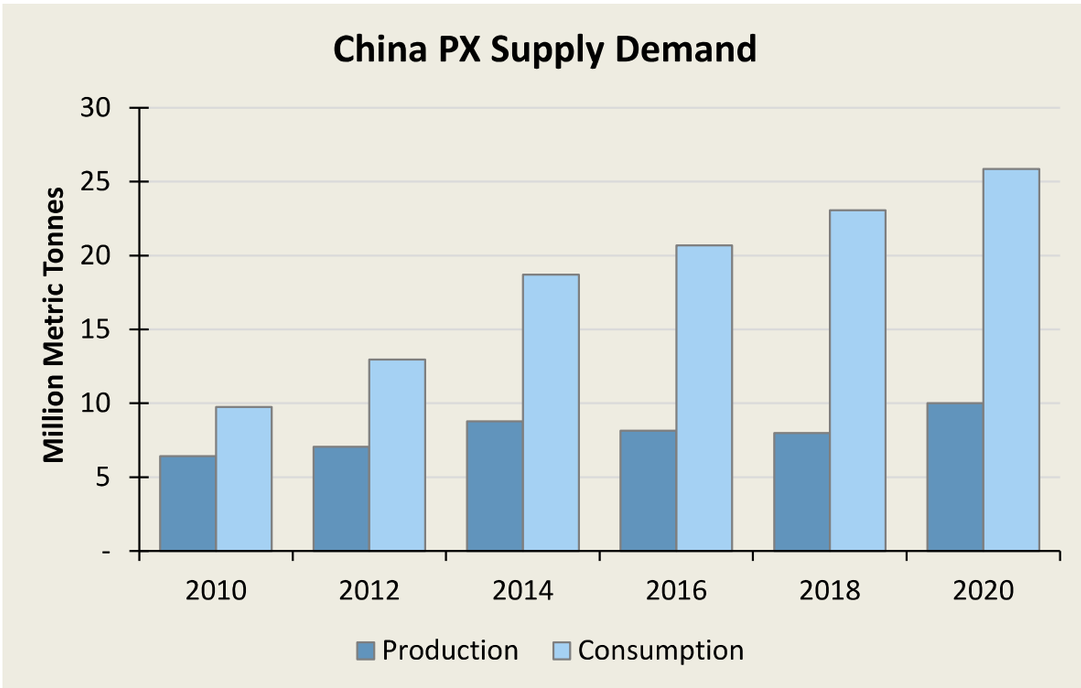
*Volumes in '000 tonnes

Source: ICIS Supply and Demand Database

Lightening of feedstocks in the US and specialty chemicals-focused Europe mean more benzene imports are needed, primarily from Asia, aided soon by Middle East

Huge paraxylene deficit in China with regional supply tightening

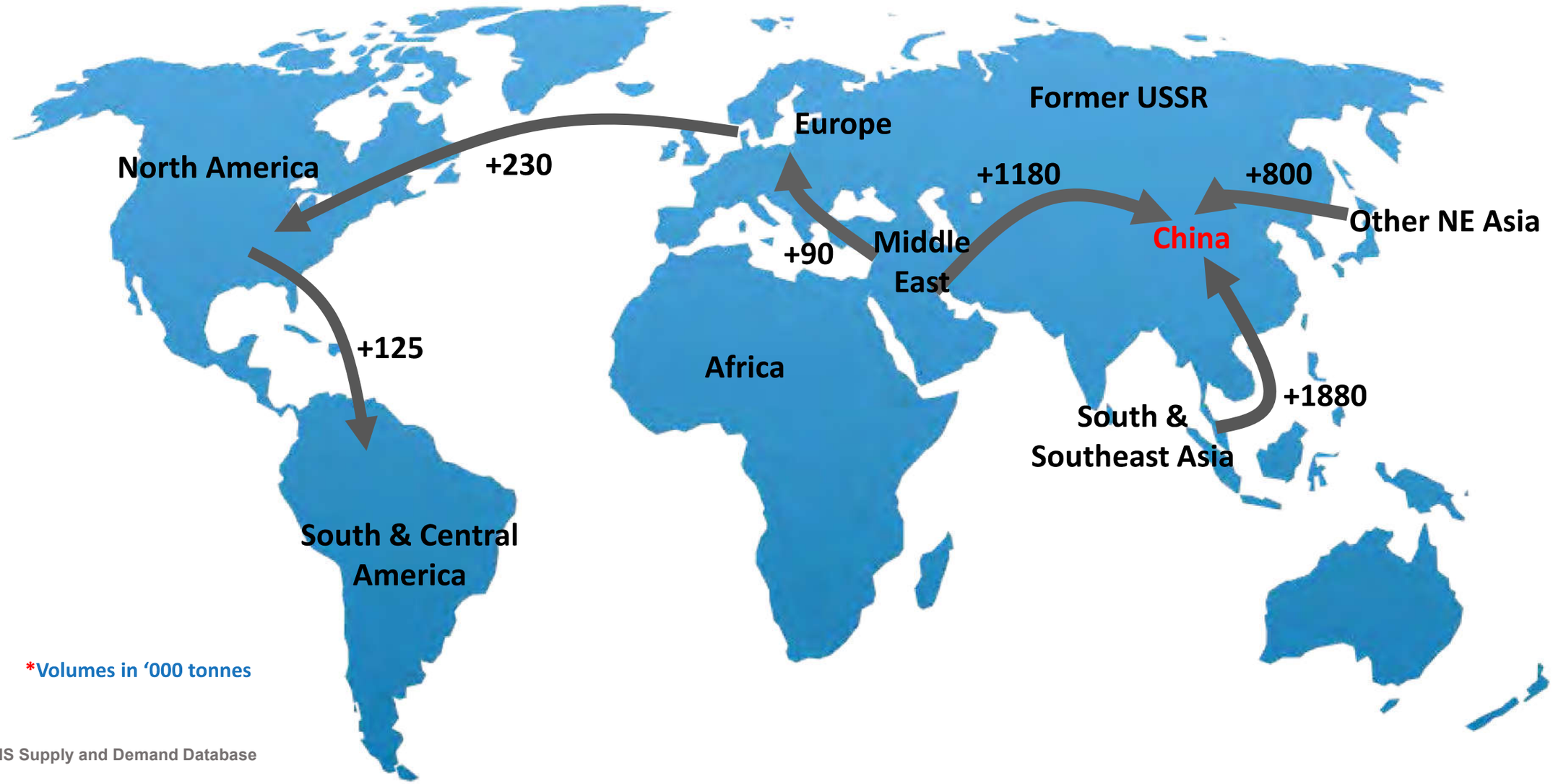




- Chinese aromatic market continues to face huge PX deficit as players with reformer assets focus primarily on gasoline conversion
- Oversupply marred by mishaps in new capacity start-ups is expected to increase utilisation rates, thus aiding higher margins going forward

Source: ICIS Supply and Demand Database

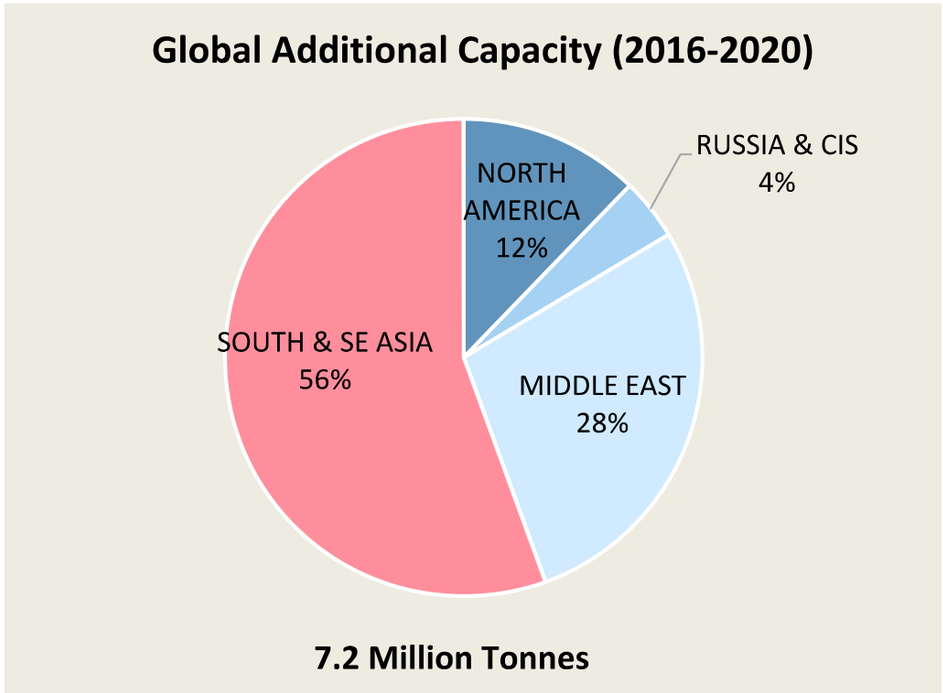
All paraxylene export volumes flow to China (2015 vs 2020)

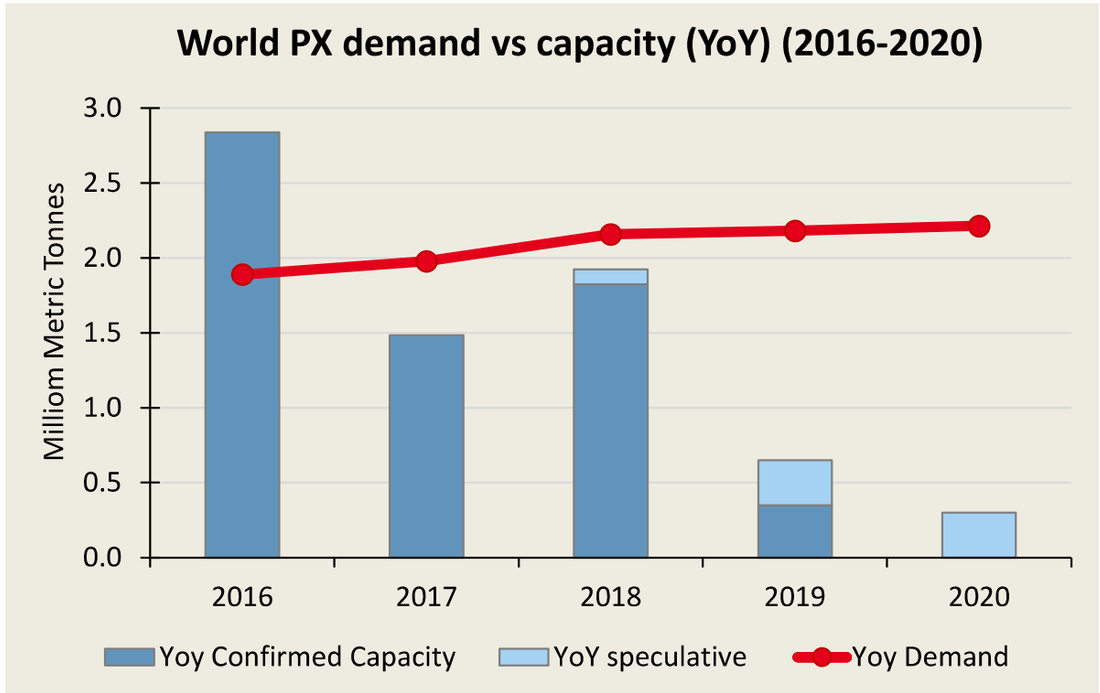


*Volumes in '000 tonnes

Source: ICIS Supply and Demand Database

Looking into the future – industry to allow utilisation rate to creep up

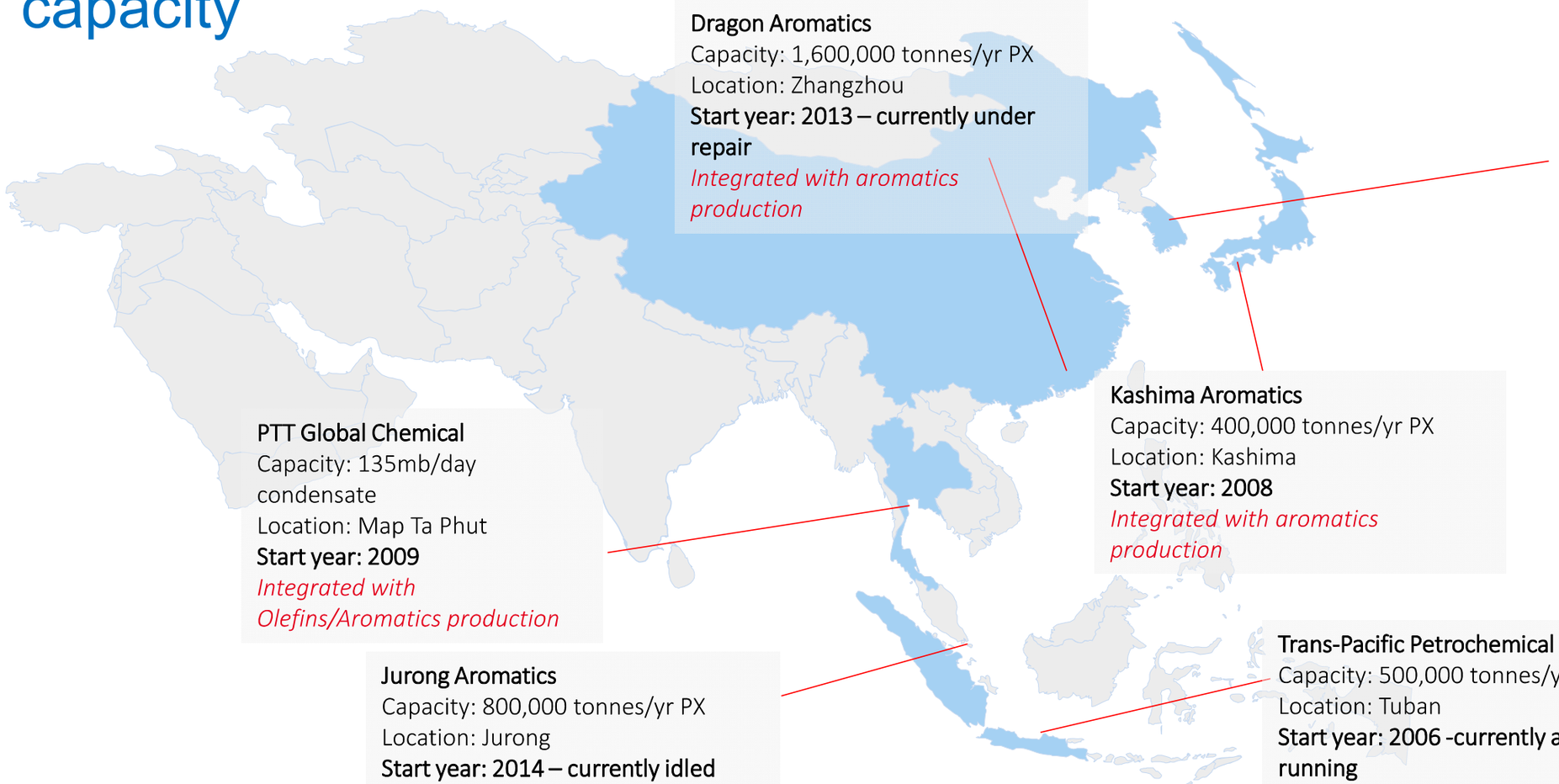




- PX capacity addition beyond 2018 looks to have slowed down, allowing for demand to catch up
- PX production seeing a shift towards dedicated naphtha reformer unit, leading to recent emergence of dedicated condensate splitters as feedstock providers for aromatics

Source: ICIS Supply and Demand Database

Condensate splitter based PX capacity accounts for 16% of global PX capacity



Dragon Aromatics
Capacity: 1,600,000 tonnes/yr PX
Location: Zhangzhou
Start year: 2013 – currently under repair
Integrated with aromatics production

PTT Global Chemical
Capacity: 135mb/day condensate
Location: Map Ta Phut
Start year: 2009
Integrated with Olefins/Aromatics production

Jurong Aromatics
Capacity: 800,000 tonnes/yr PX
Location: Jurong
Start year: 2014 – currently idled
Integrated with aromatics production

Kashima Aromatics
Capacity: 400,000 tonnes/yr PX
Location: Kashima
Start year: 2008
Integrated with aromatics production

Trans-Pacific Petrochemical Indotama
Capacity: 500,000 tonnes/yr PX
Location: Tuban
Start year: 2006 -currently aromatics not running
Integrated with aromatics production

1. Hyundai -Lotte
Capacity: 140 mb/day condensate with BTX
Location: Daesan
Start year: 2016
Integrated with Aromatics production

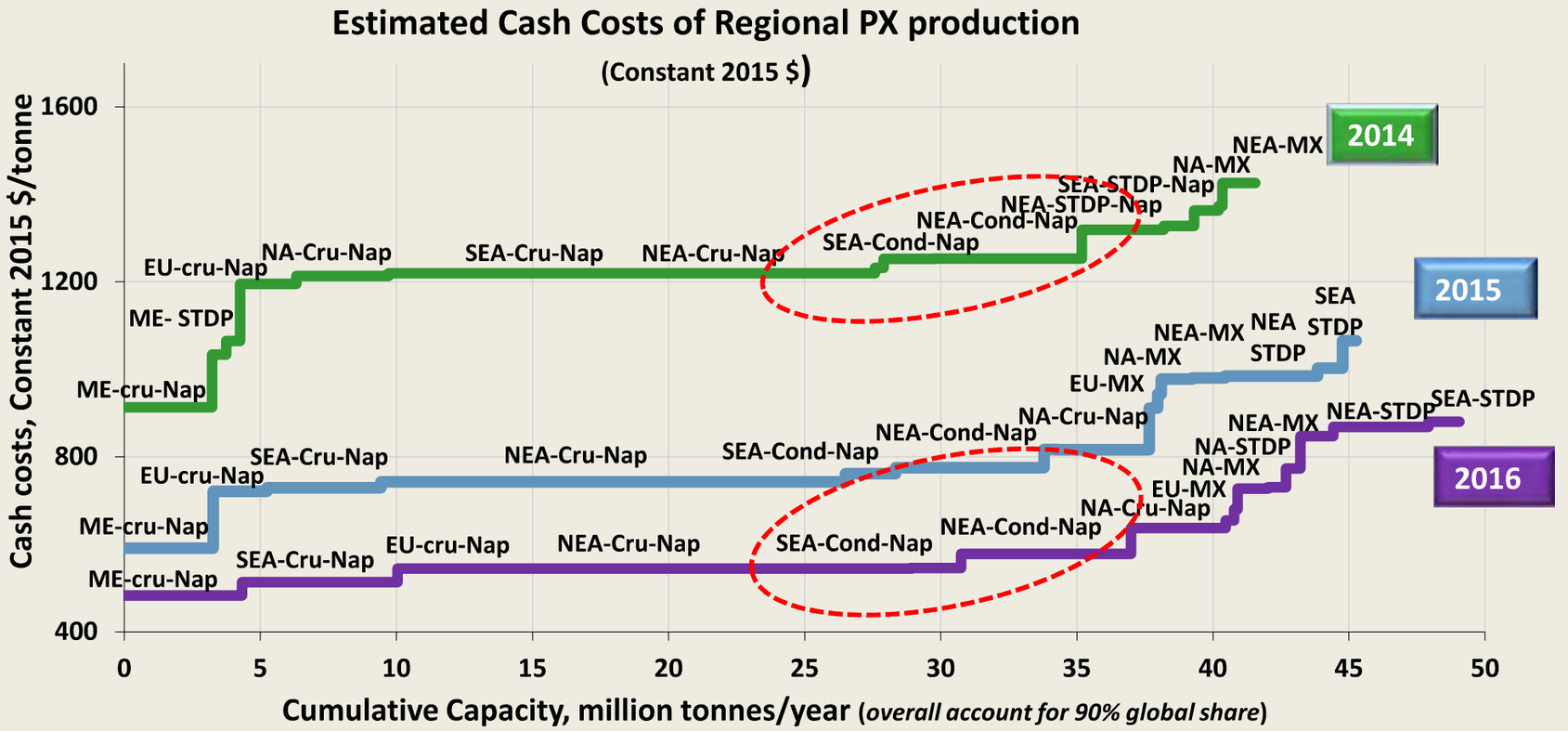
2. Hanwha-Total PC
Capacity: 1,700,000 tonnes/yr PX
Location: Daesan
Start year: 2014
Integrated with Olefins/Aromatics production

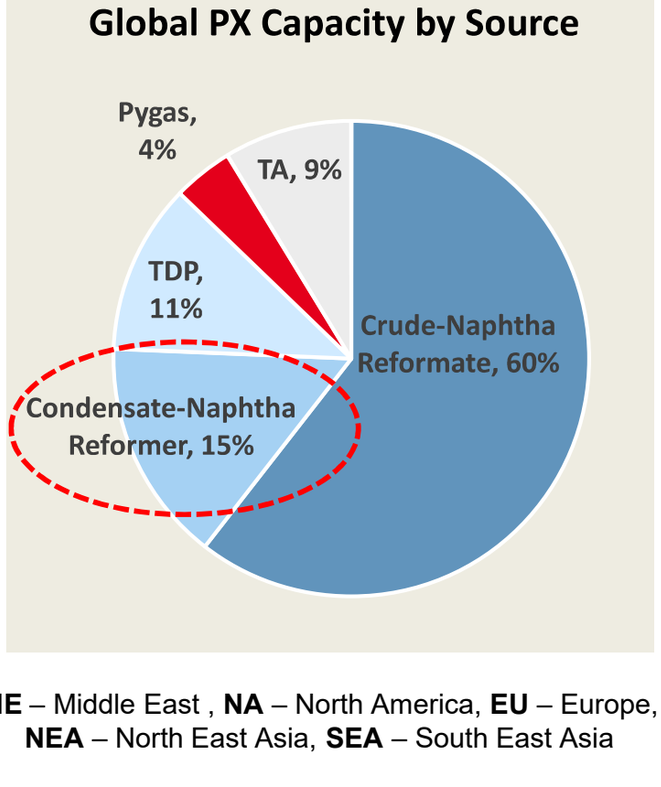
3. SK Global Chemical
Capacity: 1,300,000 tonnes/yr PX
Location: Incheon
Start year: 2014
Integrated with Aromatics production

4. S-Oil
Capacity: 1,700,000 tonnes/yr PX
Location: Onsan
Start year: 2011
Integrated with Aromatics production

"Mixed signals" for emergence of splitter + aromatic capacities

Condensate splitter/aromatics sits near middle of cost curve



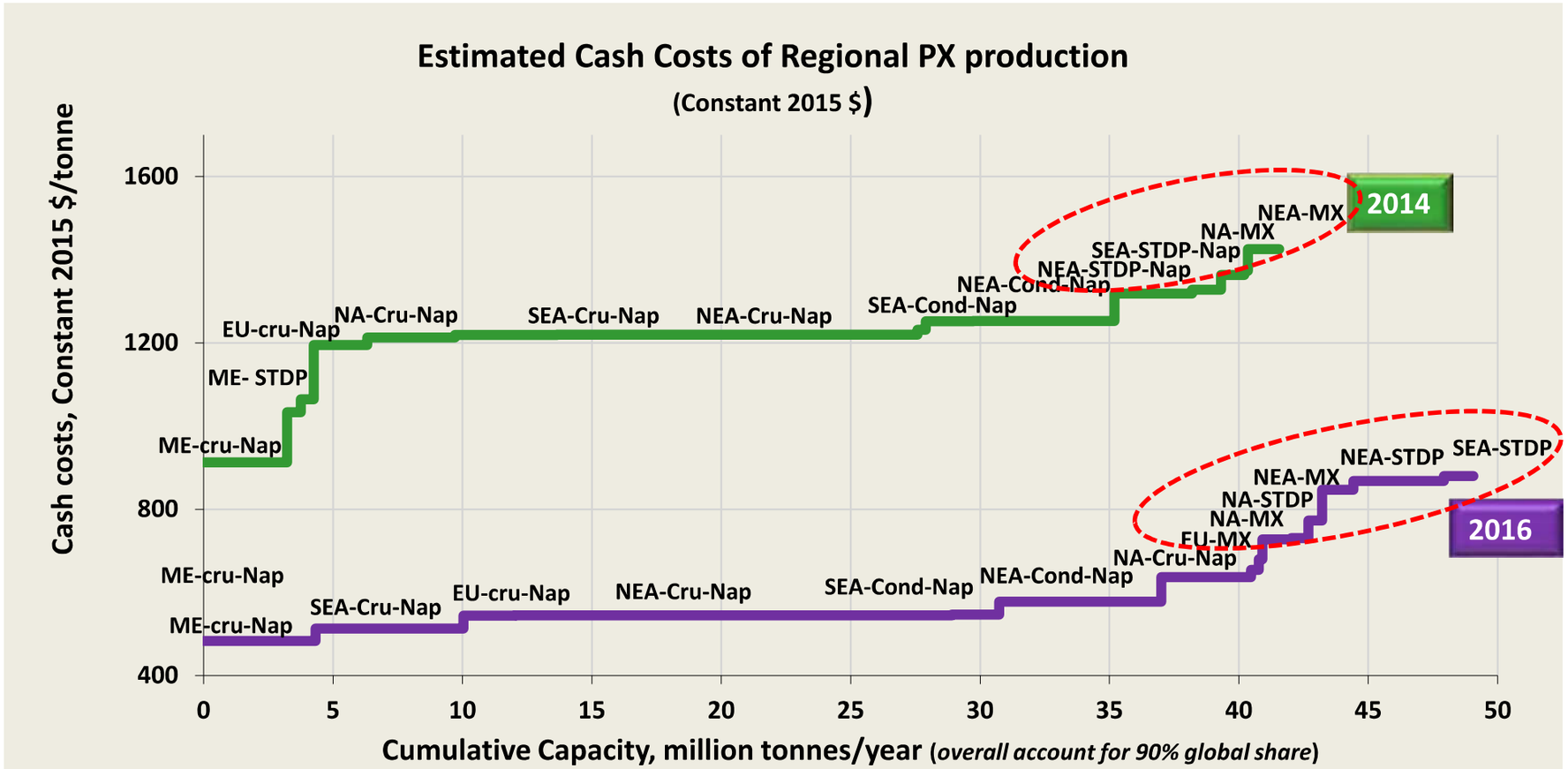


ME – Middle East , **NA** – North America, **EU** – Europe, **NEA** – North East Asia, **SEA** – South East Asia

Cru - Nap – Crude Oil based Naphtha Reformer Aromatics Complex ; **Cond - Nap** – Condensate based Naphtha Reformer Aromatics Complex
STDP - STDP Complex with toluene feed ; **MX** - PX Standalone Complex with feed MX

- Lower crude oil price presents a lower feedstock cost to integrated aromatics production both from crude and condensate
- PX units fed by condensate splitter sits somewhere in the middle of the cost curve

Toluene conversions to PX is at higher end of the cost curve

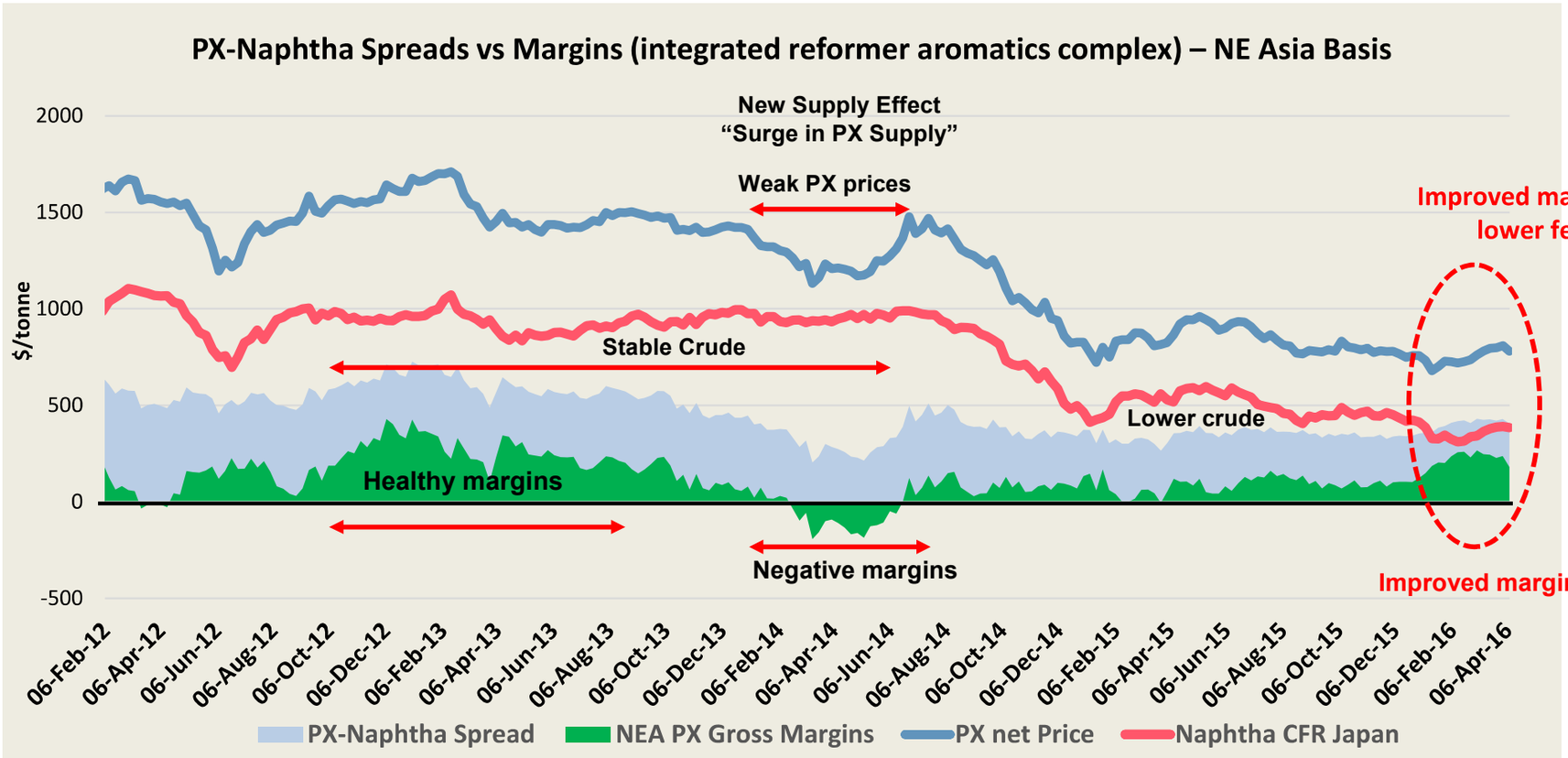


- Toluene conversion to PX via toluene disproportionation is relatively at the higher end of the cost curve in 2016, but it is a unit that becomes a swing producer – idle when margin gets squeezed; run when margin becomes acceptable

Are improving Paraxylene margins here to stay?

Spreads = **Product Price** – **Feedstock Price**

Margins = **Product Price** – **Cash Costs** (i.e. Feedstock cost + Energy, Utility and Plant costs - Co-Product Credits)



Source: ICIS Consulting

- Aromatics operating margins in Q1 of 2016 so far have been on a rise in comparison to 2015
- Relatively lower naphtha prices an interim relief to the aromatics market operating under squeezed margins
- New start-up delays and interim supply disruption from newly started plants also kept the supply in check

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Olefins / polyolefins at a glance…

- North America polyethylene, albeit squeezed margin, is coming to Asia (2017?) with SE Asia players facing new challenges
- Non-traditional route olefins via PDH, CTO & MTO help to fill S/D gap, notably in China, even though most are today at top end of the cost curve
- China has grown near self-sufficiency for PP with changing trade flows for Middle East and SE Asia players
- PDH has grown in significance, and remains a viable high-cost route; likely becomes the “price setter”
- Earlier advantage of “Integrated” MTO eroded in current low oil environment

What’s next? Time for new investment planning?

Traditional or non-traditional routes for new olefin manufacture?

Benzene and paraxylene at a glance…

- Olefin (Pygas) and PX (Reformate) will continue to drive benzene supply with no major change in trade flows
- China remains hugely short of PX
- PX margins improving with growing regional supply tightness due a few recent plant mishaps
- Emerging dedicated condensate splitter aromatics plants help to supplement PX shortfalls, albeit some were embroiled in either safety or financial troubles. Further integration of splitter with cracker will enhance viability.
- Toluene conversion to benzene and xylenes at higher cost regime may be idle except assets can be re-activated when spread becomes viable

Time to re-visit aromatic investment amid low oil / gloomy outlook?

What's the right strategy for new aromatics capacity investment?

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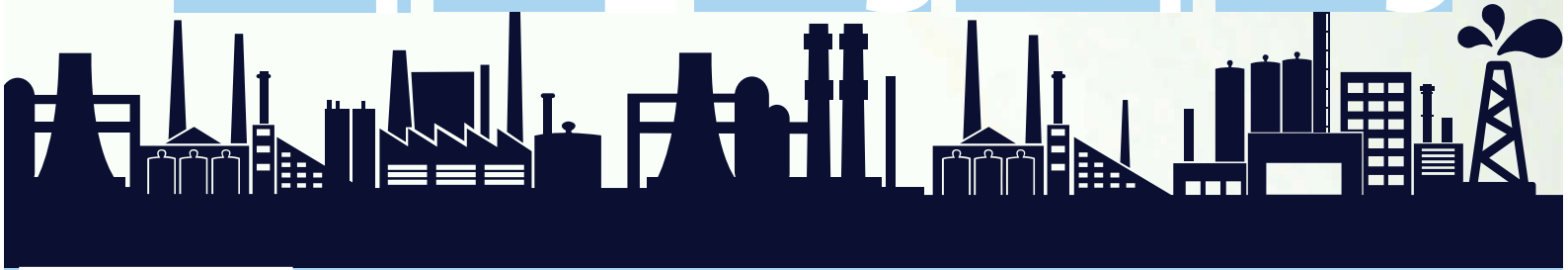
3. How will China's slowdown impact global markets?
4. What demographic paradigm shifts impact supply & demand fundamentals?
5. Where are the future opportunities?



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