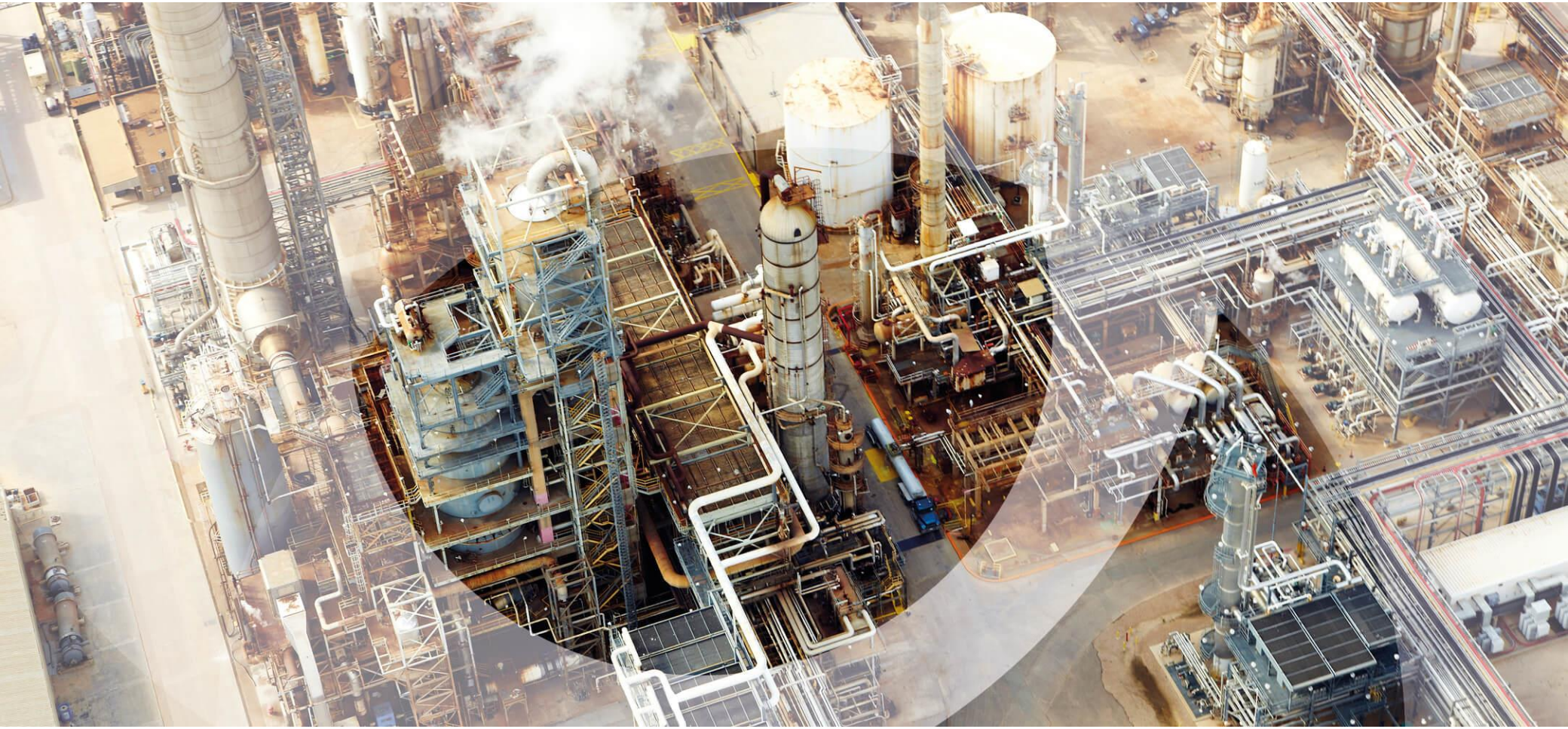
Wood Mackenzie Downstream Seminar

Moscow, 9th April 2019



Wood Mackenzie – Moscow Downstream Seminar

Putting together the global downstream puzzle and what it means for Russia

Tuesday 9th April 2019

13:00 – 14:00	**Registration and Refreshments**	
14:00 – 14.10	**Welcome Address**	**Elena Borisova** Senior Manager
14:10 – 14:50	**Global Oil & Gas Outlook**	**Alan Gelder** VP Refining, Chemicals and Oil Markets
14:50 – 15:30	**Global Refining Outlook**	**Alan Gelder** VP Refining, Chemicals and Oil Markets
15:30 – 16:00	**Coffee Break**	
16:00 – 16:45	**Global Petrochemical Outlook**	**Patrick Kirby** Principal Analyst, EMEARC Olefins
16:45 – 17:00	**Closing Remarks**	**Elena Borisova** Senior Manager

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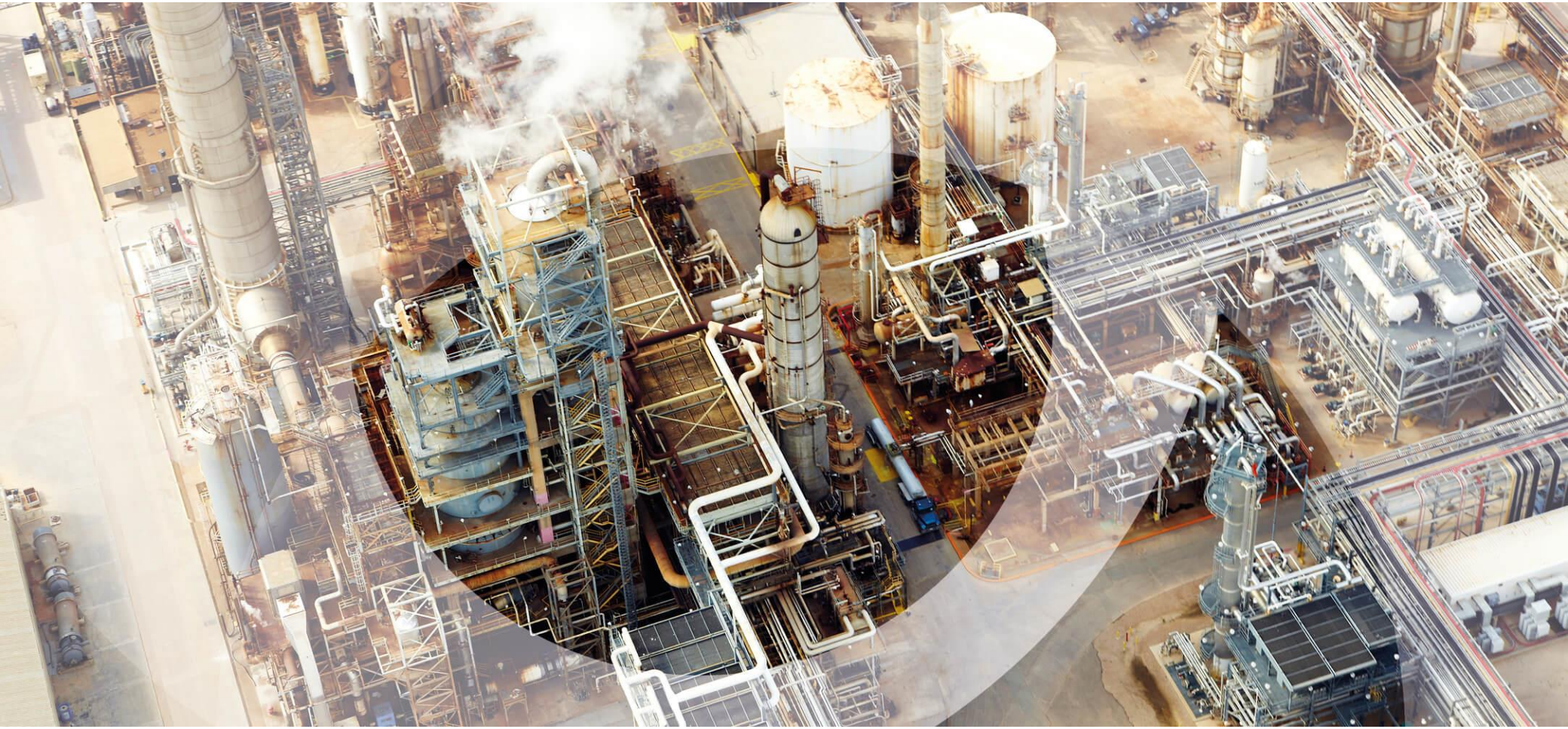
Global Oil & Gas Outlook

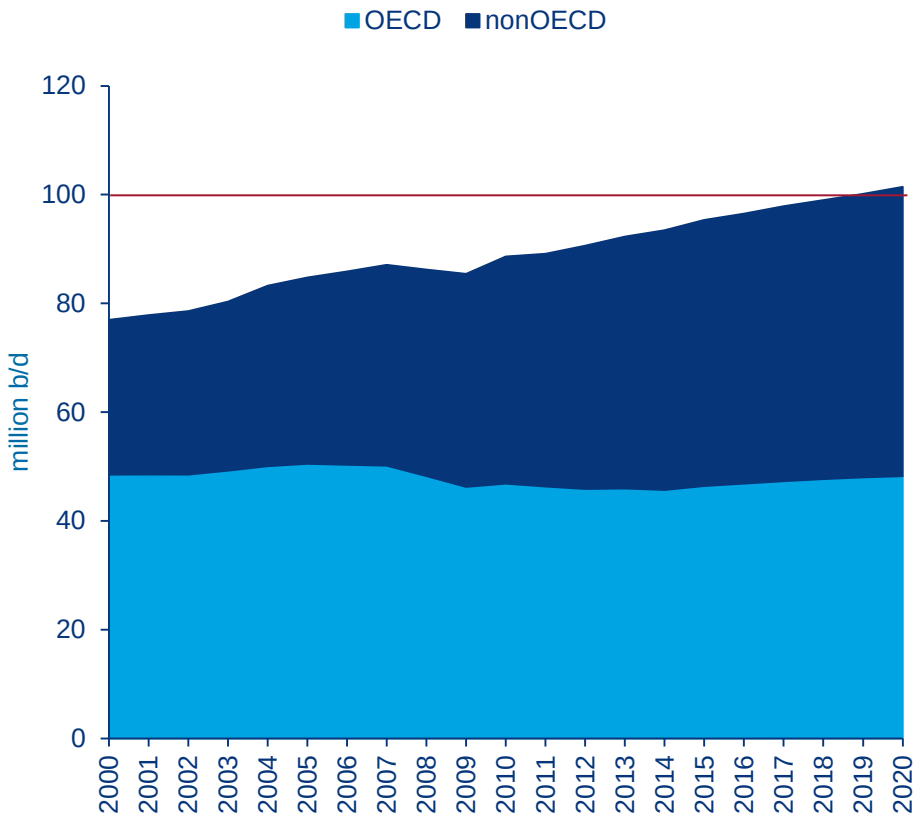
Moscow, 9th April 2019



Global demand reached 100 million b/d in Q4 2018. Growth in 2018 averaged 1.1 million b/d

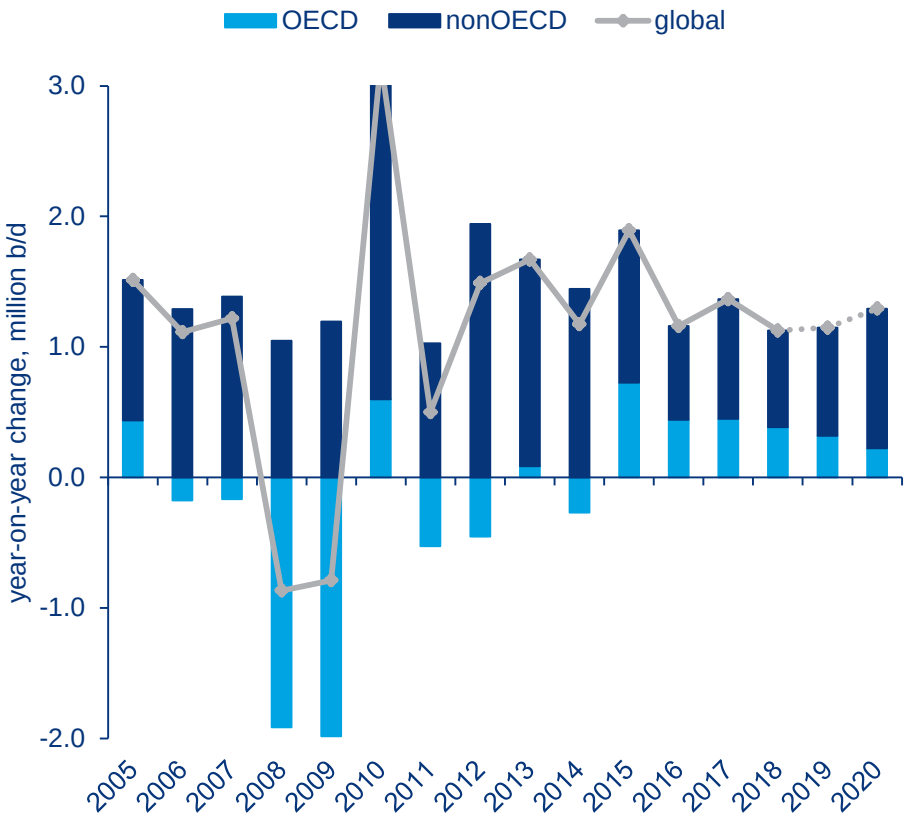
Recovery in OECD demand has been a key feature since 2015. OECD growth to soften by 2020.

Global liquids demand



Source: Wood Mackenzie

Growth in global oil demand



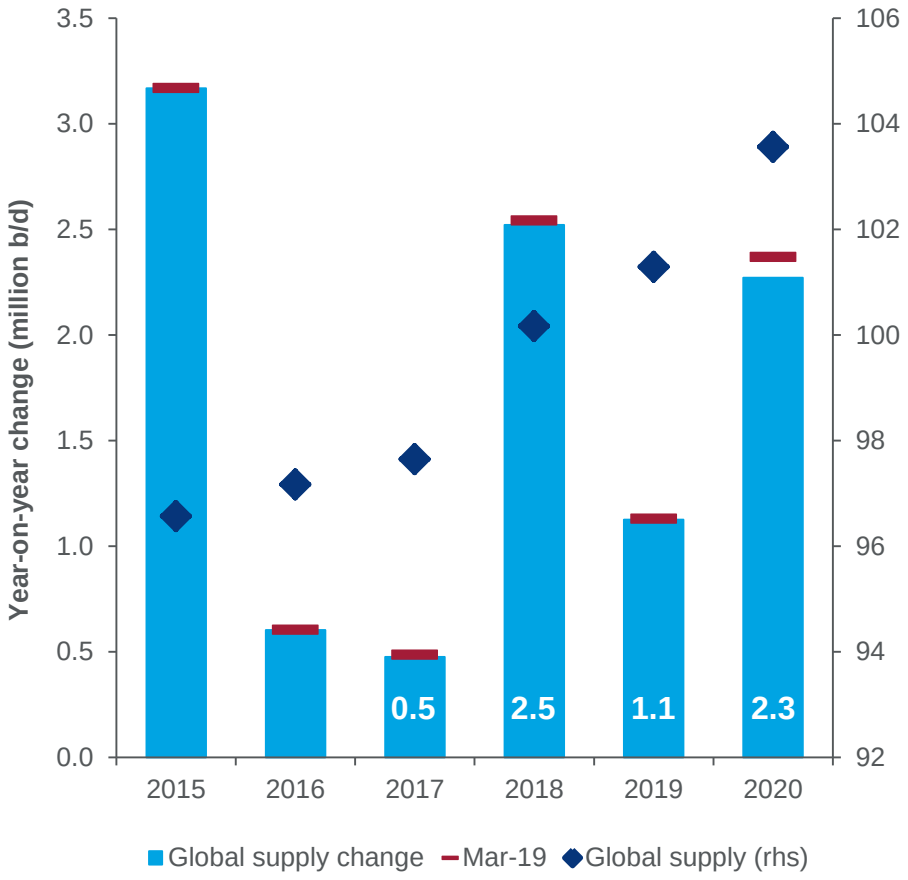
Source: Wood Mackenzie

Source: IEA MODS, EIA, local statistics Forecast: Wood Mackenzie

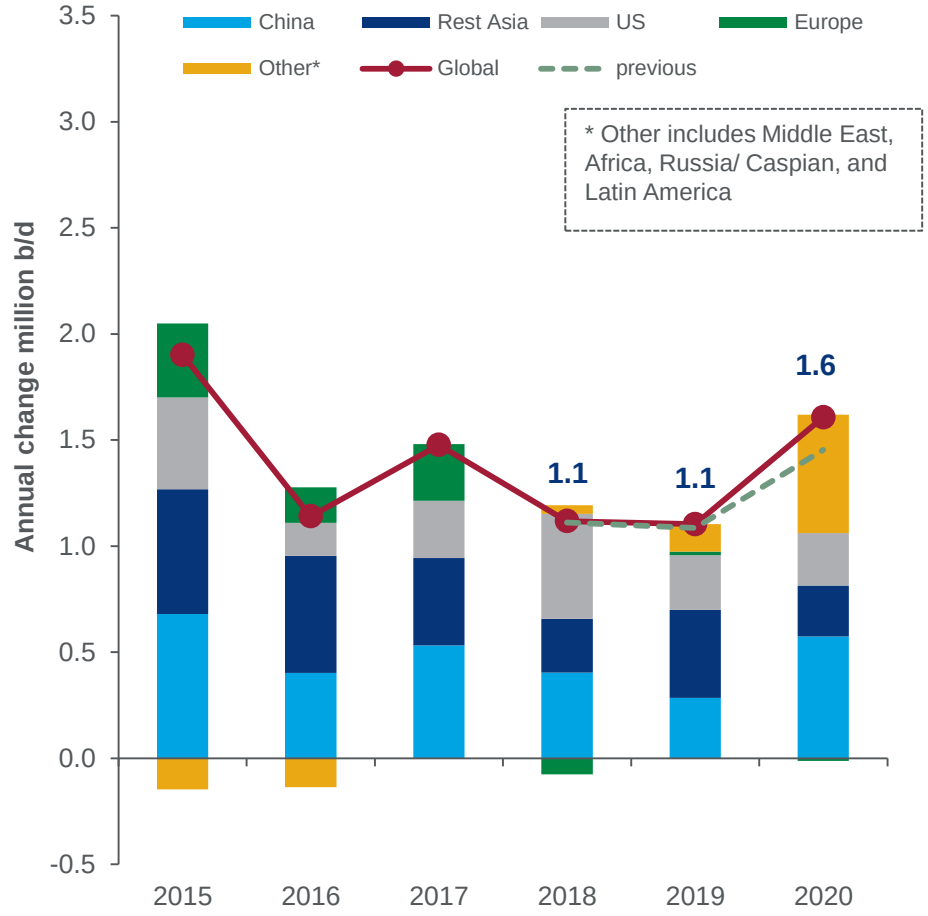
Global supply growth to slow to 1.1 million b/d in 2019: non-OPEC growth offset by OPEC declines in Iran and Venezuela

Demand gains for 2019 match those of oil supply making 2019 tighter than expected early this year and reflecting the impact of geopolitical risk on the supply/demand balance

Global liquids supply



Global liquids demand

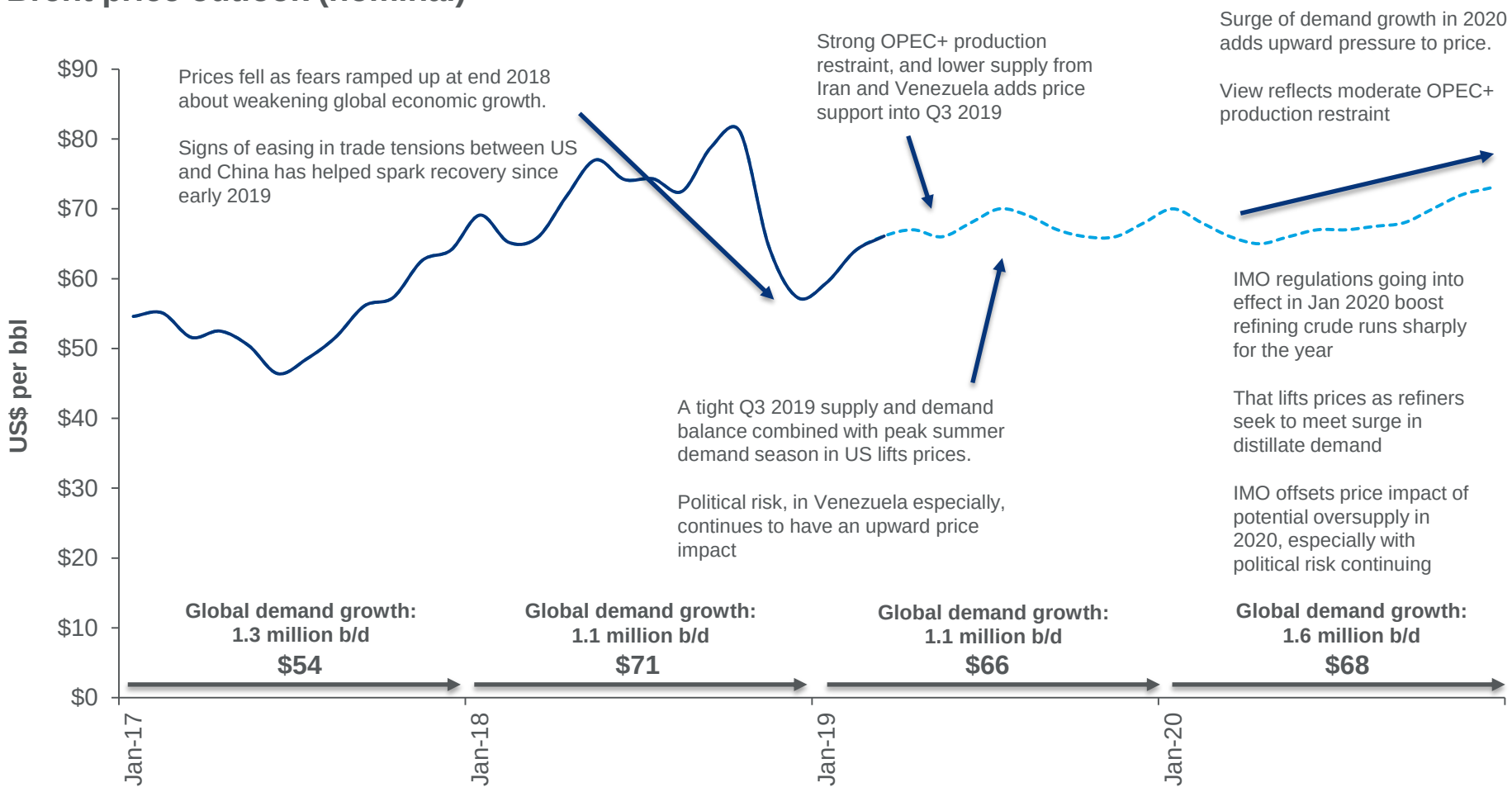


Source: Wood Mackenzie

Brent forecast to remain broadly stable, with 2020 supported by IMO

Strong global oil demand growth in 2020 adds support to price

Brent price outlook (nominal)

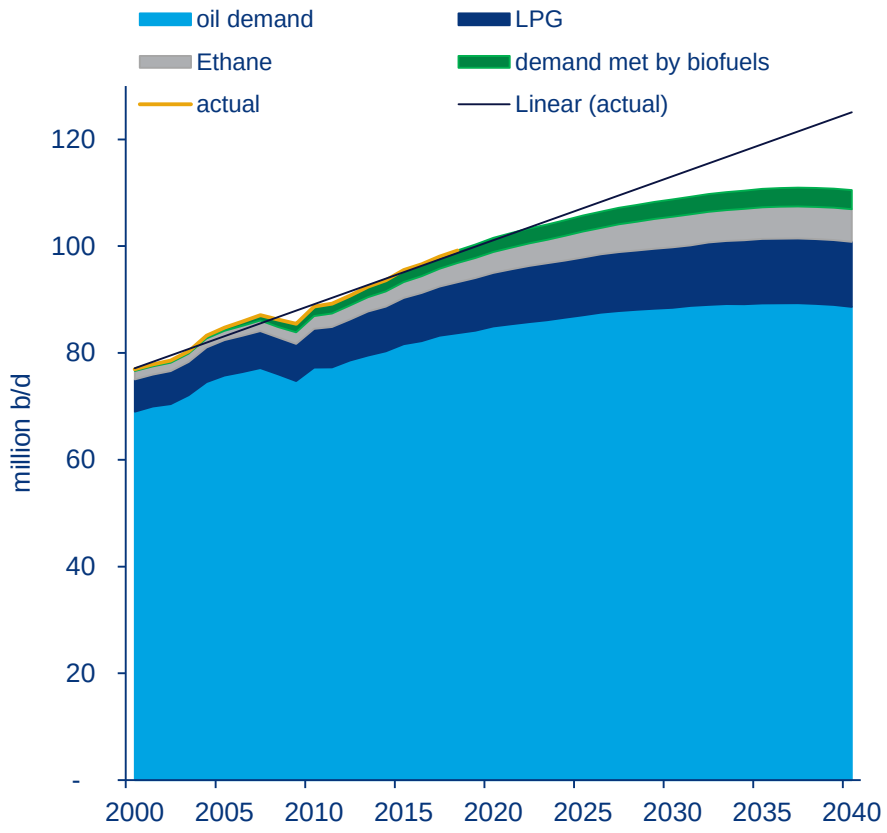


Source: Argus, Wood Mackenzie forecast

Longer term, global liquids demand growth rate to slow. Demand to reach around 110 million b/d in 2040

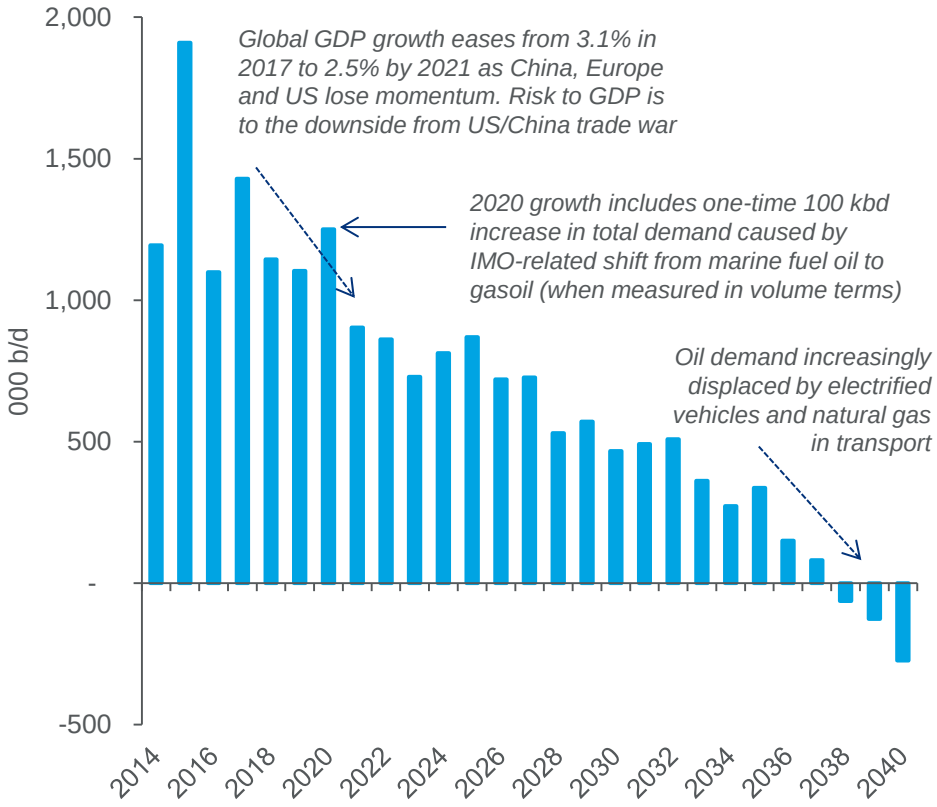
Excluding biofuels, LPG and ethane, oil demand grows 5 million b/d between now and 2040. Annual growth decelerates steadily through mid-2030s

Global liquids* demand



Source: Wood Mackenzie

Annual growth in global liquids demand

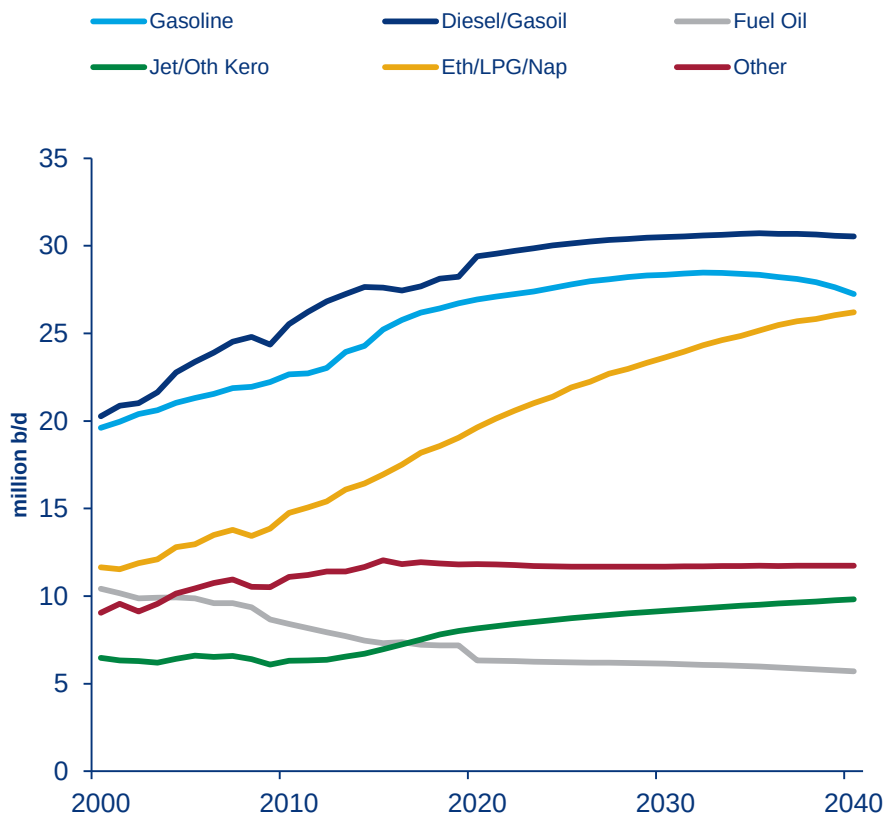


Source: Wood Mackenzie * liquids includes oil products, NGLs, and biofuels

Growth in gasoline demand loses momentum post-2020 as fuel efficiency kicks in, followed by rising penetration of EVs

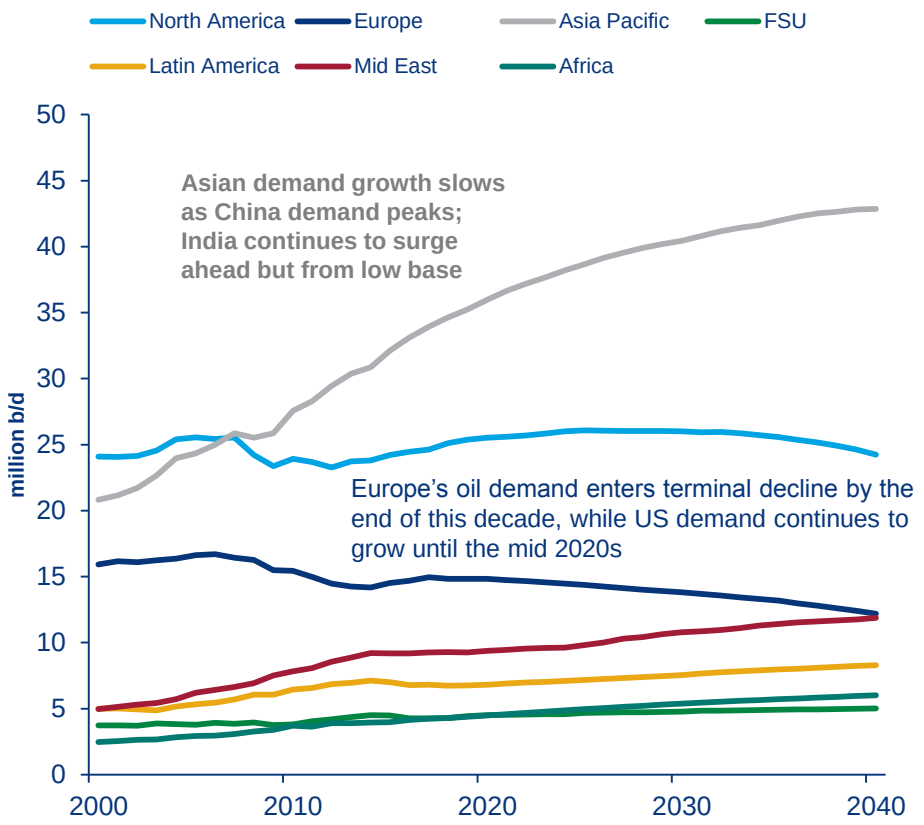
Europe and North America lead the decline in global demand, but growth rate also slows in Asia

Global demand by main product



Source: Wood Mackenzie

Global demand by region



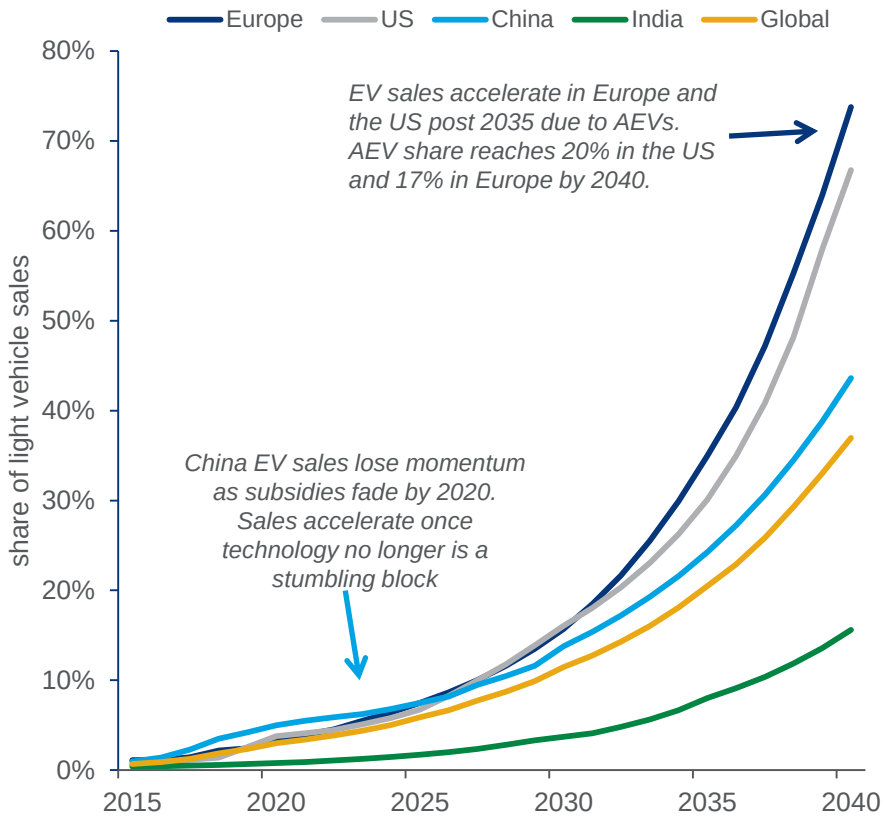
Source: Wood Mackenzie

Source: IEA Energy Statistics, Local Statistics Forecast: Wood Mackenzie

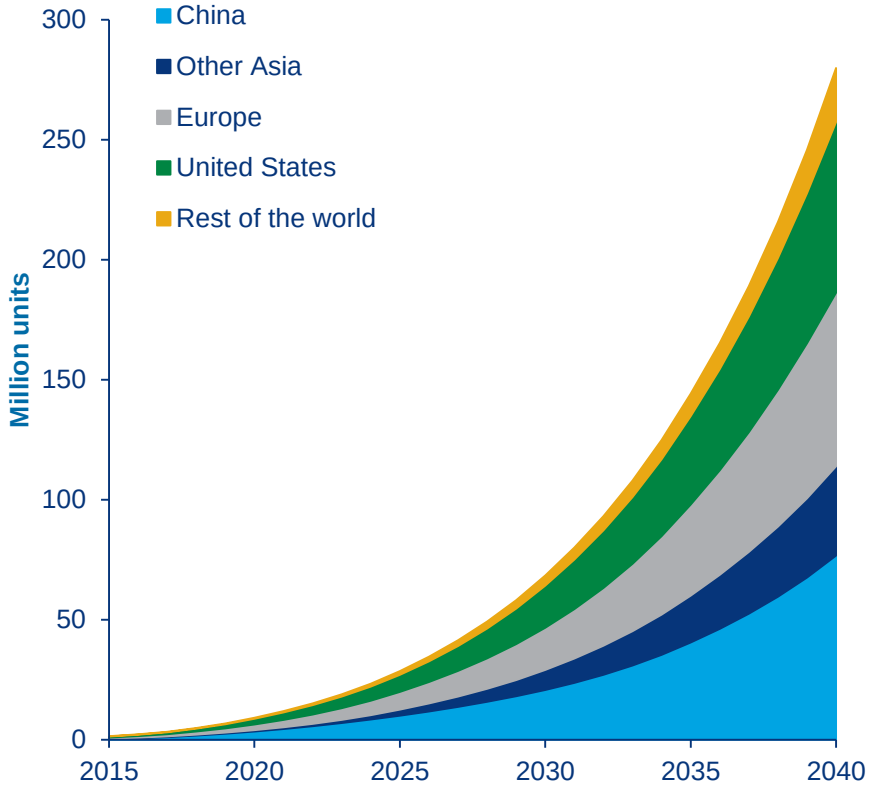
Global stock of EVs is expected to grow to 290 million passenger cars by 2040. AEVs reach 3 mil by 2035, 24 mil by 2040.

Europe and the US lead with 60-70% of sales by 2040, while China leads the developing world at half that level of penetration

EVs as a share of total light vehicle sales



Global electric vehicle stock

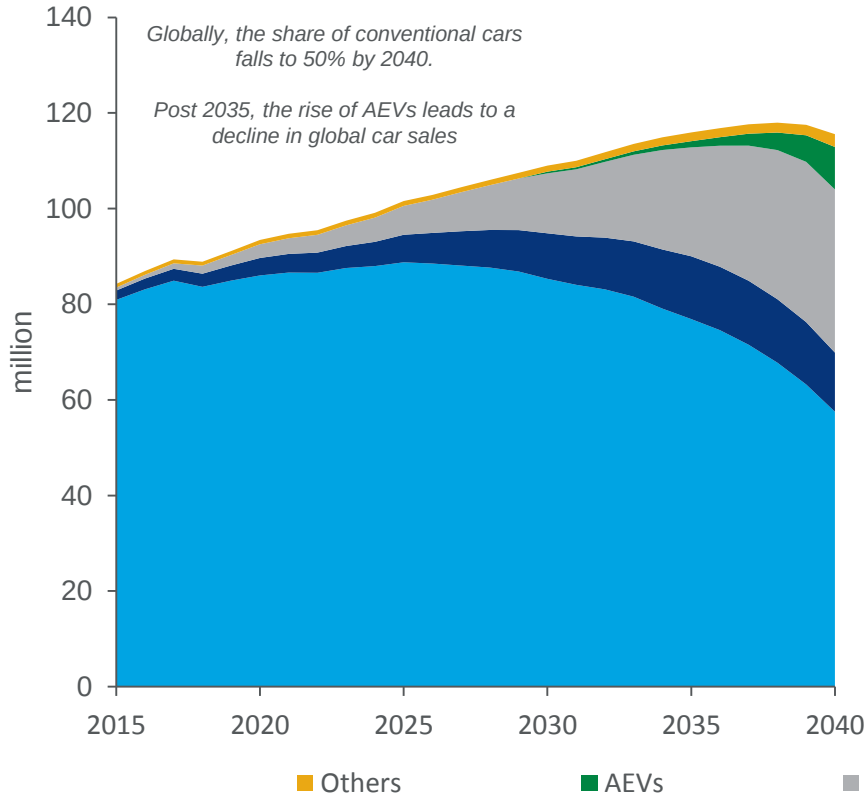


Note: "Electric vehicles" include autonomous electric vehicles (AEVs), battery electric vehicles (BEVs), and plug-in hybrid electric vehicles (PHEVs)
Europe defined as OECD Europe plus Albania, Bosnia, Bulgaria, Croatia, Cyprus, Lithuania, Macedonia, Malta, Montenegro, Romania and Serbia
Source: Wood Mackenzie

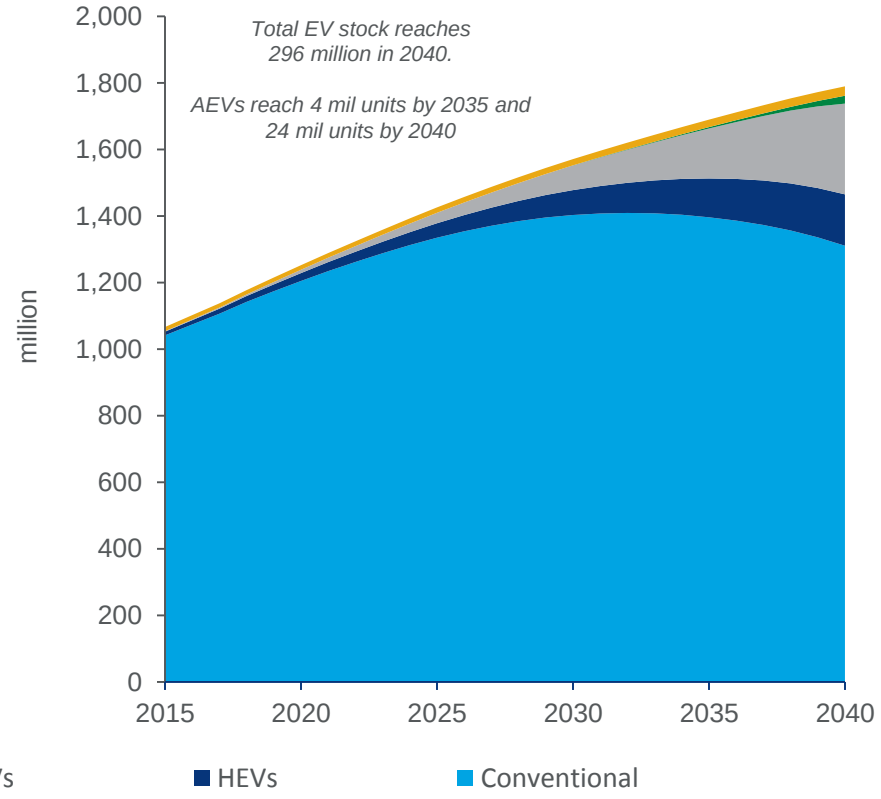
In road transport, electrification and autonomous technology disrupt oil demand in the long-run

While the shift in car sales to EVs is rapid post-2030, the impact on the car parc is gradual. By 2040, EVs account for 37% of new car sales and 17% of total cars in operation.

Global passenger car sales by type



Global passenger car stock by type

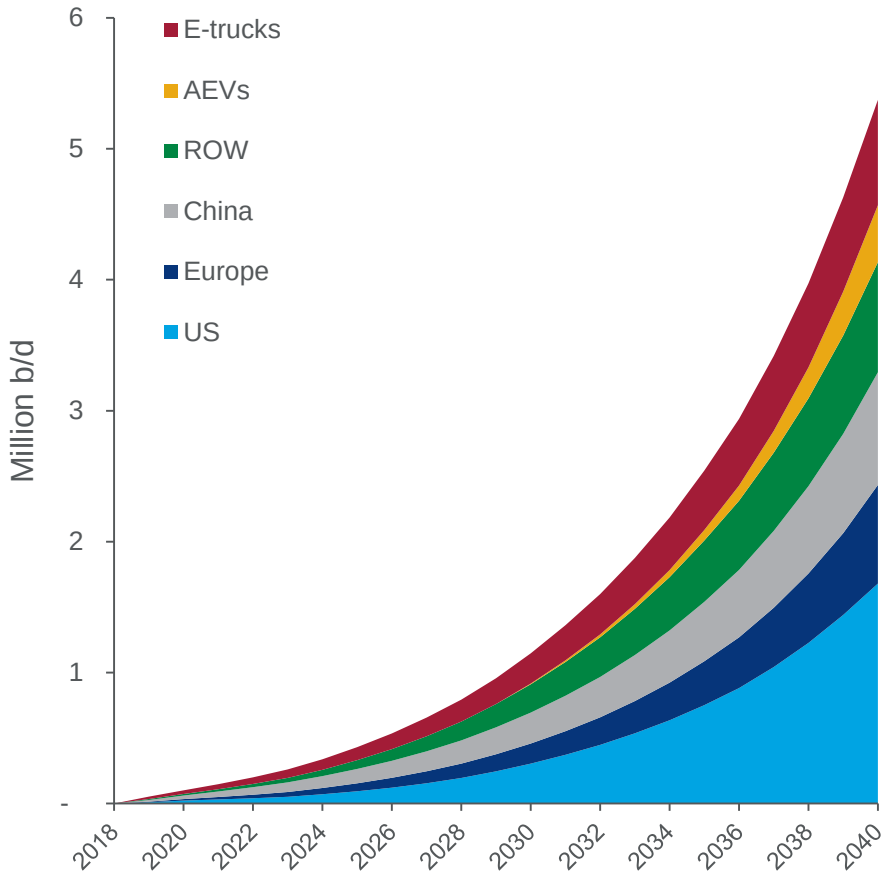


Source: Wood Mackenzie
Conventional: Gasoline, Diesel and LPG internal combustion engine vehicles, HEVs: Hybrid Electric Vehicles, PHEVs: Plug-in Hybrid Electric Vehicles, EVs: Battery Electric Vehicles; AEVs: Autonomous Electric Vehicles

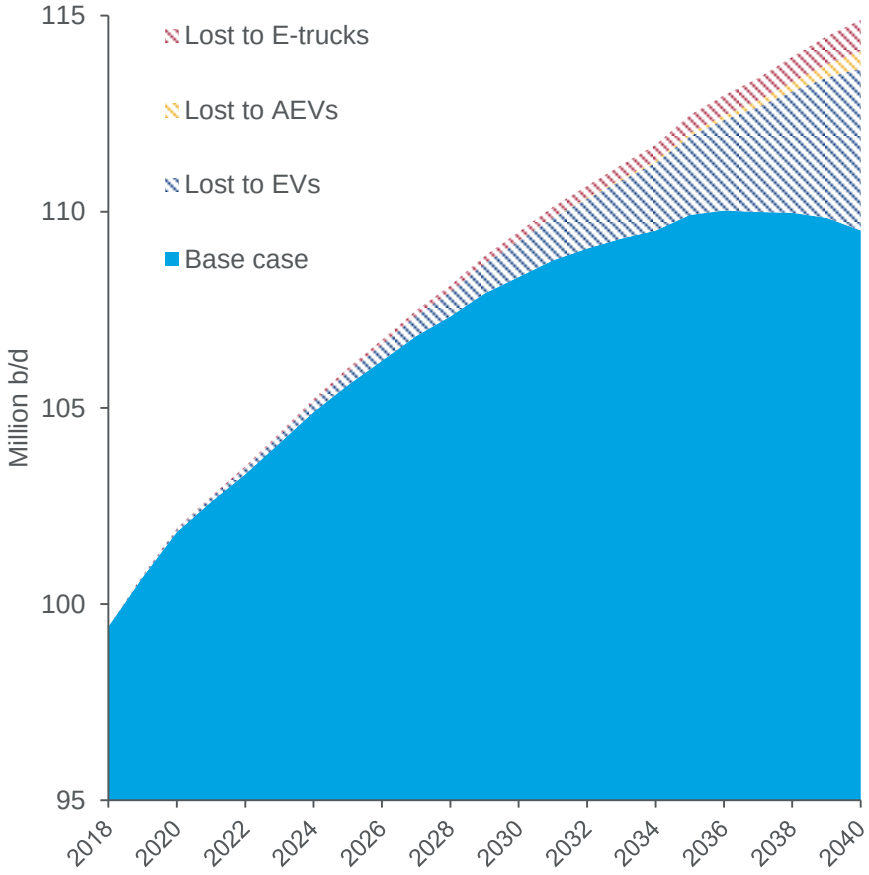
Acceleration of EV adoption post-2030 leads to ~5.3 million b/d of oil demand displaced by 2040

The US, China and Europe, in particular, will see the most oil demand displaced

Global liquids demand displaced by EVs



Global liquids demand

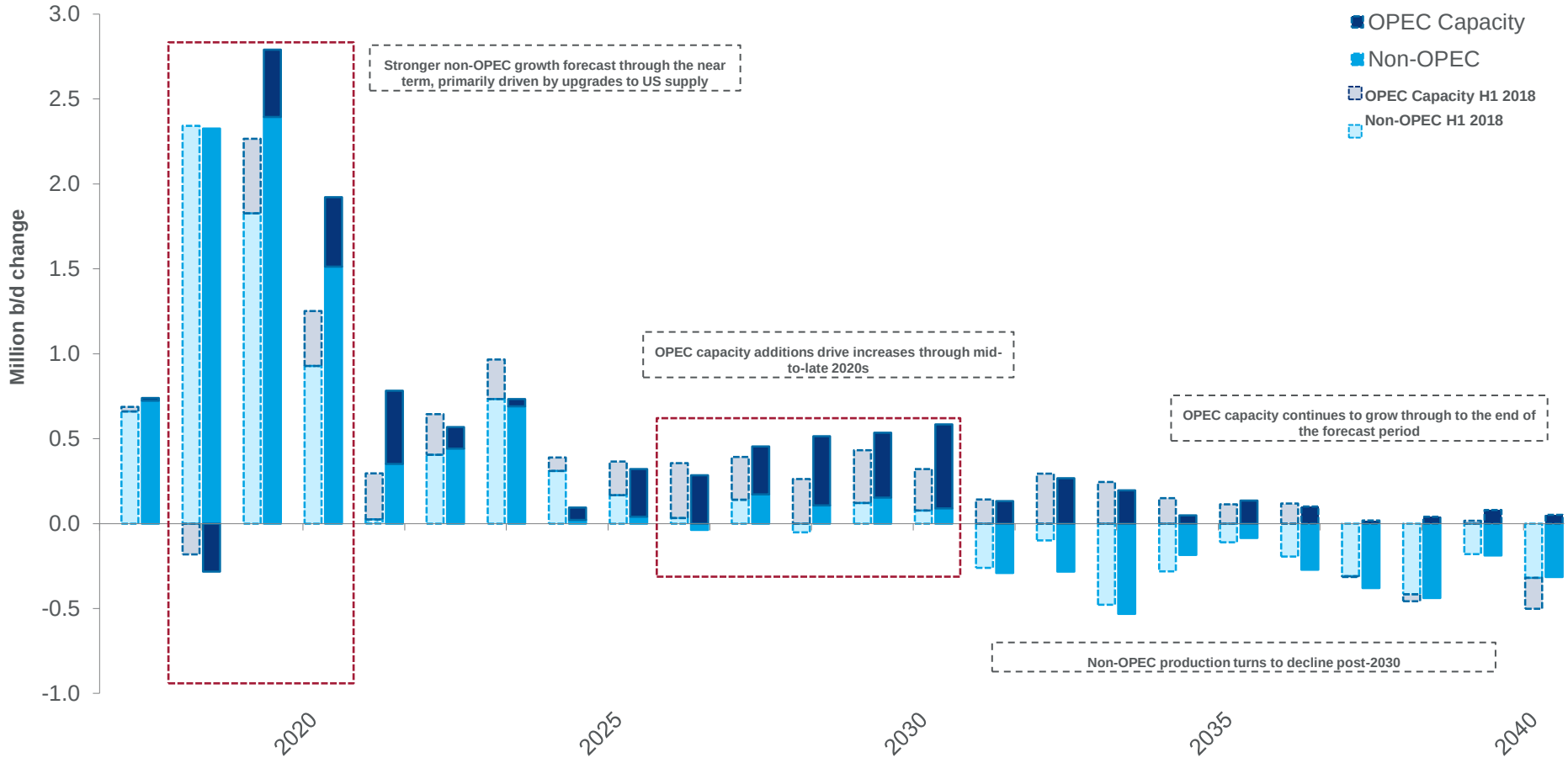


Source: Wood Mackenzie

Non-OPEC countries dominate near term supply increases…

…but OPEC capacity additions strengthen through the mid-to-late 2020s

Year-on-year change in OPEC capacity and non-OPEC production*

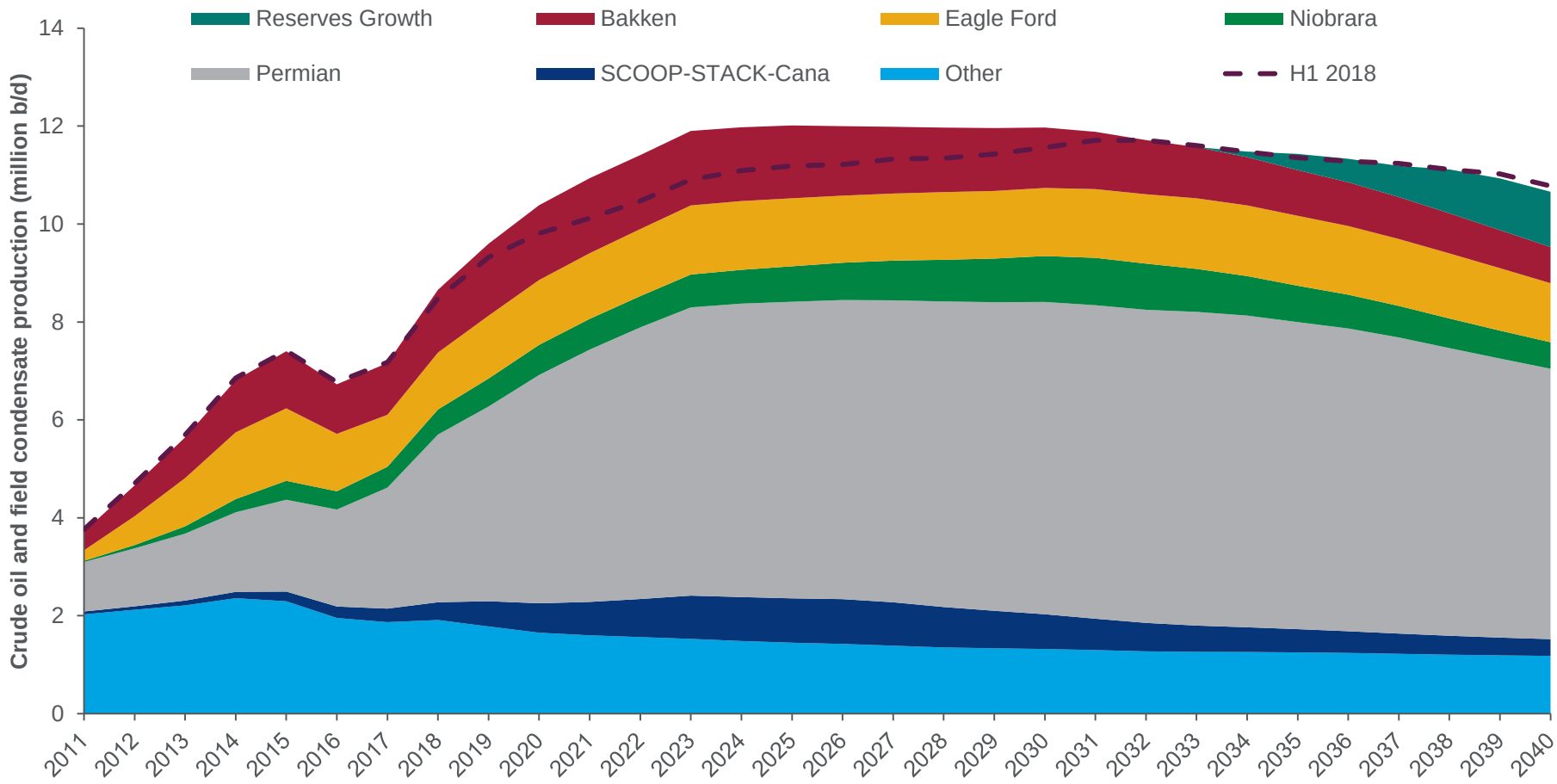


Source: Wood Mackenzie *Excludes unconventionals (biofuels, gas-to-liquids and coal-to-liquids) and processing gains

US lower 48 crude oil: production coming in higher and faster

The peak occurs in 2025 at 12 million b/d compared to 11.7 million b/d in 2031 in our H1 2018 outlook. This is supported by stronger than expected short-term growth

US Lower 48 crude and condensate production

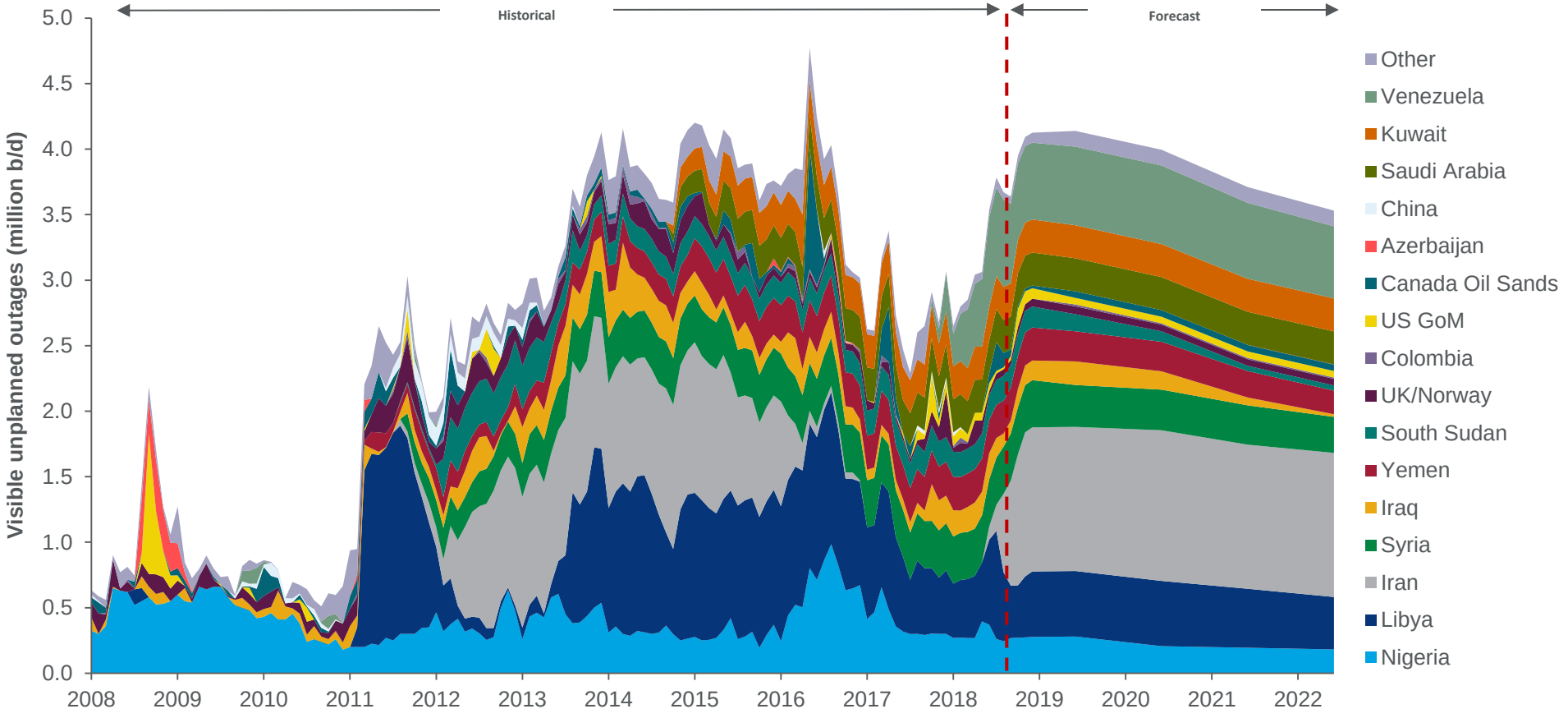


Source: Wood Mackenzie

The level of supply outages remains highly unpredictable

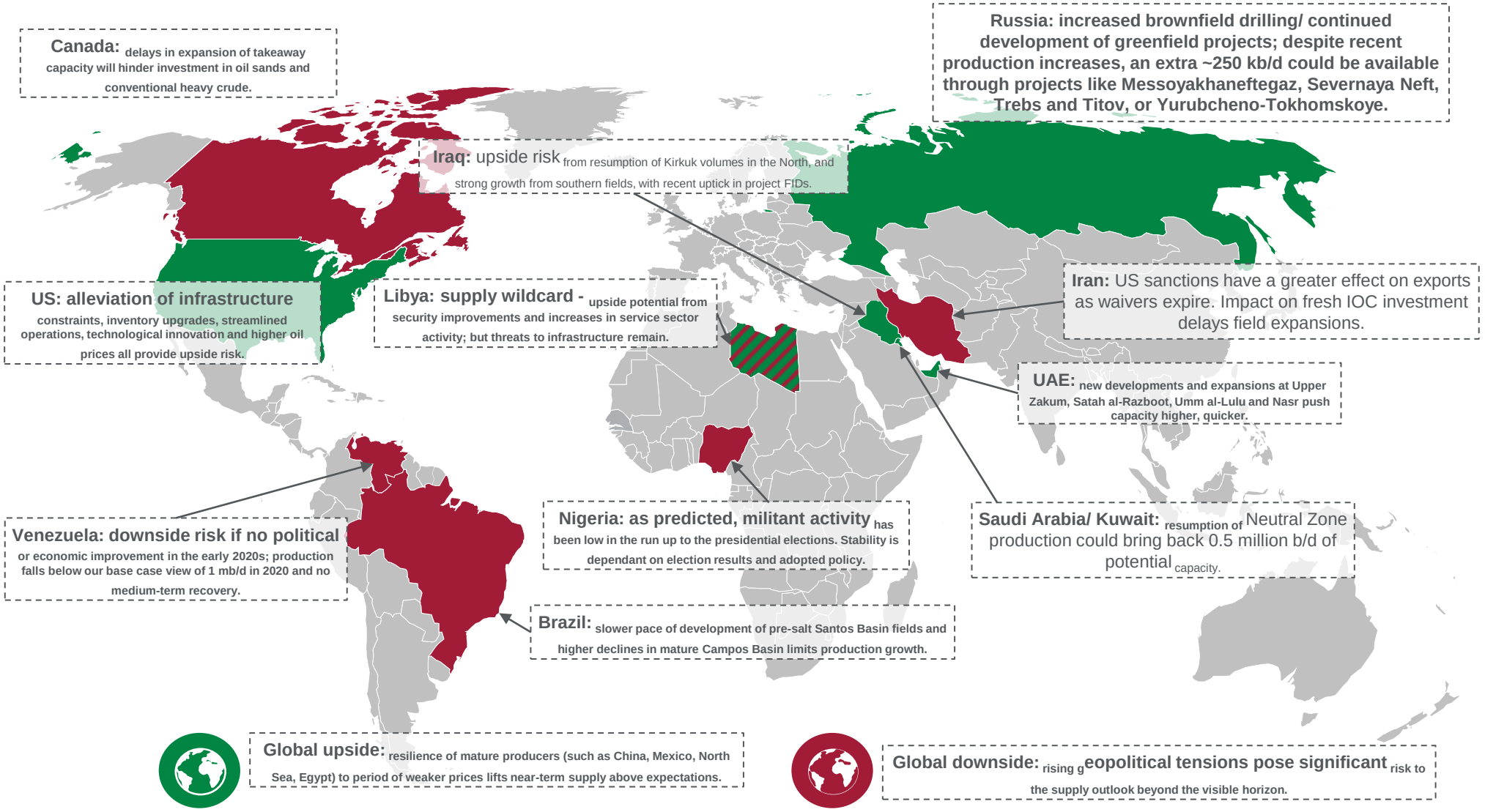
Iran sanctions and Venezuelan economic and political turmoil help push unplanned supply losses back to 4 million b/d in 2019

Global unplanned supply outages



Source: Wood Mackenzie

Geopolitical risk remains a critical driver of the supply outlook

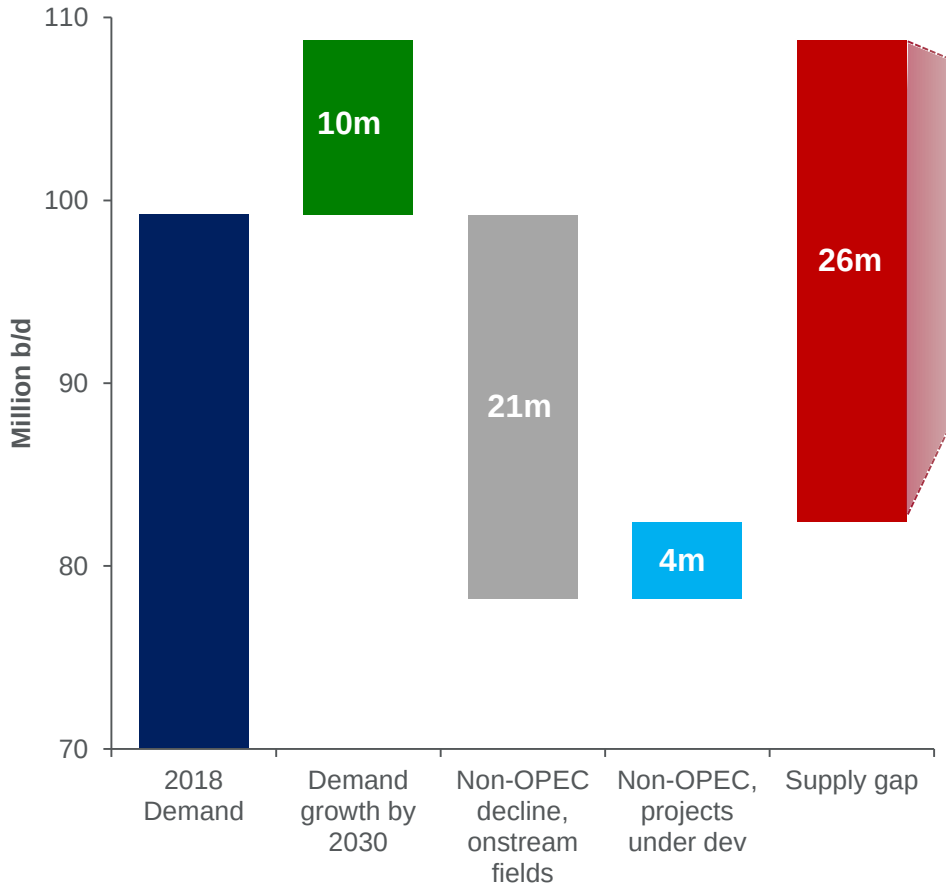


Source: Wood Mackenzie

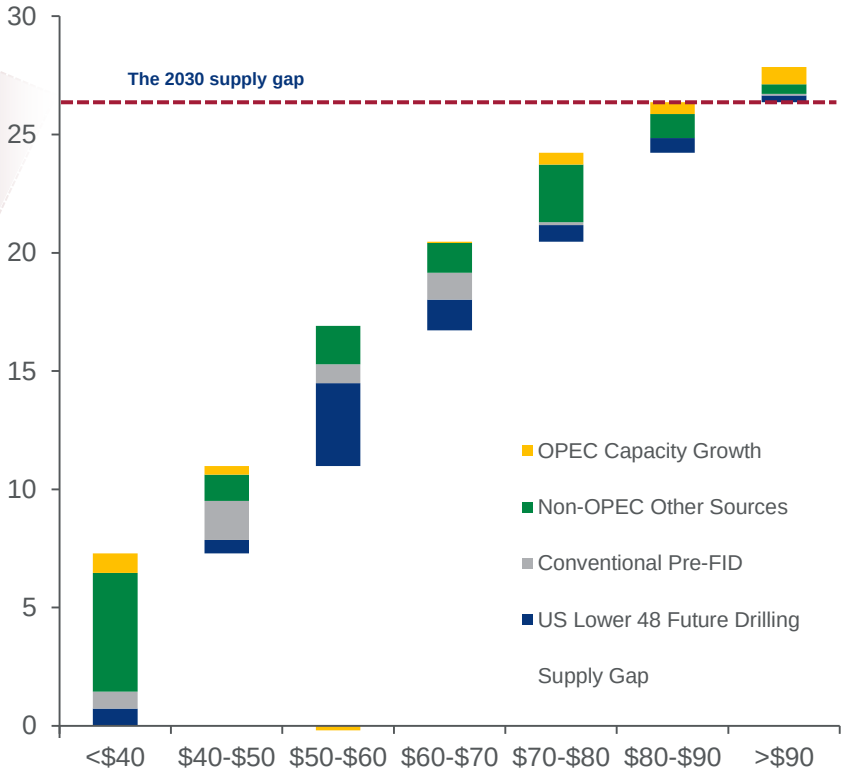
The oil ‘supply gap’ to 2030 will be met by US crude, OPEC capacity growth and more expensive conventional production

Over 25 million b/d liquids supply must be met by new drilling by 2030

The 2030 supply gap



Filling the ‘supply gap’ to 2030

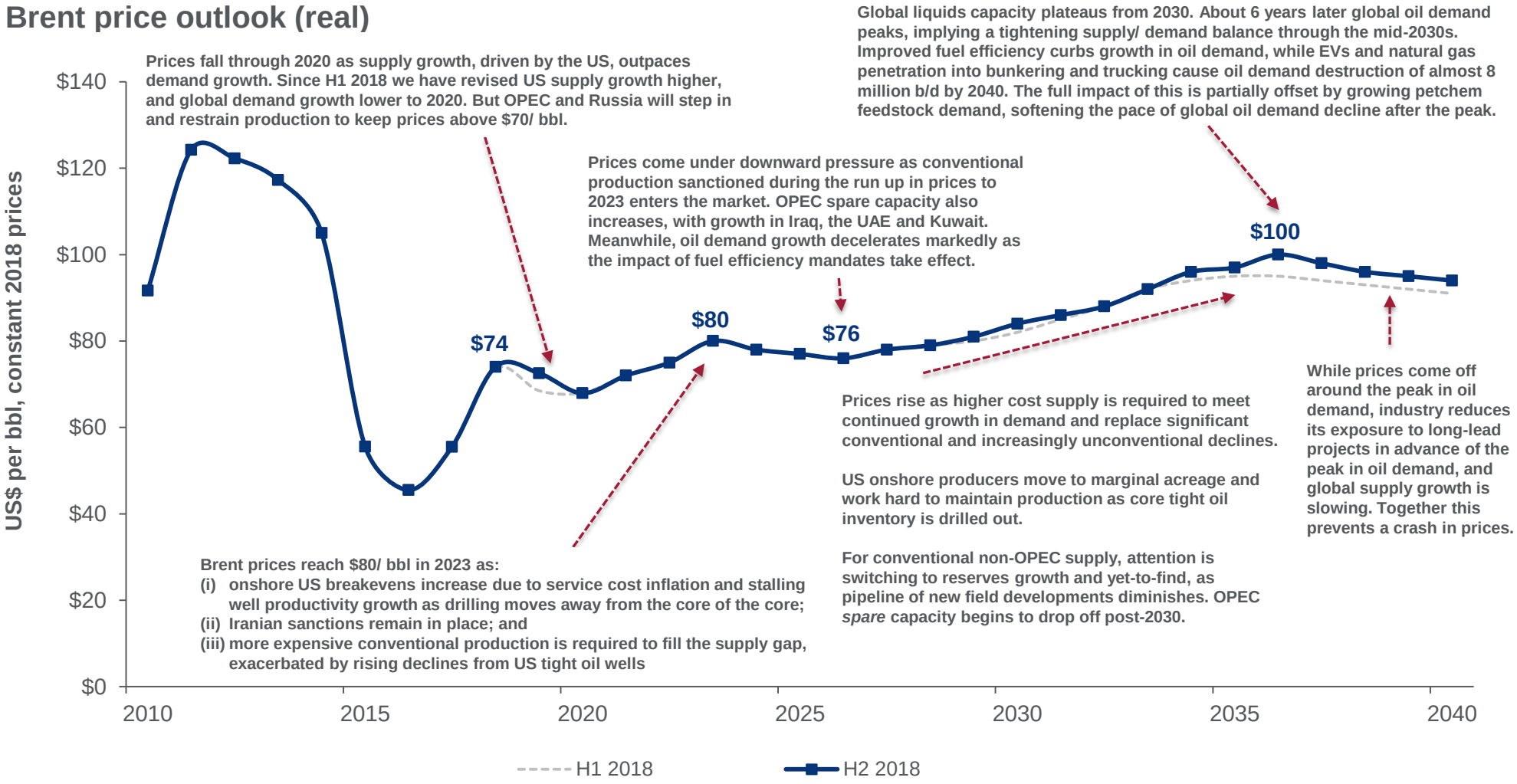


Source: Wood Mackenzie
Non-OPEC other sources includes reserves growth, contingent resources, yet-to-find and unconventionals (biofuels, CTL and GTL)

Fundamentals downward price pressure in the short-term gives way to higher price pressure as supply-demand balance tightens

Oil demand peaks in the late-2030s but total liquids capacity plateaus from the early 2030s

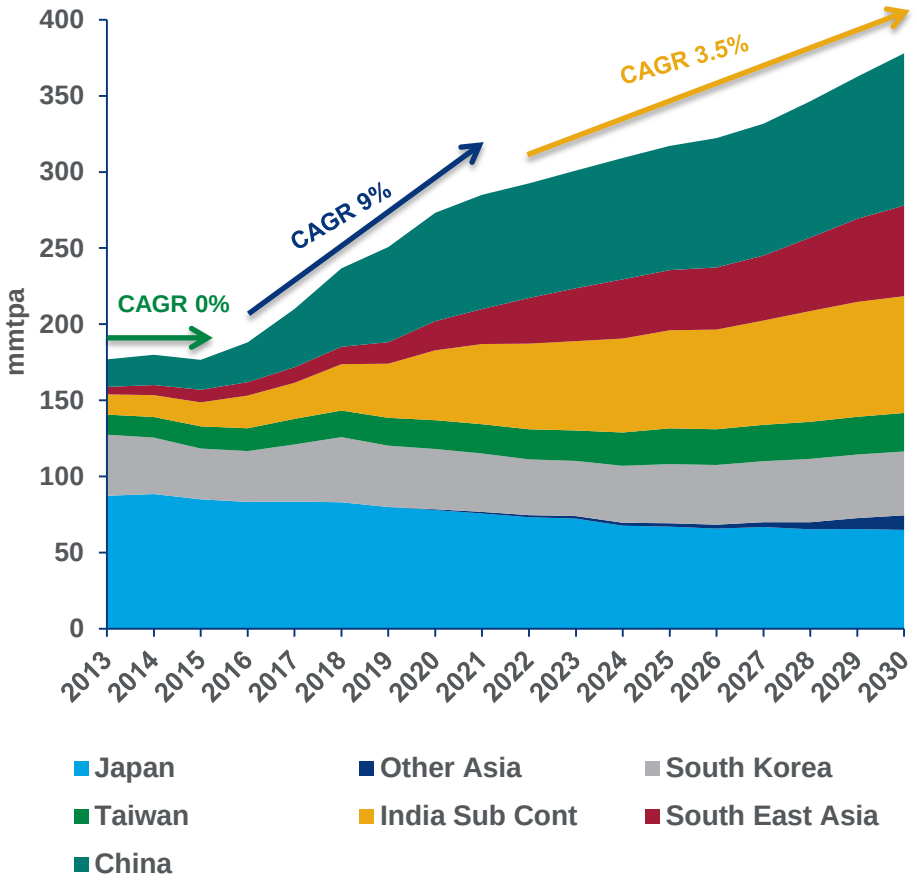
Brent price outlook (real)



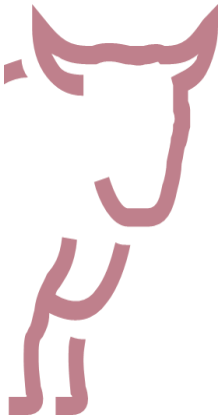
Source: Wood Mackenzie

Asian LNG demand growth will start to slow next decade and pace of future growth is uncertain

Asian LNG demand growth to 2030



- Increased domestic production and pipe import competition in China
- Coal and nuclear competition in South Korea and Japan
- Renewable developments
- Economic slowdown



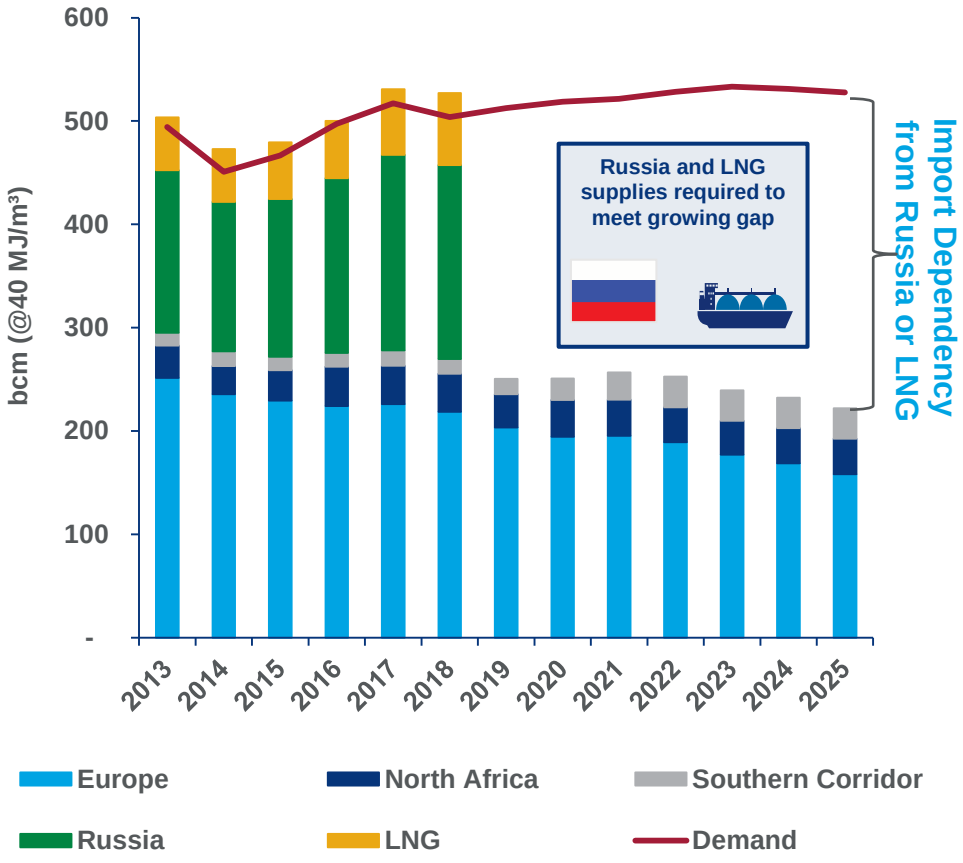
- Increased concern about pollution and backlash against coal
- Infrastructure and demand creation in emerging markets
- LNG prices remain competitive against oil

Source: Wood Mackenzie

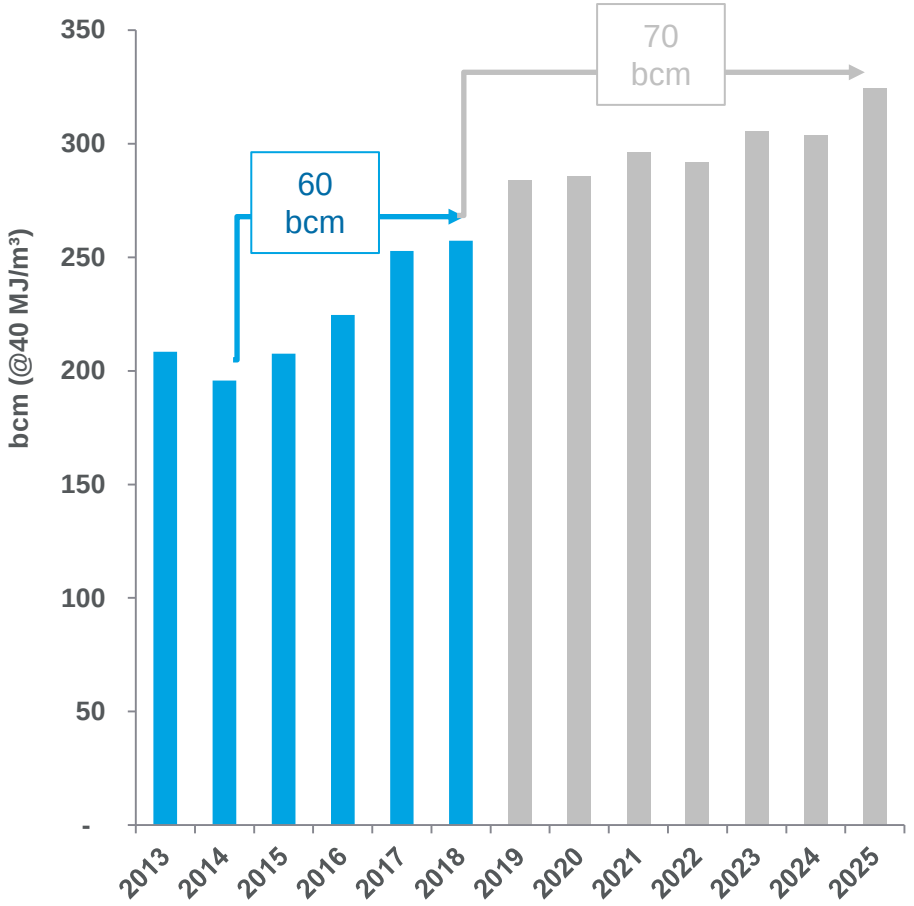
…however resilient demand and declining indigenous production are making Europe increasingly import dependent

Europe will require 70 bcm of additional imports by 2025

European Supply-Demand Gap



Europe Import Dependency from Russia or LNG

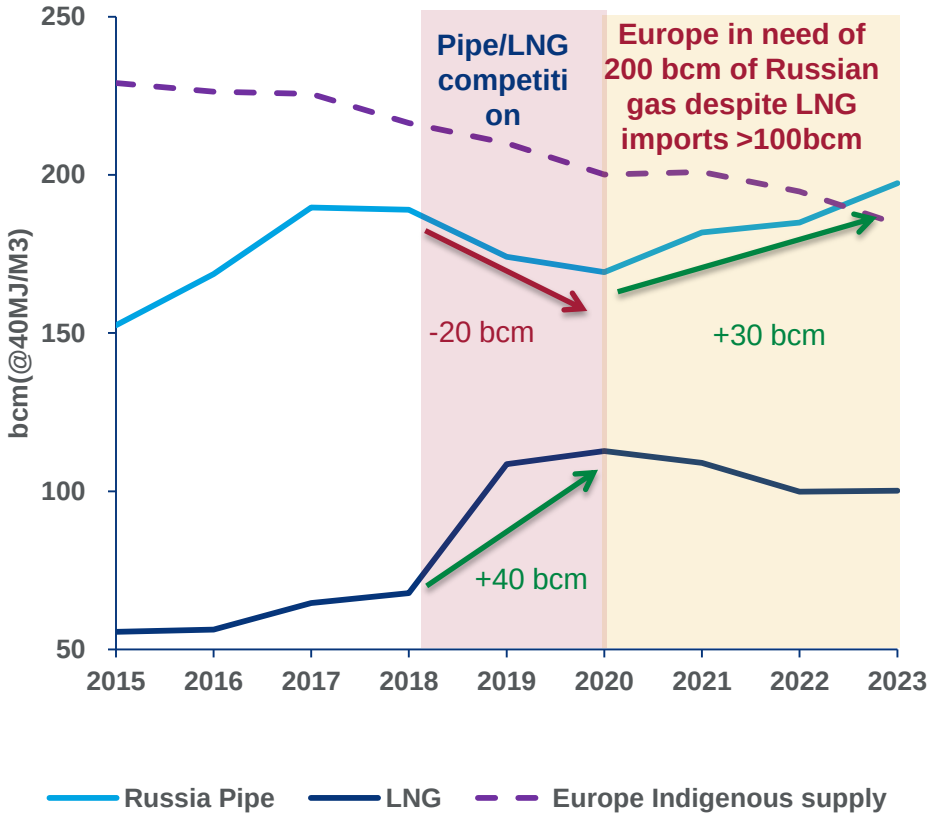


Source: Wood Mackenzie European Energy Service

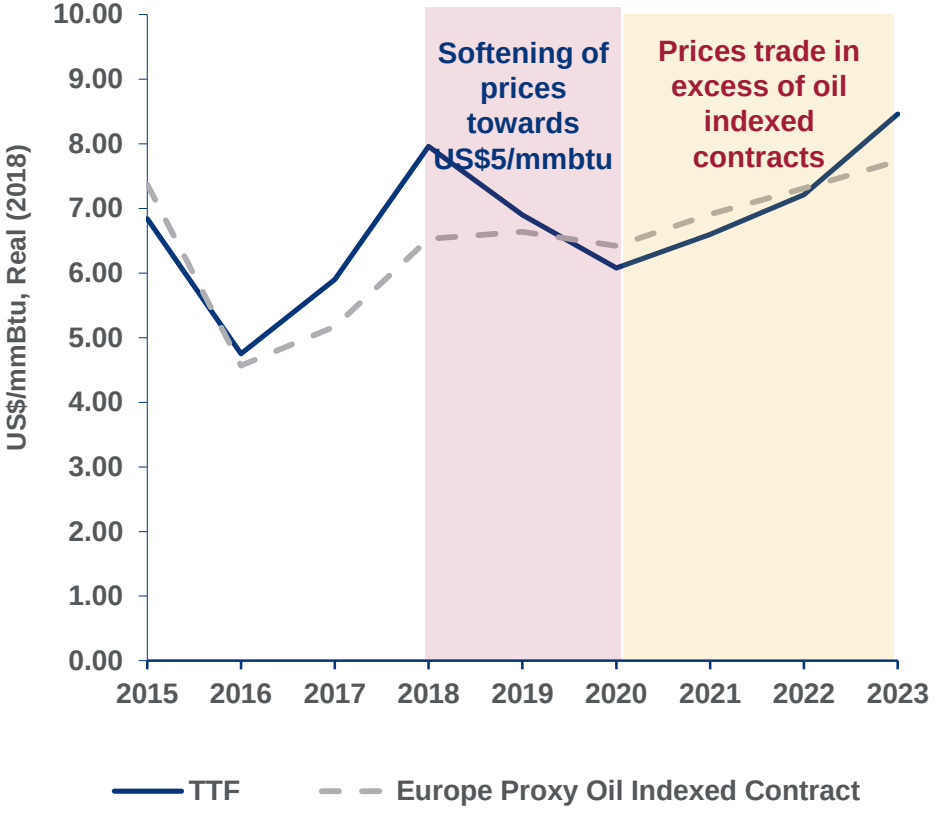
Europe will be a “sink” for the global LNG market in the short-term but it will need to compete post-2020 as the global market tightens

We now see market tightening in 2023, a year earlier than our previous update

Russia pipe and LNG imports into Europe



TTF price



Source: Argus Media, NYMEX, Wood Mackenzie

Source: Wood Mackenzie

2019 is set to be a record year for new LNG project sanctions….

FID taken in 2019 | Expected FID in 2019 | Wildcard FID in 2019 | Targeted FID in 2020

Golden Pass: Announced FID on 05-Feb on 16.0 mmtpa, $10 billion project. Partners expect start up in 2024

ExxonMobil Qatar Petroleum

Woodfibre LNG: Has HoAs for most of the capacity ; needs to finalise EPC costs and SPAs

PACIFIC OIL&GAS

Arctic LNG-2: Busy signing engineering contracts early in 2019. Significant global interest with more partner announcements expected soon

NOVATEK TOTAL

Tortue Phase 2 & 3: Partners pushing to take FID on additional phase(s) in 2020, supported by cost efficiencies from Phase 1

KOSMOS ENERGY bp

Calcasieu Pass: Venture Global has line of sight on FID in 2019 after successful marketing campaign in 2018 and obtaining FERC approval. Financing the final hurdle

VENTURE GLOBAL LNG

NLNG 7: Partners pushing for FID but financing, marketing and country elections could hamper progress

Qatar Megatrains: Partner announcements expected mid 2019 with FID planned for late 2019/early 2020

Qatar Petroleum

Sabine Pass T6: Cheniere state FID is imminent on sixth train (4.5 mmtpa)

CHENIERE

Other North America: Many projects moving through legislative, environmental, marketing and financing milestones. Driftwood, Costa Azul and Freeport Train 4 all targeting FID before end of 2019.

Rovuma LNG (Area 4): Partners announced offtake agreements end of 2018. Targeting FID mid 2019 but requires progress on government approval and clarity on financing to make FID this year

ExxonMobil eni

Mozambique LNG (Area 1): Signed numerous SPAs at the start of 2019 sufficient to secure financing. FID target is H1 2019.

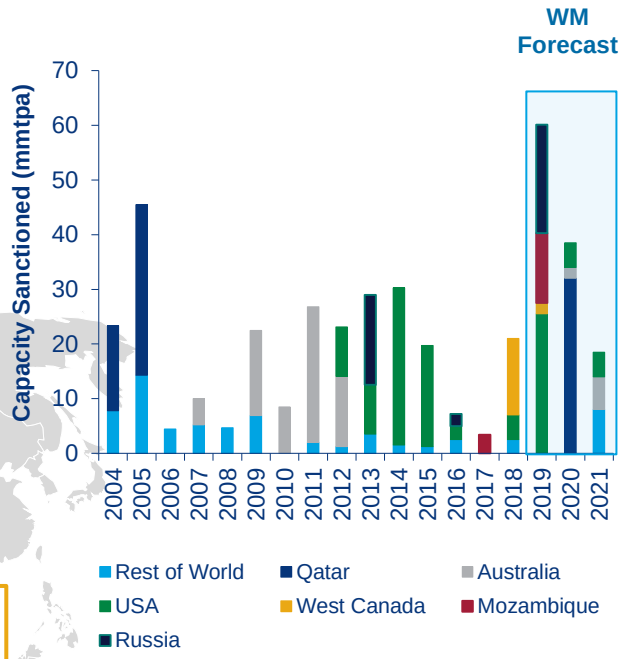
Anadarko Petroleum Corporation

Pluto Expansion: Woodside selected Bechtel as EPC contractor. FID target of H1 2020, but looking to farm down in upstream asset (Scarborough)

woodside

PNG LNG Train 3 / Papua LNG: Partners in both projects signed MOU with government at end of 2018 defining key terms of Gas Agreement. Working on Gas Agreement, engineering and offtake agreements in 2019

ExxonMobil Oil Search TOTAL



Crude Trade Service offers a holistic view of global crude trade

Oil Supply Tool

Global oil supply forecast by grade

Macro Oils

Benchmark crude price forecast

Product Market Service/Refinery Evaluation Model

Refinery investments and crude runs, historical crude slate

Crude price

Crude supply

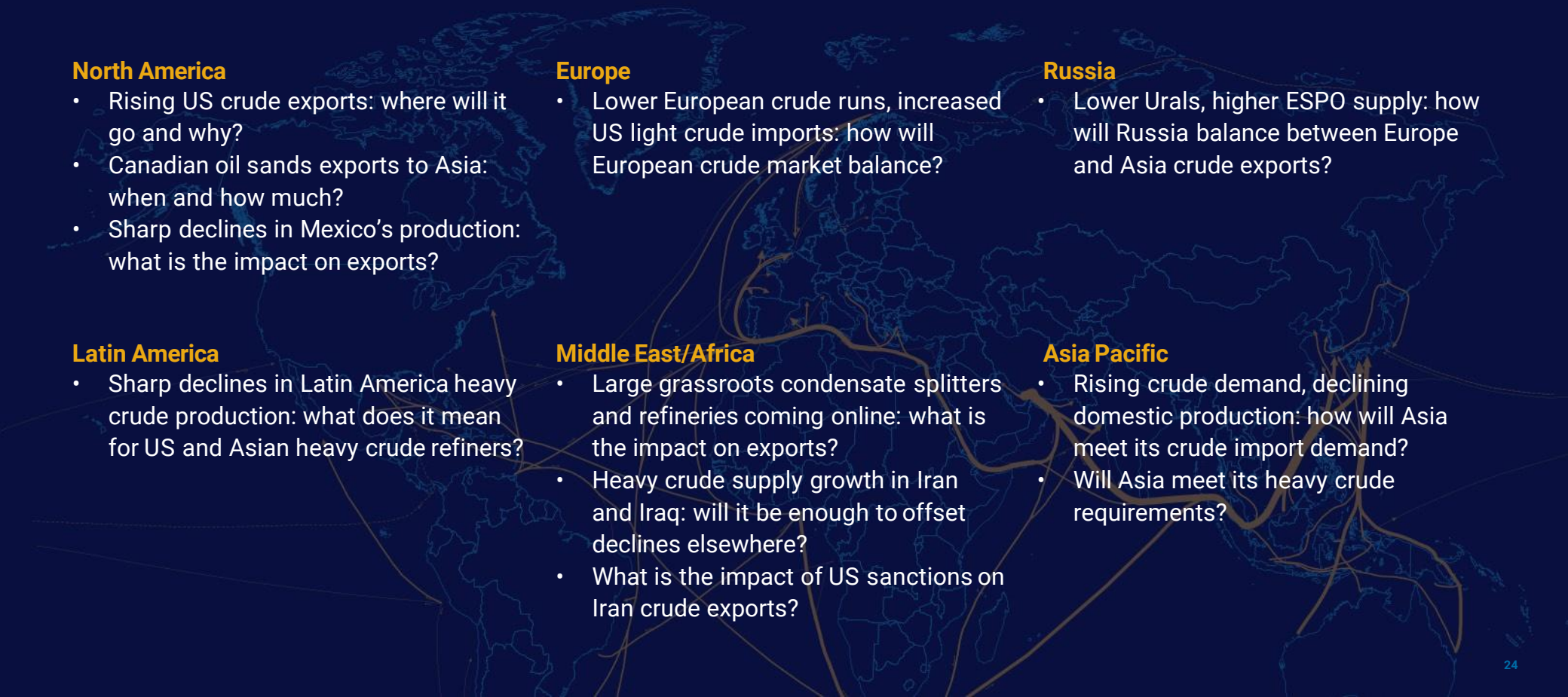
Crude demand

Crude Trade Service

Crude trade flows and crude price differentials by quality

Why will **global crude trade** see significant changes?

Although, growth in US light crude exports is the single biggest reason, there are several other important reasons that will change global crude trade flows



North America

- Rising US crude exports: where will it go and why?
- Canadian oil sands exports to Asia: when and how much?
- Sharp declines in Mexico's production: what is the impact on exports?

Europe

- Lower European crude runs, increased US light crude imports: how will European crude market balance?

Russia

- Lower Urals, higher ESPO supply: how will Russia balance between Europe and Asia crude exports?

Latin America

- Sharp declines in Latin America heavy crude production: what does it mean for US and Asian heavy crude refiners?

Middle East/Africa

- Large grassroots condensate splitters and refineries coming online: what is the impact on exports?
- Heavy crude supply growth in Iran and Iraq: will it be enough to offset declines elsewhere?
- What is the impact of US sanctions on Iran crude exports?

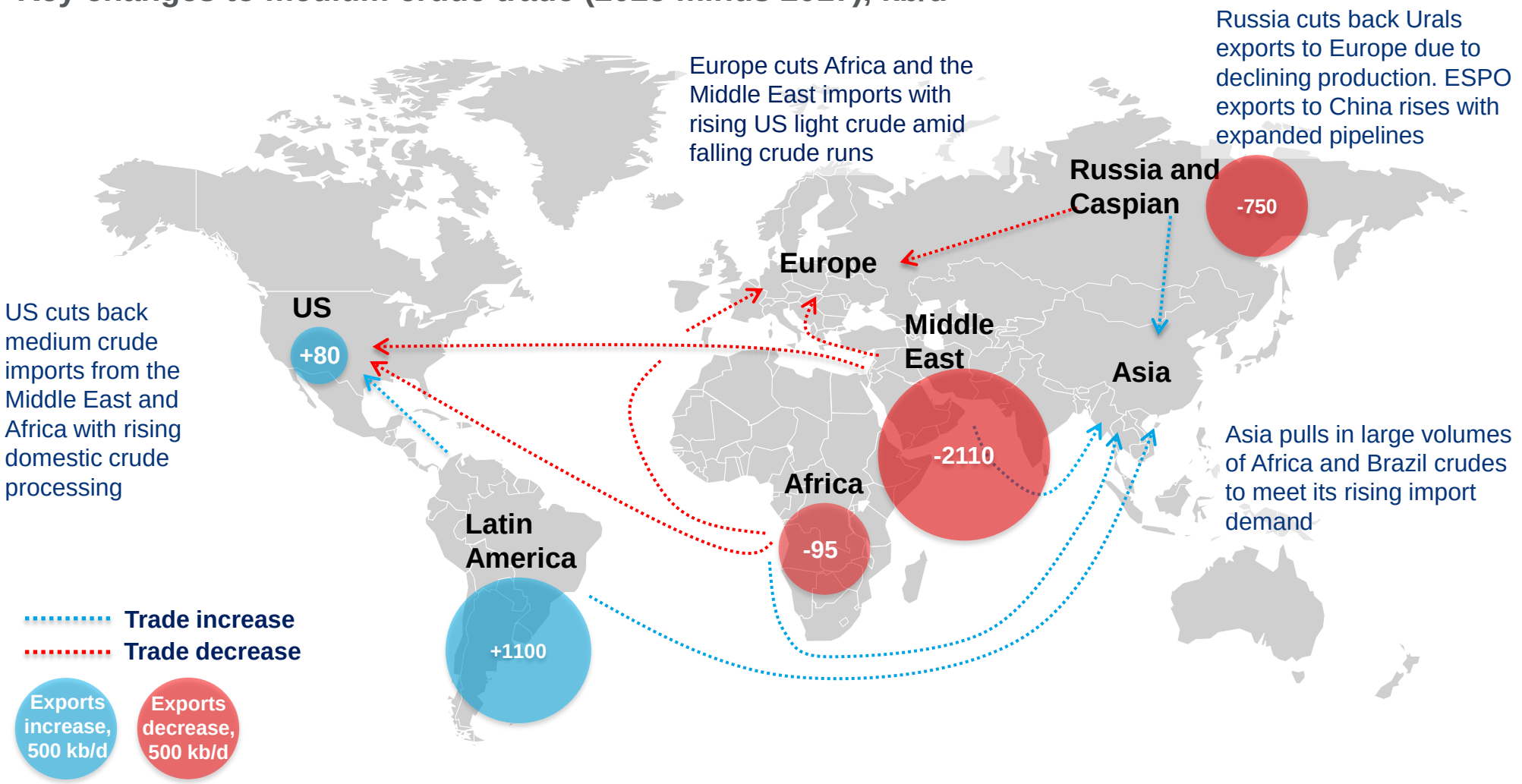
Asia Pacific

- Rising crude demand, declining domestic production: how will Asia meet its crude import demand?
- Will Asia meet its heavy crude requirements?

Medium crude trade changes due to competition from US grades

US and Europe cut back Africa and Middle East imports. Asia pulls in these barrels to meet rising crude demand

Key changes to medium crude trade (2025 minus 2017), kb/d



Exports = domestic supply – domestic demand

Source: Wood Mackenzie

Crude Trade Service deliverables

Excel data and PowerPoint updated six-monthly

Global crude supply (2016 to 2025 – annual)

- By country/region
- By quality (Condensates/Light/Medium/Heavy)

Crude oil demand for refining (2016 to 2025 – annual)

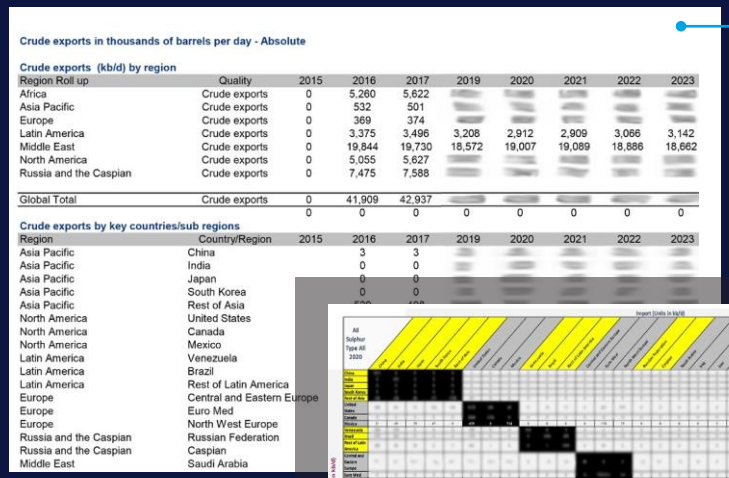
- Refinery investments
- Crude capacity
- Crude intake by region/country
- Crude intake by quality
- Crude imports/exports/domestic

Trade flows matrices (2016 to 2025 – annual)

- Condensates/Light/Medium/Heavy

Crude price forecasts for 90+ benchmark and key crude grades

PowerPoint slides to explain the key messages



Crude exports in thousands of barrels per day - Absolute

Crude exports (kb/d) by region

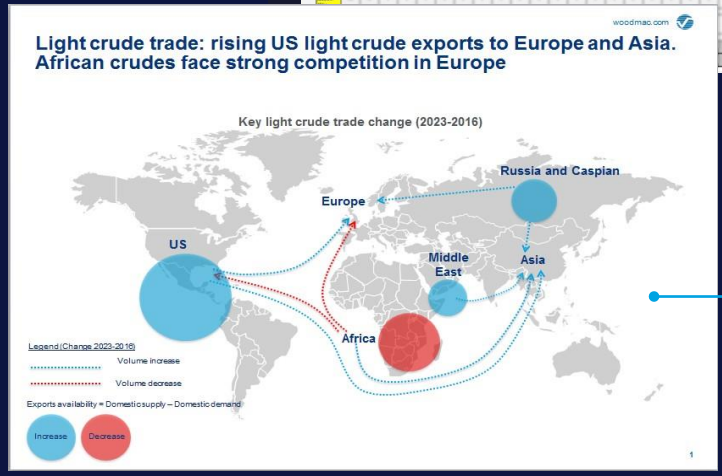
Region Roll up	Quality	2015	2016	2017	2019	2020	2021	2022	2023
Africa	Crude exports	0	5,260	5,622					
Asia Pacific	Crude exports	0	532	501					
Europe	Crude exports	0	369	374					
Latin America	Crude exports	0	3,375	3,496	3,208	2,912	2,909	3,066	3,142
Middle East	Crude exports	0	19,844	19,730	18,572	19,007	19,089	18,886	18,662
North America	Crude exports	0	5,055	5,627					
Russia and the Caspian	Crude exports	0	7,475	7,588					
Global Total	Crude exports	0	41,909	42,937					
		0	0	0	0	0	0	0	0

Crude exports by key countries/sub regions

Region	Country/Region	2015	2016	2017	2019	2020	2021	2022	2023
Asia Pacific	China		3	3					
Asia Pacific	India		0	0					
Asia Pacific	Japan		0	0					
Asia Pacific	South Korea		0	0					
Asia Pacific	Rest of Asia								
North America	United States								
North America	Canada								
North America	Mexico								
Latin America	Venezuela								
Latin America	Brazil								
Latin America	Rest of Latin America								
Europe	Central and Eastern Europe								
Europe	Euro Med								
Europe	North West Europe								
Russia and the Caspian	Russian Federation								
Russia and the Caspian	Caspian								
Middle East	Saudi Arabia								

Data tables

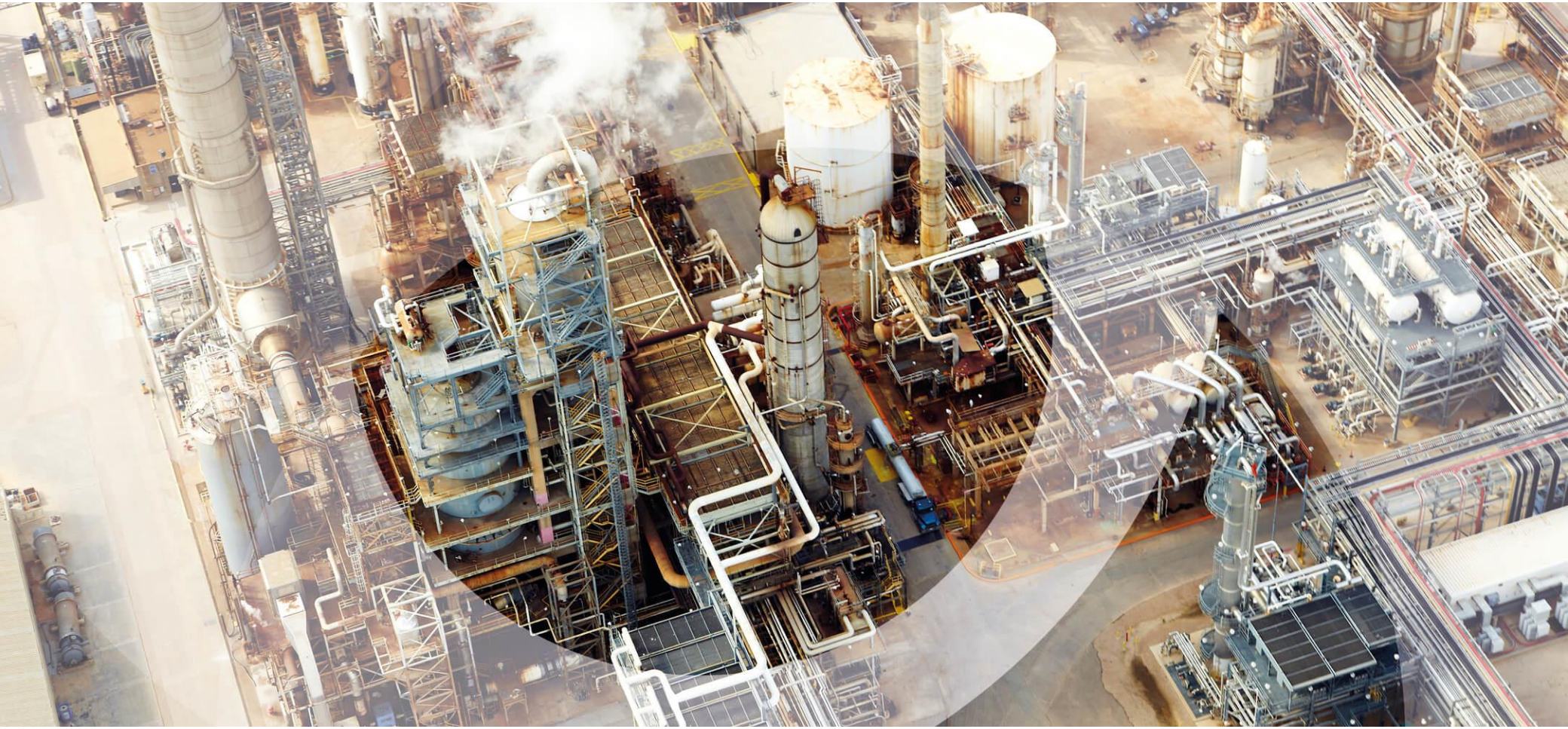
Trade flows matrices



PowerPoint slides

Global Refining Outlook

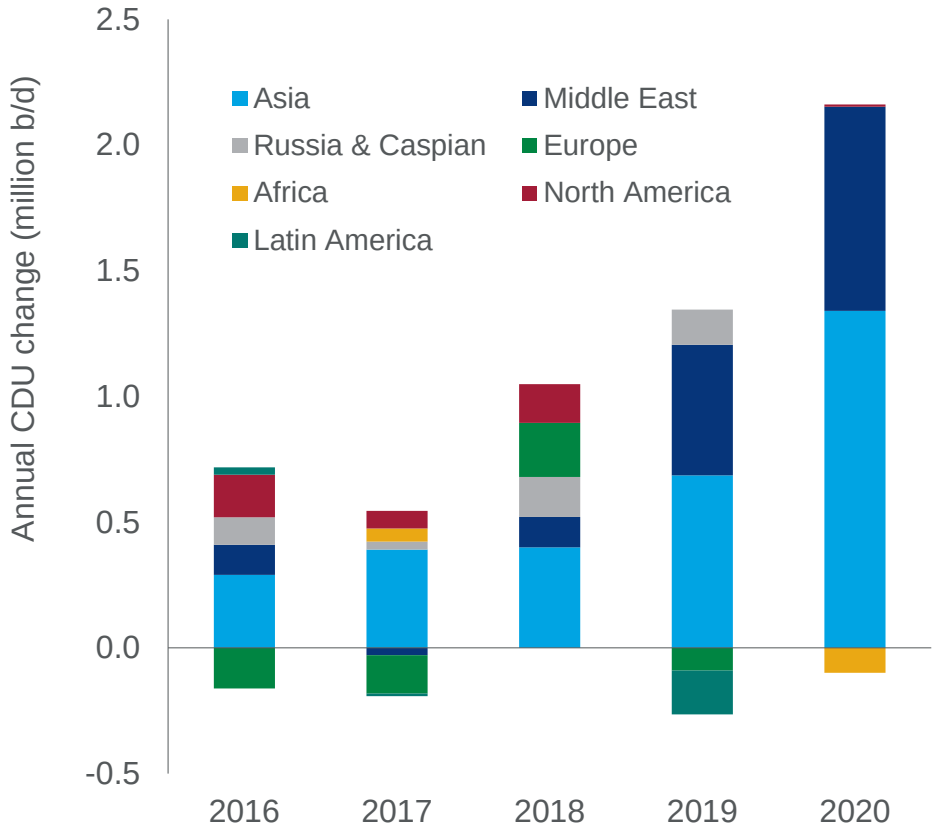
Moscow, 9th April 2019



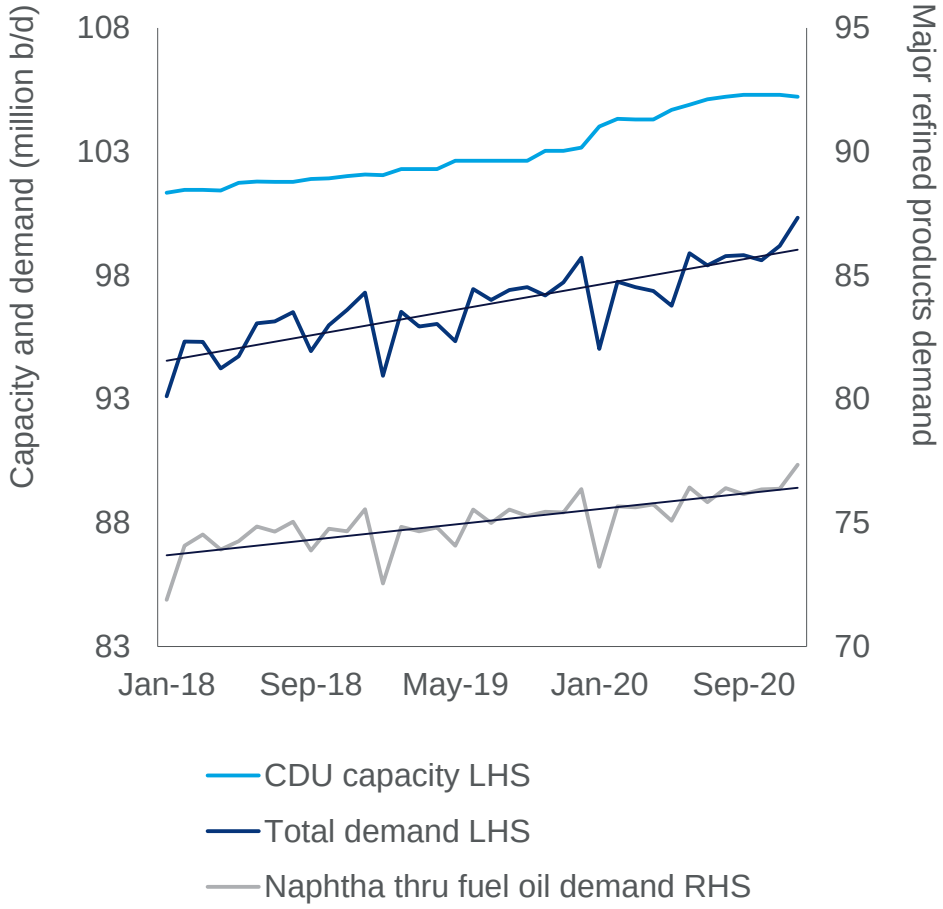
Refinery capacity additions accelerate in 2019 and 2020, with 2020 capacity additions outpacing oil demand growth

Spare capacity increases in 2020 but IMO distillate demand growth limits the downside for utilisation

Global CDU capacity changes



Refining capacity and products demand

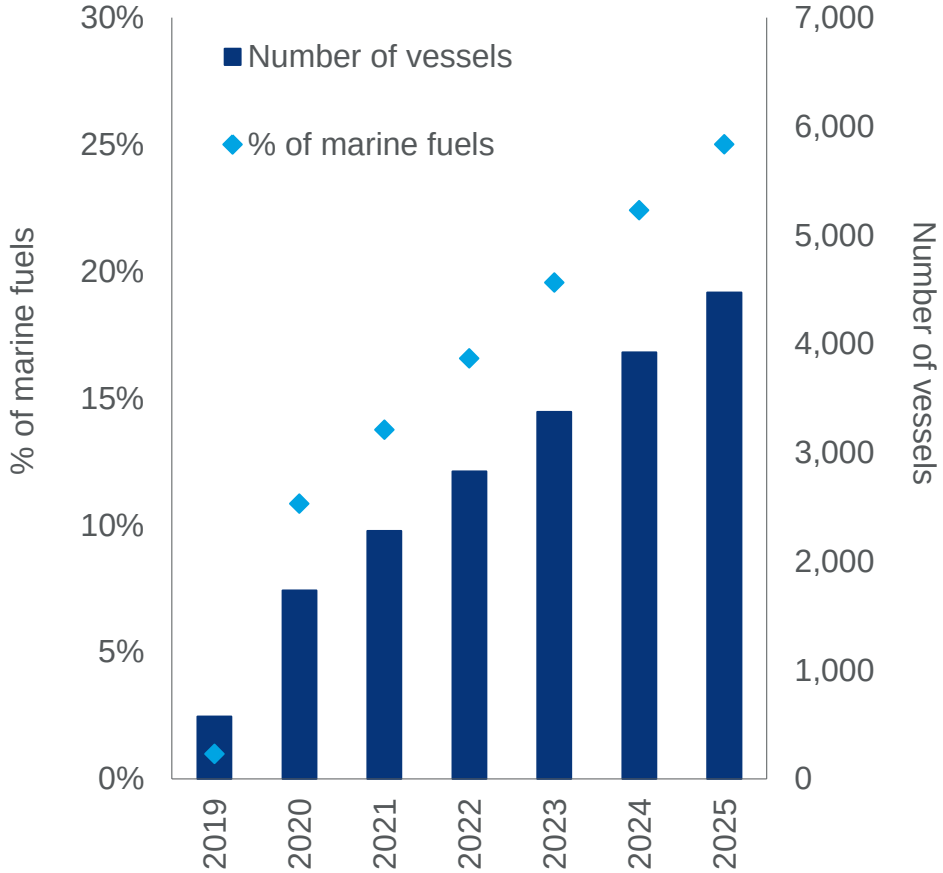


Source: Wood Mackenzie

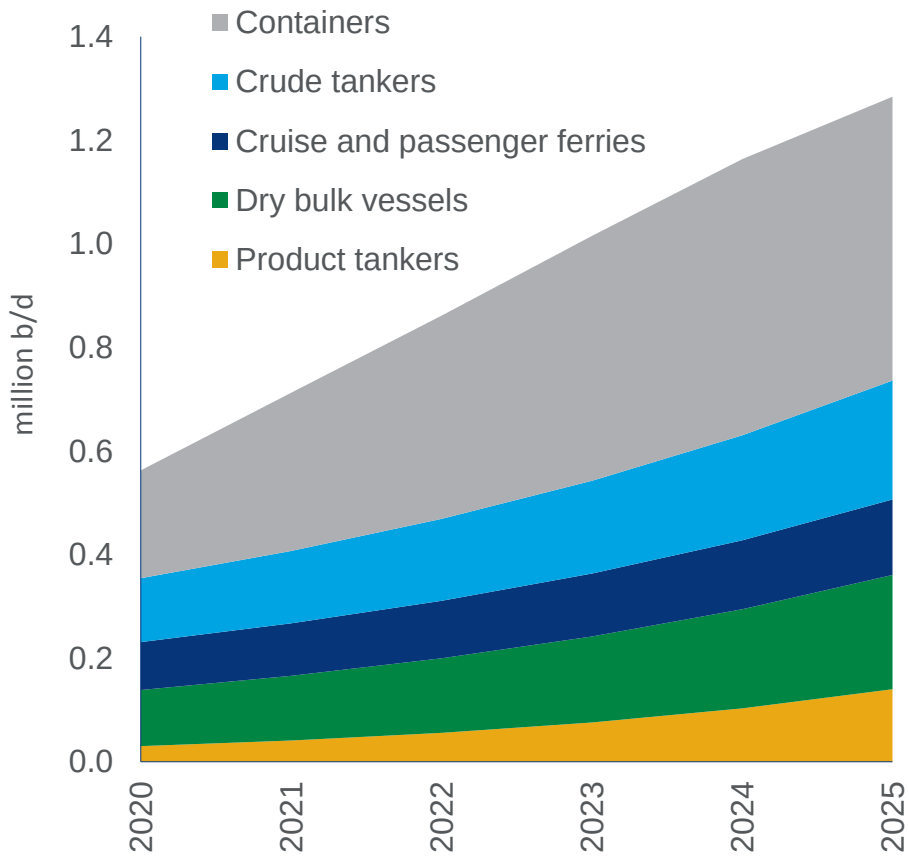
IMO is getting closer - there are now over 2,000 confirmed orders for scrubbers as the uptake from shippers starts to accelerate

The volume of scrubbed HSFO is expected to grow steadily after 2020, rising to around 1.3 million b/d by 2025

Outlook for scrubber installations



Scrubbed HSFO outlook by vessel type

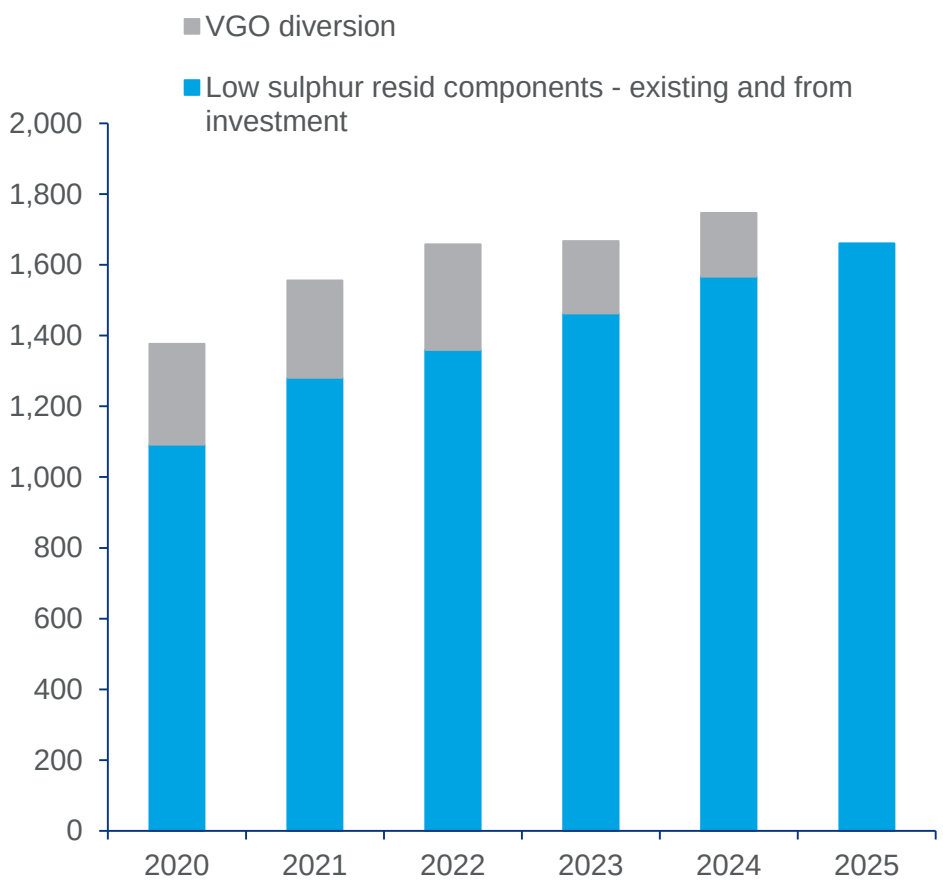


Source: Wood Mackenzie Product Markets Service

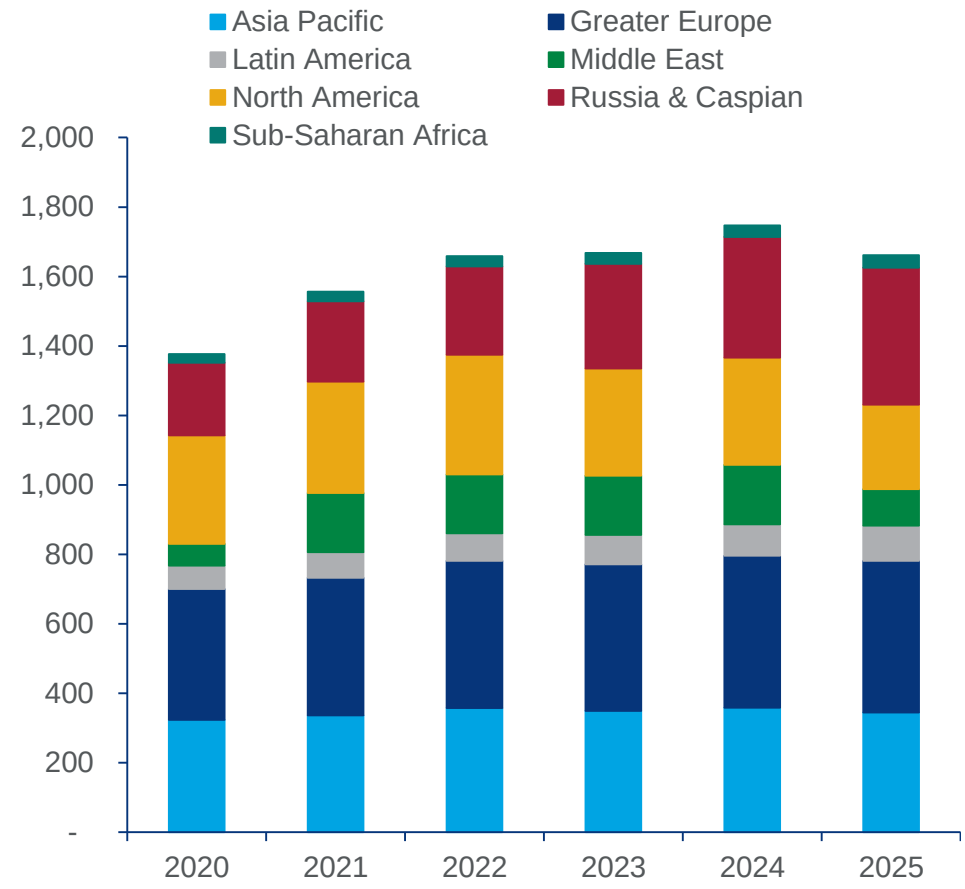
Improving crude and stream segregation at refineries, combined with VGO blending, should support increasing VLSFO production

VLSFO supply reaches 1.7 million b/d by 2024

Global VLSFO supply forecast, kb/d



Global VLSFO supply forecast by region, kb/d

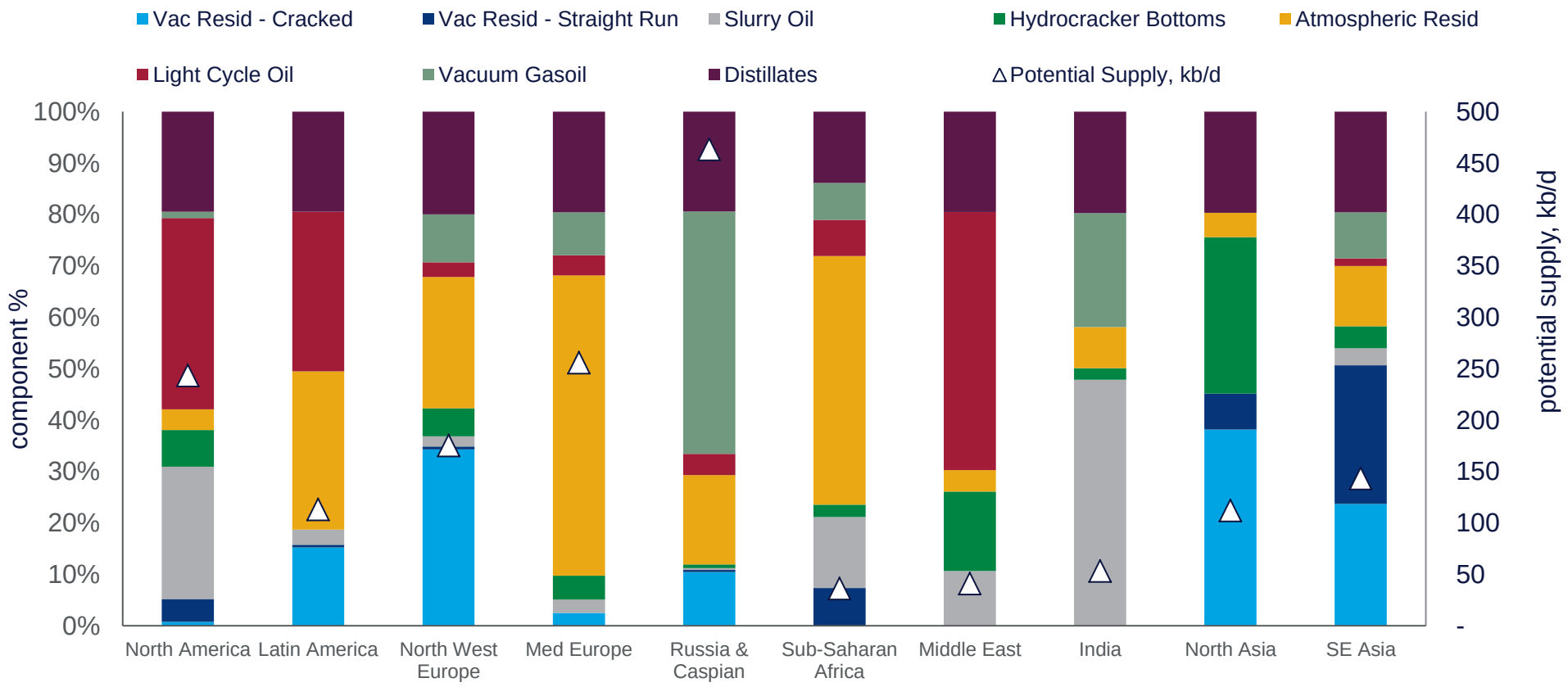


Source: Wood Mackenzie

VLSFO component availability varies by region

This may present shippers with fuel compatibility challenges when refuelling in different regions

Regional VLSFO component "blends"*

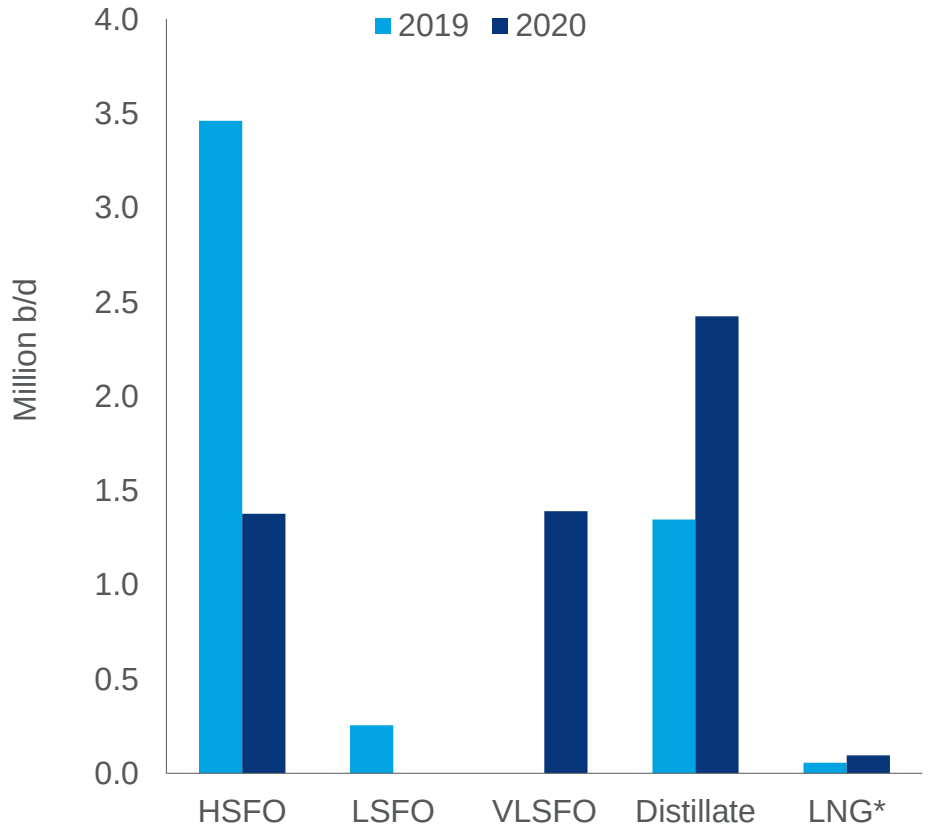


Source: Wood Mackenzie Refinery Evaluation Model/PetroPlan
*availability of components from refineries deemed likely to supply to the marine fuels market. Based on 2017 output

Refiners cannot make enough VLSFO to meet demand so gasoil will have to make up the gap of low S fuels

There are some concerns about quality but we assume most shippers will buy the cheapest compliant fuel while refiners will look to get best value for their residues

Global marine bunker demand by fuel



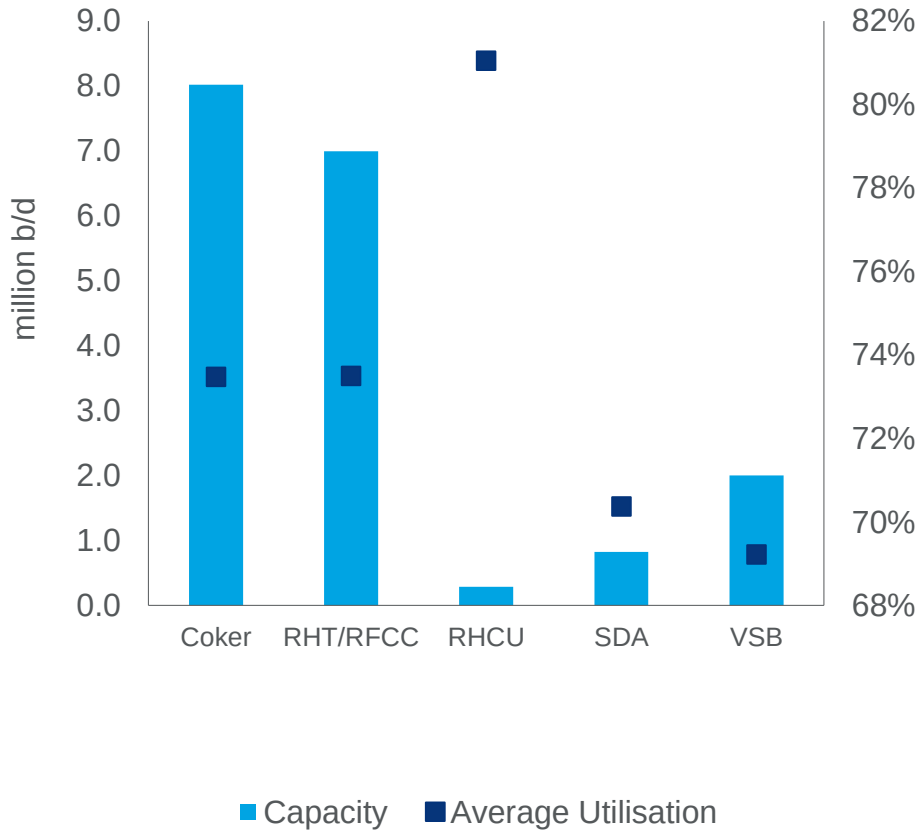
- Nearly 2.1 million b/d of HSFO is displaced by low sulphur fuels in 2020
- MGO sales rise by nearly 1.1 million b/d in 2020
- VLSFO displaces the remaining LSFO market by 2020, as well as a sizable amount of HSFO, amounting to total sales of ~1.4 million b/d in 2020
- LNG use rises by over 70% between 2019 and 2020, but this only displaces a further 40 kb/d of marine fuels, as LNG bunker infrastructure is still in its infancy

Source: Wood Mackenzie

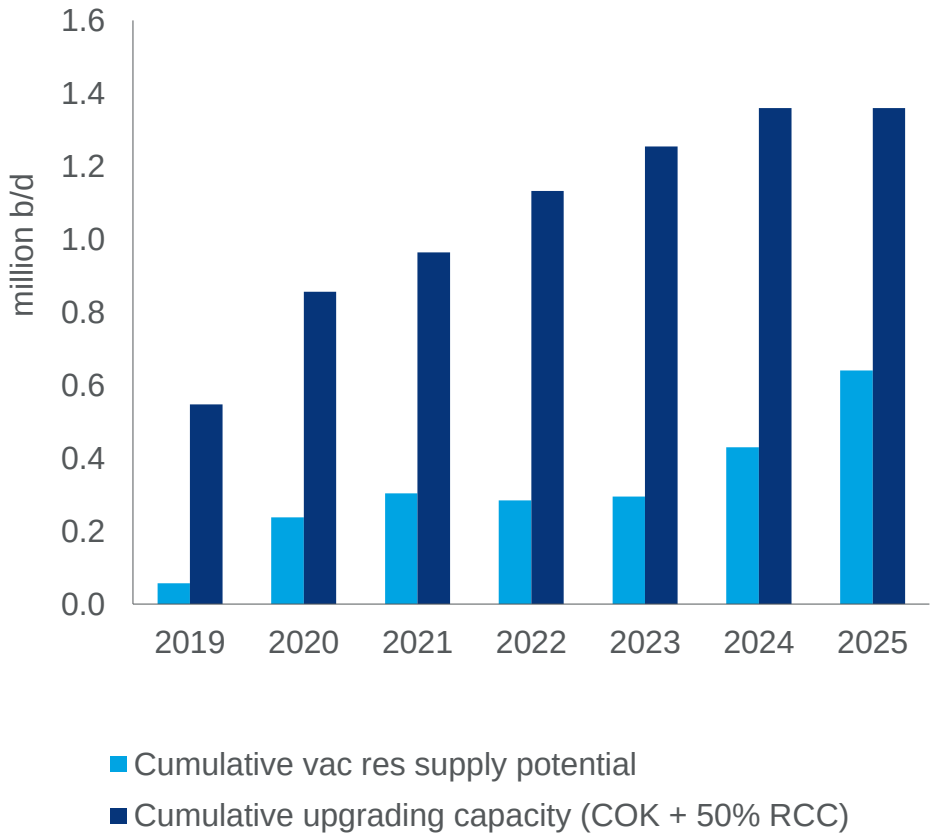
There is spare capacity in upgrading units to process additional volumes of feedstock

And refiners are investing in more resid upgrading capacity

Global resid upgrading unit capacity and average utilisation, 2017



Global supply of vac res from crude production versus capacity to upgrade it

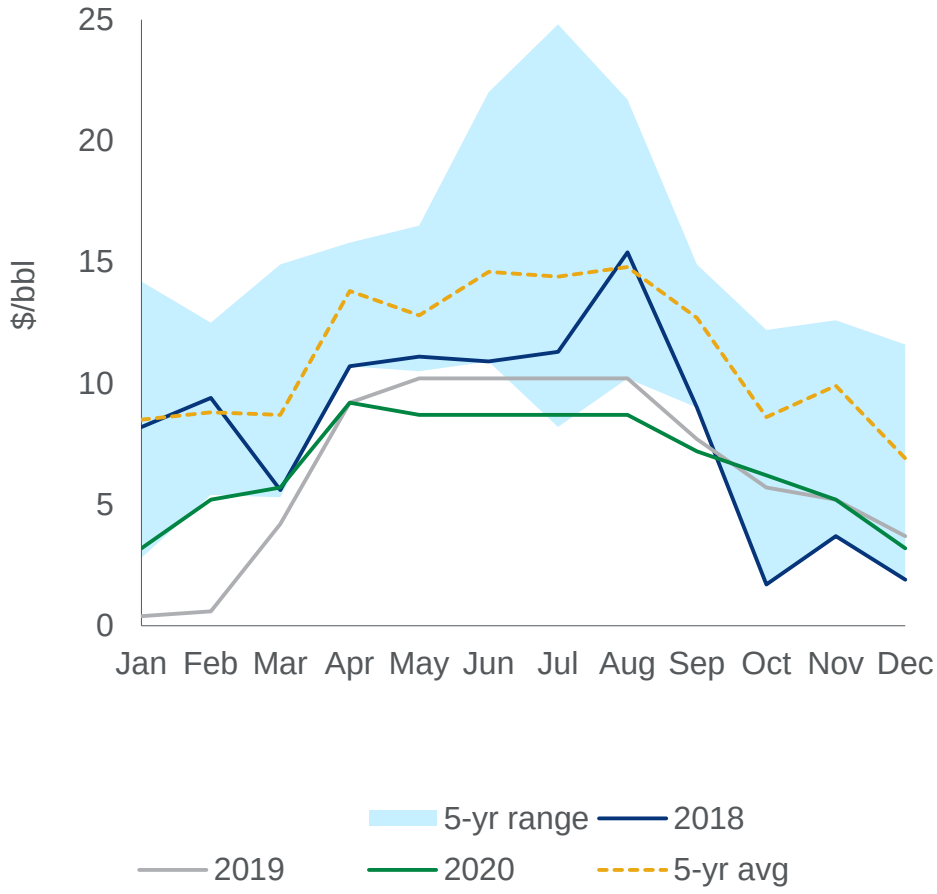


* in refineries with CDU capacity above 50 kb/d
Source: Wood Mackenzie

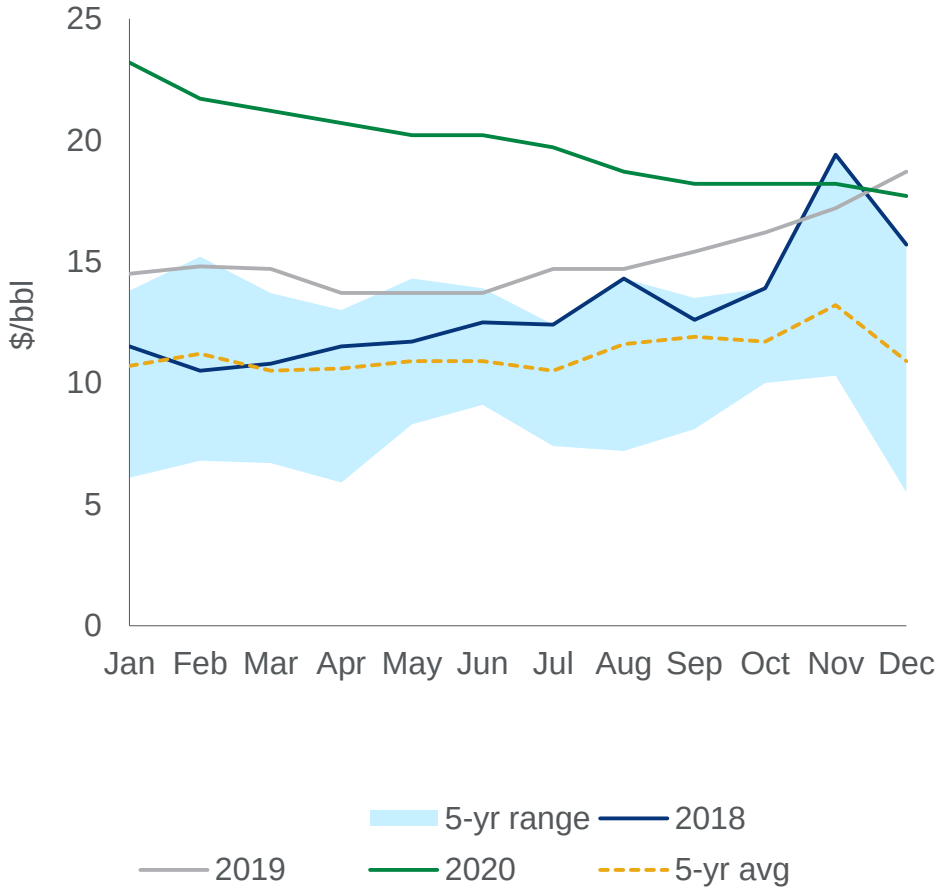
Gasoline cracks remain under pressure in 2019 but there is a new floor in 2020

Gasoil cracks to get a boost in Q4 2019 and average $20/bbl in 2020

NWE gasoline crack vs Brent



NWE gasoil 0.1%S crack vs Brent

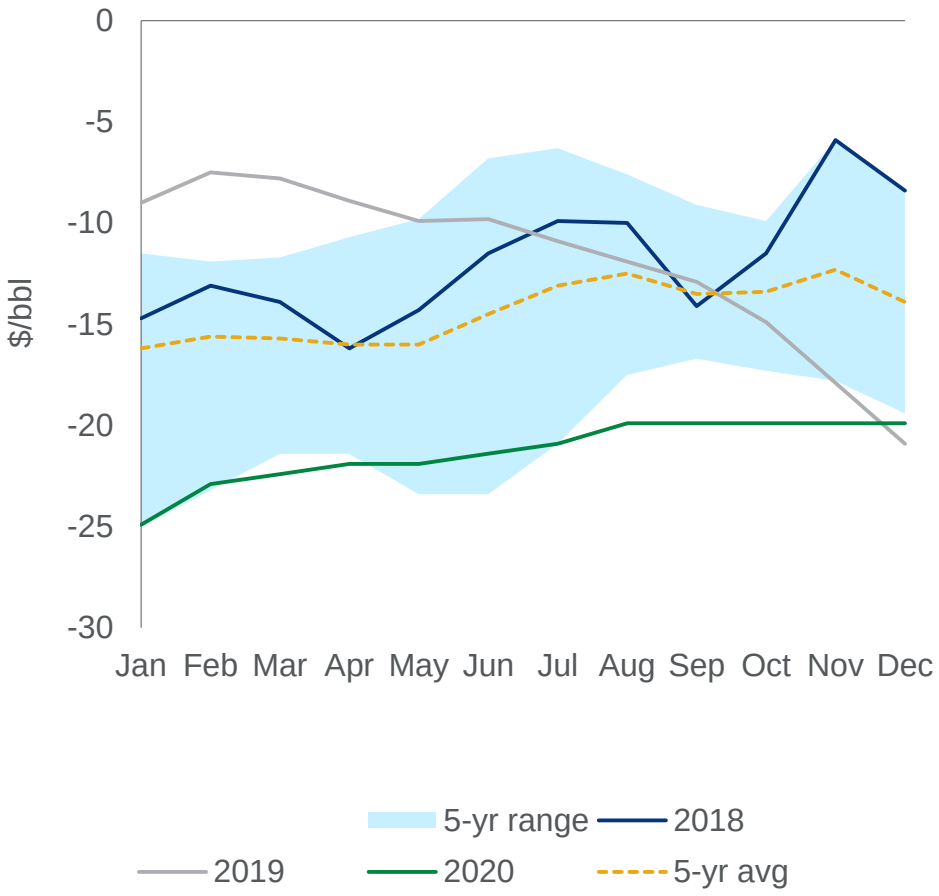


Source: History Argus, Forecast Wood Mackenzie

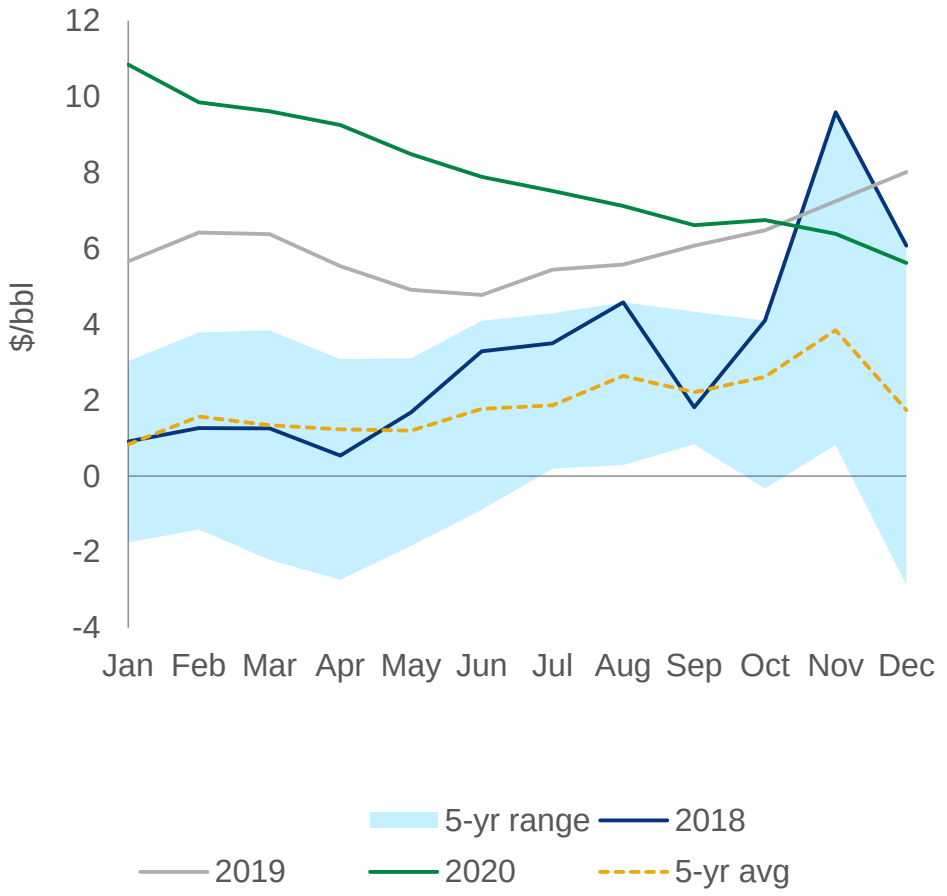
HSFO has to lose its recent strength as demand collapses

VLSFO price is midway between diesel and LSFO and so could price higher than shown

NWE HSFO 3.5%S crack vs Brent



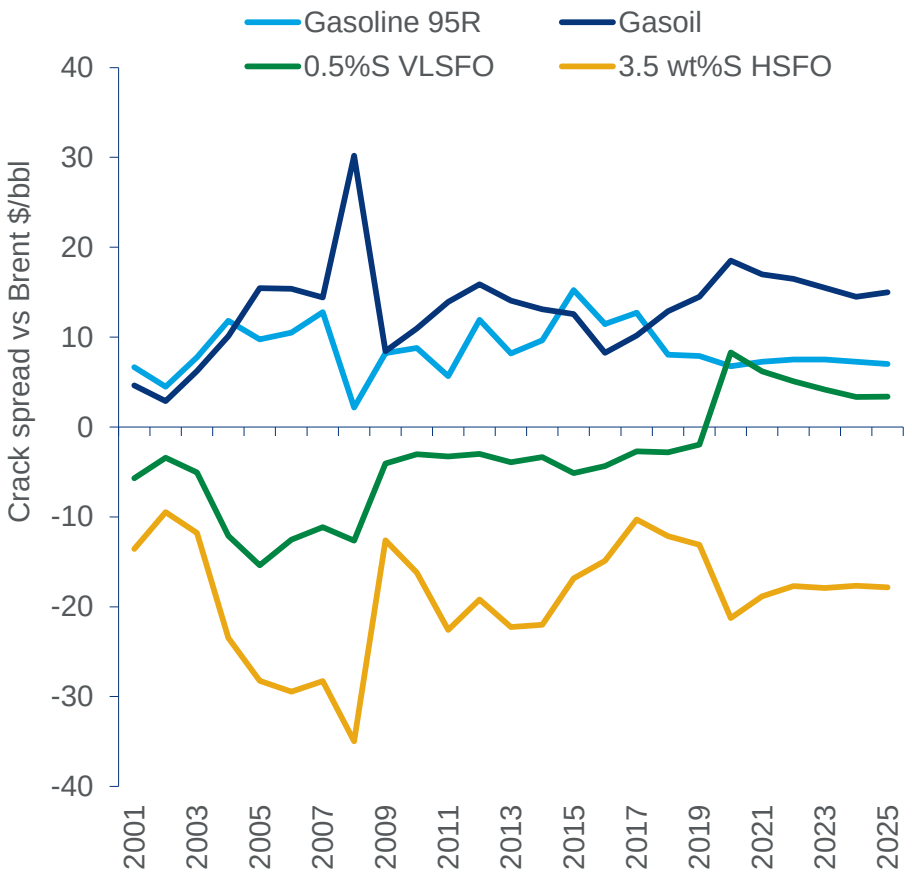
NWE VLSFO 0.5%S crack vs Brent



Source: History Argus, Forecast Wood Mackenzie

Increased use of distillate bunker fuel will support gasoil crack spreads over the medium term

Product crack spread profile, 2001-2025

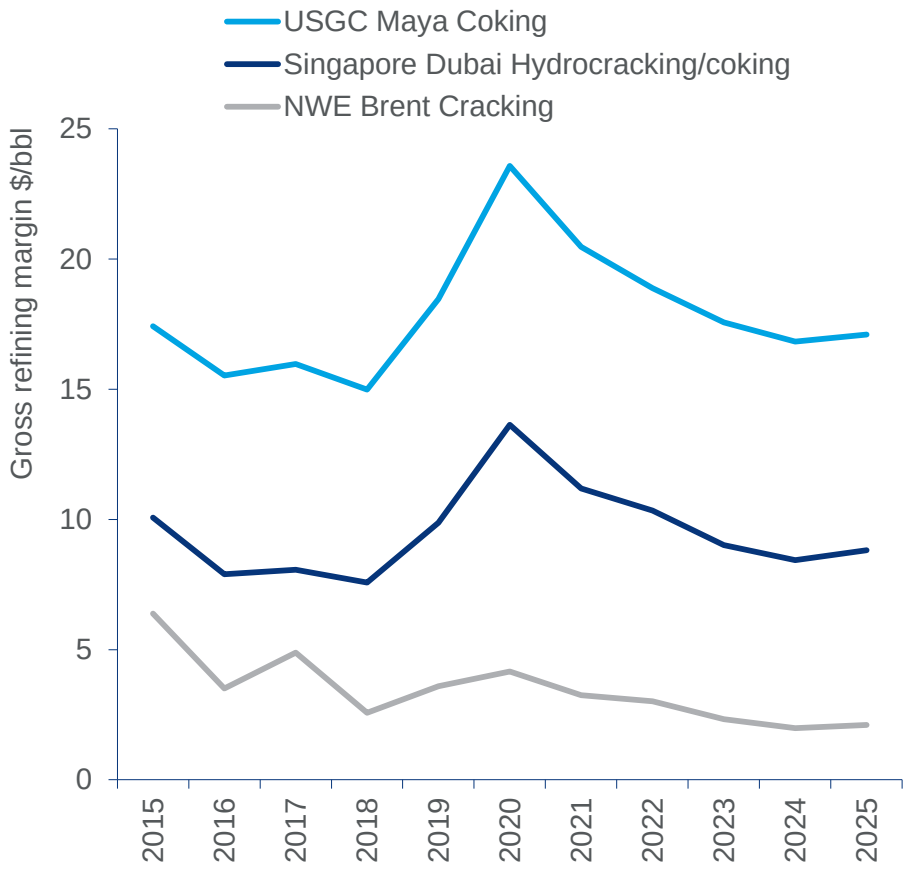


- Refineries will have to increase crude throughputs in order to produce sufficient distillate fuel for the bunker sector
- There is limited flexibility for refiners to shift yields between products meaning that there will be excess production of other products
- Gasoline crack spreads are expected to weaken in 2020 as production increases beyond demand.
- The reduction in demand for HSFO means that it will need to price lower relative to crude to encourage increased upgrading and to compete in other markets
- As HSFO cracks get much weaker in 2020, gasoil cracks have to strengthen in order to provide a strong enough margin for refiners to increase runs and meet the extra demand for gasoil
- VLSFO pricing methodology is assessed as the floor price to make the assumed VLSFO volumes available.
- LSFO crack spreads are likely to get some support from demand for blending into VLSFO

Source: Product Markets Service

The biggest windfall in 2020 is for deep conversion refineries with a distillate orientation

Gross refinery margins for selected reference assets

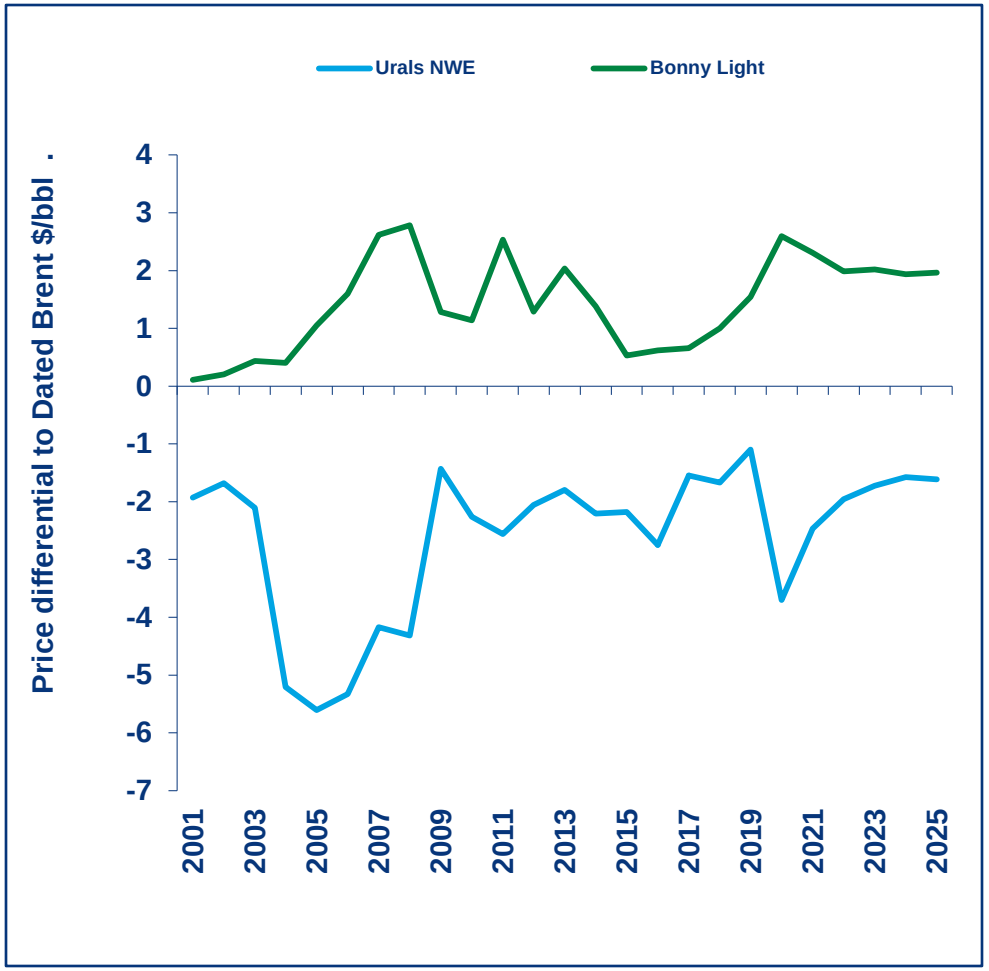


- Stronger crack spreads for middle distillates and weaker HSFO cracks will result in a steep increase in margins for complex refiners
- Coking refineries will see the biggest advantage as they will be able to process widely discounted crudes while not producing loss-making fuel oil
- Refineries based on the US Gulf Coast are particularly advantaged, due to their residue import capabilities
- There is an incentive for refiners with high naphtha/gasoline/fuel oil yields to maximise the switch to distillates
- The impact is much more muted for more simple FCC refineries focused on producing gasoline, and a sizeable proportion of fuel oil
- The overall increase in margins in 2020 should be sufficient to incentivise refiners to increase crude throughputs enough to meet the extra distillate demand

Source: Wood Mackenzie Product Markets Service

Heavier sour crudes will fall in value relative to lighter sweeter crudes and the relative value of very sweet crudes will rise

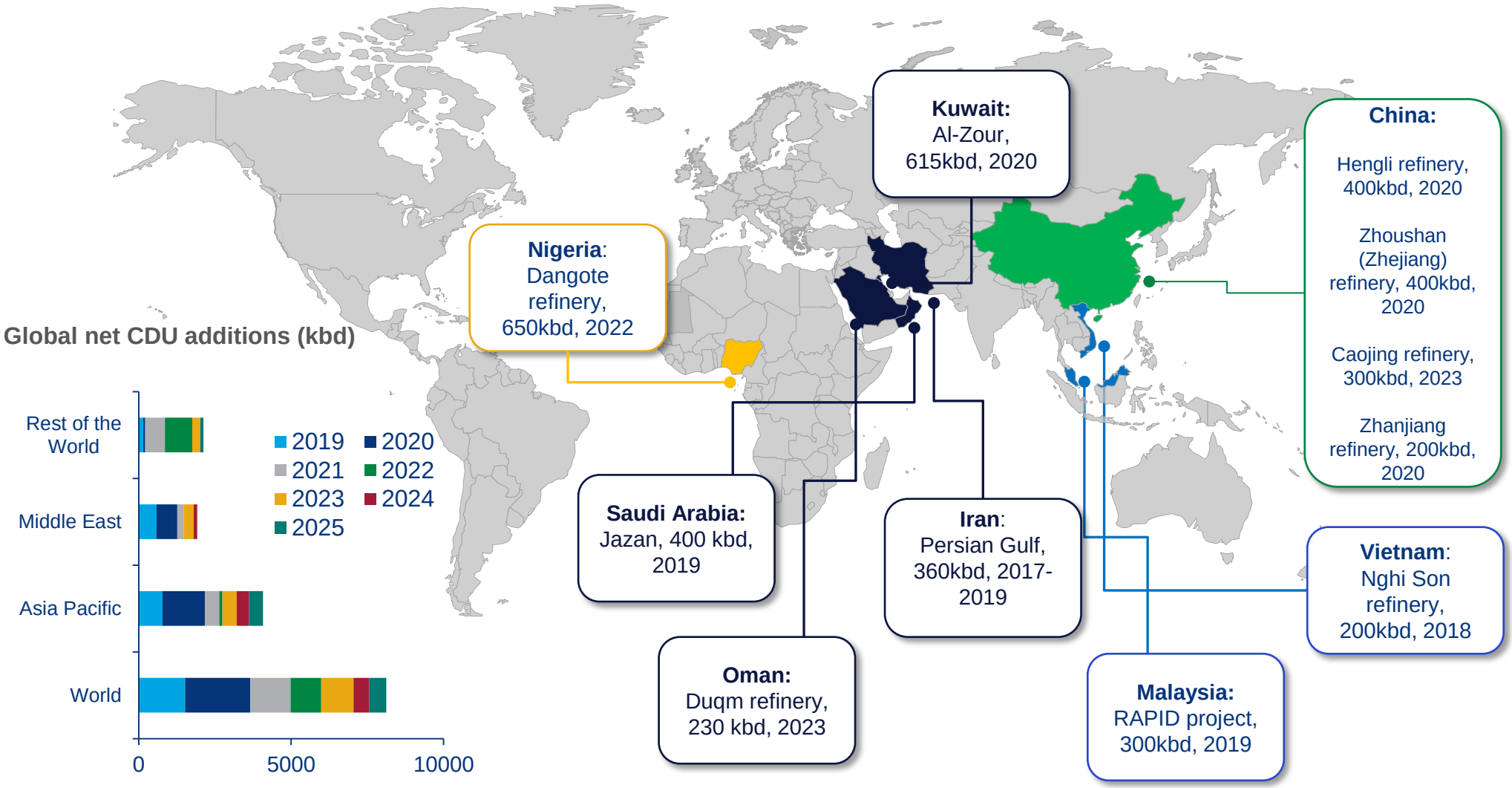
Crude differentials to Brent, 2015-2025



- Crack spreads for middle distillates are expected to strengthen while high sulphur fuel oil cracks are forecast to weaken
- As a result, refiners will make more profit from crudes with high middle distillate yields and the value of these crudes is expected to strengthen relative to crudes with a high gasoline yield
- A weaker HSFO crack would result in heavier sour crudes becoming less attractive to refiners and falling in value relative to light sweet crudes
- Less complex refiners, in particular, will seek out light sweet crudes in order to reduce their HSFO yields and maximise middle distillate output
- More complex refiners, with coking and hydrocracking facilities, will enjoy wide discounts for their target crudes
- Medium/heavy sweet crudes could be in strong demand to produce VLSFO

Source: Wood Mackenzie Product Markets Service

China, the Middle East and other developing Asia to build more than 70% of the new grassroots capacity additions by 2025

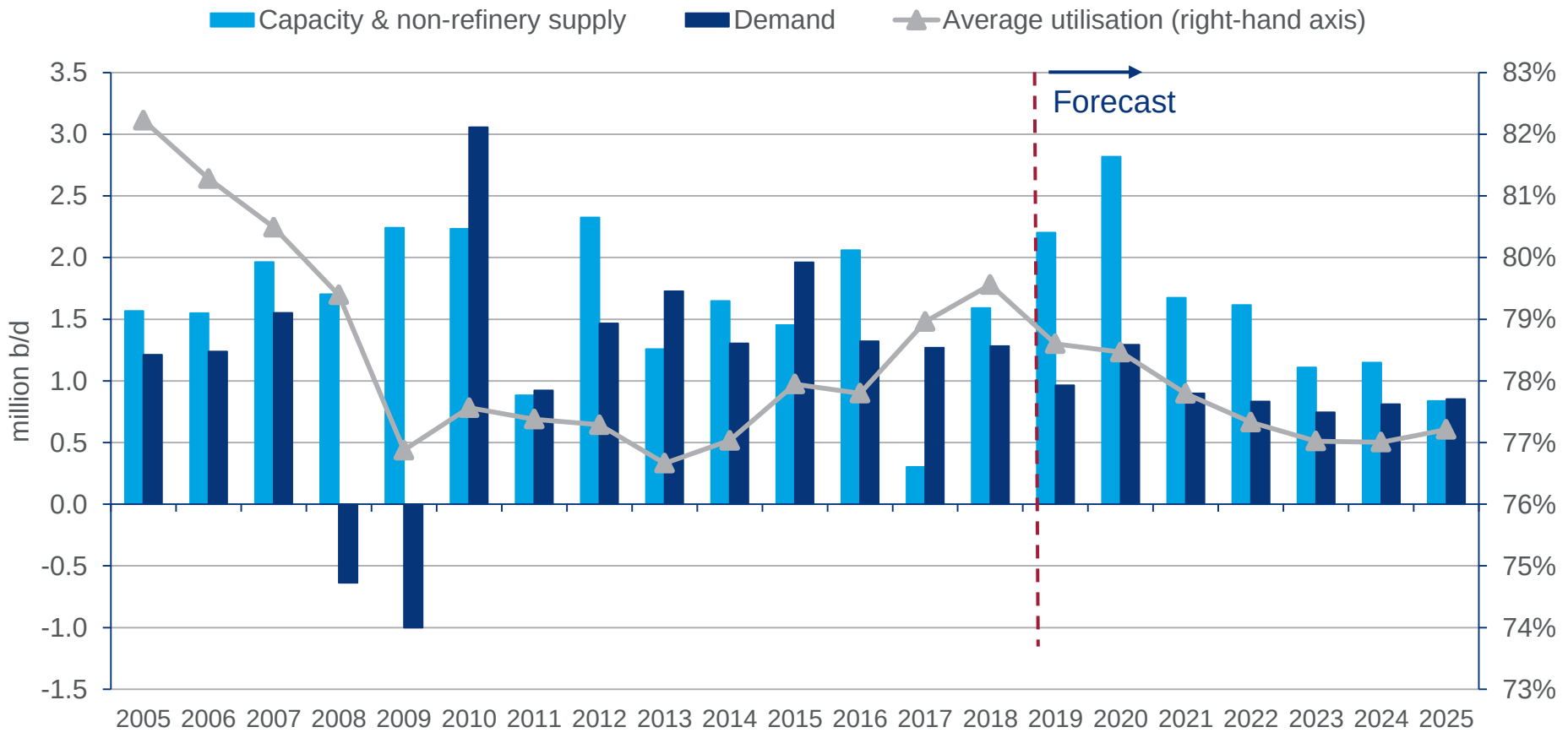


Source: Wood Mackenzie – *Product Markets Long Term Outlook*

Global refining capacity additions start to outpace global demand growth

Average global utilisation is forecast to fall

Global refining capacity versus demand

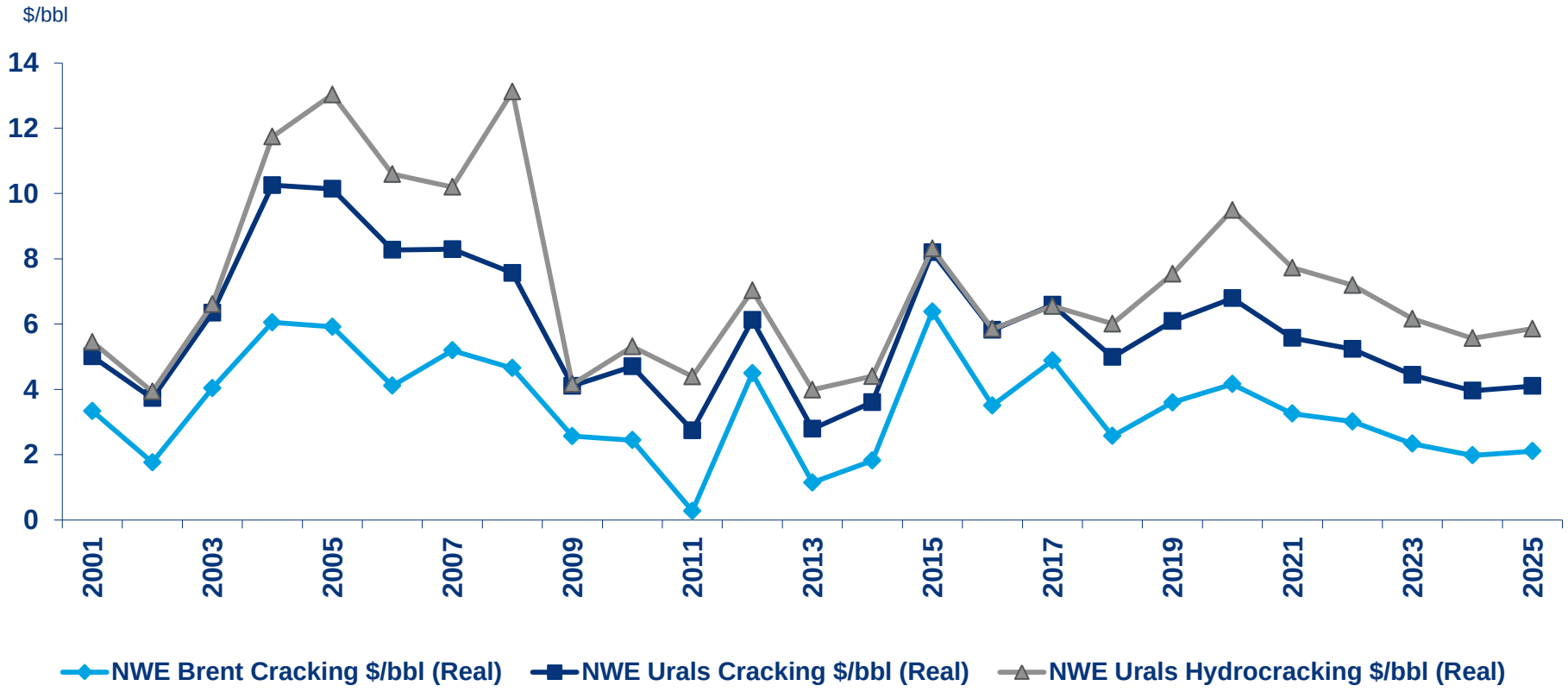


Source: Wood Mackenzie

Refining margins are forecast to fall from 2020, particularly in Europe

Margins return to closure threat levels by 2024

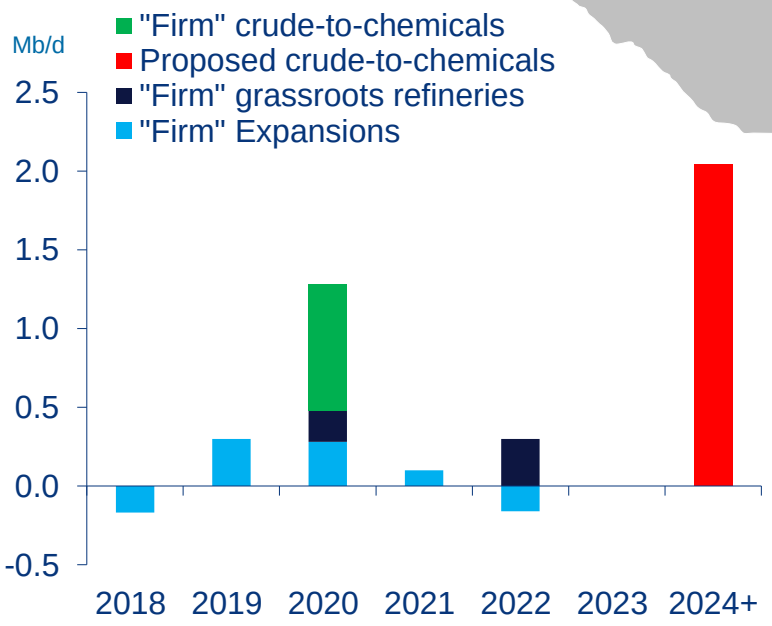
NWE reference gross refining margins (US$/bbl)

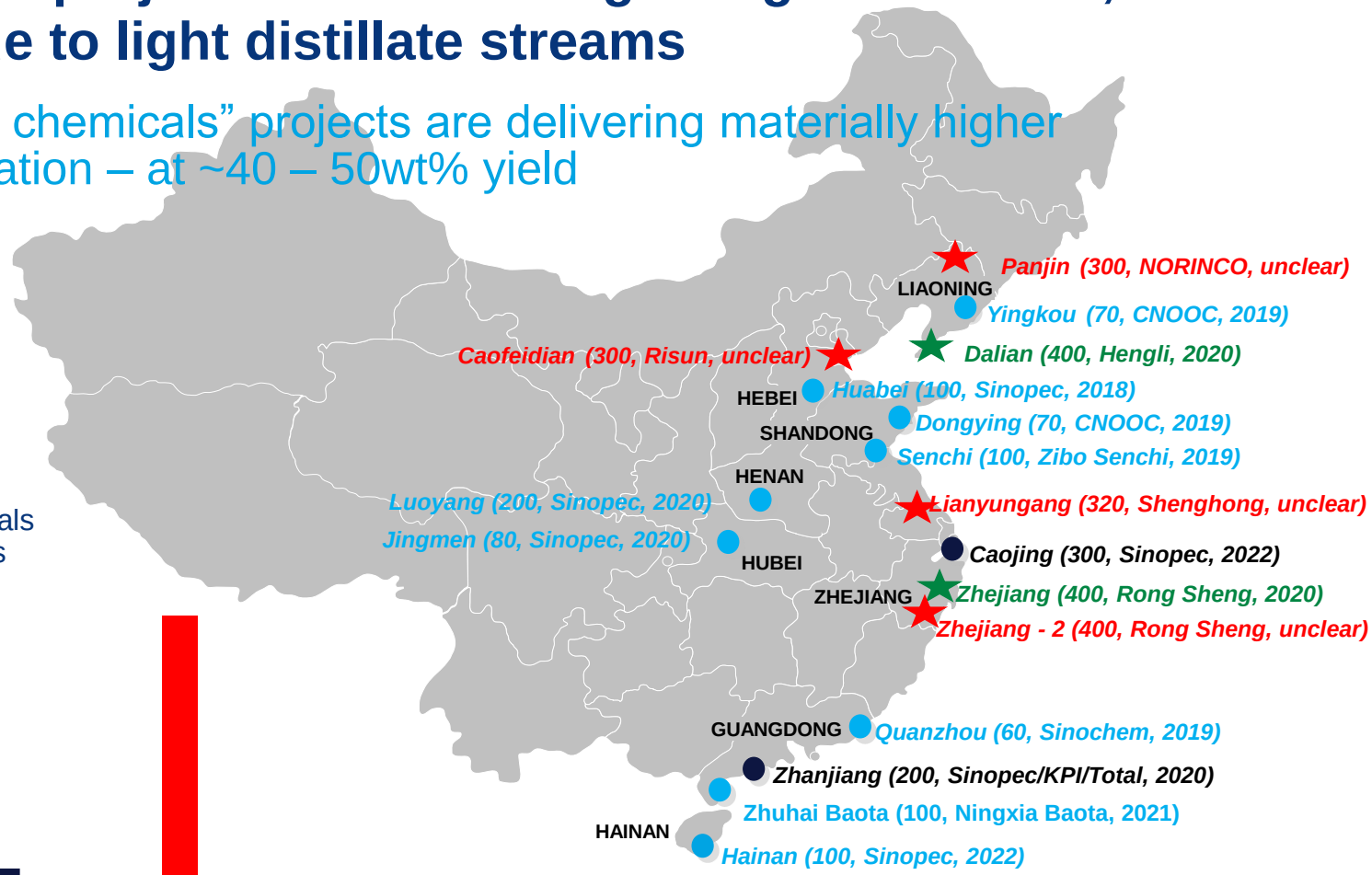


Source: Wood Mackenzie

Crude-to-chemicals projects in China are gaining momentum, as a means to add value to light distillate streams

China's new "crude to chemicals" projects are delivering materially higher petrochemicals integration – at ~40 – 50wt% yield





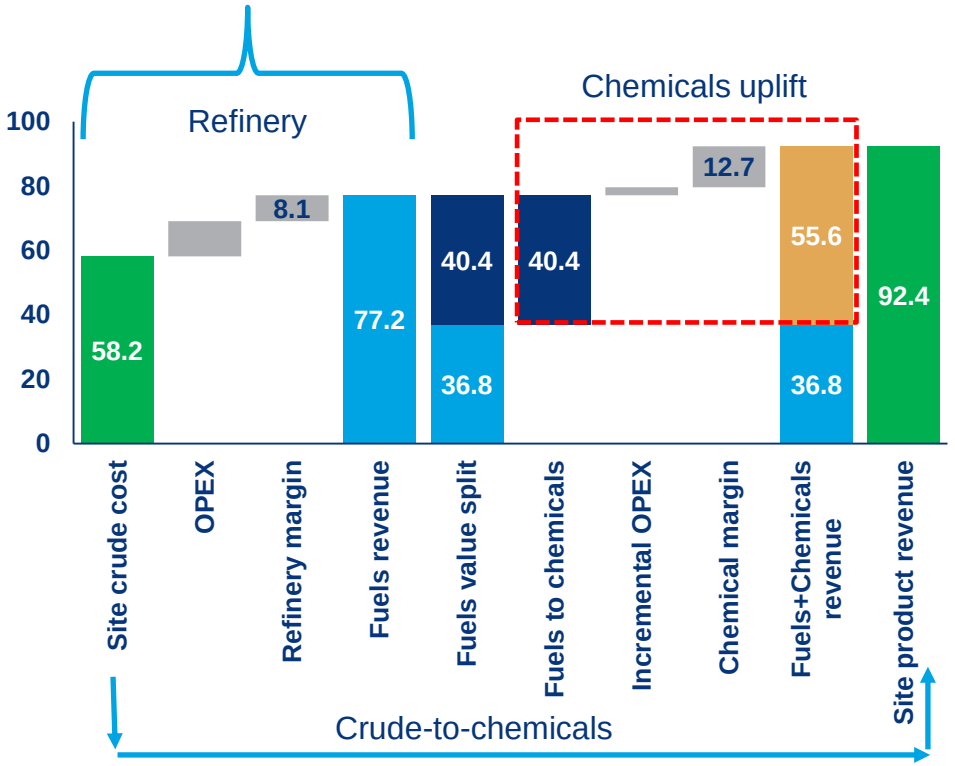
Source: Wood Mackenzie Product Markets Service

Numbers in the brackets represents CDU capacity in kb/d

Value-add from petrochemical integration can be significant

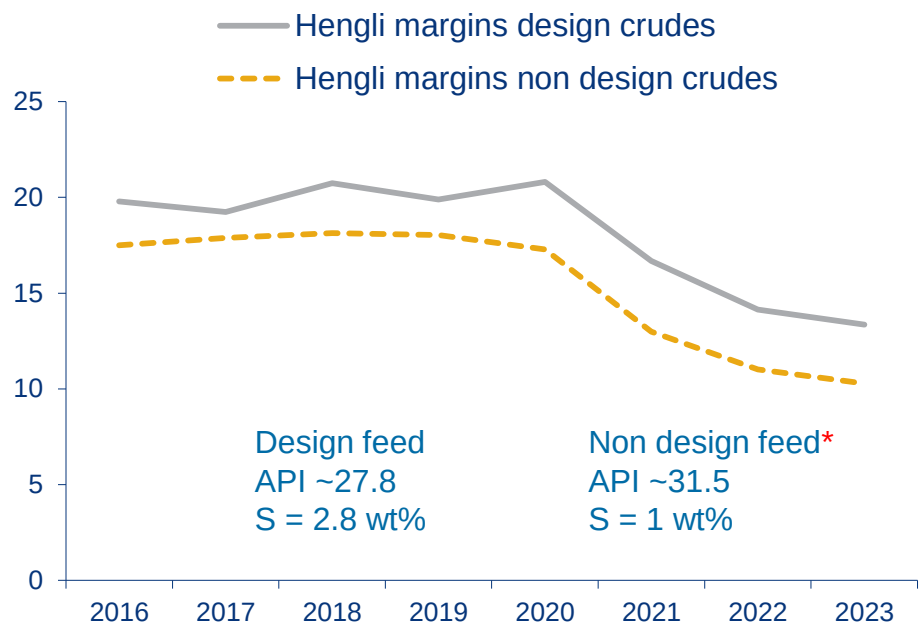
China's new "crude to chemicals" projects are delivering materially higher petrochemicals integration and value addition

Hengli margins and value build-up (2020), US$ for every barrel of crude



- Location will be a key driver in overall project economics
- Relative fuels/chemicals pricing, utility fuel costs, relative crude freight, will all impact relative project economics in various locations of these mega projects

Hengli integrated site net margins, US$/bbl



- Margin loss because of sub-optimal feed varies from $2/bbl to $4/bbl, based on market environment

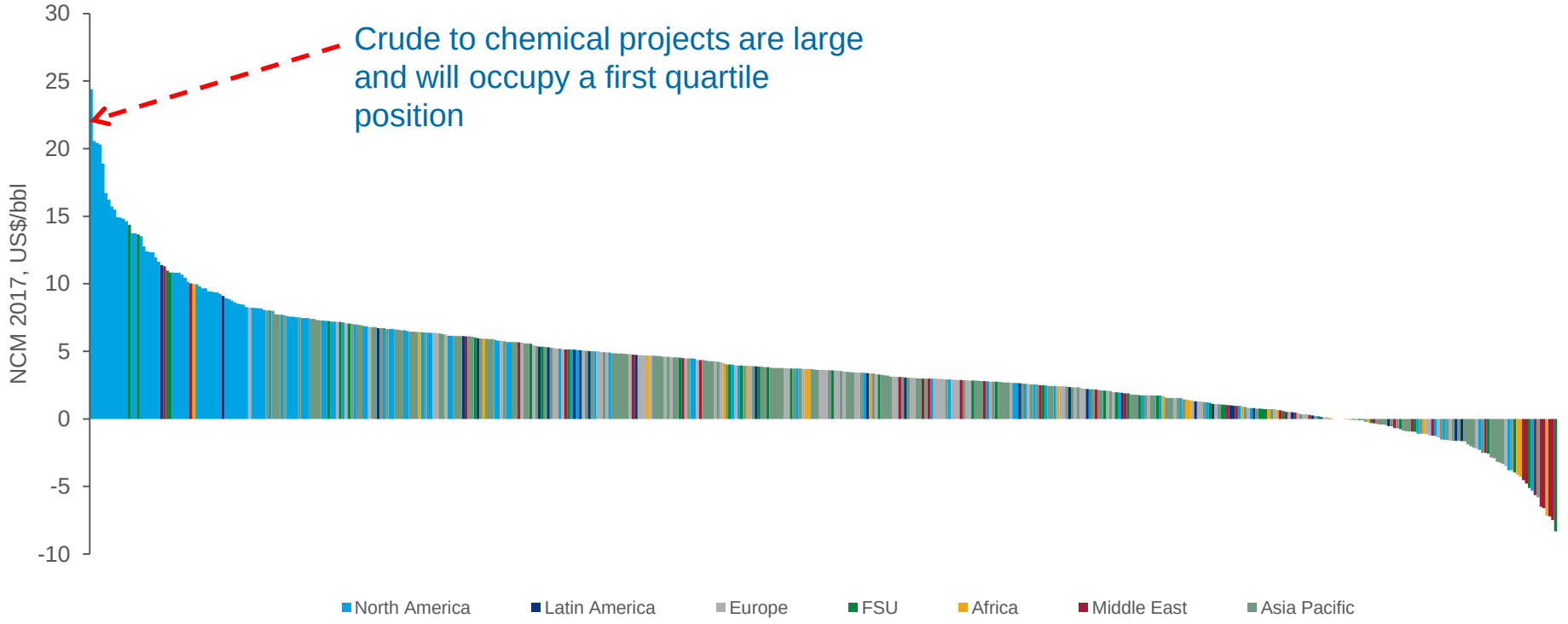
Source: Wood Mackenzie Product Markets Service, PetroPlan

* Non design feed assumed at similar levels to average Sinopec/Petrochina

Weaker refiners will struggle to compete when over-capacity returns to the sector, as first quartile sites achieve high utilisation

A key challenge is that slowing global demand growth reduces the capability to absorb world-scale refineries, which are getting larger and more competitive

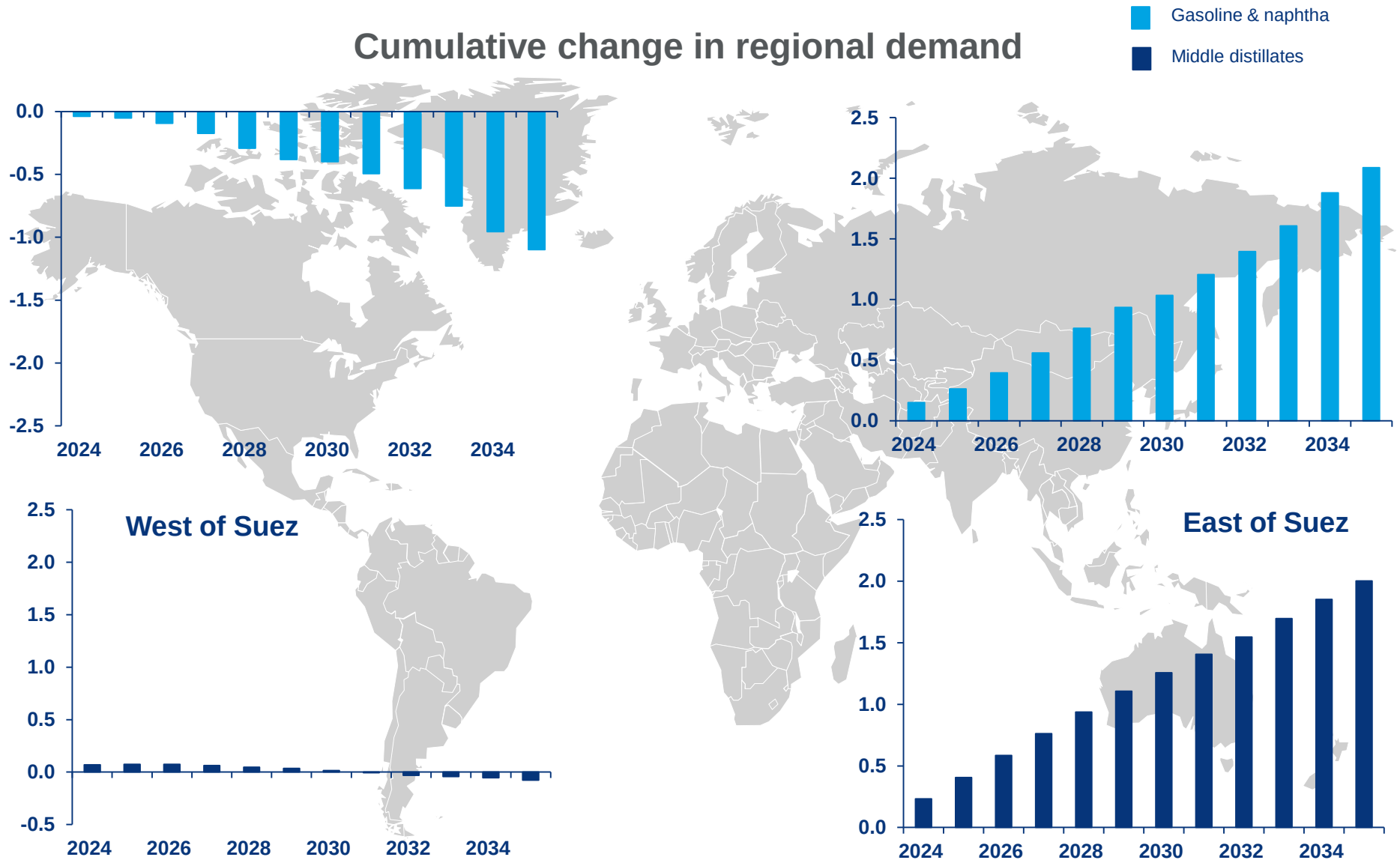
2017 Regional Net Cash Margin profile for North America, Asia, Russia, Middle East and Europe

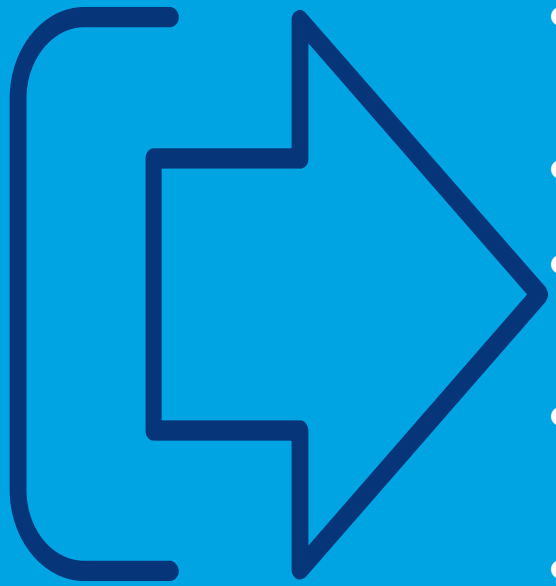


Source: Wood Mackenzie

Source: Wood Mackenzie Refinery Evaluation Model

Longer-term gasoline demand trends will challenge refiners in the US and Europe



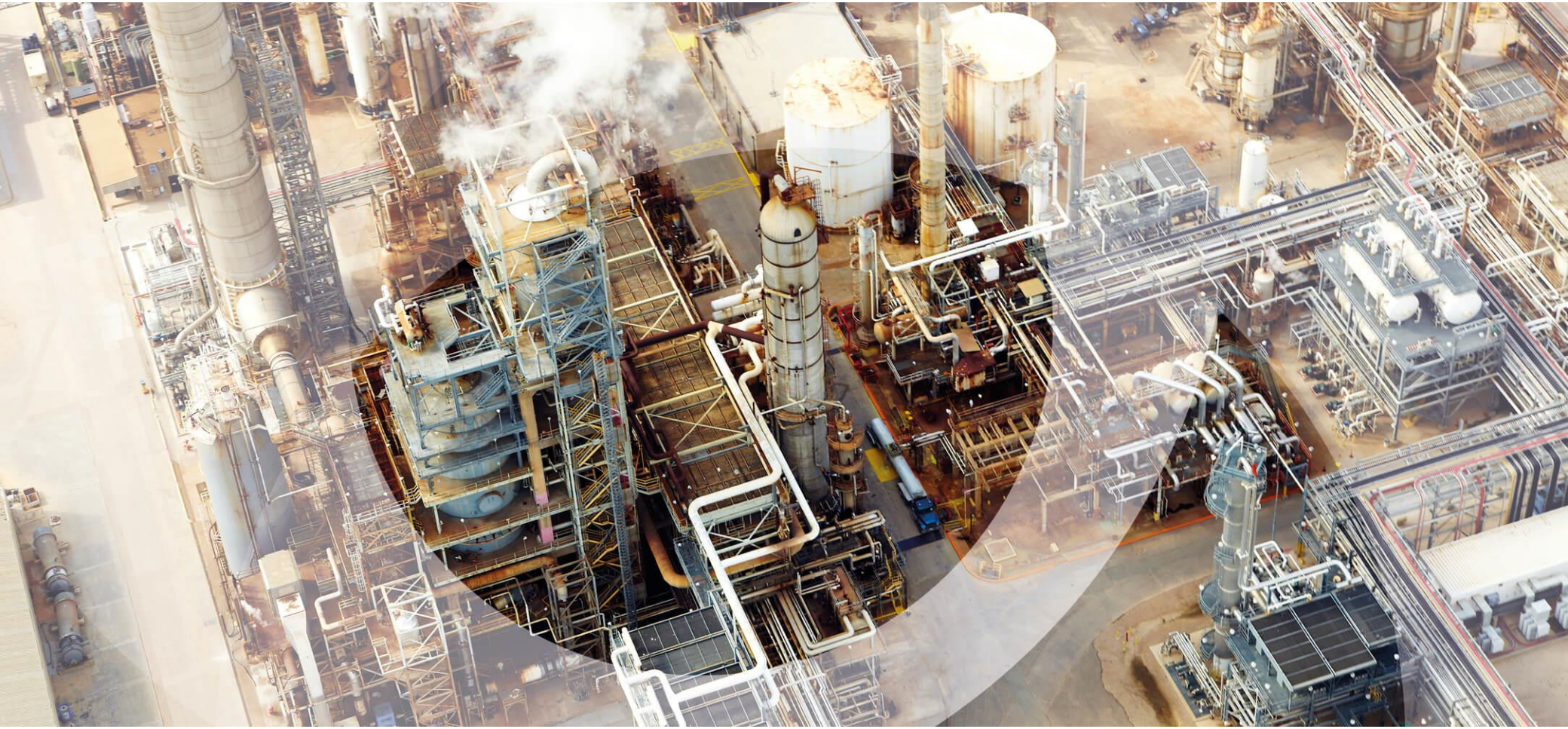


- OPEC+ has a supply dilemma for at least the next 2 years
- Longer term, OPEC's role grows in the medium term as US tight oil growth slows
- The Energy Transition slows demand growth, but the Upstream sector is less impacted than refining
- IMO remains uncertain, but it supports refining margins in 2020
- Over-capacity is returning to the refining sector, so lowering utilisation and margins. Threat of closure returns to Europe
- Exports of crude and products to Europe will become more challenging
- Refinery/petrochemical integration is a key theme to develop structurally sustainable refining assets

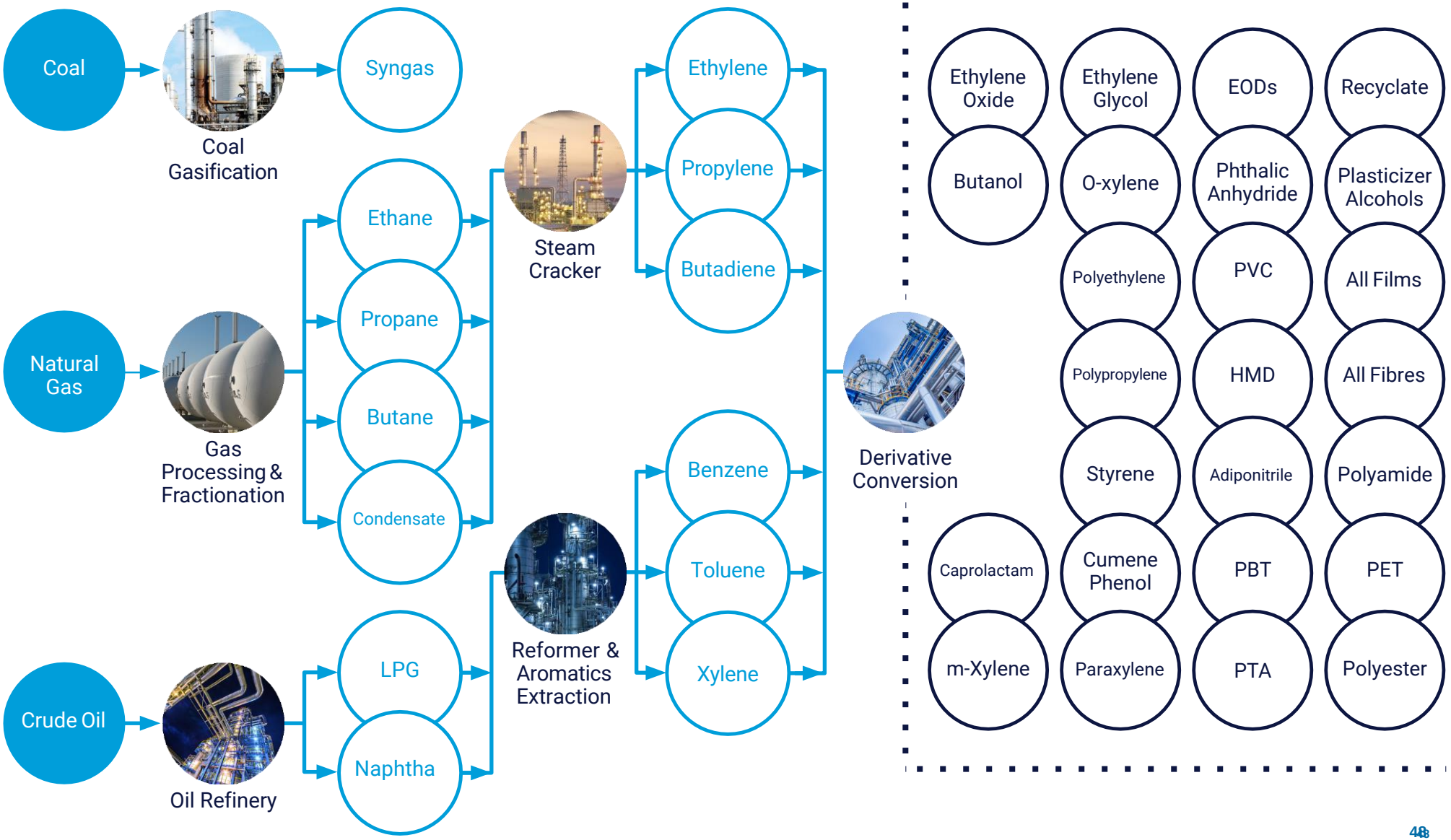
Alan Gelder
VP Refining, Chemicals and Oil Markets
Refining Global Content Lead

Global Petrochemicals Outlook

Moscow, 9th April 2019



The petrochemical industry



Agenda

1 **Global petrochemical trends**

What is driving the focus on chemicals?

2 **Ethylene market outlook**

Latest forecast for the biggest petrochemical market

3 **Ethylene economics**

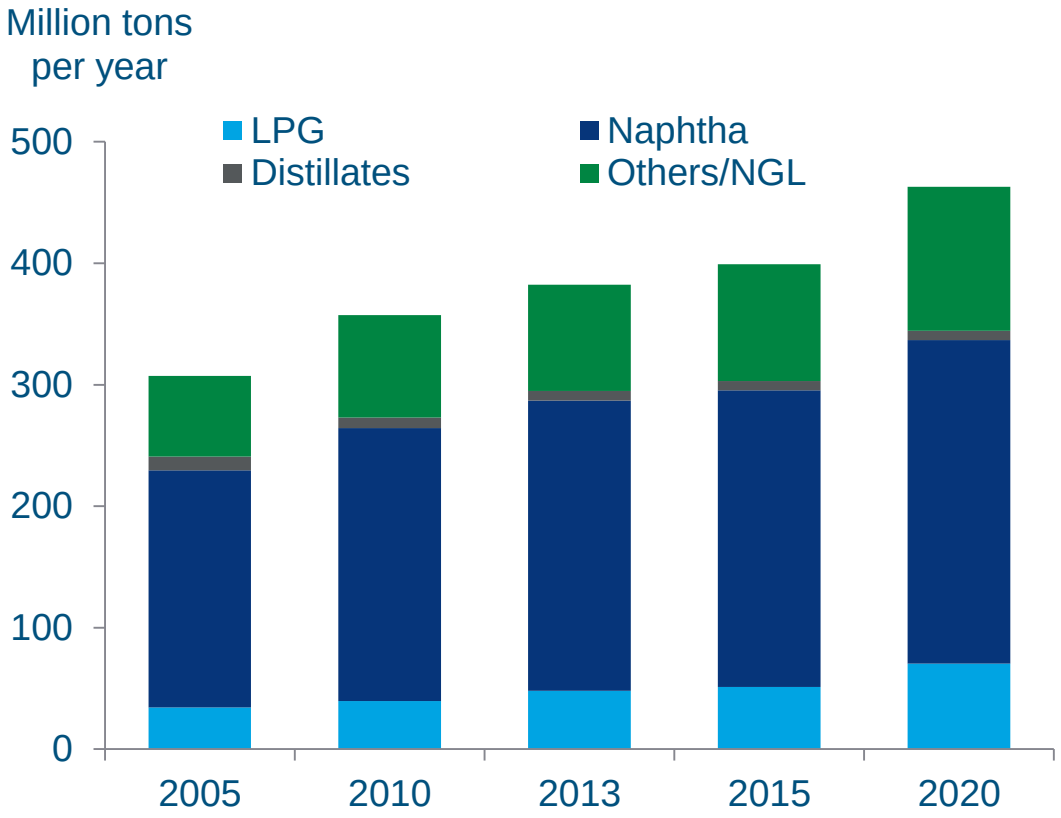
What is next for costs and margins

Global petrochemicals

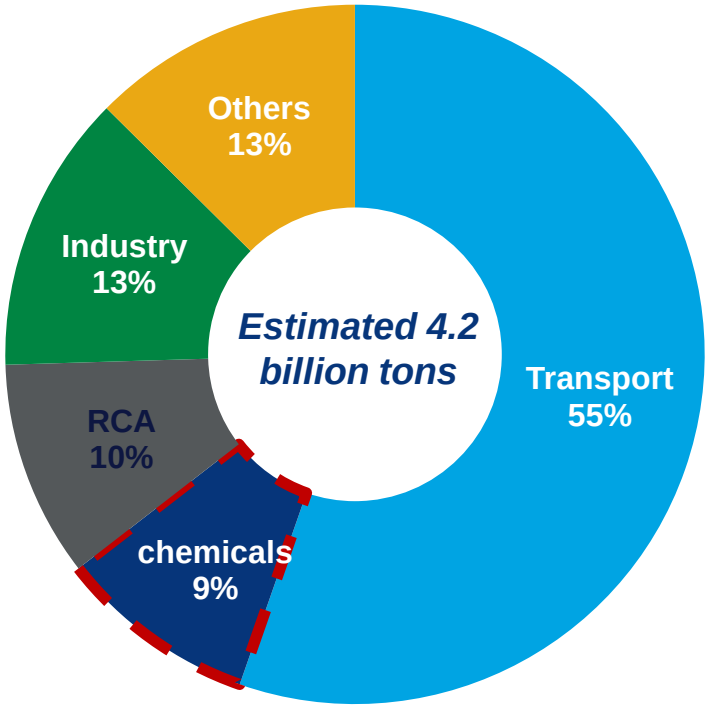
Megatrend 1 – small part of the barrel, but increasing focus

Liquid hydrocarbon use

Hydrocarbon liquids used in chemical production



2019 Global oil demand by key segments



Megatrend 2 – emerging and growing plastics concern

Although chemicals are integral to every day life

Polyethylene


Polystyrene / ABS


PVC


PET / Polyester


Polypropylene


Methyl Methacrylate

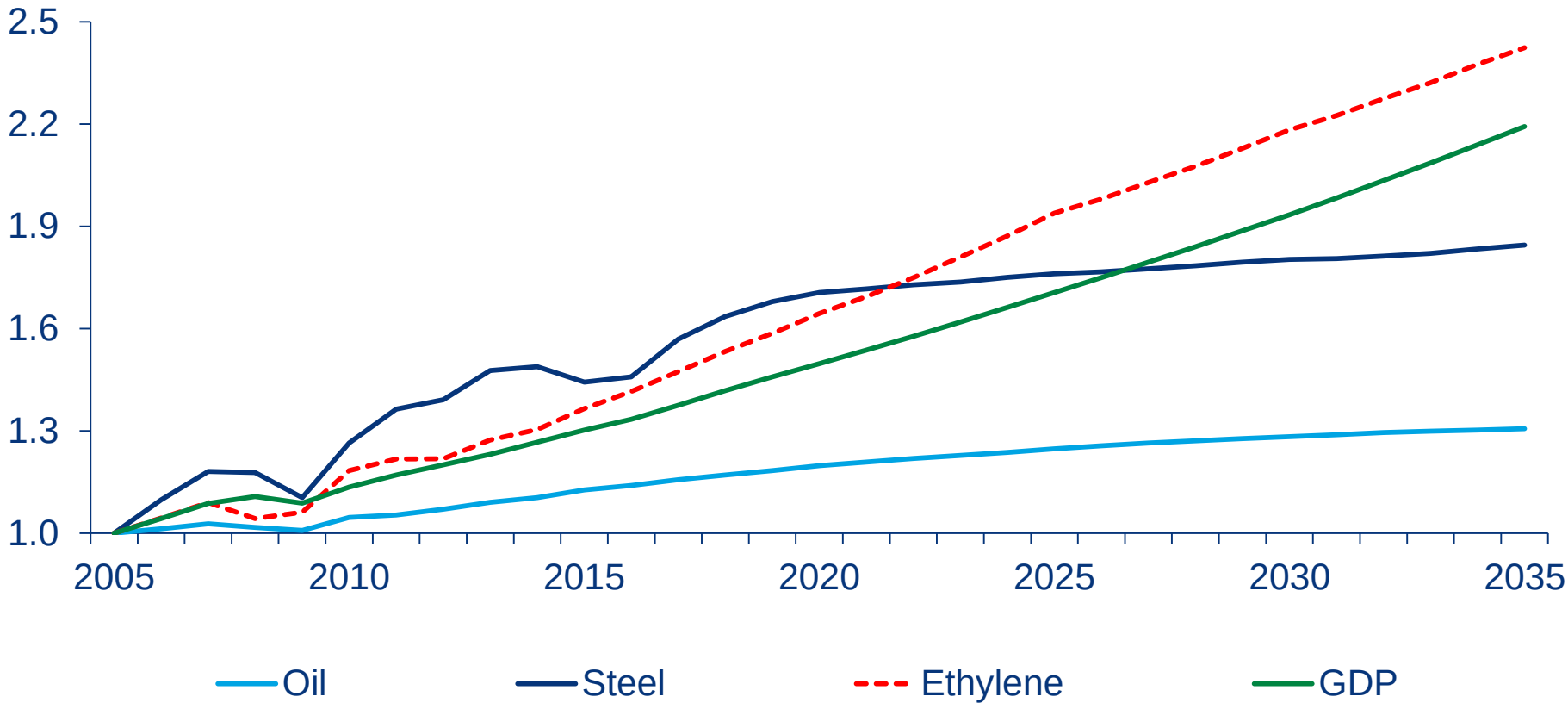

Synthetic Rubber


Fertilizer

Global commodities outlook – focus on ethylene

The growth of ethylene is expected to continue to be significant through the long-term forecast

Global commodities outlook – demand growth relative to 2005 base

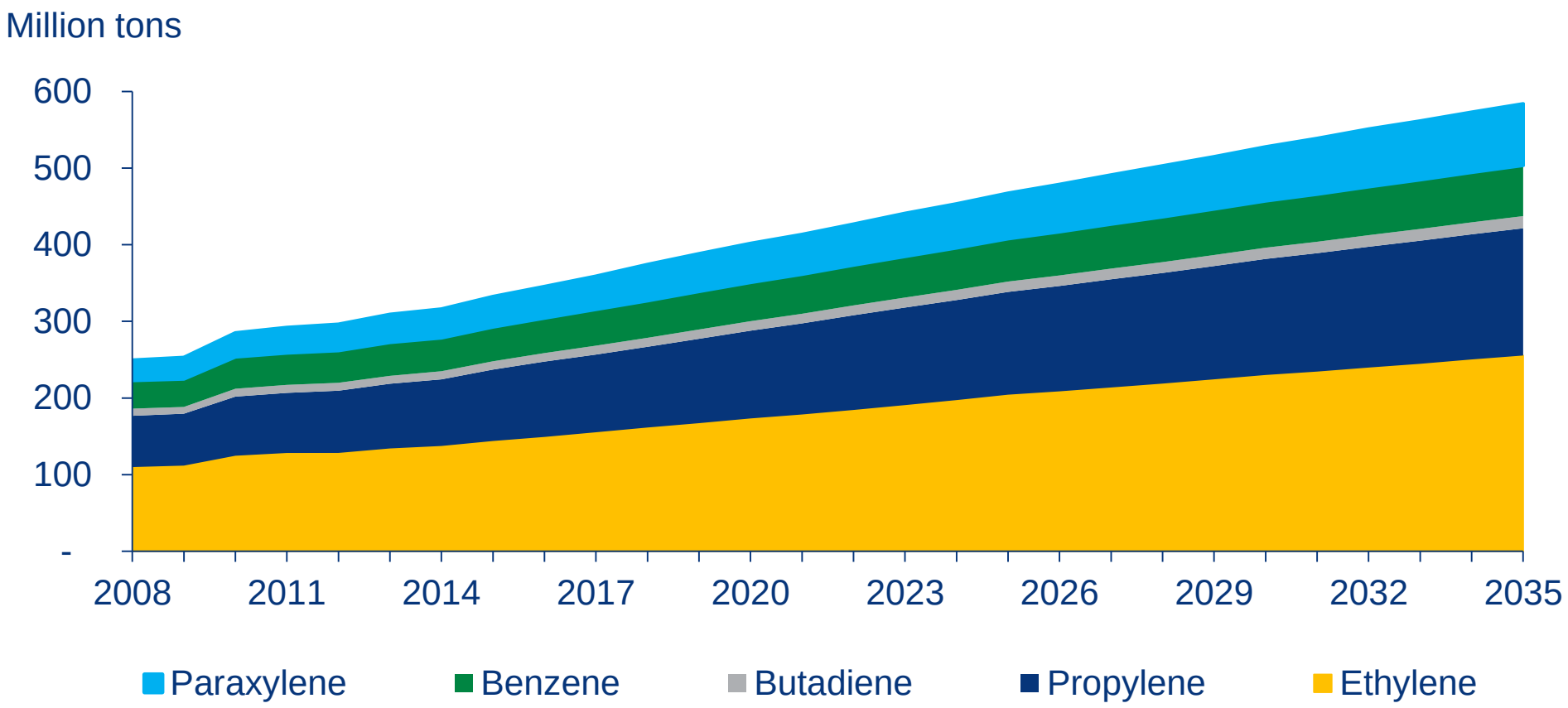


Source: Wood Mackenzie

Global base chemical demand outlook

Global market for base chemicals is expected to grow by over 50% through to 2035

Global base chemical demand outlook



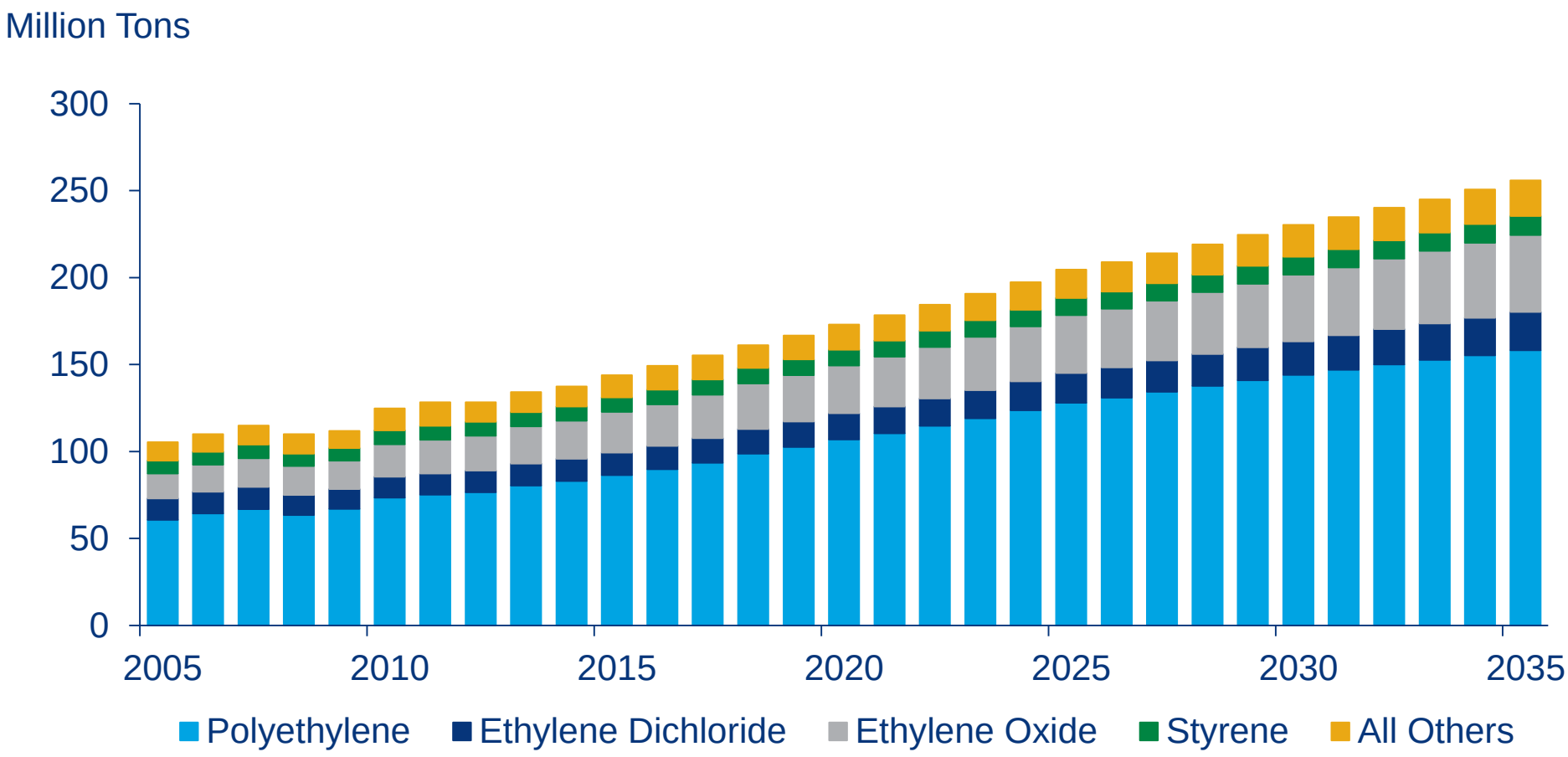
Source: Wood Mackenzie Chemicals

Ethylene market outlook

Global ethylene demand by major derivative

Polyethylene is the engine of long-term ethylene volume growth. Growth is present across all derivative chains, with ethylene oxide showing strong growth driven by MEG/polyester chain.

Global ethylene demand by major derivative

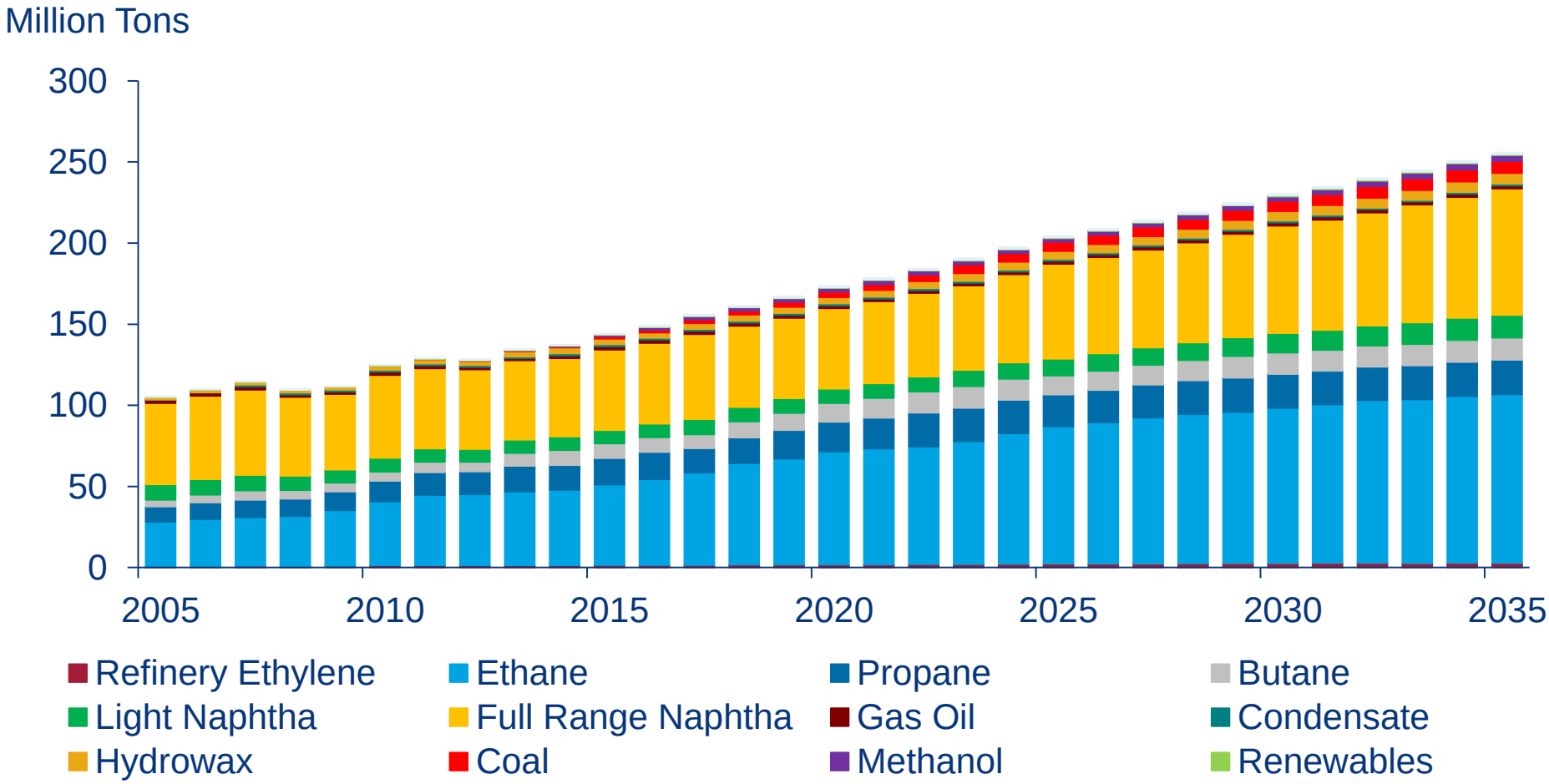


Source: Wood Mackenzie Chemicals

Global ethylene supply by feedstock

Naphtha and ethane remain the workhorses of long-term ethylene supply. Ethane overtook naphtha in 2018 and maintains a higher share through the forecast period.

Global ethylene supply by feedstock



Source: Wood Mackenzie Chemicals

Ethylene "gold rush" underway – strong profitability attracted many

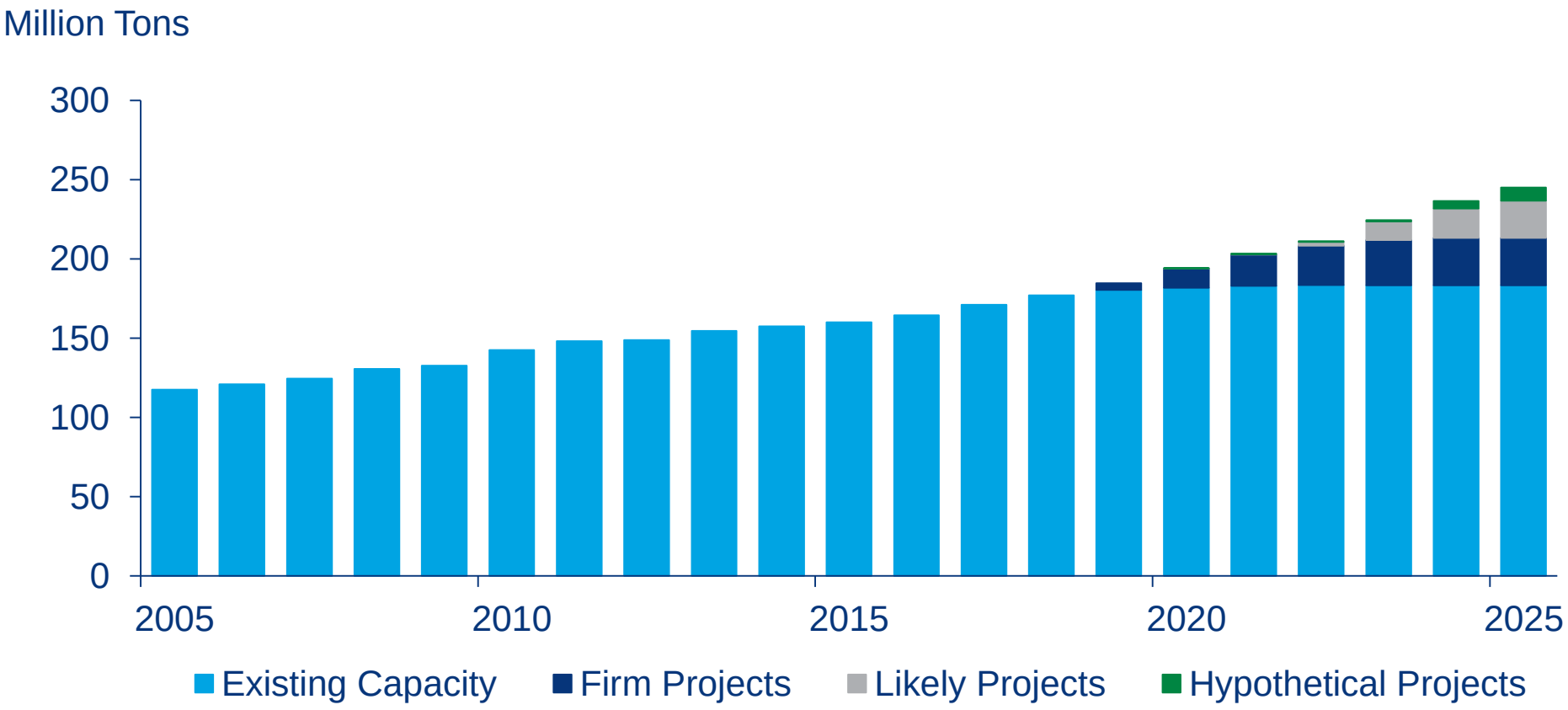
Ethylene investments planned from upstream through refiners to pure chemical players

Source: Wood Mackenzie

Global ethylene capacity developments

The world needs to continue to invest in ethylene capacity in order to meet future demand. The rate of capacity additions relative to demand is key to setting industry cycle and profitability.

Global ethylene capacity developments

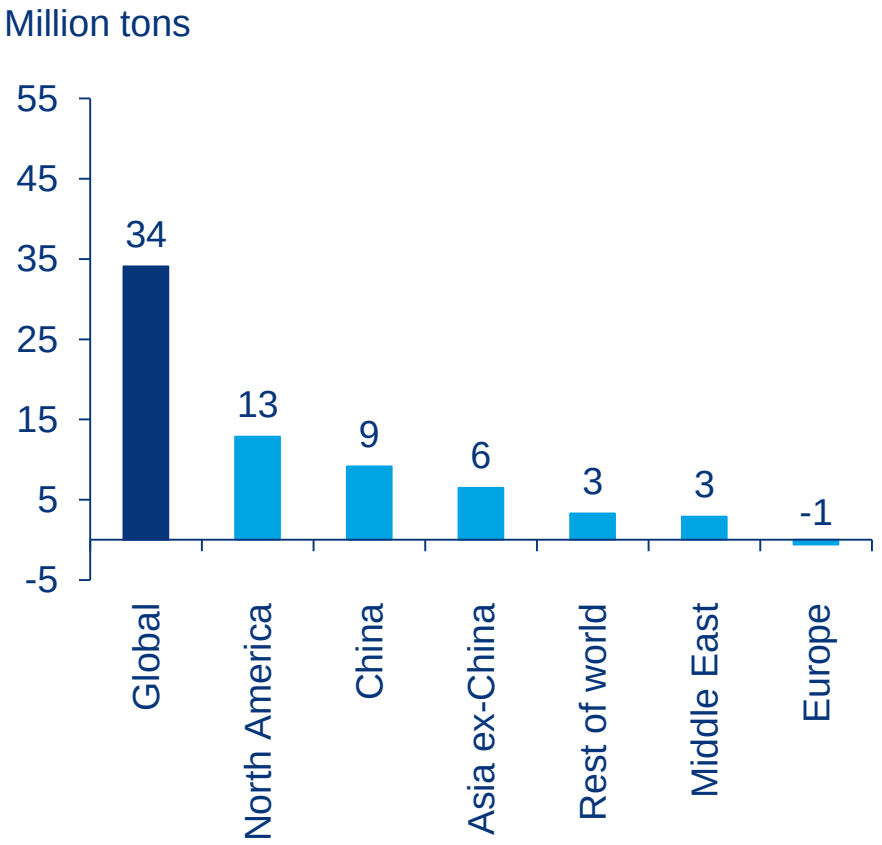


Source: Wood Mackenzie Chemicals

Global ethylene capacity additions by major region

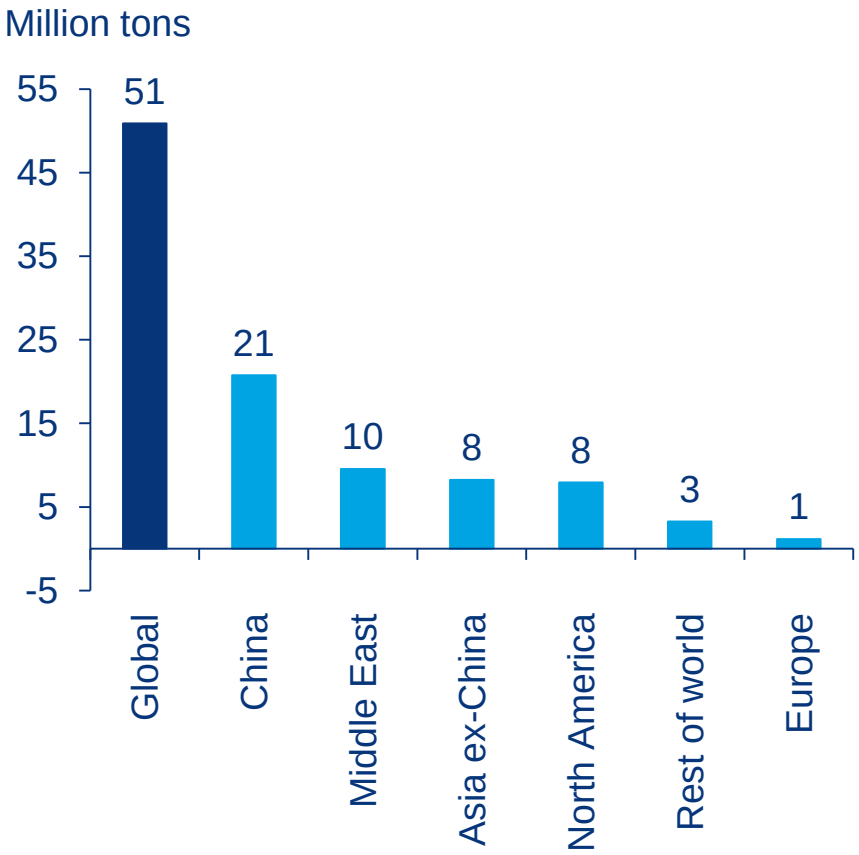
Global ethylene capacity additions surge by 50% in 2020-2025 outlook. China and the Middle East drive forward largest regional growth. North America sustained but lower than 2015 – 2020 period.

Global ethylene capacity additions by major region (2015 – 2020)



Source: Wood Mackenzie Chemicals

Global ethylene capacity additions by major region (2020 – 2025)

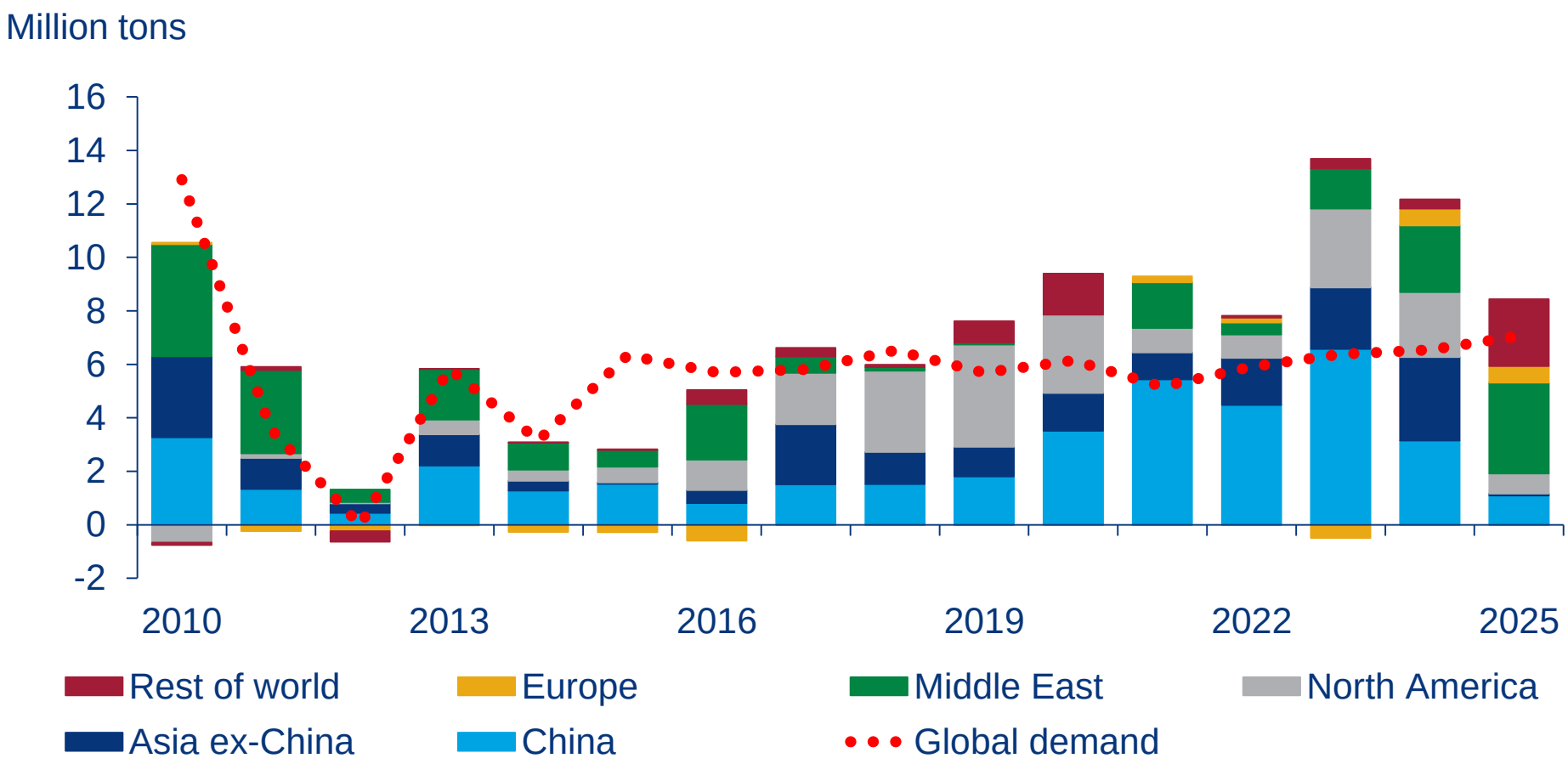


Source: Wood Mackenzie Chemicals

Global ethylene capacity additions by major region

Asia accounts for over 50% of ethylene project capacity in the forecast, with China over 40% alone. Supply driven investments in North America and the Middle East account for most other projects.

Global ethylene capacity additions versus global ethylene demand by year

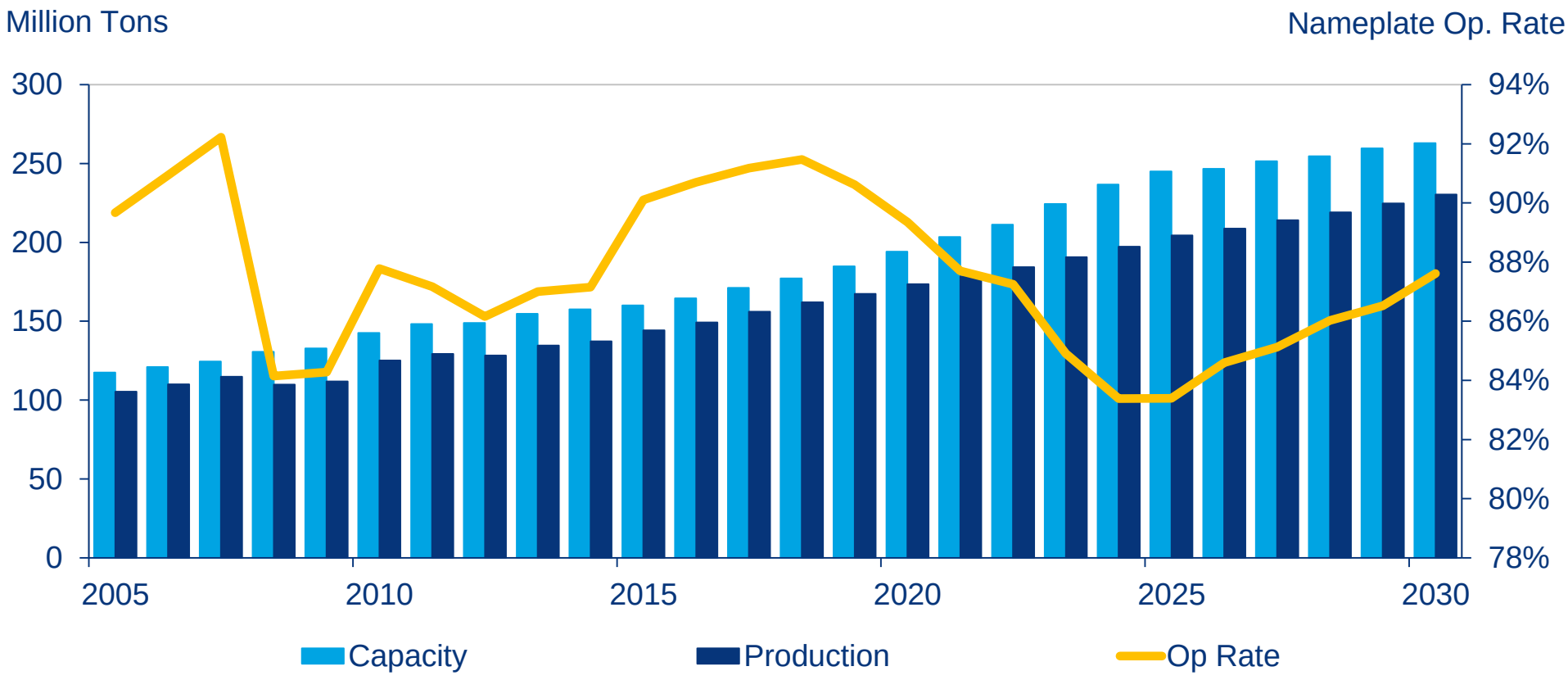


Source: Wood Mackenzie Chemicals

Global ethylene supply/demand balance

Global ethylene industry is entering a supply driven downturn, driven by good margins and an increasing trend of oil/refining players further focussing on petrochemicals.

Global ethylene supply/demand balance

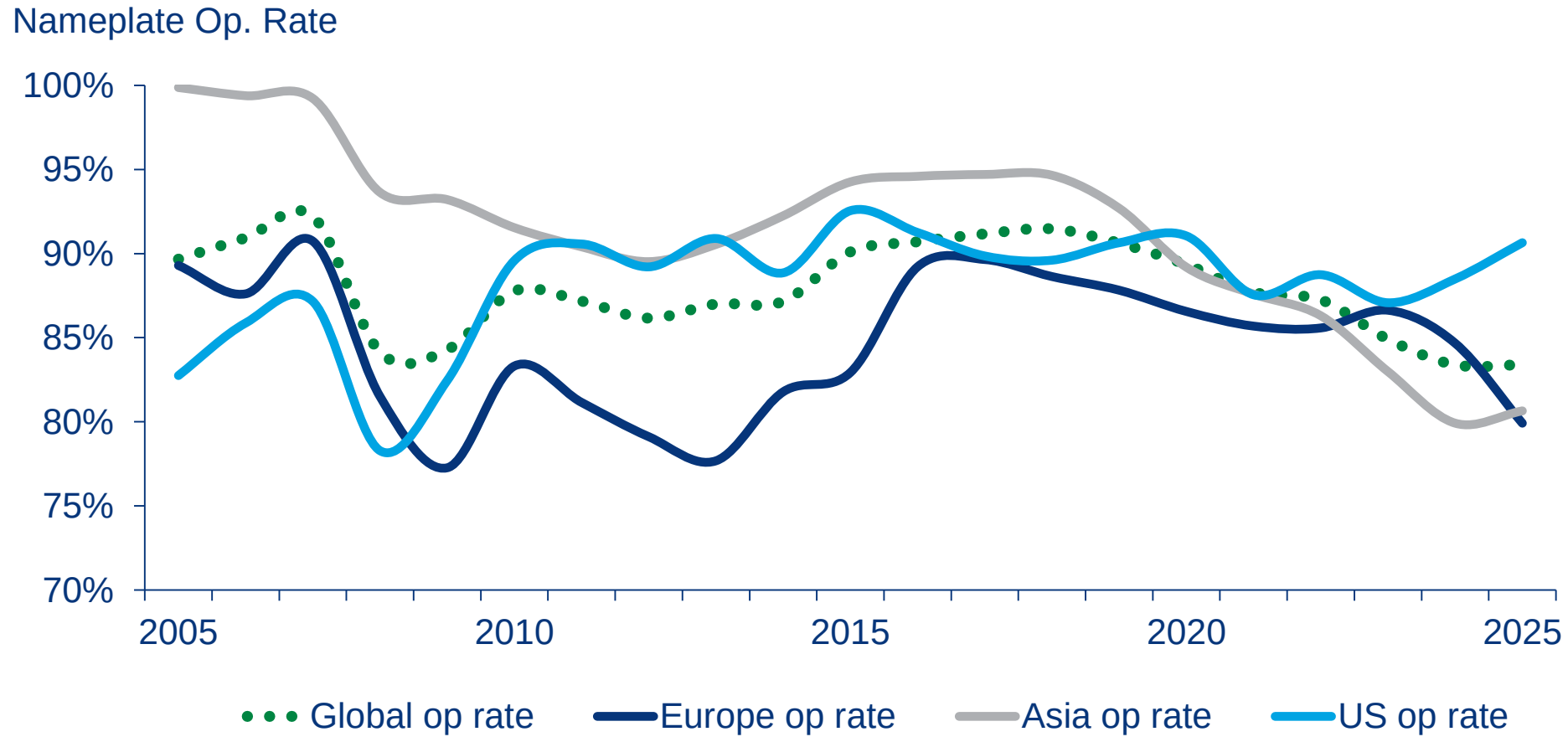


Source: Wood Mackenzie Chemicals

Global / regional ethylene operating rates

Global operating rates to pass below 85% in 2023 – 2025 period driven by large and sustained ethylene capacity additions in this period following a prior easing in the global ethylene balance.

Global / regional ethylene operating rates

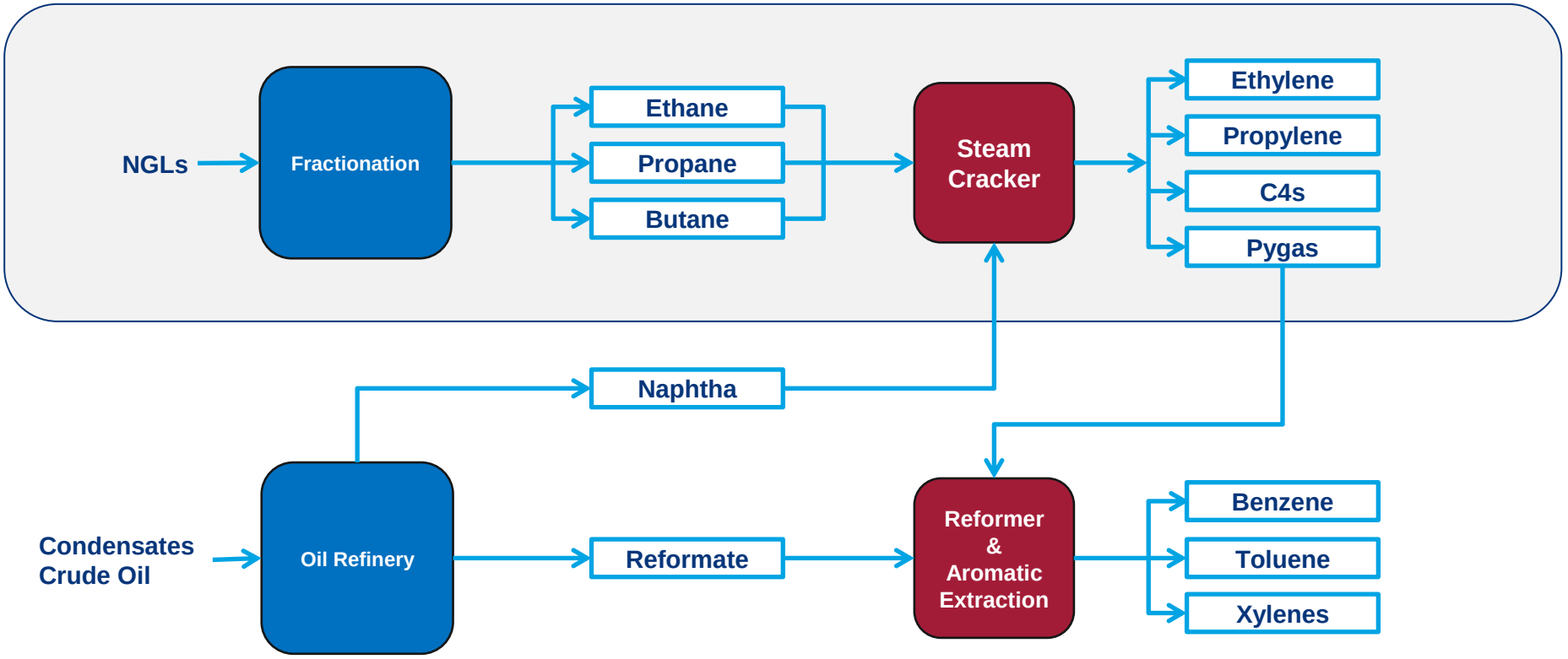


Source: Wood Mackenzie Chemicals

Ethylene economics

Chemical Feedstocks – NGLs

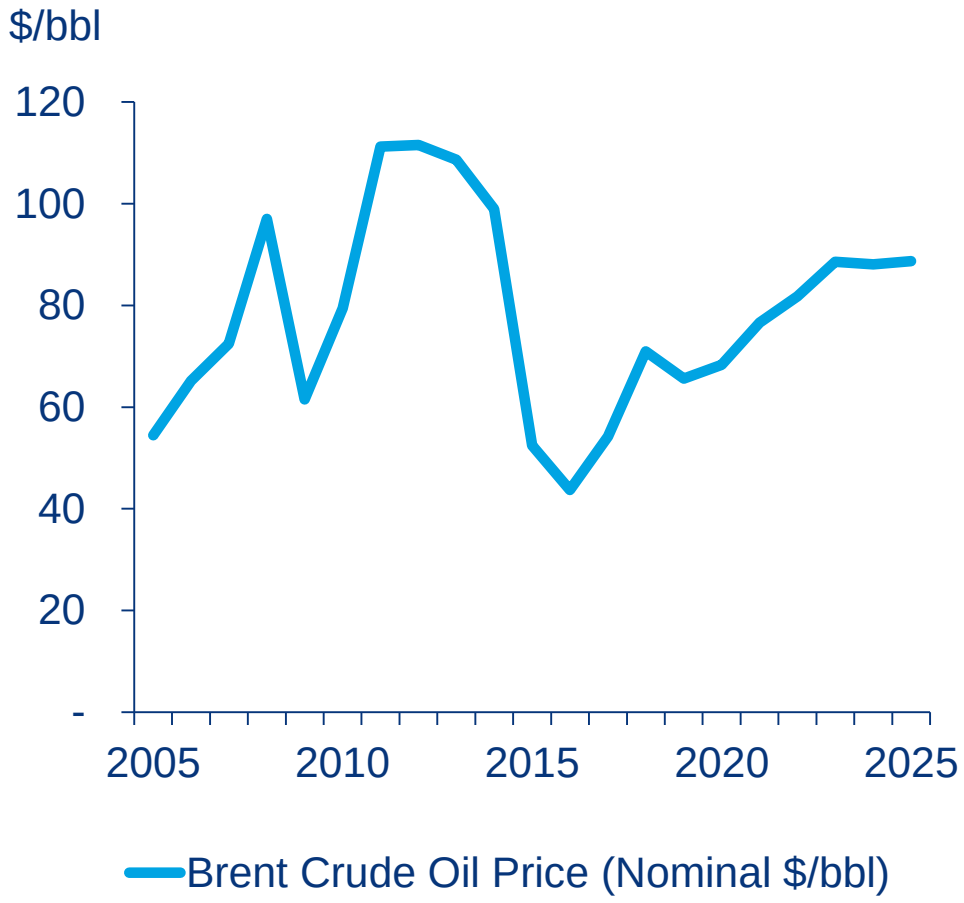
Integrated flow into a steam cracker for ethylene production



Oil and ethane price outlook comparison

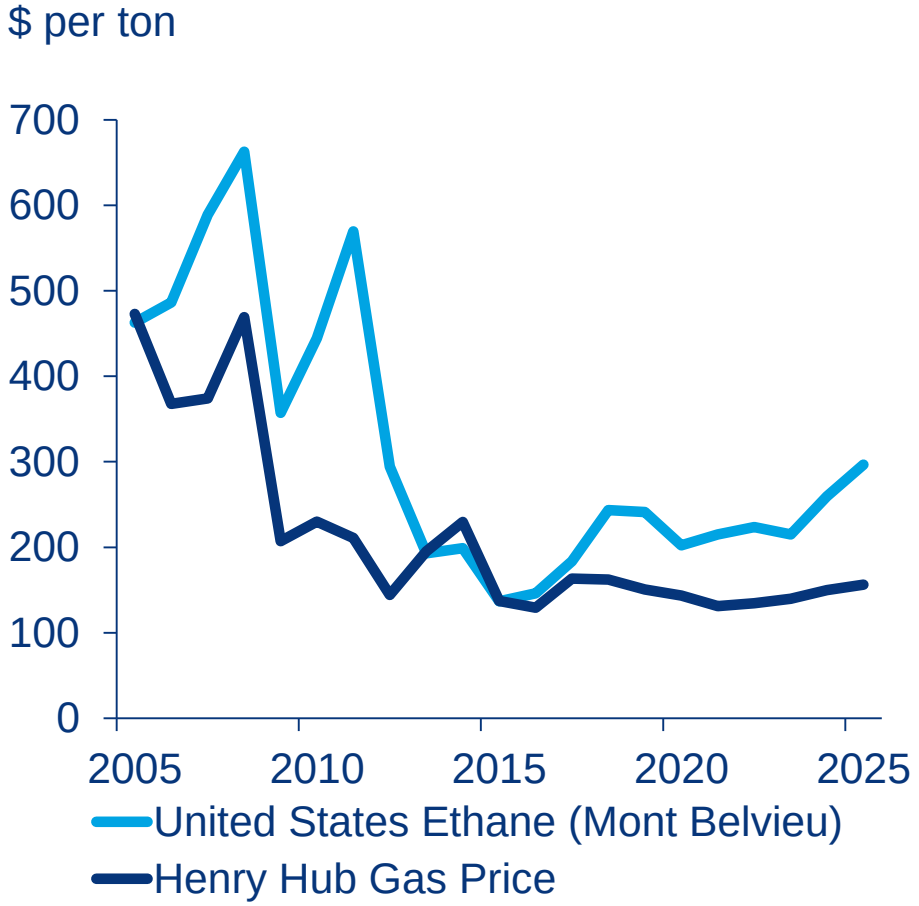
Oil price rises more quickly than US ethane price, widening gas-based advantage for North America.

Brent crude oil price outlook ($US/bbl)



Source: Wood Mackenzie

United States ethane price (Mont Belvieu) and Henry Hub Gas Price

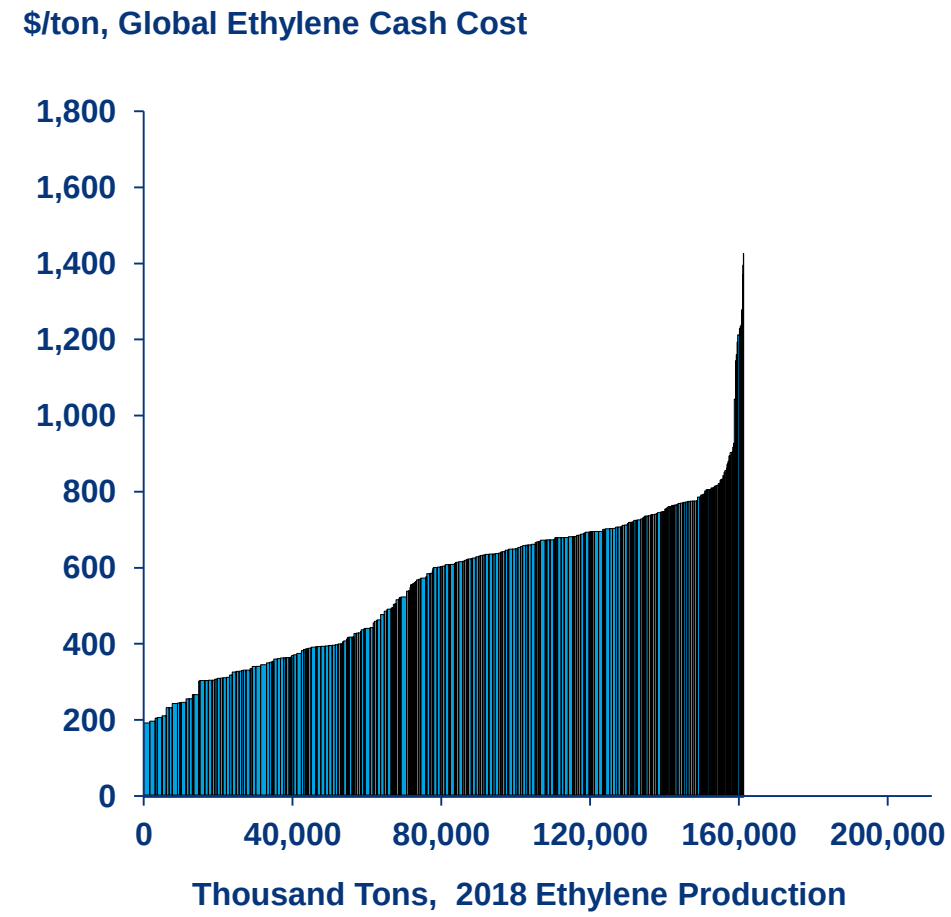


Source: Wood Mackenzie

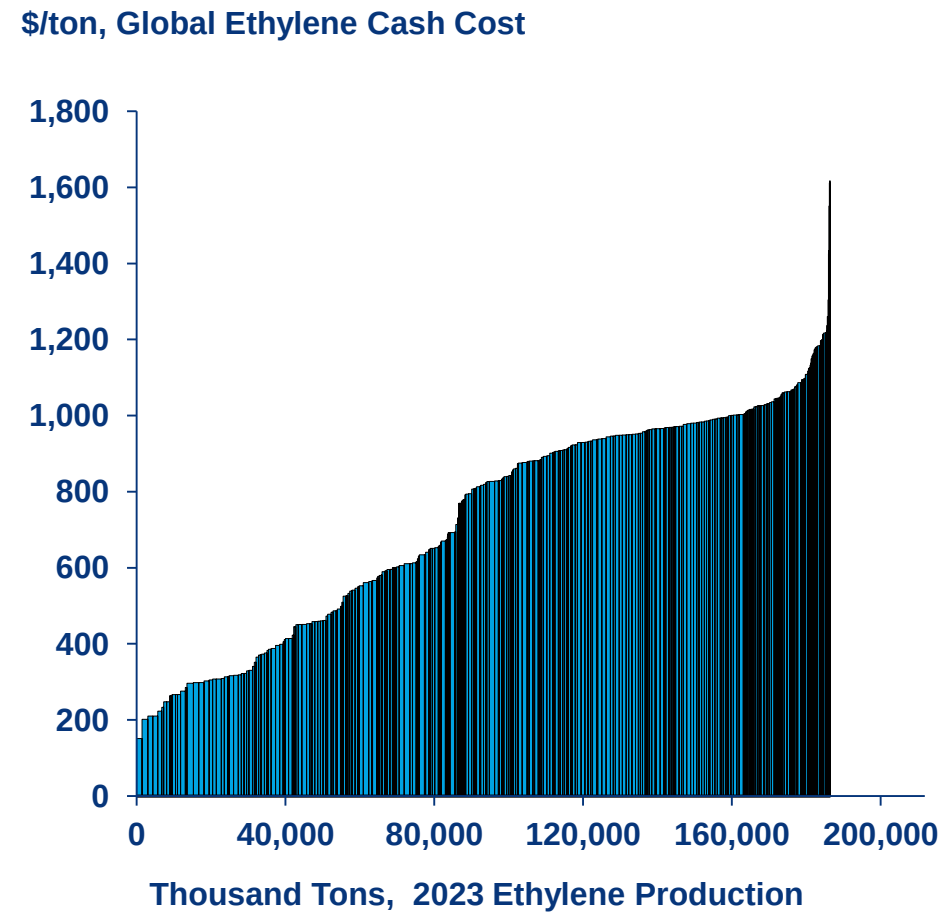
Global ethylene cost curve (2018 / 2023)

Ethylene production cost curve widens with new supply and overall cost structure (shape) is set to steepen with increasing crude oil price (2018 = $71/bbl, 2023 = $89/bbl).

2018 Global Ethylene Cost Curve



2023 Global Ethylene Cost Curve

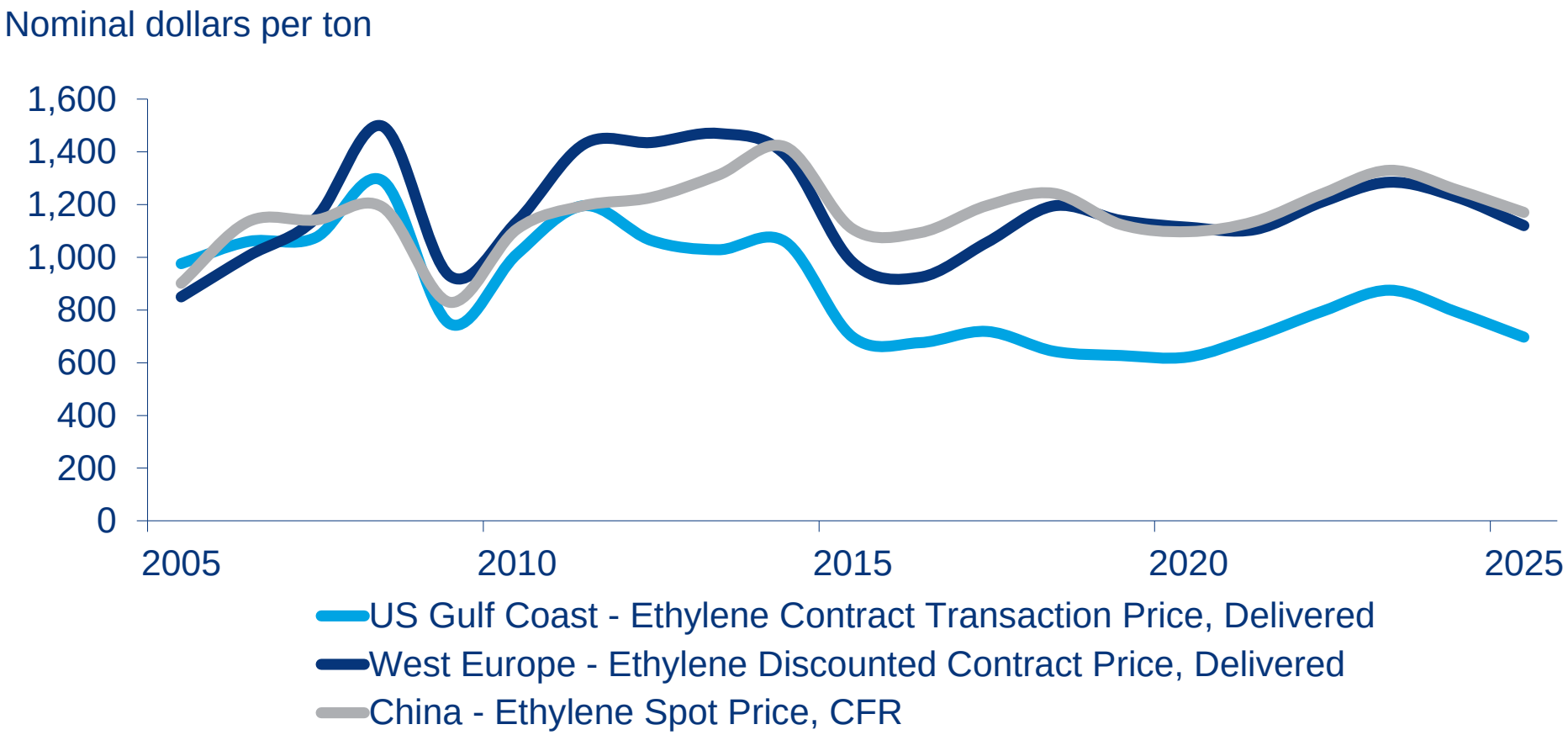


Source: Wood Mackenzie Chemicals Ethylene Asset Cost Tool (December 2018). Values in Nominal Dollars.

Ethylene pricing outlook

Weakness in United States ethylene prices expected for several years, as regional overcapacity situation persists. Global ethylene prices in long-term forecast to be set by Asian polyethylene economics.

Ethylene market prices by region

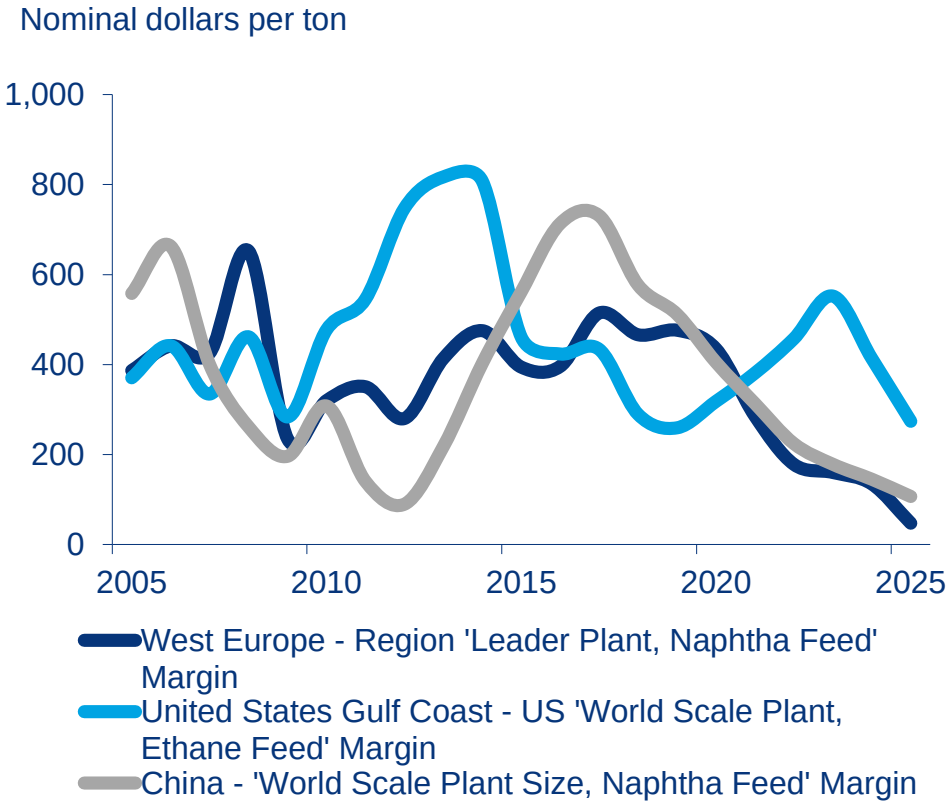


Source: Argus Media, PetroChem Wire, Wood Mackenzie Chemicals

Ethylene production margins and return on investment

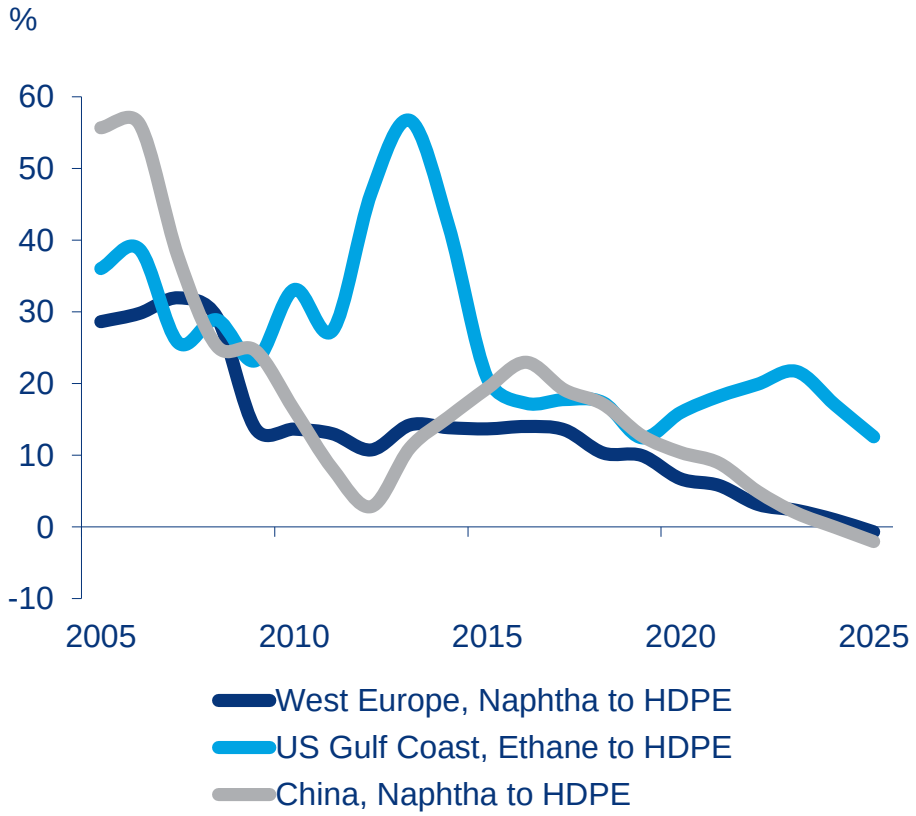
Ethylene margins in Asia Pacific and Europe perform better than United States through to 2021. From this point, the United States advantage is set to be restored as ethylene prices in the United States move higher, alongside crude oil prices rising faster than ethane prices.

Ethylene Production Margins, by Region



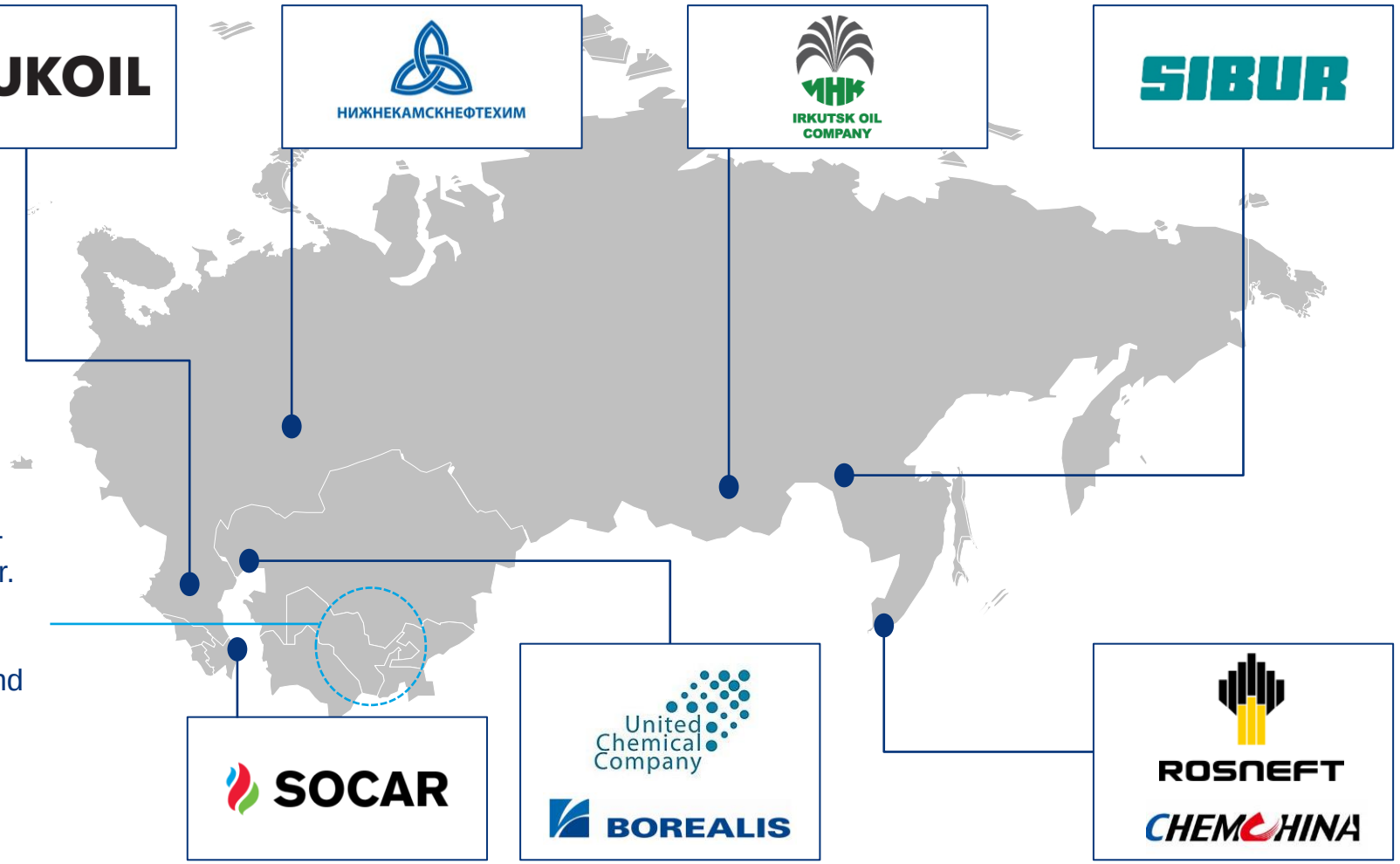
Source: Wood Mackenzie Chemicals

Integrated Ethylene-HDPE Return on Investment, by Region

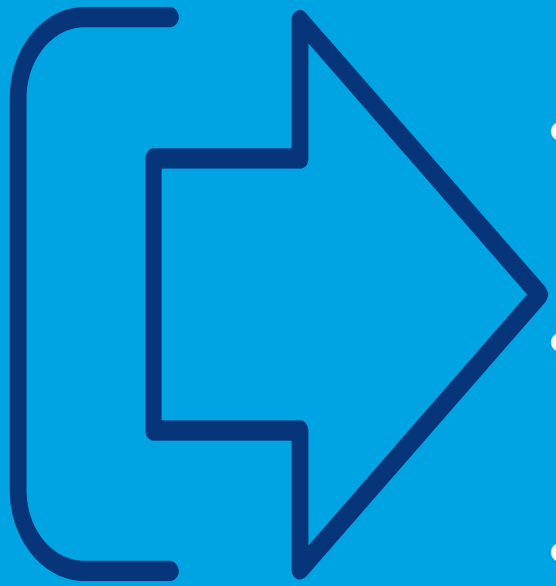


Source: Wood Mackenzie Chemicals

ZapSibNeftekhim (SIBUR) due online this year – what is potentially next for ethylene investments?



Source: Wood Mackenzie Ethylene Global Supply/Demand Analytics Service

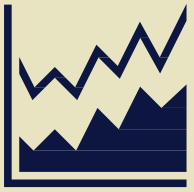


- Petrochemical industry is gaining increased focus as a long-term oil demand driver.
- The overall industry is moving from top-of-cycle profitability to a period of lower utilisation and margins – predominantly driven by large investments exceeding near-term demand.
- Ethylene is the biggest petrochemical by volume and value and is driven by scale and costs. Strong underlying demand still remains for major ethylene derivatives like polyethylene.
- Increasing oil price coupled with lower global utilisation will change global cost and margin structure. Large pressure will be felt in some regions towards the middle of next decade.
- The Global ethylene industry presents huge opportunities for Russia. 4-5 world-scale ethylene plants needed on average to keep pace with long-term demand growth.
- Monetisation of both gas-based and refinery-based streams are a possibility. Advantaged feedstock positon allows Russia to compete on global stage in terms of product exports.

Short-term Market Services

- Monthly/Weekly Reports
- Price/Cost/Margin Database
- Capacity/Supply/Demand Database
- Regular Insights
- Analyst Access

Long-term Market Services



- Semi-Annual Reports
- Price/Cost/Margin Database
- Capacity/Supply/Demand Database
- Regular Insights
- Analyst Access

Asset Services

- Semi-Annual Reports
- Asset Operations
- Asset Economics
- Regular Insights
- Analyst Access

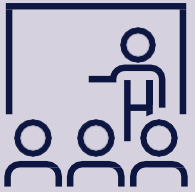
Bespoke Consulting

- Business and Strategic Planning
- Commercial Advisory
- Transaction Support
- Business Strategy
- Litigation & Insurance Supports
- Training & Workshops

Multi-Client Topical Studies

- N America PE Exports
- N America Polyester
- China CTO/MTO
- China Paraxylene
- Ethylene Oxide Derivatives

Conferences & Training



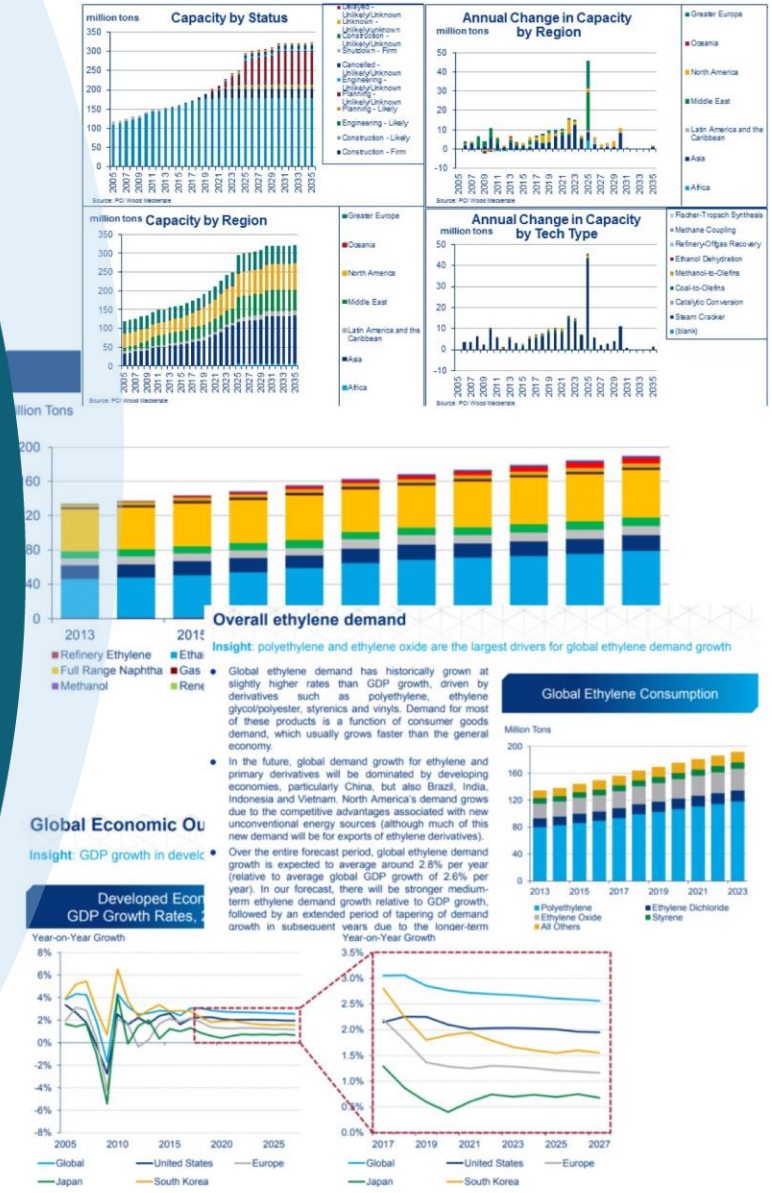
- Polyester: Americas, Europe
- Nylon: Americas, Europe, Asia
- Olefins: Americas
- Polymers: Americas
- Living with Plastics: Europe

Ethylene

Gain essential insight into supply/demand, capacity developments and price forecasts to understand today's markets and tomorrow's trends.

Global supply demand analytics and Americas monthly market reports

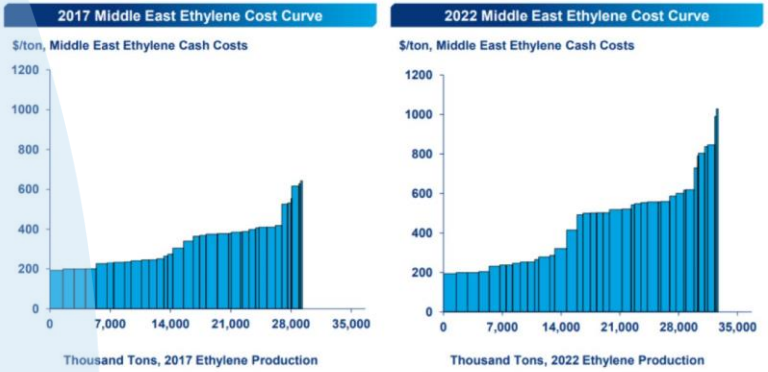
- Long-term capacity and trade data and price forecasts with comprehensive ethylene production capacities itemized by operator, location, technology and size
- Listing of all announced projects, including our assessment of the projects' timing and likelihood
- Monthly overview of supply/demand, accounting for inventories, outages and new capacities for 18-36 months
- Price forecasts and cost-margin analysis, compared against forward curve market expectations and inventory trends for actionable insight
- Complete volumetric and economic analysis for every regional producing asset
- Detailed commercial analysis for the North American ethylene outlook

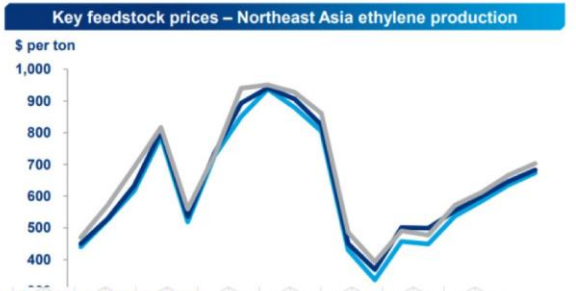


Ethylene Asset Cost Tool

Asset-by-asset evaluation of cost and key production metrics can be viewed for key ethylene technologies - **not available from other providers.**

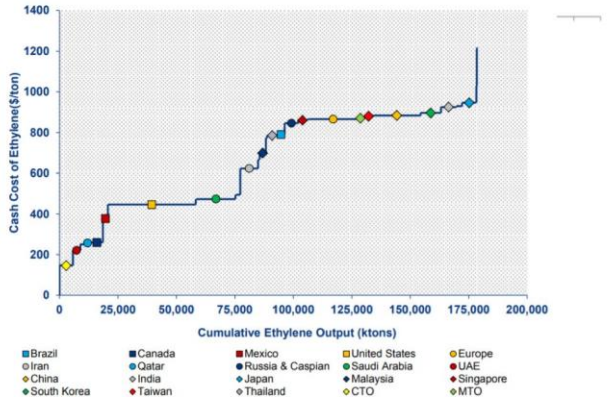
- Dataset covers approximately 350 assets and projects
- Granular data on feedstocks, production volumes, costs and margins updated twice per year
- Analyse ethylene supply using trusted price forecasts and rigorous data files
- Benchmark performance of competitor assets
- Manage risk of supply chain disruptions by understanding the position of current and potential suppliers
- Compare your own data against our analysis for project evaluations
- Run scenarios to develop optimum business plans





2022 Global ethylene cost curve

Crude oil price = $80.7/bbl and US natural gas price = $3.24/mmbtu

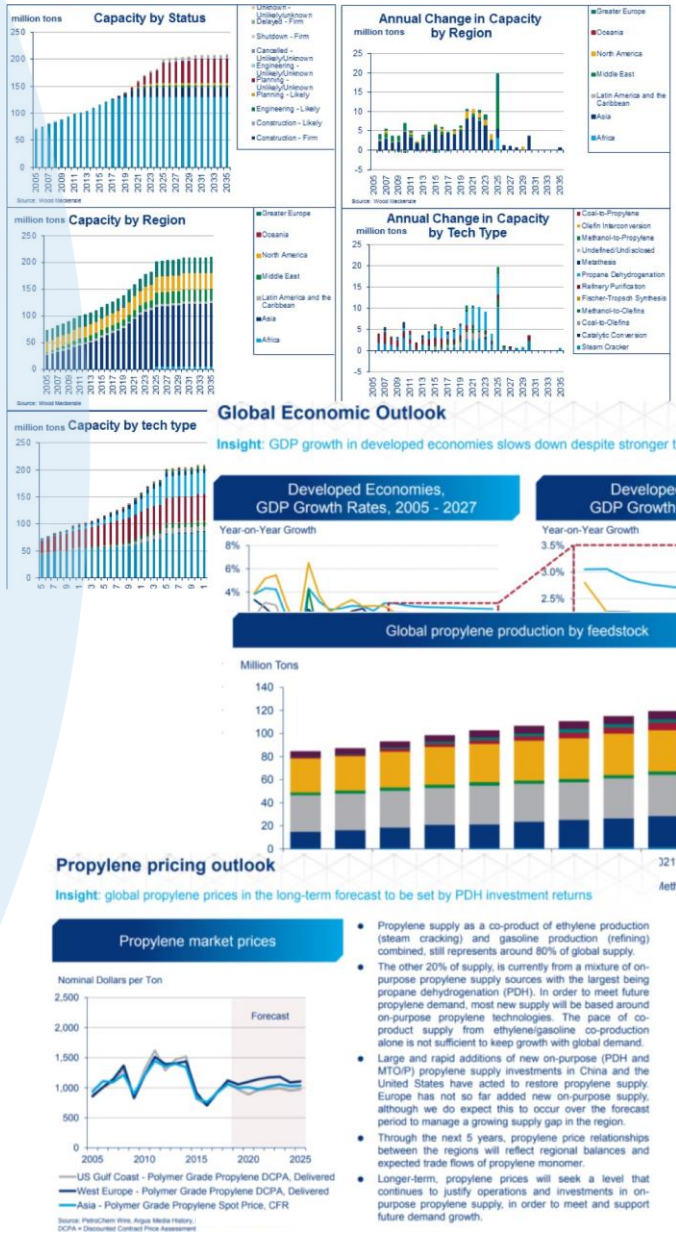


Propylene

Use our suite of propylene research to understand the feedstock trends and build a picture of supply/ demand of propylene's key derivatives.

Global supply demand analytics and Americas monthly market report

- Annual capacity, supply by technology and feedstock, demand by end-use, trade and other key indicators for each producing/consuming country from 2005 – 2040
- Propylene prices, production costs and cash margins for US, Europe and Asia annually from 2005 – 2040
- Propylene production assets by site, operator, capacity and technology
- Monthly overview of short term supply/demand
- Current issues and trends discussion
- Detailed commercial analysis for North American propylene, including polypropylene outlook

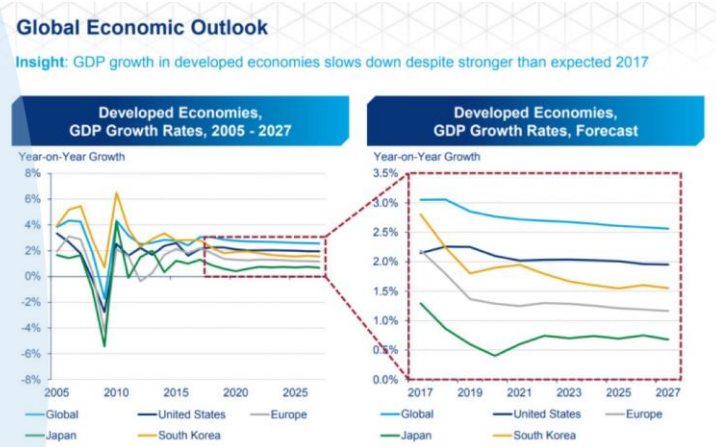


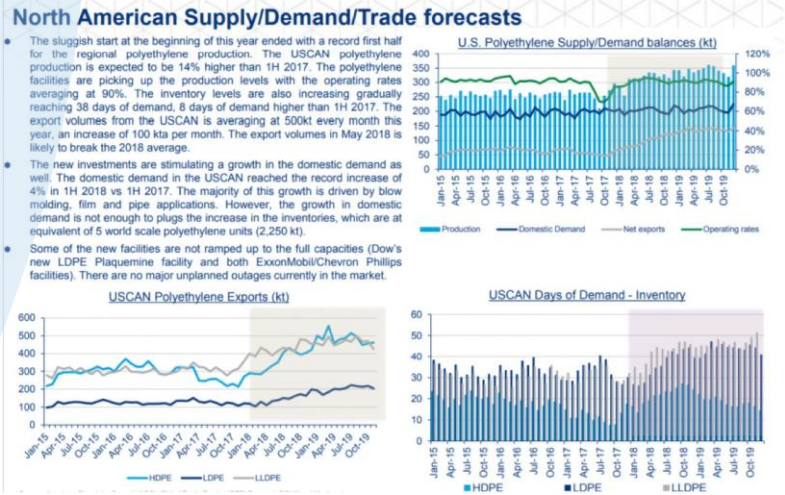
Polyethylene

Gain a comprehensive view of global supply and demand, price forecasts and petrochemical feedstock trends.

Global supply demand analytics

- Economic and energy outlook
- Price forecasts and production economics
- Global capacity, production, demand and trade outlook
- Key end-use outlook: film, sheet, injection moulding, fibre and other processes
- Existing polyethylene production assets by site, operator, capacity and technology
- Announced production projects by site, operator, capacity, technology, anticipated timing and likelihood
- Annual capacity, supply by technology and feedstock, demand by end-use, trade and other key indicators from 2005 – 2040
- Prices, production costs, cash margins and key assumptions for US, Europe and Asia annually from 2005 – 2040



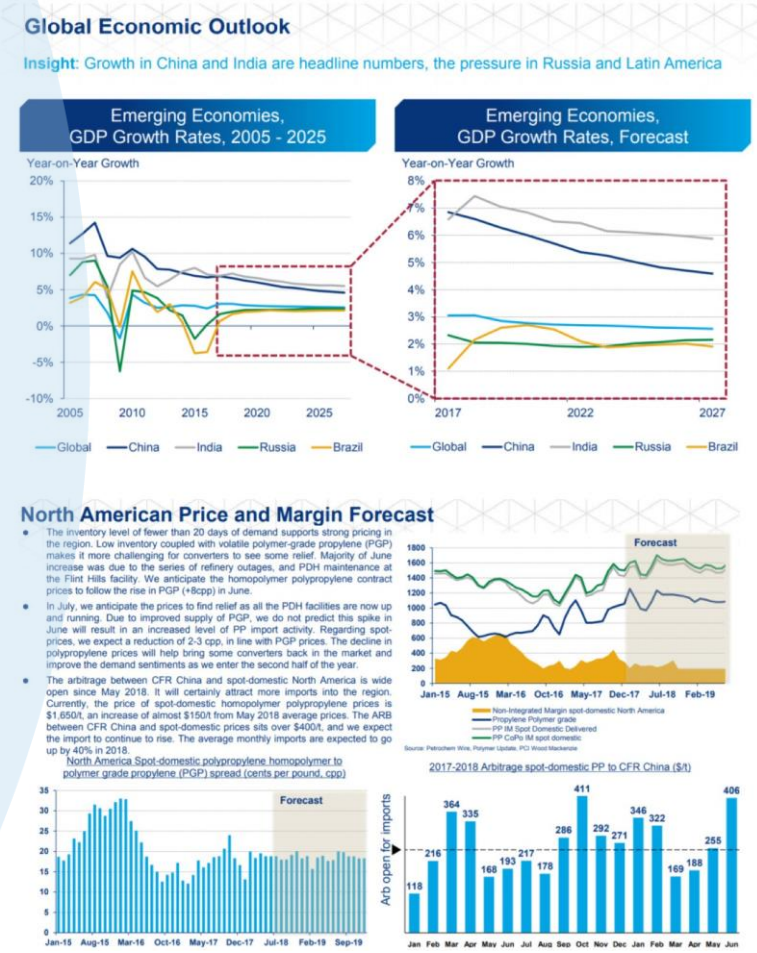


Polypropylene

Confidently forecast and plan ahead with proprietary data and integrated analysis on the polypropylene market.

Global supply demand analytics

- Economic and energy outlook
- Price forecasts and production economics
- Global capacity, production, demand and trade outlook
- Key end-use outlook: film, sheet, injection moulding, fibre, raffia and other processes
- Current production assets by site, operator, capacity and technology
- Announced projects by site, operator, capacity, technology, anticipated timing and likelihood
- Annual capacity, supply by technology and feedstock, demand by end-use, trade and other key indicators for each producing/consuming country from 2005 – 2040
- Polypropylene prices, production costs, cash margins and key assumptions for the US, Europe and Asia annually from 2005 – 2040



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Alan Gelder

VP Refining, Chemicals and Oil Markets
Downstream Global Content Lead

Biography

Alan is VP Refining, Chemicals and Oil Markets. As Downstream Global Content Lead, he is responsible for formulating Wood Mackenzie's research outlook and integrated cross-sector perspectives on this global sector.

Alan Gelder joined Wood Mackenzie's Downstream Consulting team in 2005 and became global head in 2009. He transitioned into research upon his return from Houston in 2011 and was Global Head of Refining and Chemicals.

Prior to joining Wood Mackenzie, Alan had 10 years of industry consulting after working for ExxonMobil in a variety of project planning and technical process design roles.

Alan has a first class Master Degree in Chemical Engineering from Imperial College, London, supplemented by an MBA from Henley Management College.

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Patrick Kirby

Principal Analyst – EMEARC Olefins & Derivatives

Biography

Patrick joined Wood Mackenzie's Chemicals team in 2013 as an experienced chemical industry professional, holding almost a decade of direct experience. In his current role, Patrick is integral to developing and forming Wood Mackenzie's light olefins forecast for the EMEARC region.

He was previously with IHS Chemical (formerly CMAI) as a senior consultant in the EMEA region, involved in leading and performing strategic advisory projects across all of the major petrochemical value chains, with significant project experience in the development of the petrochemical projects in the CIS region.

Prior to joining CMAI, Patrick held both project and operations based positions in the olefins division of SABIC Europe – including feedstock flexibility, propylene train de-bottlenecking and butadiene uprate strategic projects. Patrick gained prior olefins industry experience with Huntsman Corporation.

Patrick graduated with a first class MEng degree in Chemical Engineering from the University of Manchester, UK (formerly UMIST) and is a chartered engineer with the Institution of Chemical Engineers (IChemE).

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