



Energy Industry: Trends and Strategies

Ramin Forouzandeh | Aug 25th and Sep 1st, 2022 | RIEMP DBA

1. The Energy Cake

To provide an overview of key energy demand and supply figures by region and product

Example of an Energy Model

Non-exhaustive

55 segments

Transport

- Road transport (including buses, trucks, and cars)
- Rail
- Aviation
- Marine
- Other transport

Sustainable Fuels

Buildings

- Residential buildings
- Commercial buildings

Heat

Industry

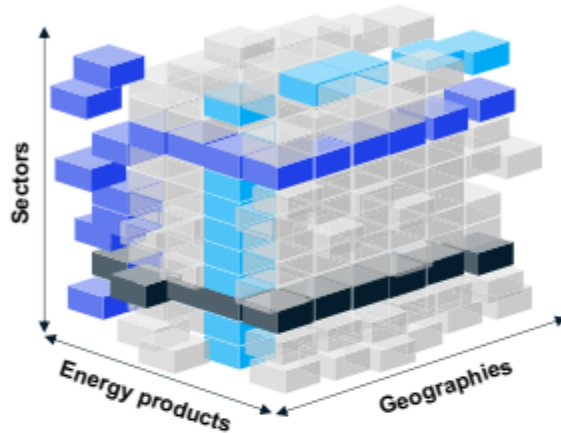
- Iron and steel
- Chemicals
- Manufacturing
- Mining
- Refining
- Other industry

CCUS

Power

- Electricity generation
- Hydrogen production

Hydrogen Supply



70+ energy products

- Natural gas
- Coal
- Oil products (eg, gasoline, diesel, and HFO)
- Renewable resources (eg, solar, wind, and hydro)
- Sustainable fuels (eg, HVO, SAF)
- Electricity
- Hydrogen

146 countries

- 45 in Asia
- 43 in Europe
- 31 in Africa
- 27 in the Americas

Builds on 20+ state-of-the-art McKinsey assets, including:

McKinsey Hydrogen Model

Combines energy and hydrogen demand projections with country-specific supply-cost dynamics. Models detailed cost outlooks for underlying technologies such as electrolyzers, SMR, RES cost decline, and CCUS

McKinsey Sustainable Fuels Model

Provides global regulatory tracking and country-level demand outlooks for more than ten bio/synfuel types (eg, advanced HVO, PtL SAF, drop-in bio/synfuel gasoline), along with advanced fuels project database, feedstock availability, and production cost models

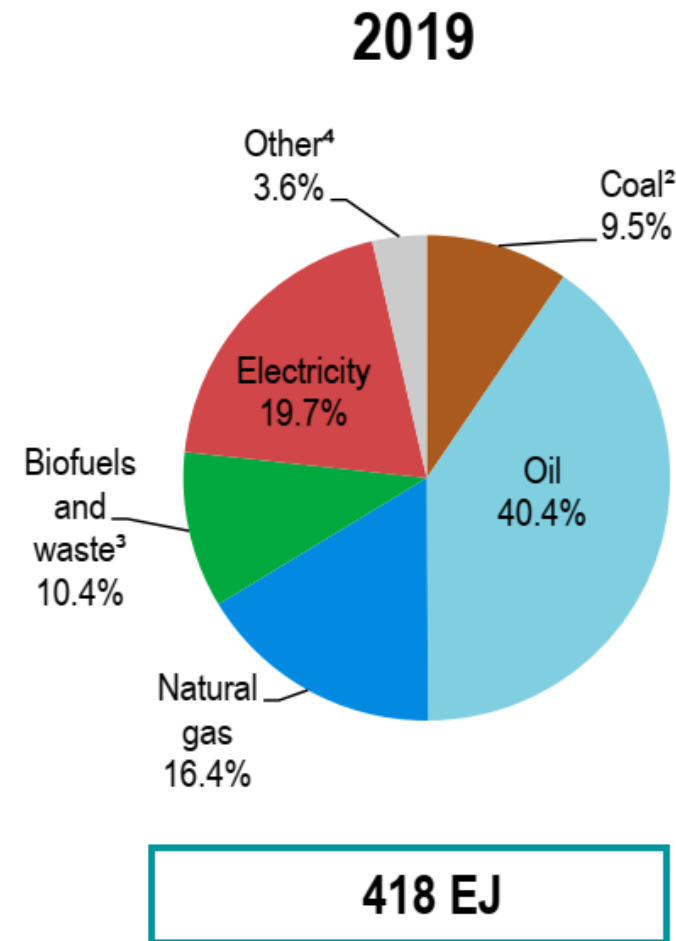
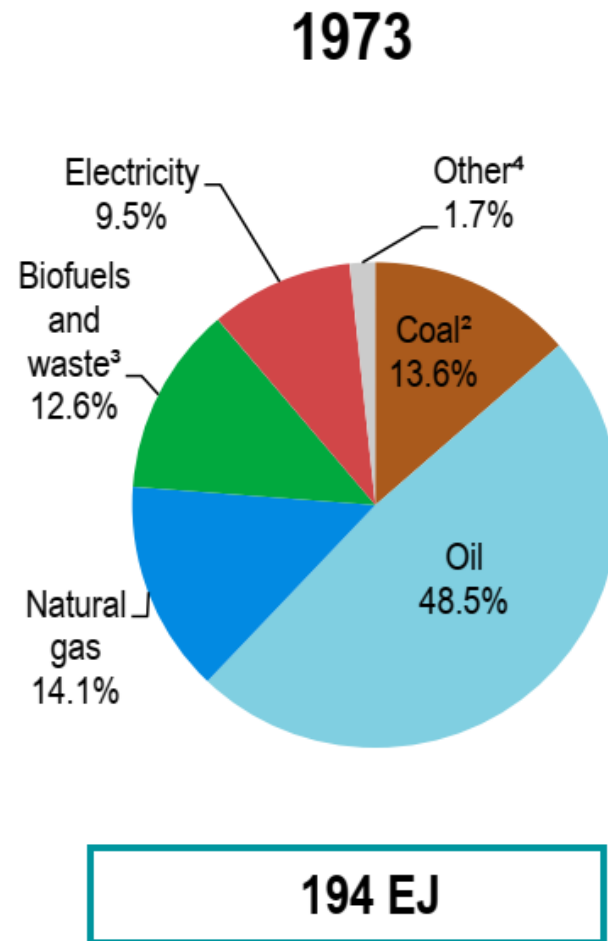
McKinsey Power Model

Projects capacity additions in the power sector and simulates dispatching decisions based on system-cost optimization. Captures more than 80% of global power demand at the country and subcountry level and models at an hourly granularity

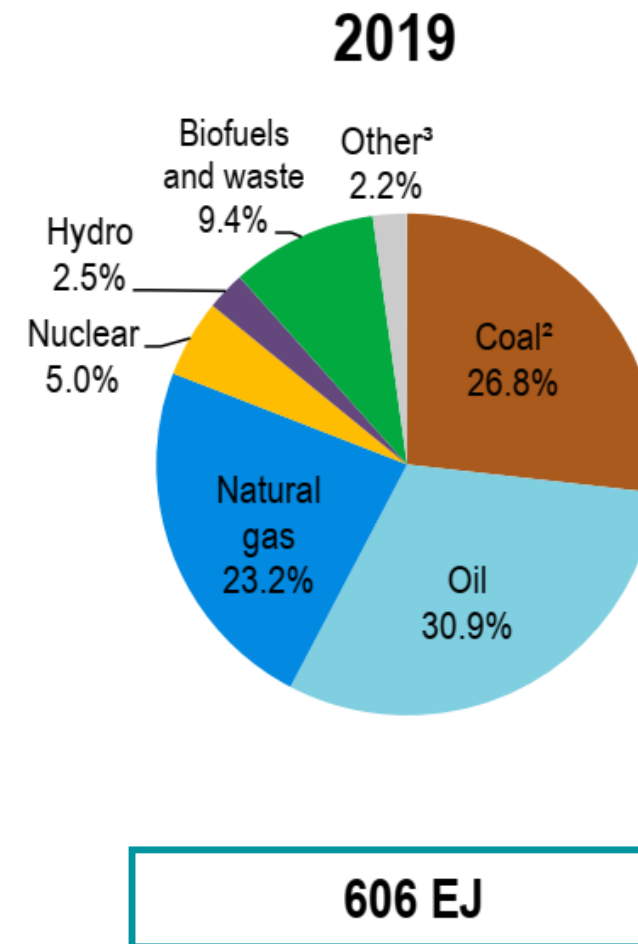
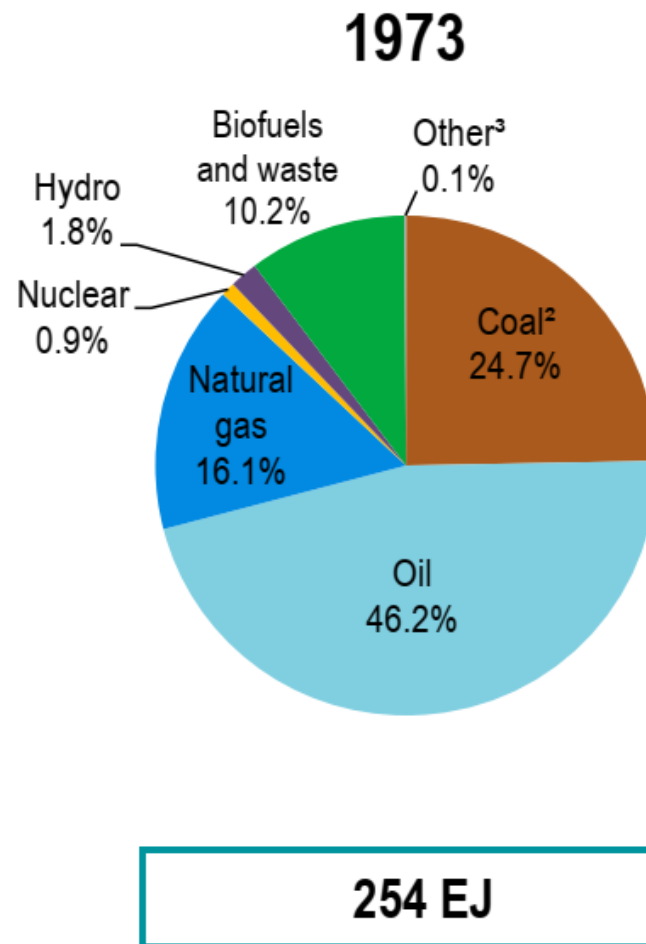
McKinsey e-Trucks TCO Model

Assesses future evolution of commercial vehicle parc by country and vehicle class and projects powertrain mix development based on total cost of ownership. Incorporates views on the cost decline of battery- and hydrogen-fueled engines in e-trucks and efficiency improvements of ICE trucks

World Total Final Consumption by Source



World Total Energy Supply by Source

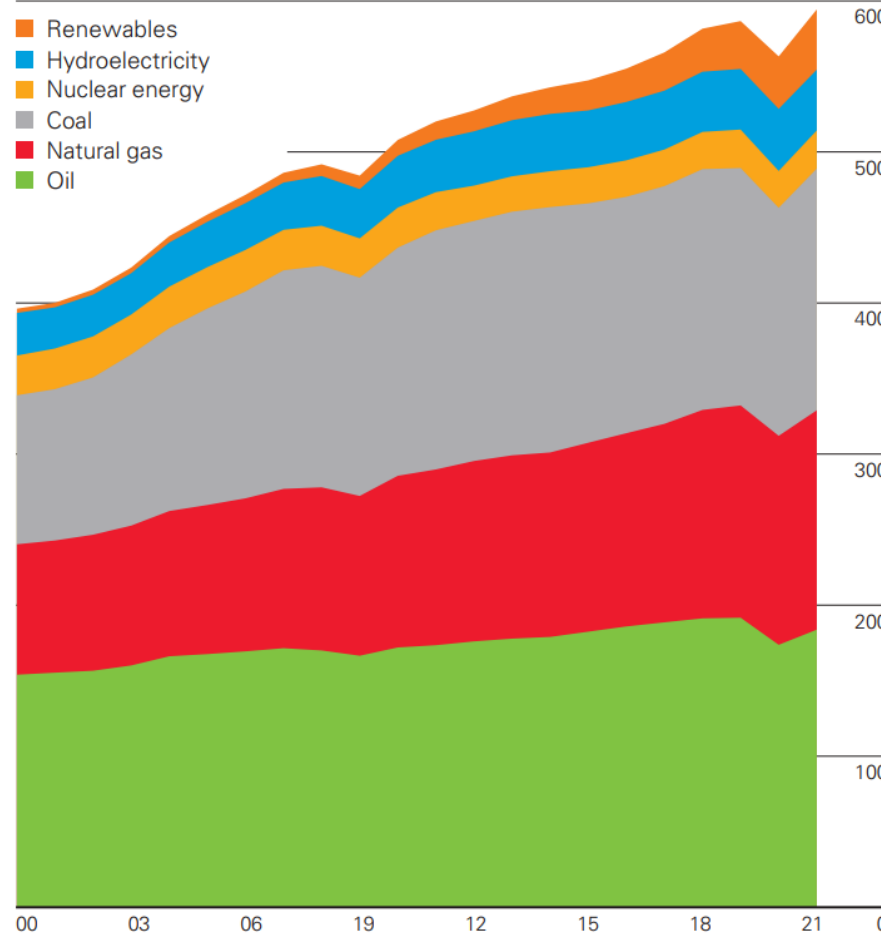


World Energy Consumption

World consumption

Exajoules

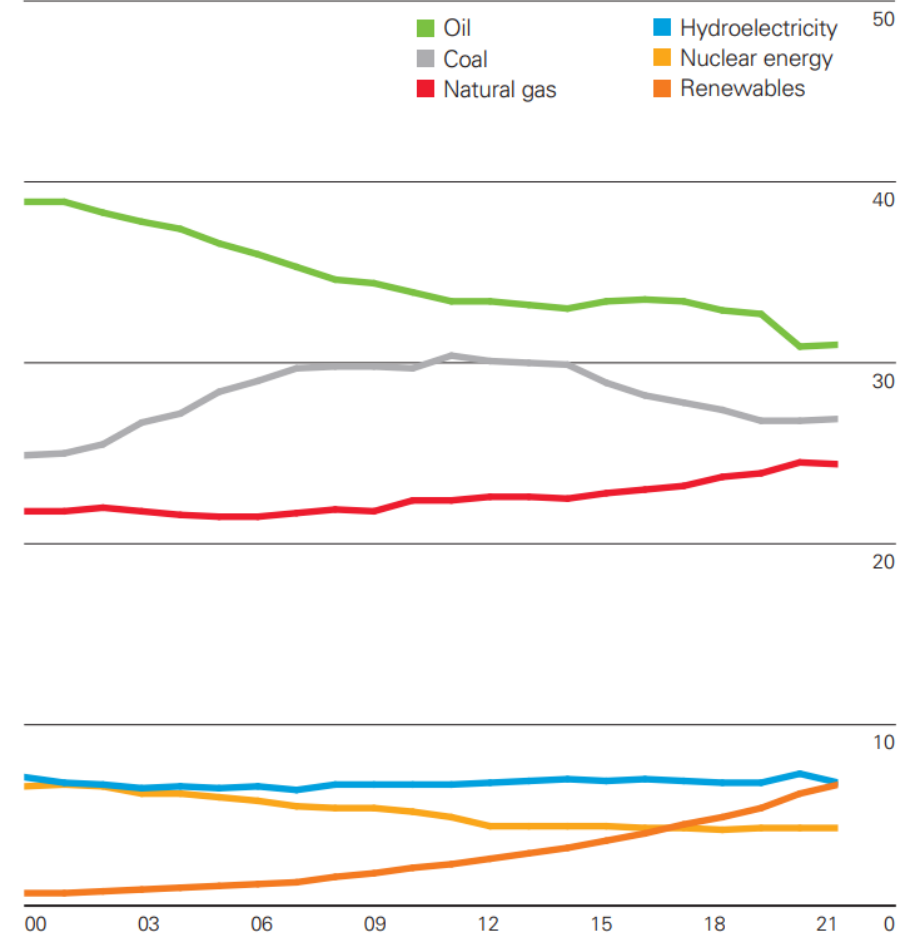
- Renewables
- Hydroelectricity
- Nuclear energy
- Coal
- Natural gas
- Oil



Shares of global primary energy

Percentage

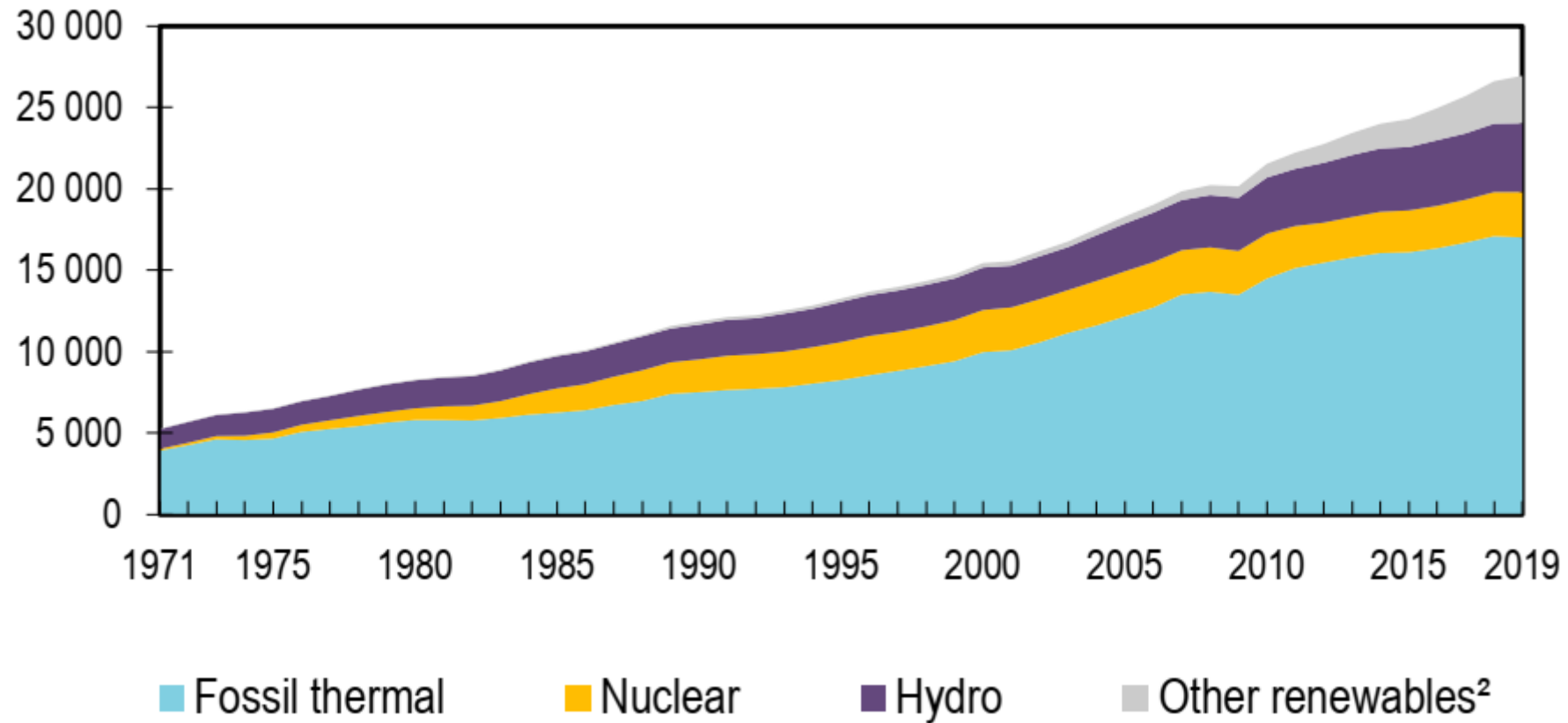
- Oil
- Coal
- Natural gas
- Hydroelectricity
- Nuclear energy
- Renewables



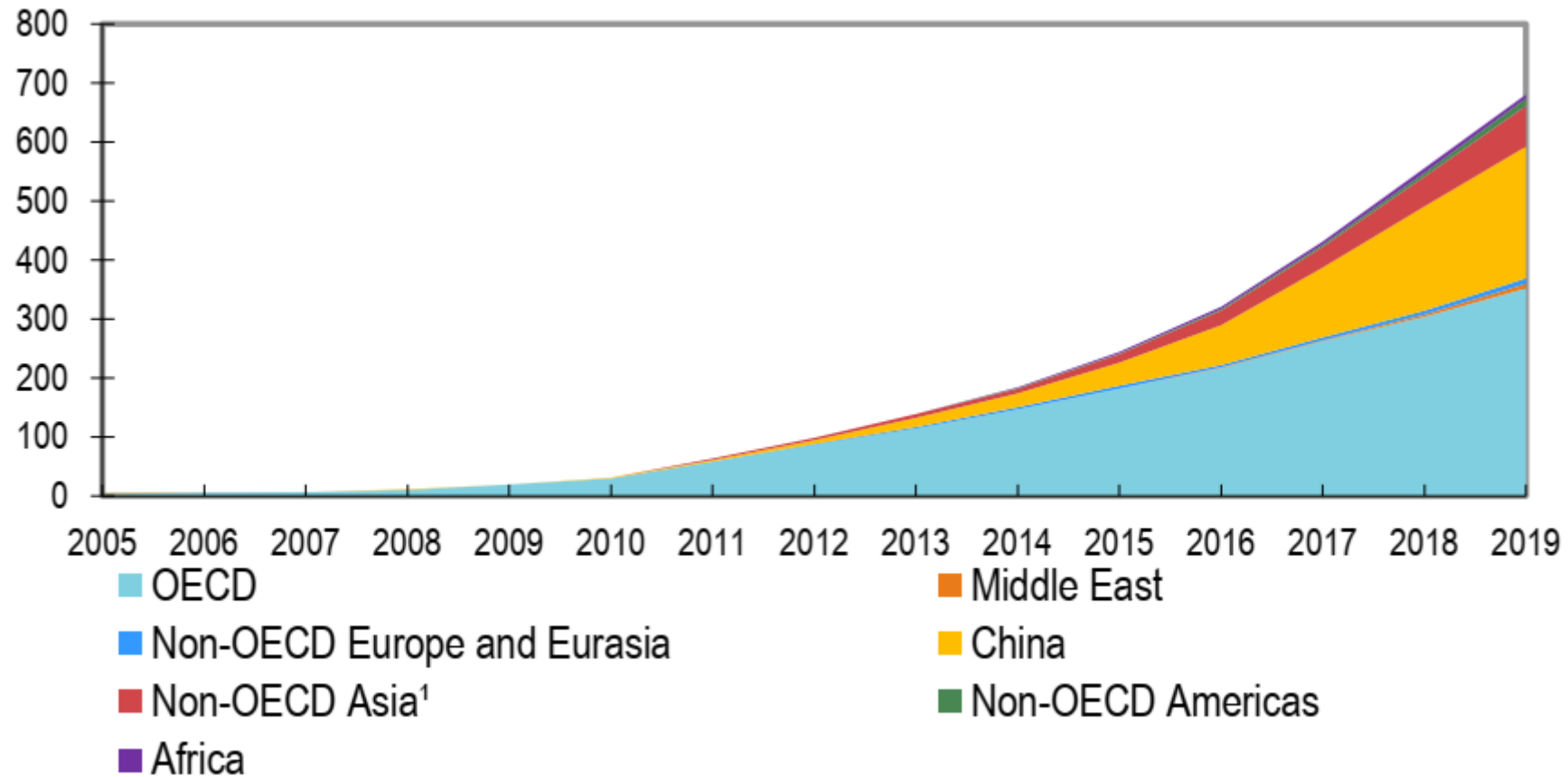
2. Electrification

To understand the role of renewable power and electric vehicles

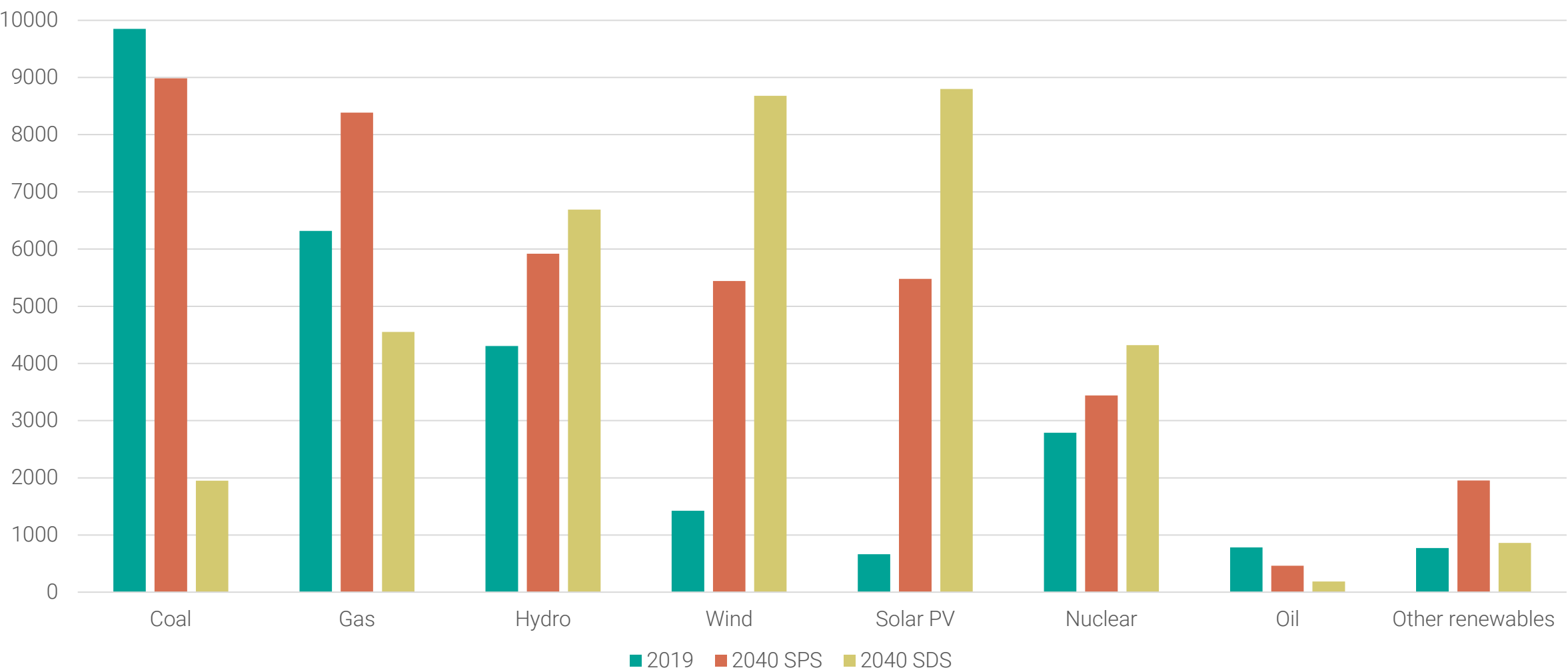
World Electricity Generation By Source (Twh)



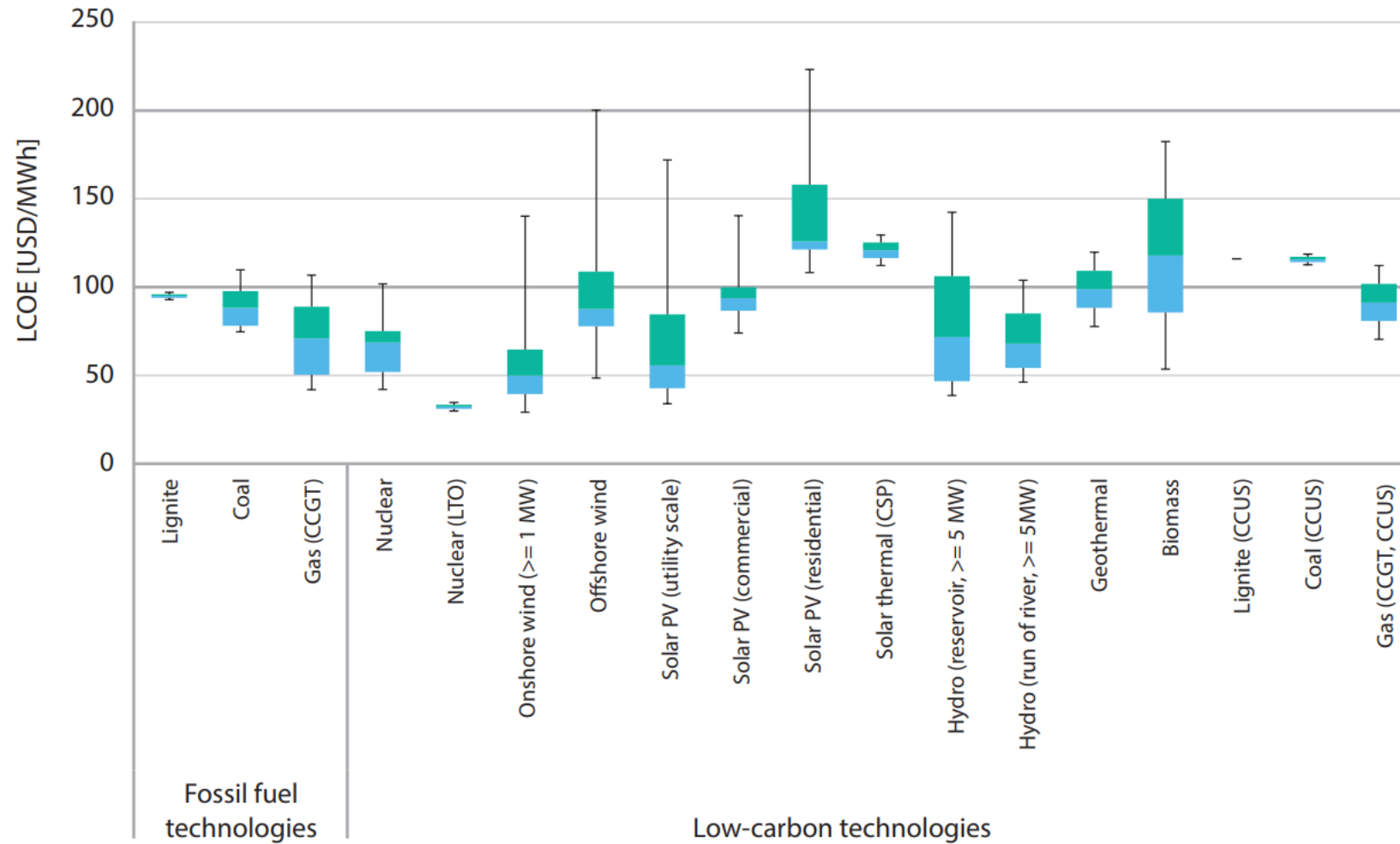
World Solar PV Electricity Production by Region (Twh)



Electricity Generation (TWh)

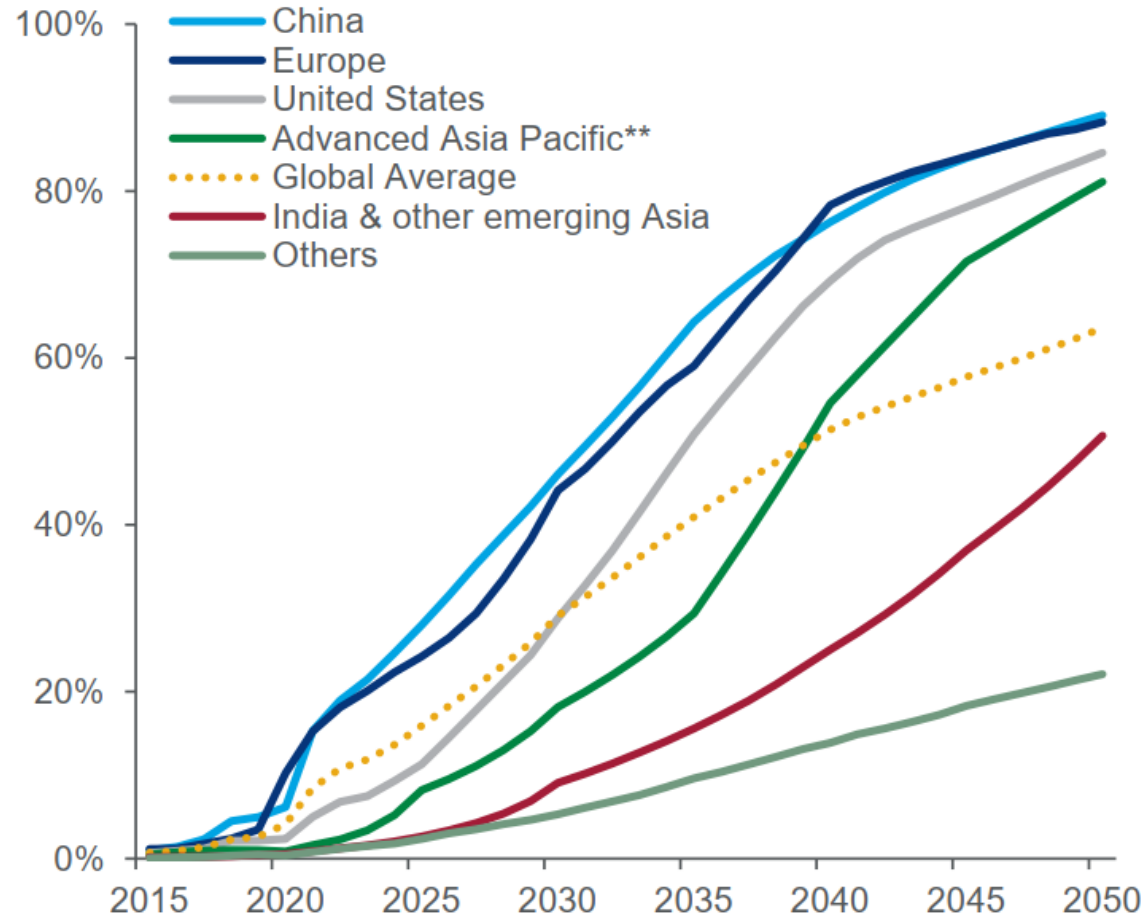


LCOE by Technology

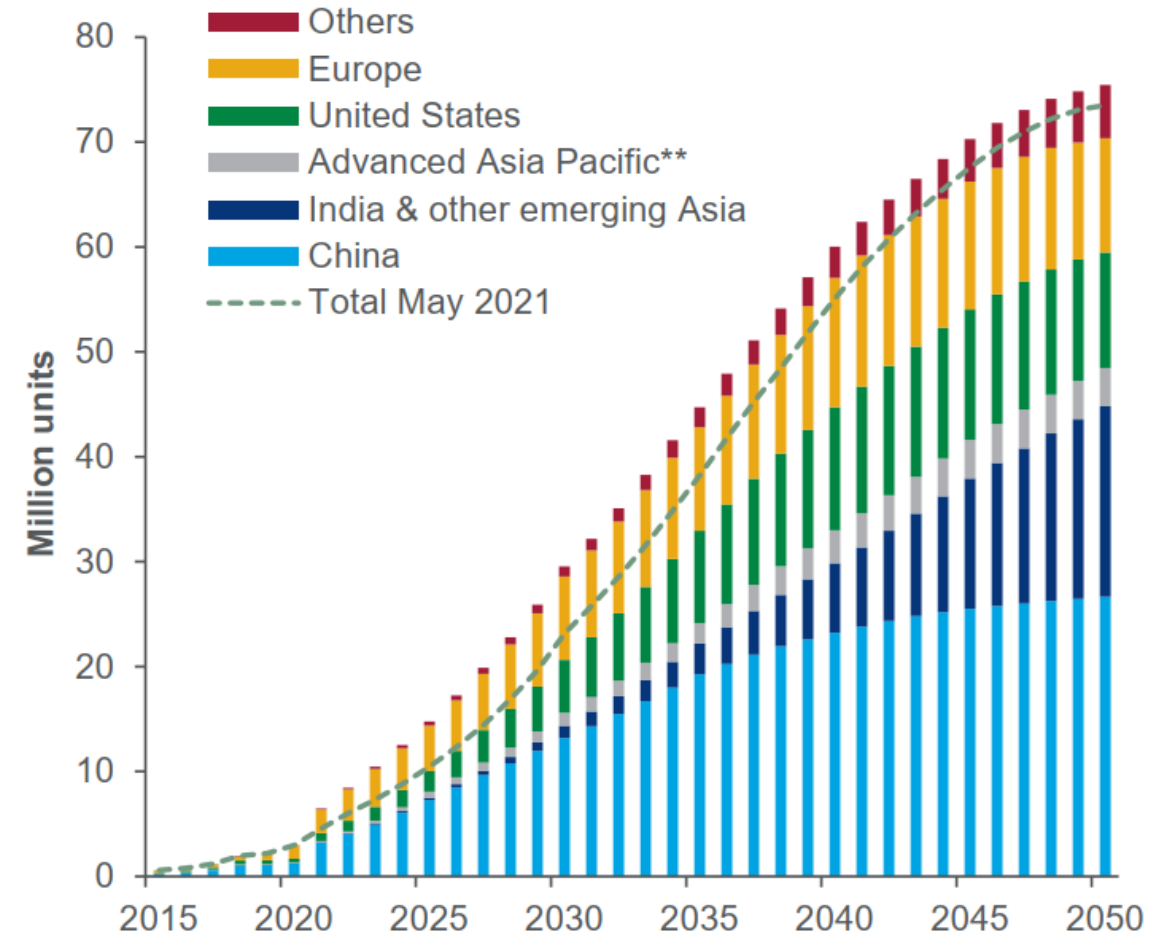


Global EV Sales

EV* share of light vehicles sales



Global EV* sales

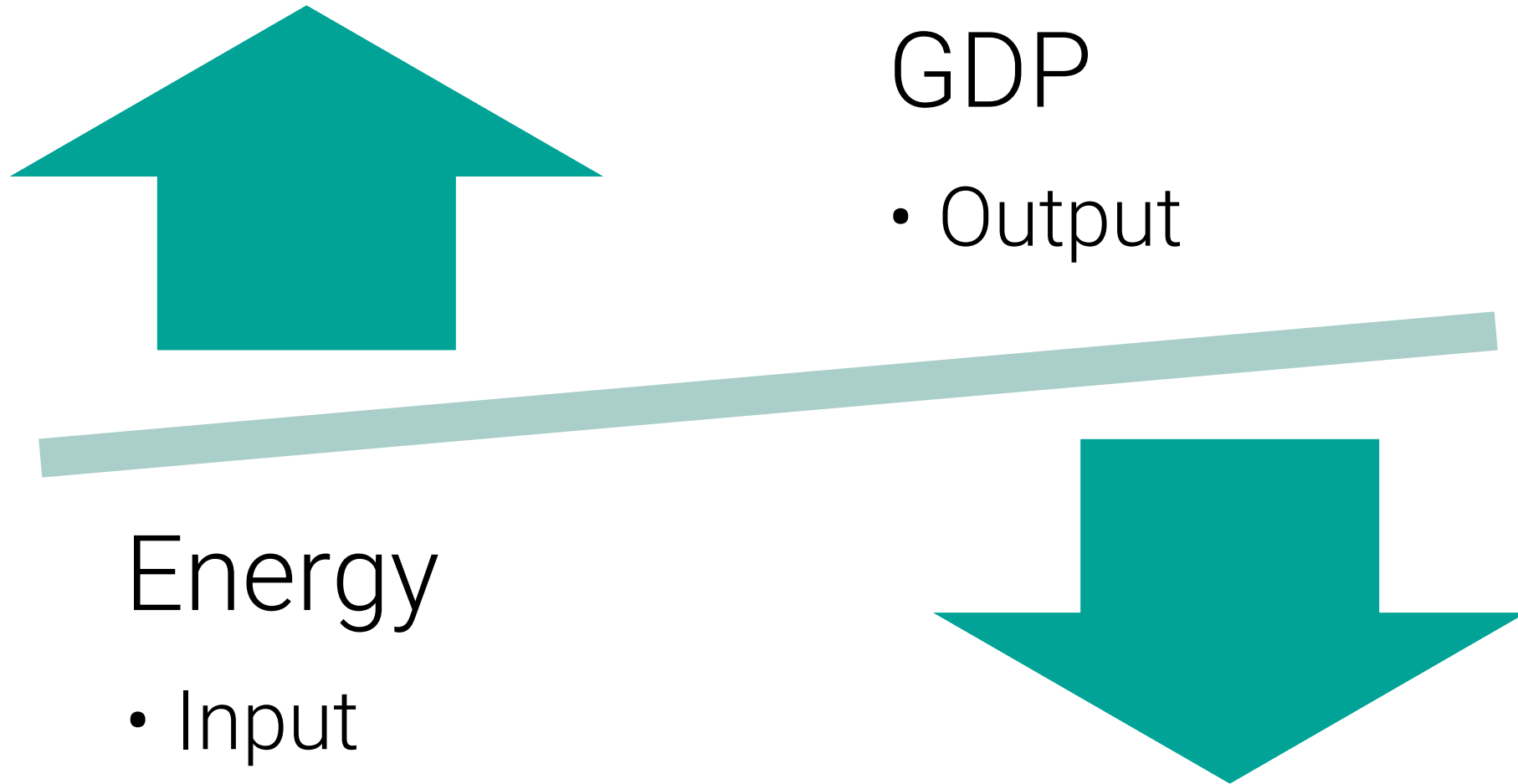


Wood Mackenzie Macro Oils long-term November 2021 outlook to 2050

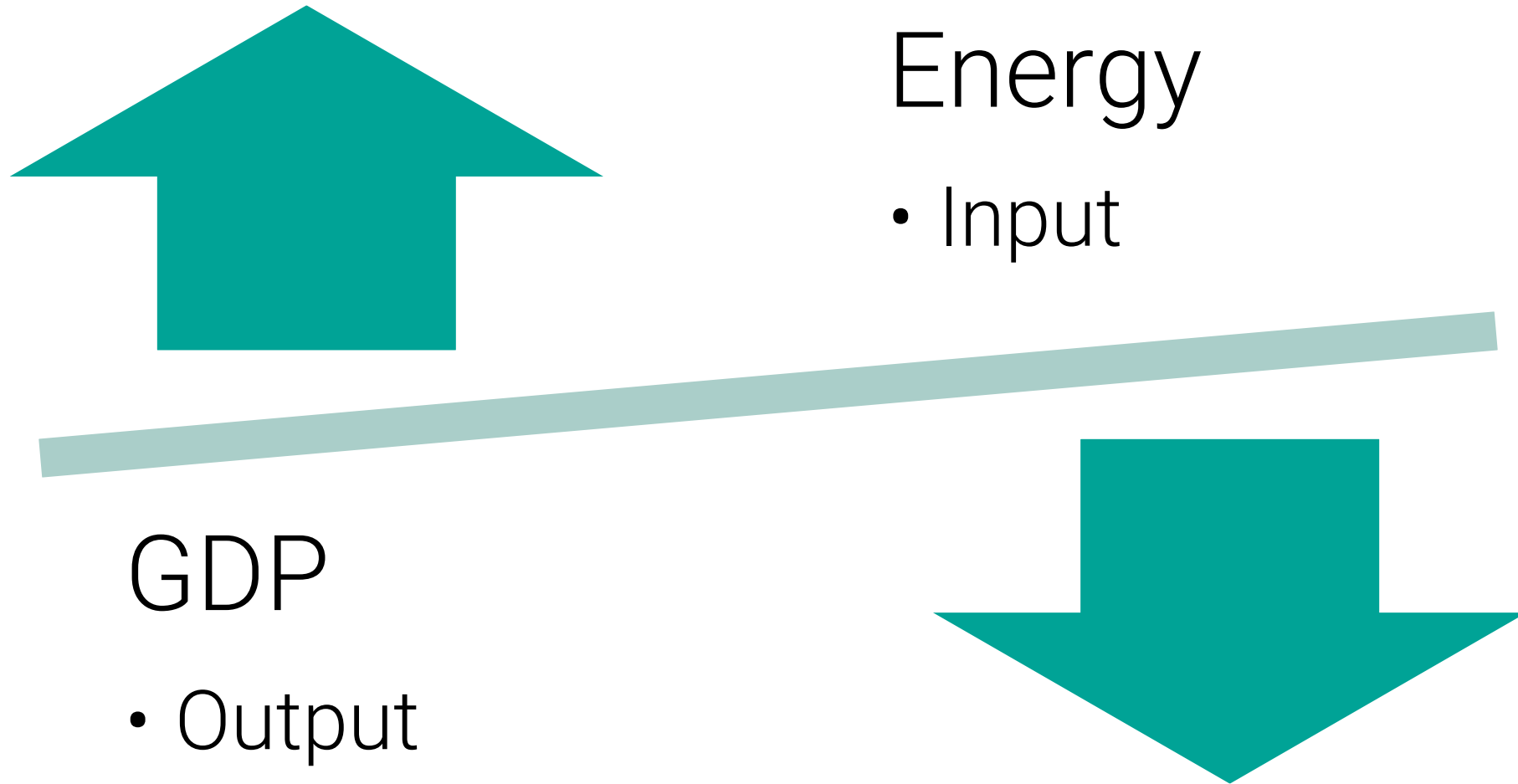
3. Efficiency

To provide an overview of scale and importance of energy efficiency in energy transition

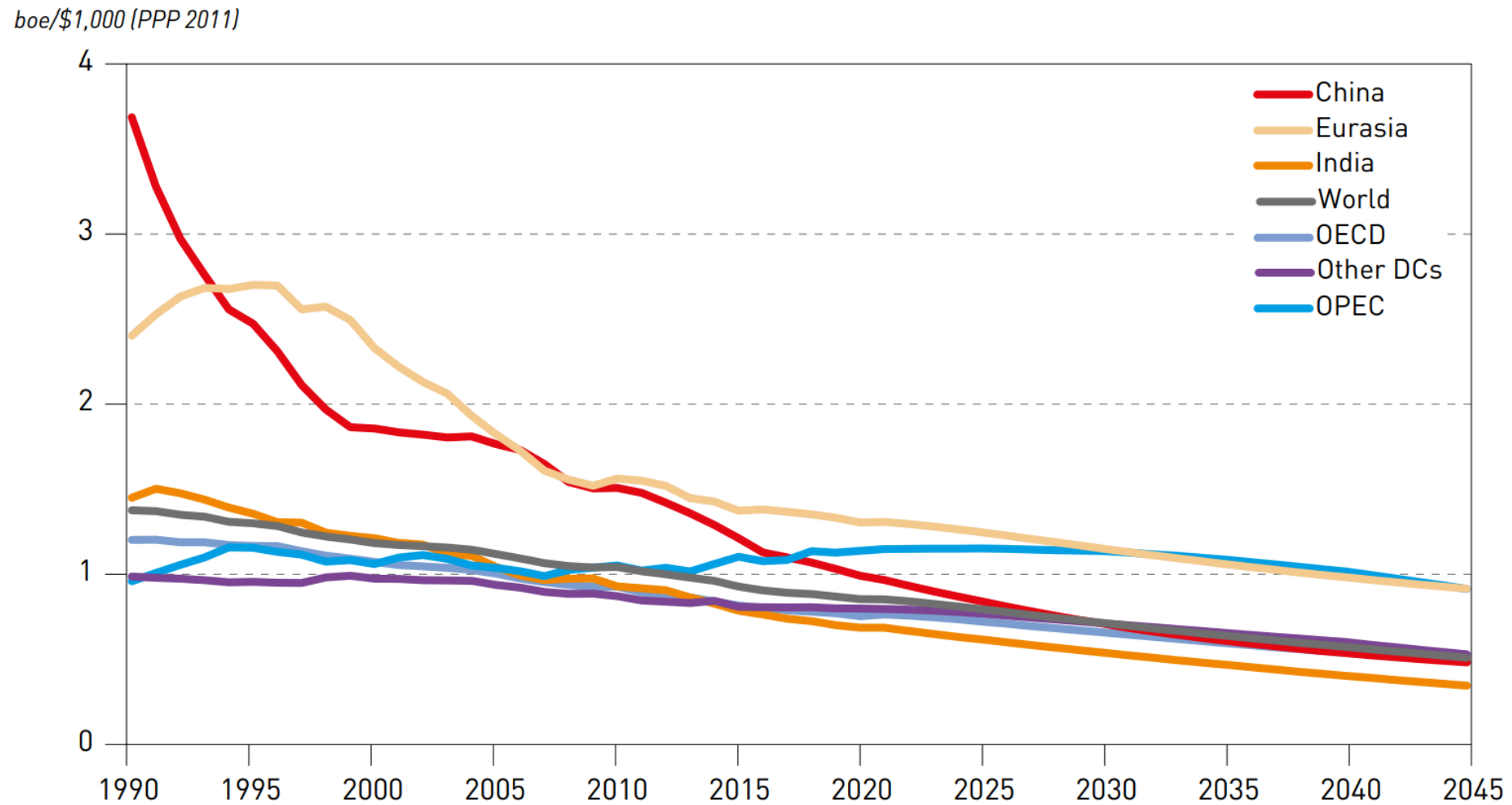
Productivity Increase



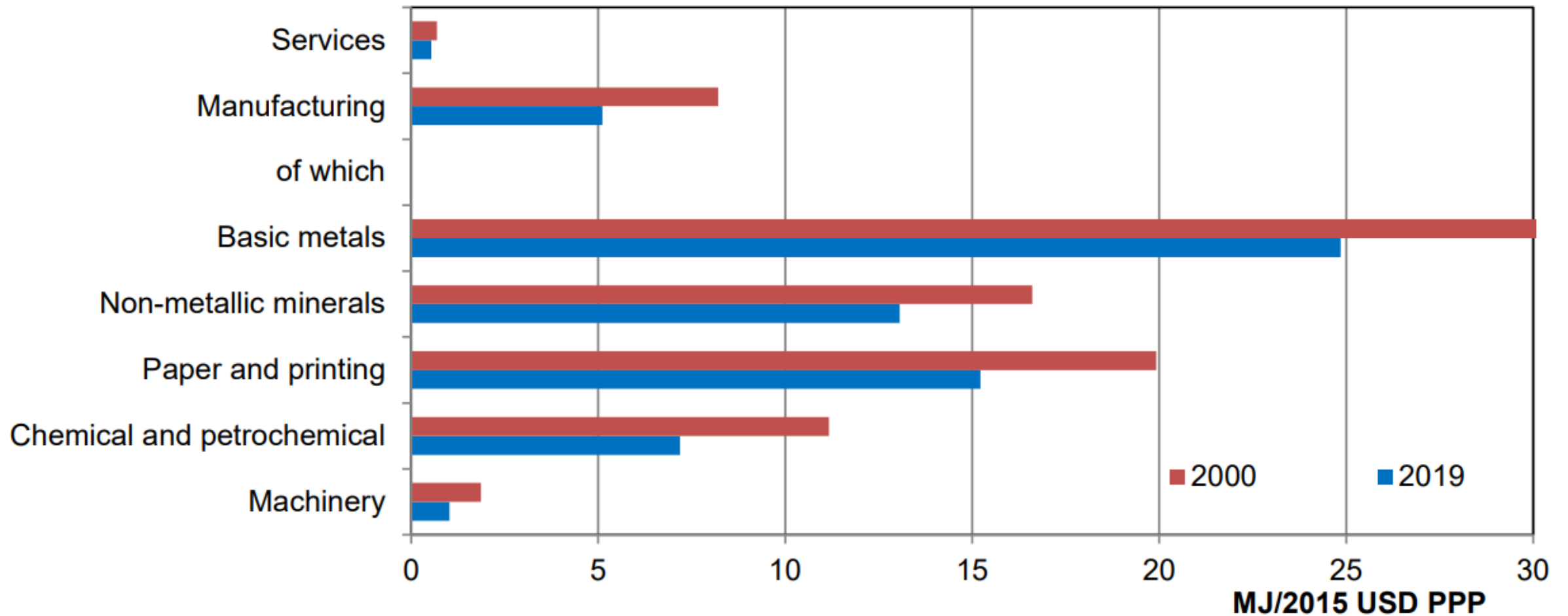
Energy Intensity



Energy Intensity



Services and Manufacturing in Selected IEA Countries: Energy Per Value Added



4. Peak Oil

To present two definitions of peak oil: the old and the new one

Peak Oil

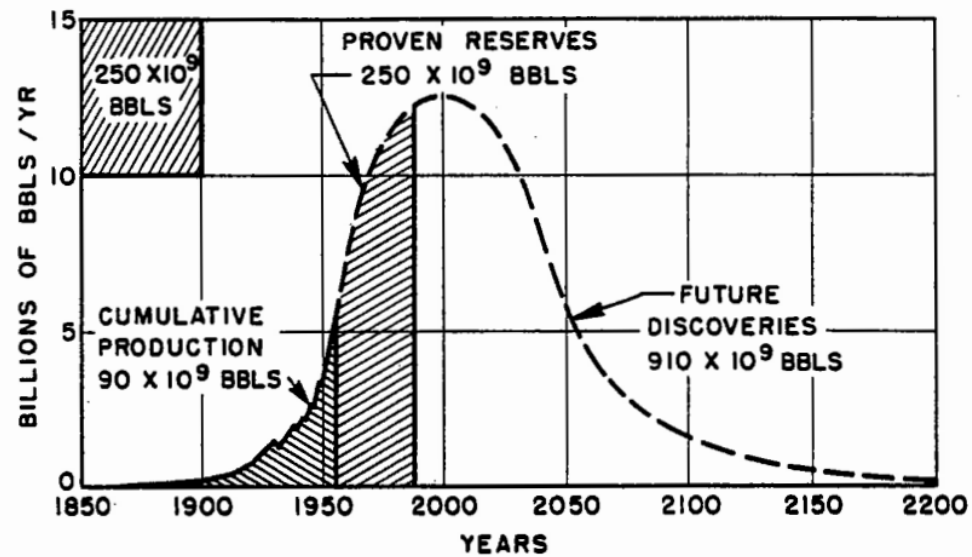


Figure 20 - Ultimate world crude-oil production based upon initial reserves of 1250 billion barrels.

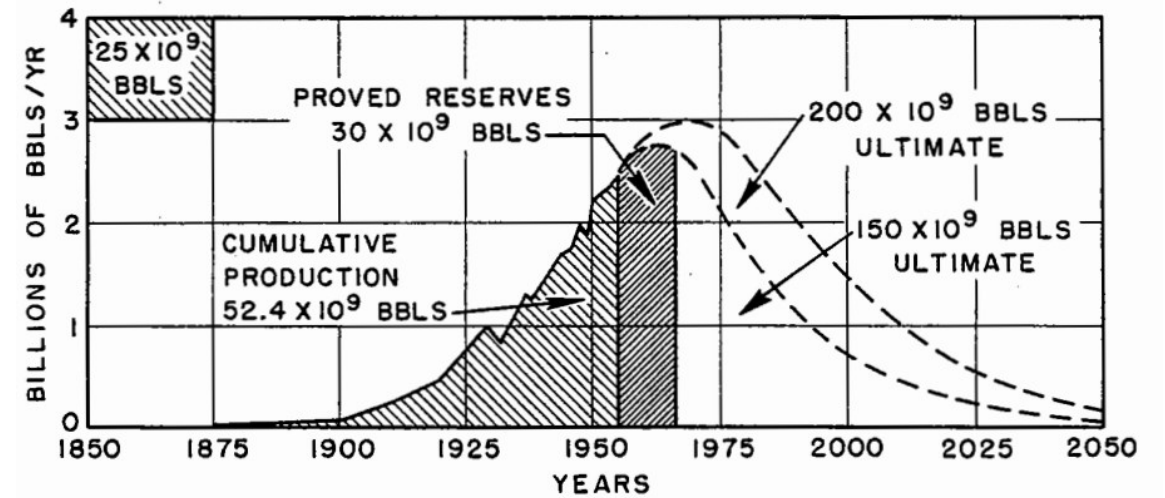


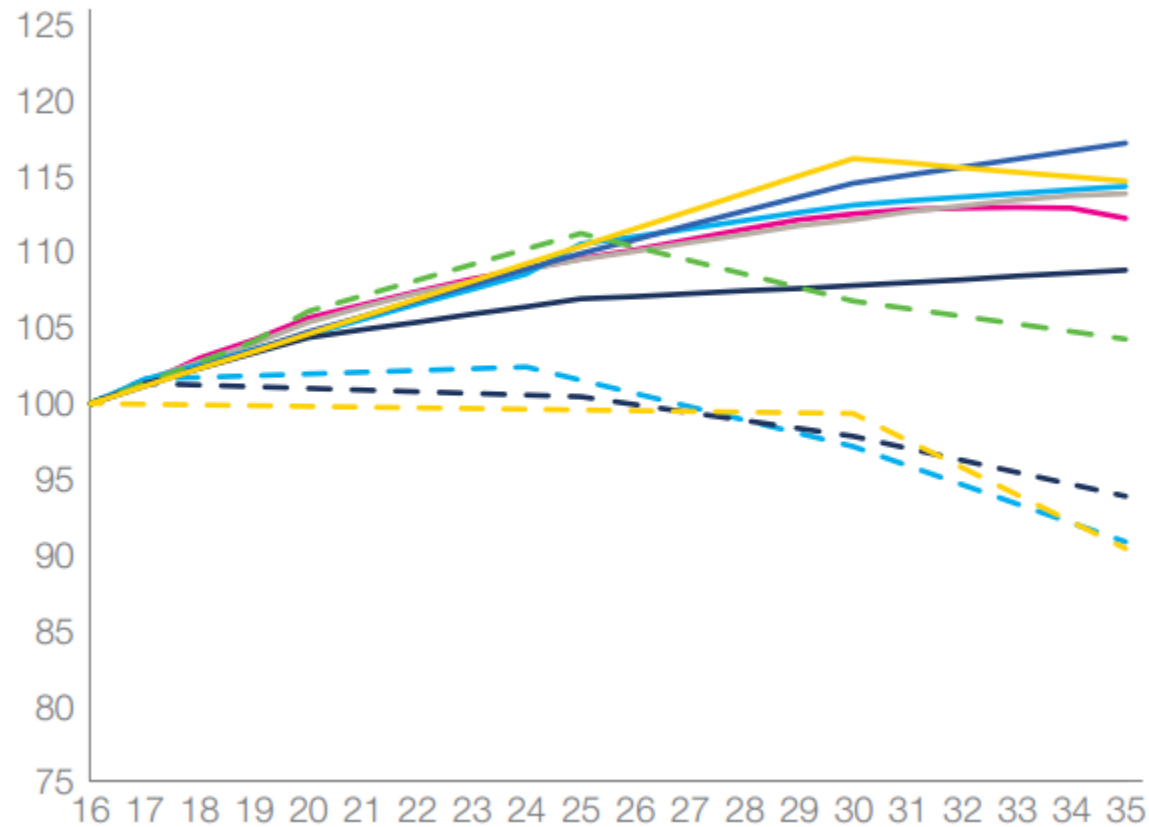
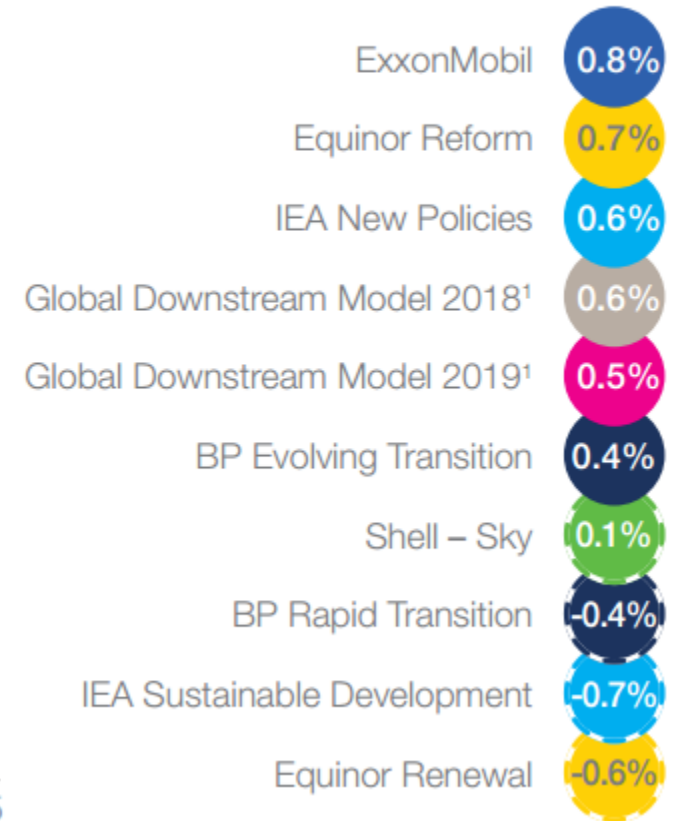
Figure 21 - Ultimate United States crude-oil production based on assumed initial reserves of 150 and 200 billion barrels.

Peak Oil Scenarios

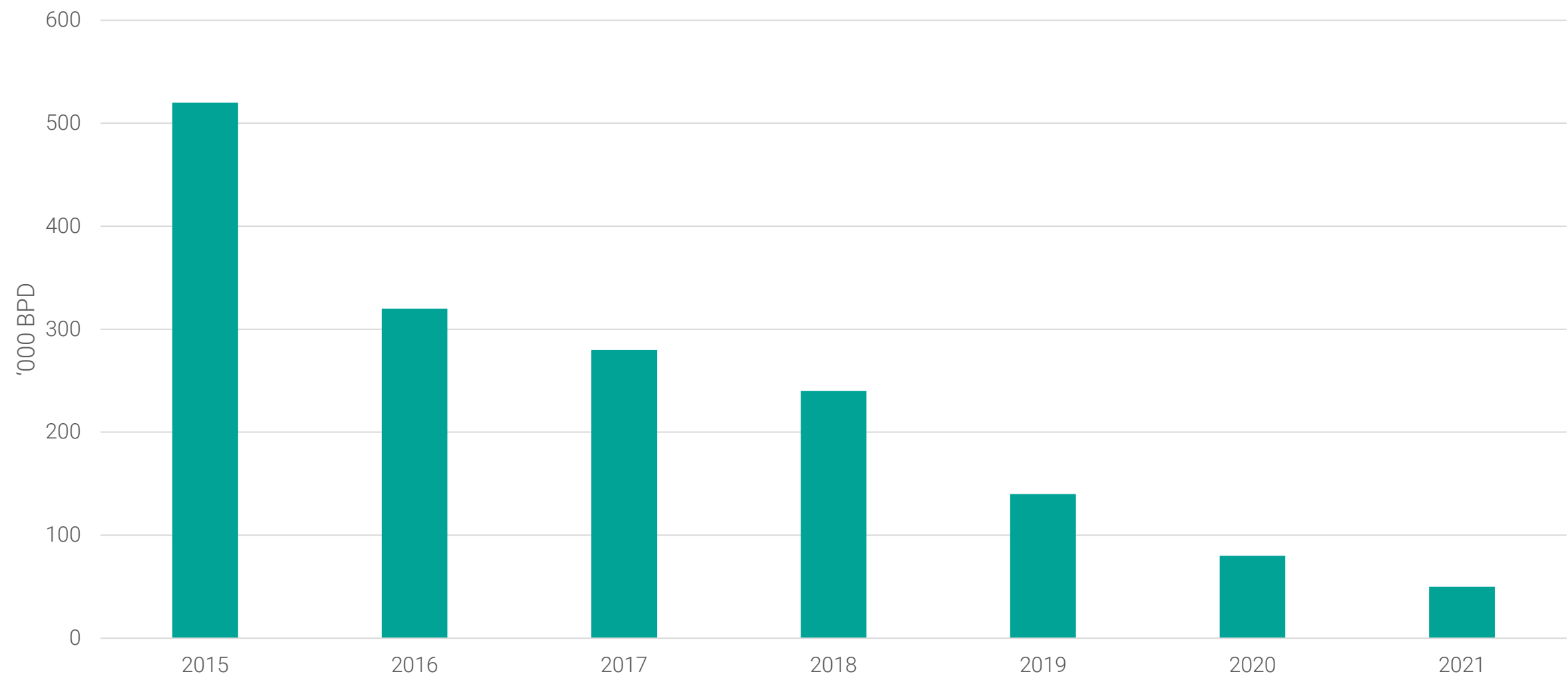
Global oil demand¹

Indexed to 100

— Reference case forecasts -- Sustainability cases

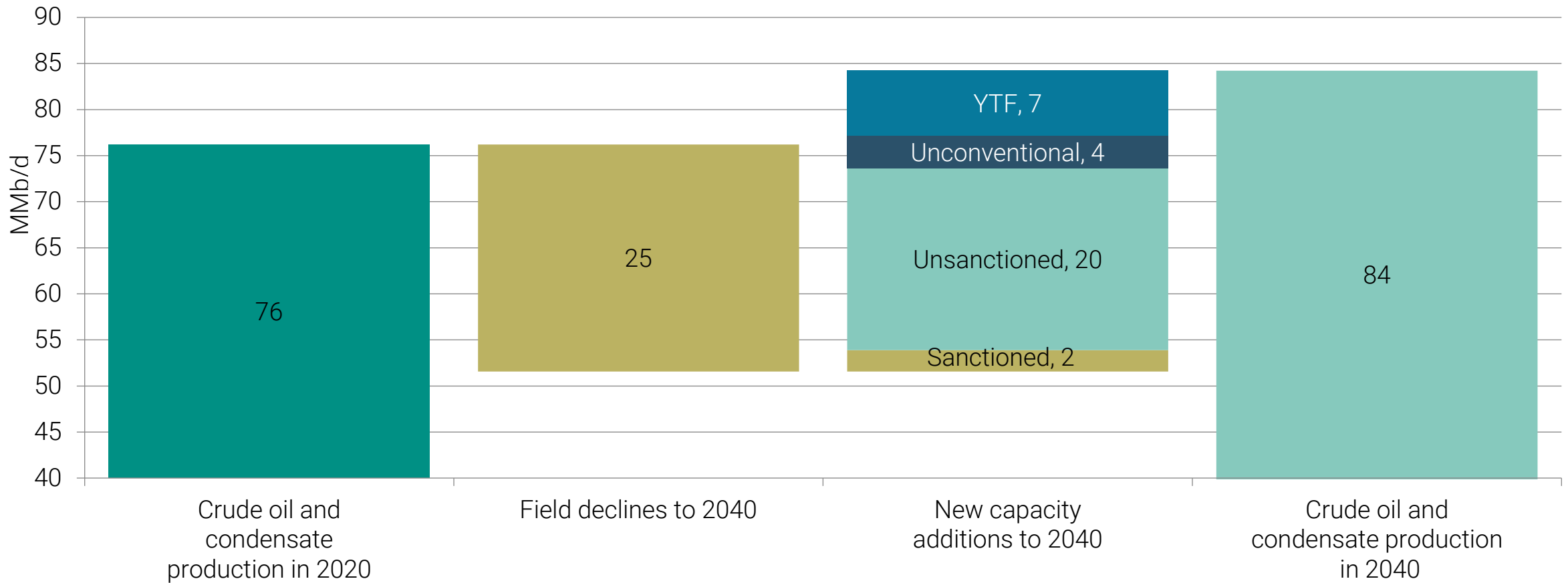
CAGR
2018-35

Average Annual Oil Demand Growth in OPEC WOO for Period 2035–2040

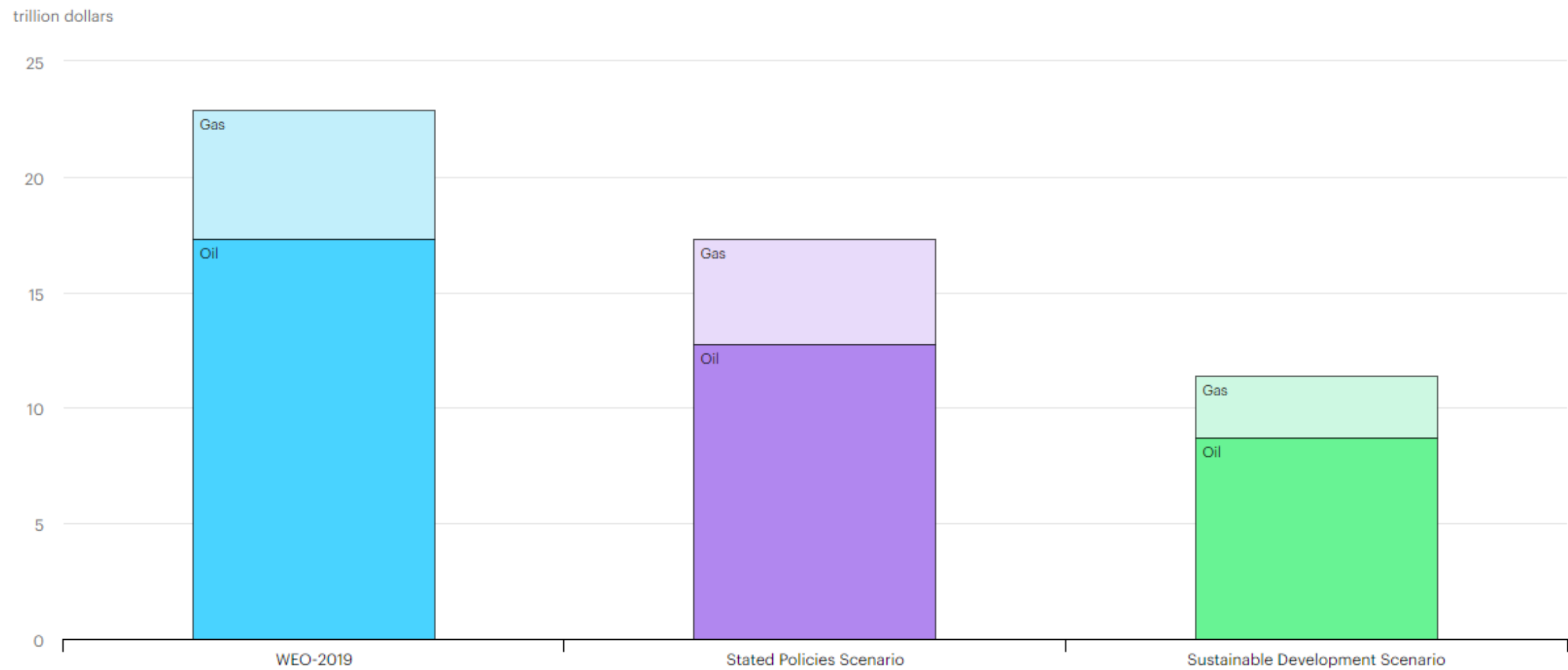


OPEC World Oil Outlook 2021

Global Crude Oil and Condensate Outlook Balance in 2040



Estimated Present Value of Future Oil and Natural Gas Production to 2040

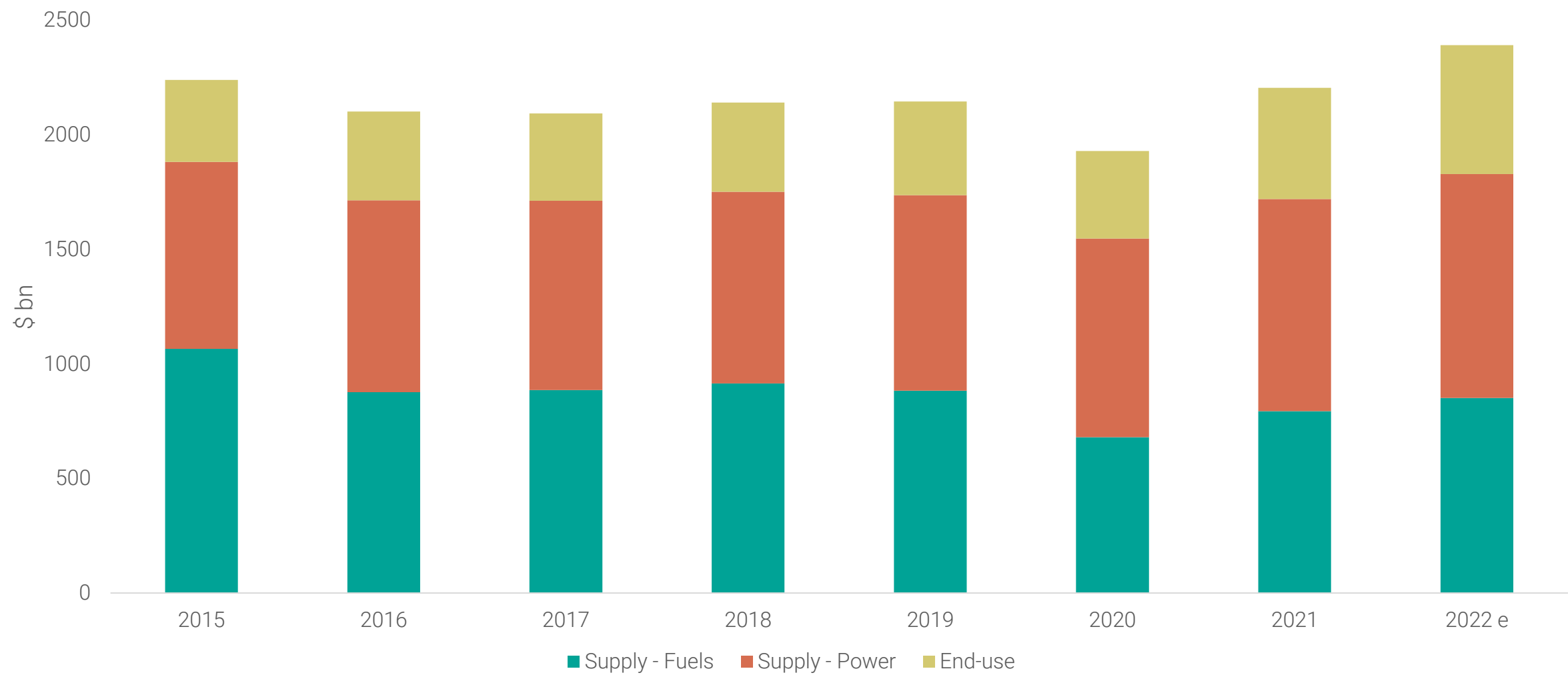


IEA World Energy Outlook 2020

5. Investment

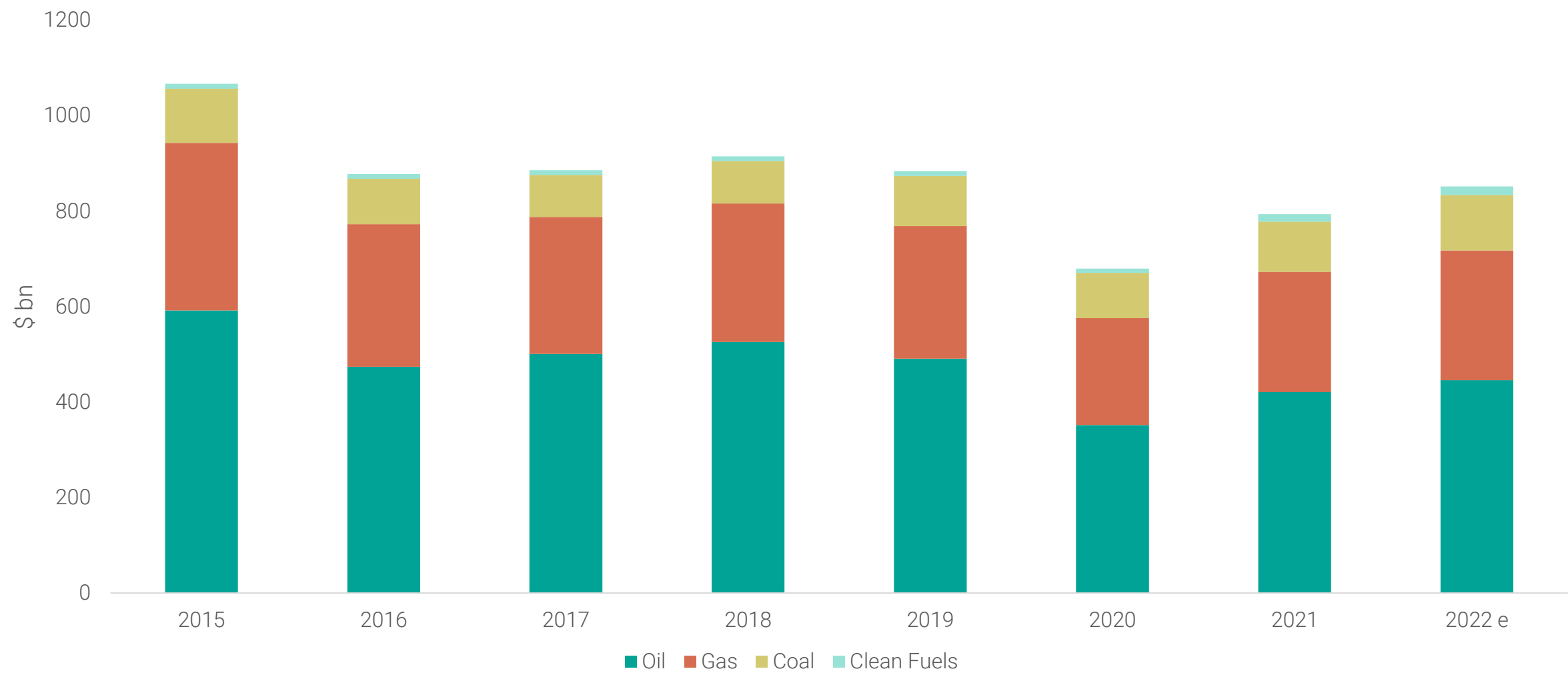
To understand key trends in global energy investment, with specific focus on upstream oil and gas industry

World Energy Investment Trend



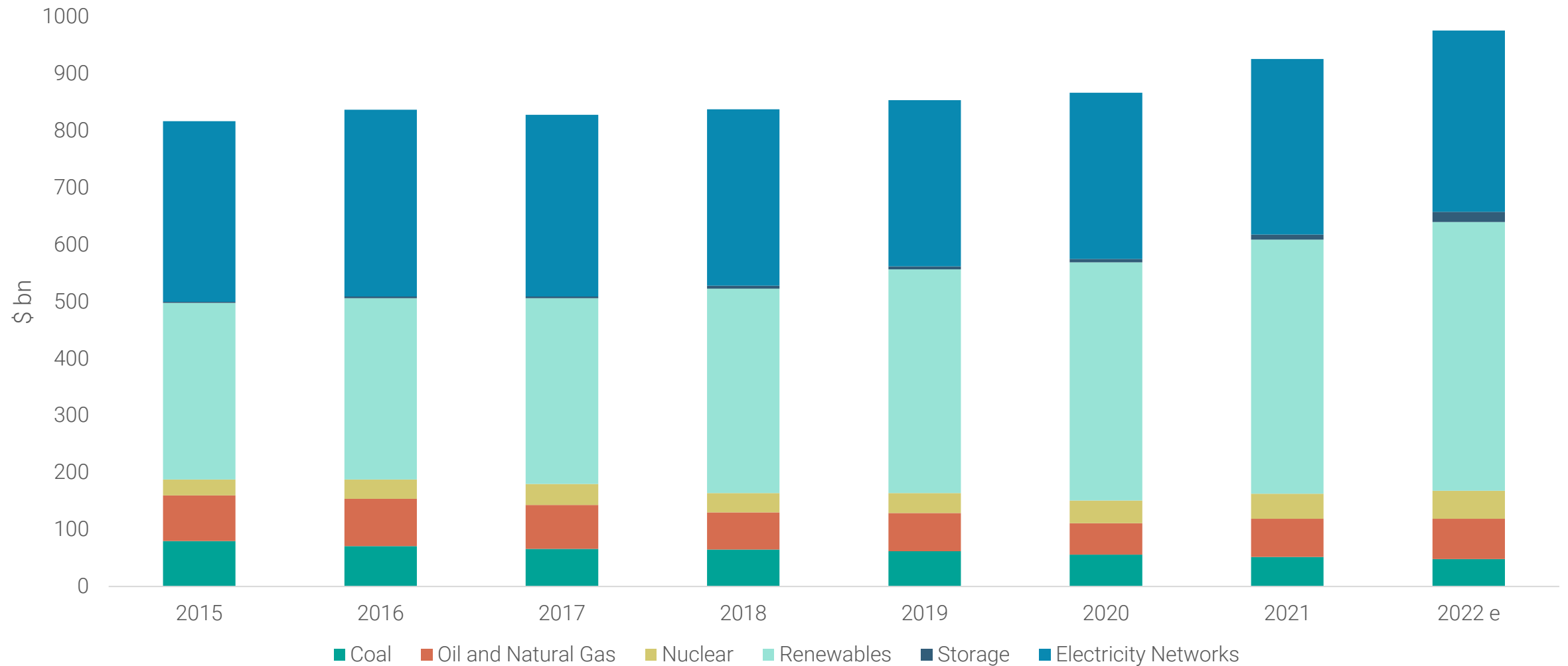
IEA World Energy Investment 2022

Investment in Fuels Supply

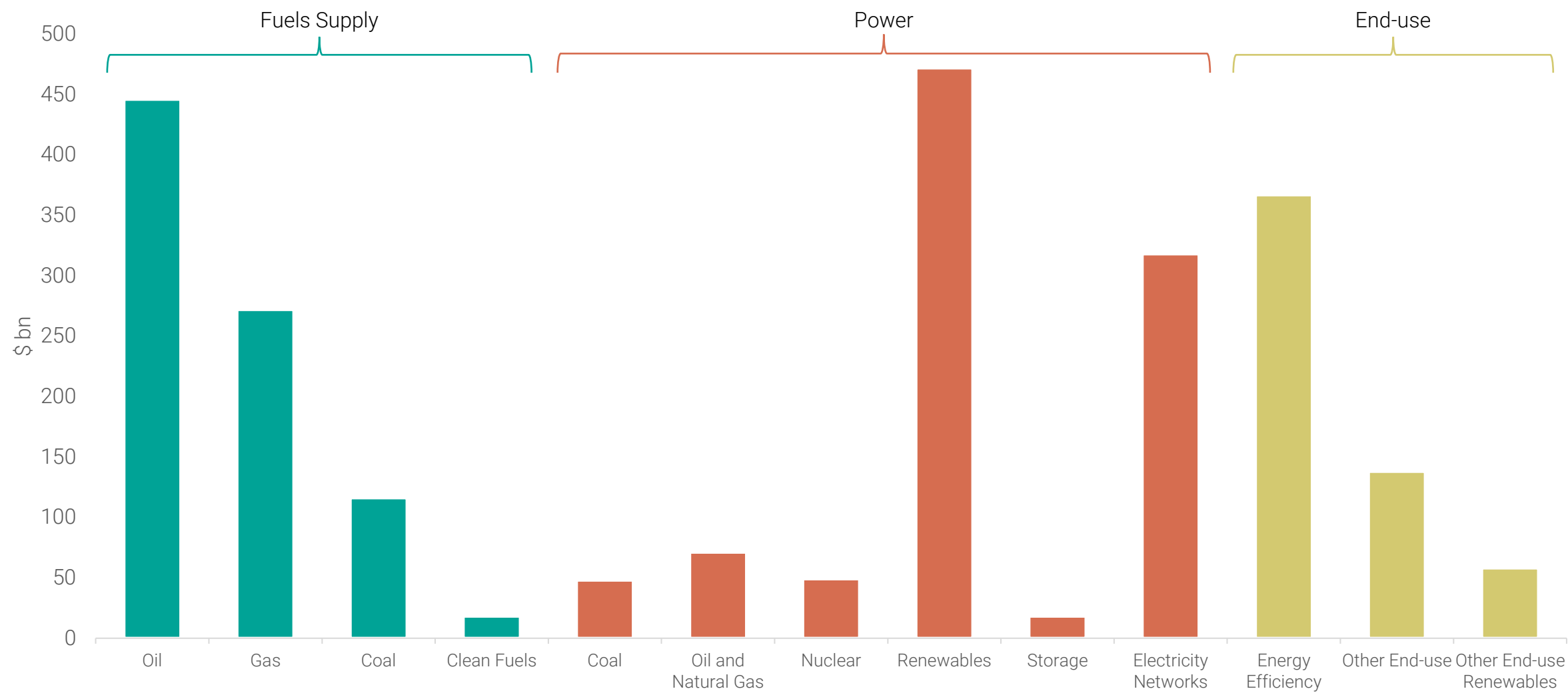


IEA World Energy Investment 2022

Investment in Power Supply

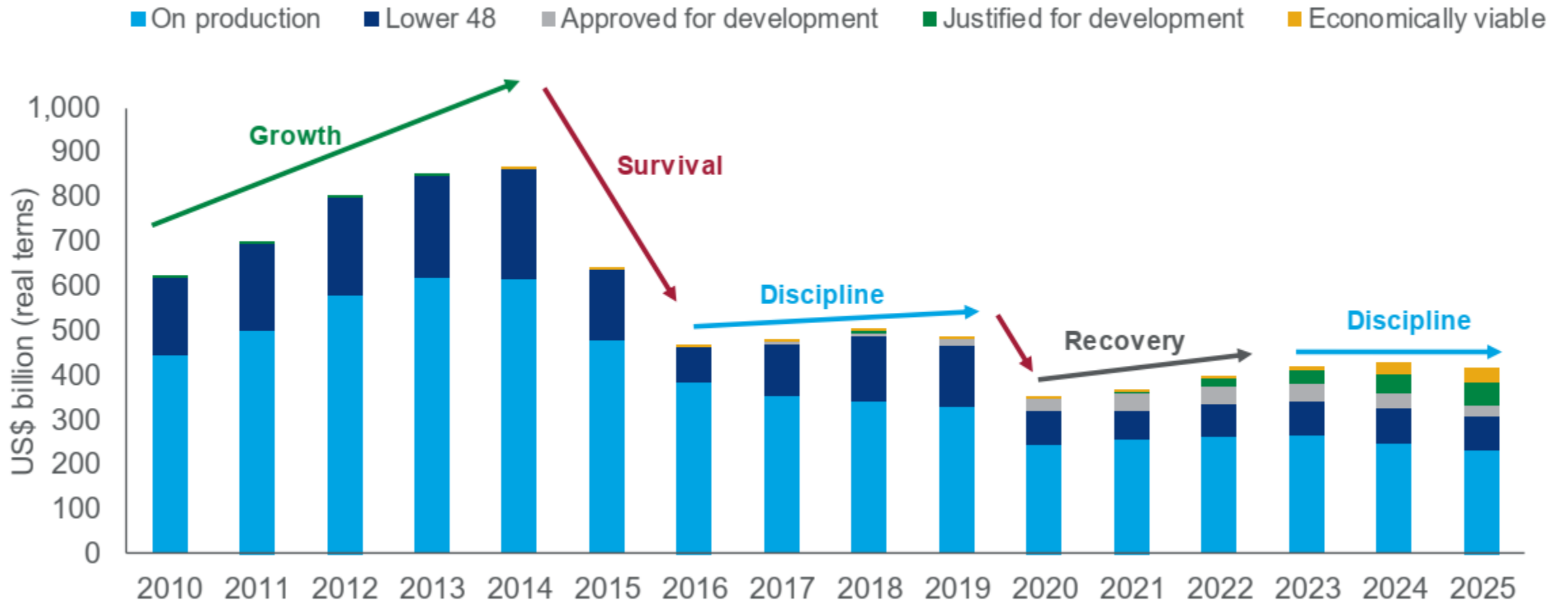


Overview of Energy Investment



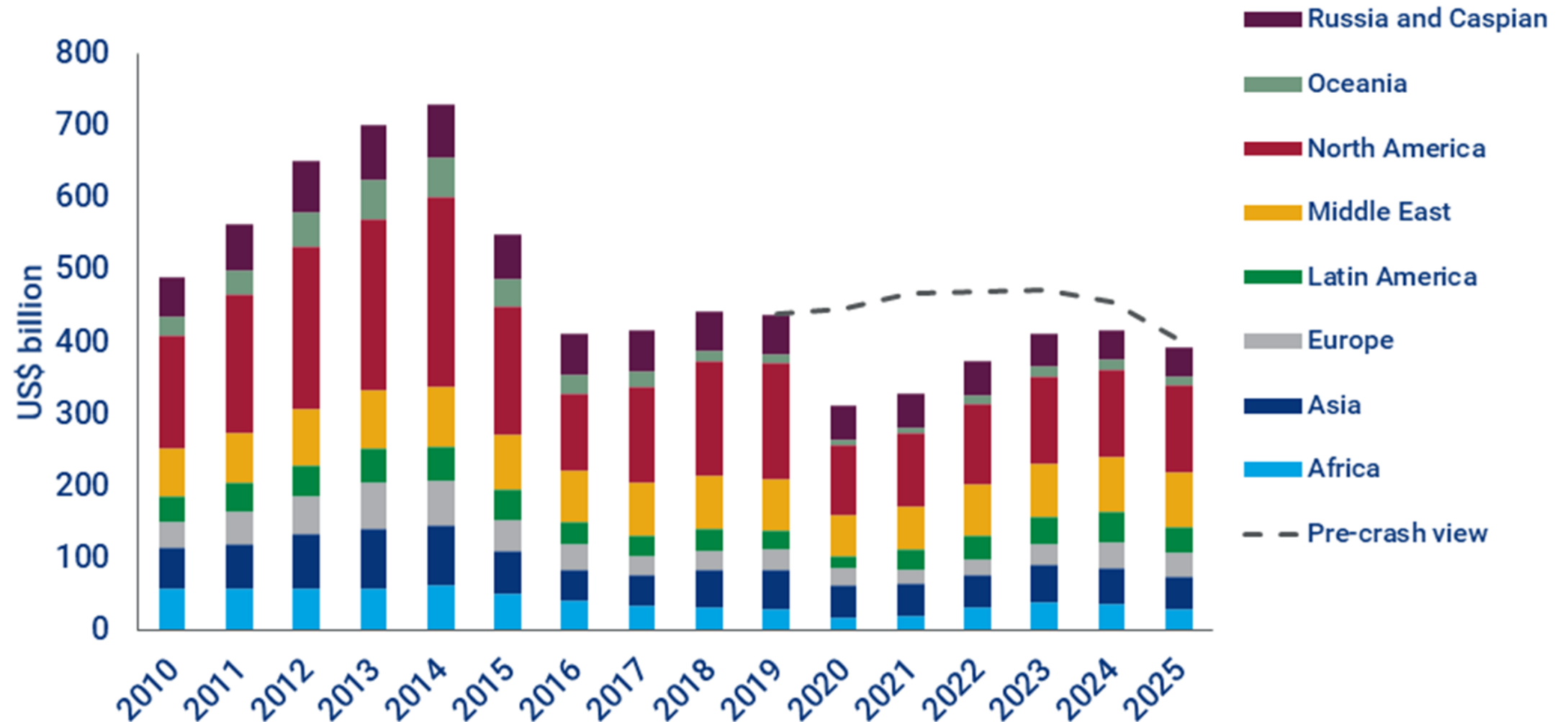
IEA World Energy Investment 2022

Upstream Development Capex



Wood Mackenzie How much does the oil and gas industry need to spend?

World Upstream Investment by Region

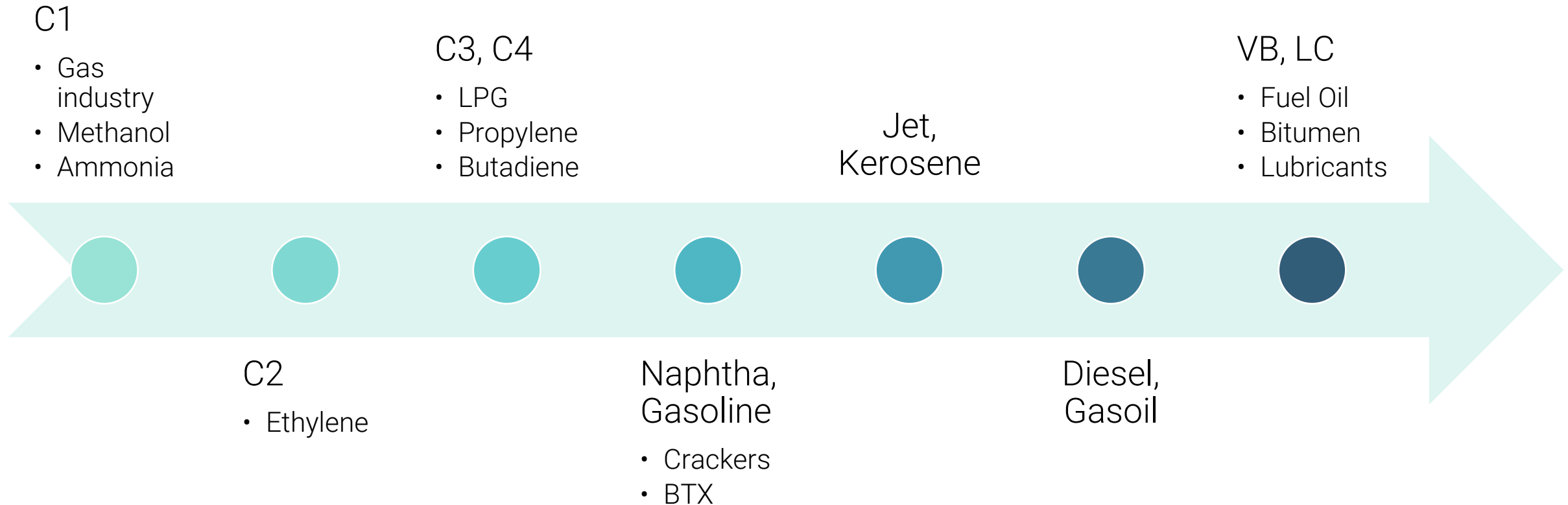


Wood Mackenzie Competing for capital in a downcycle

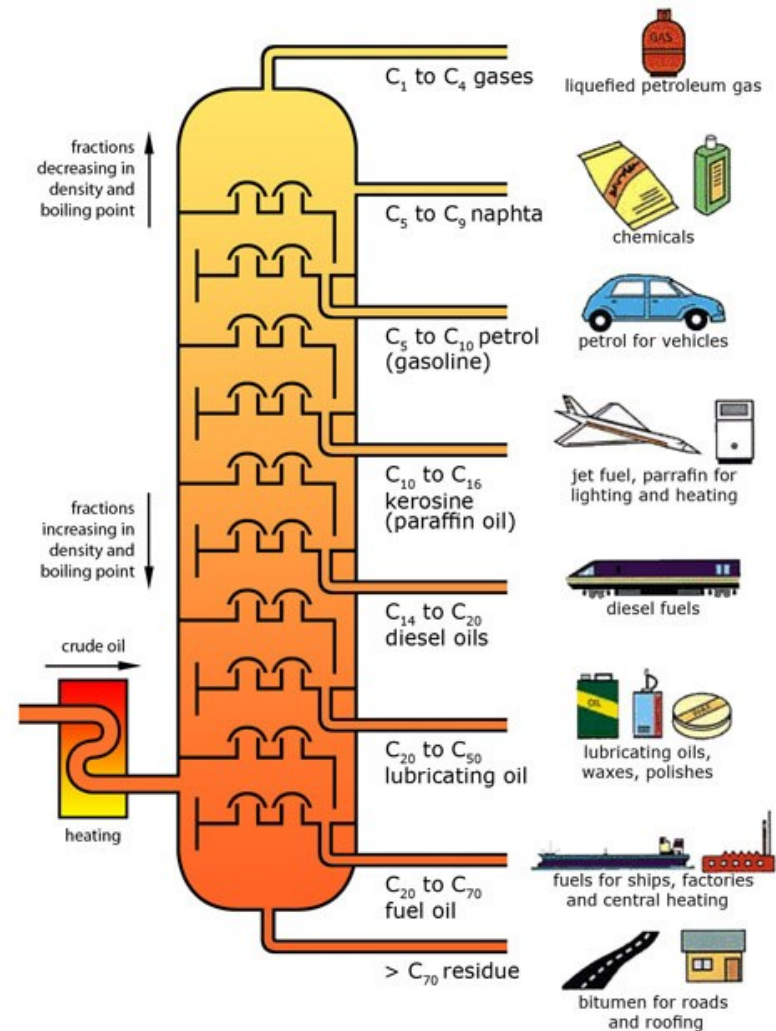
6. Carbon

To provide a high-level introduction of key elements within hydrocarbon value chain

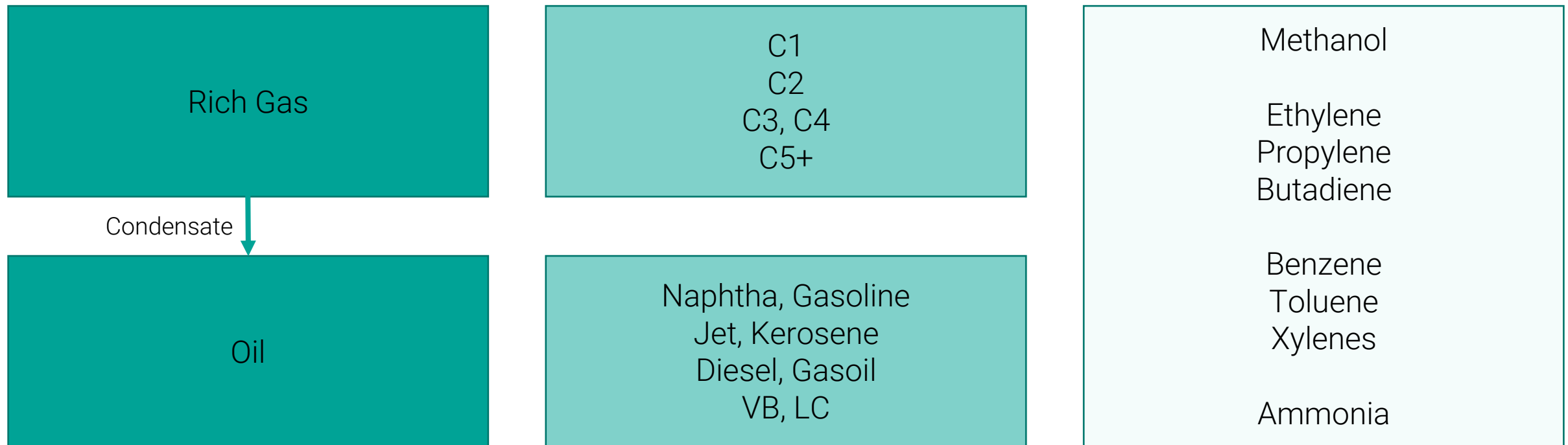
A Simplified Overview



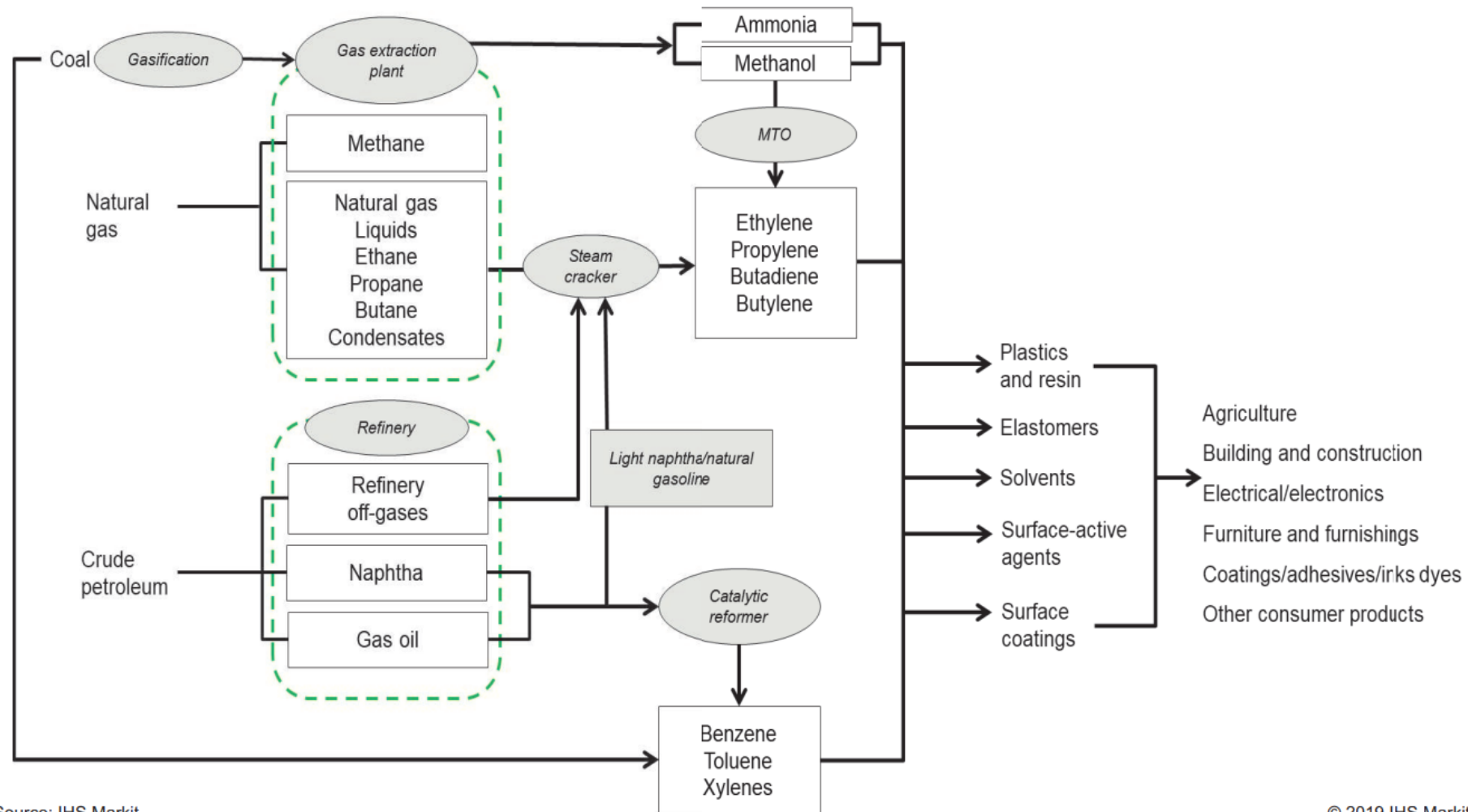
Distillation Tower



Industry Flow

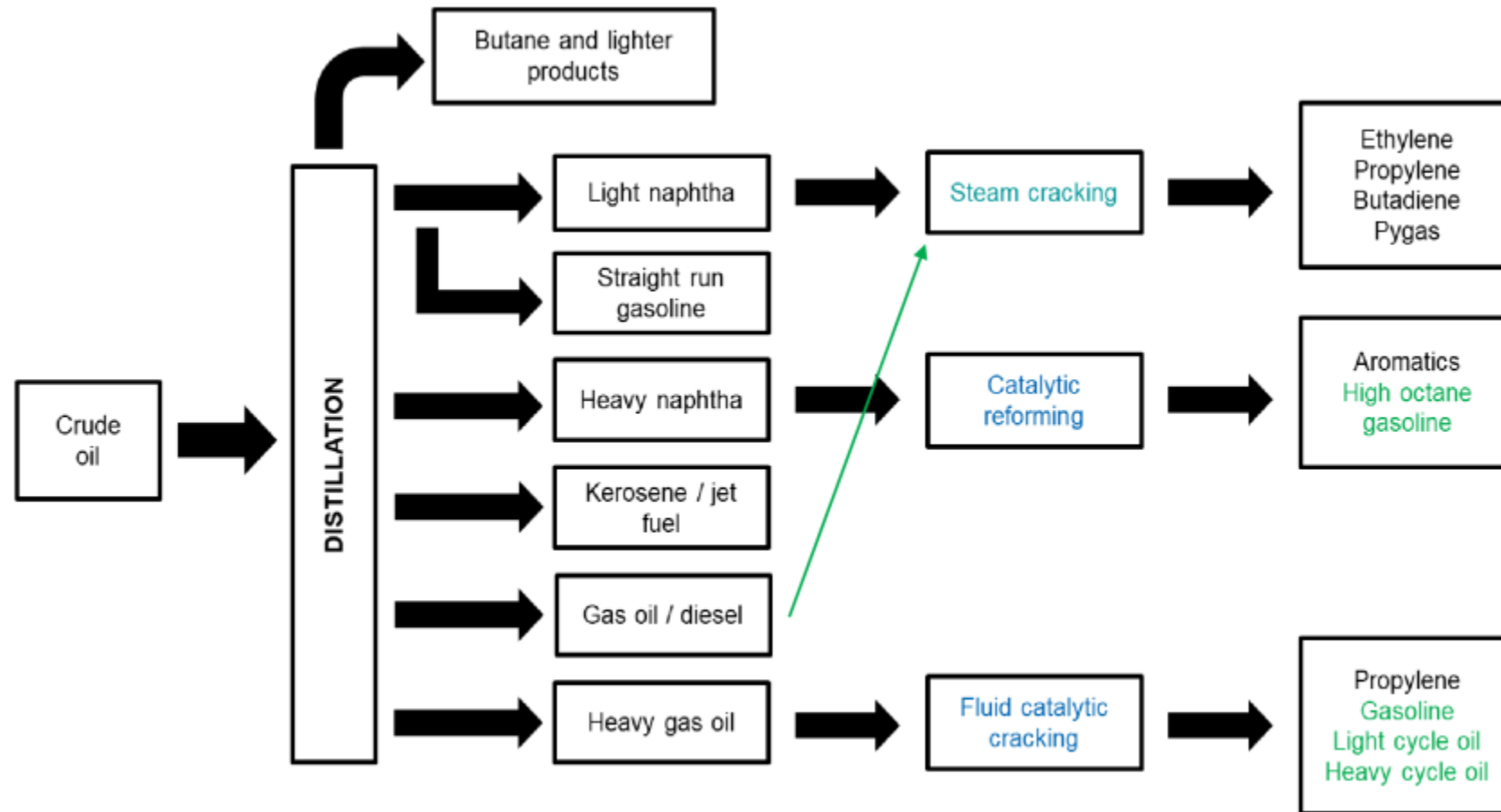


Petrochemical Feedstock and Derivatives

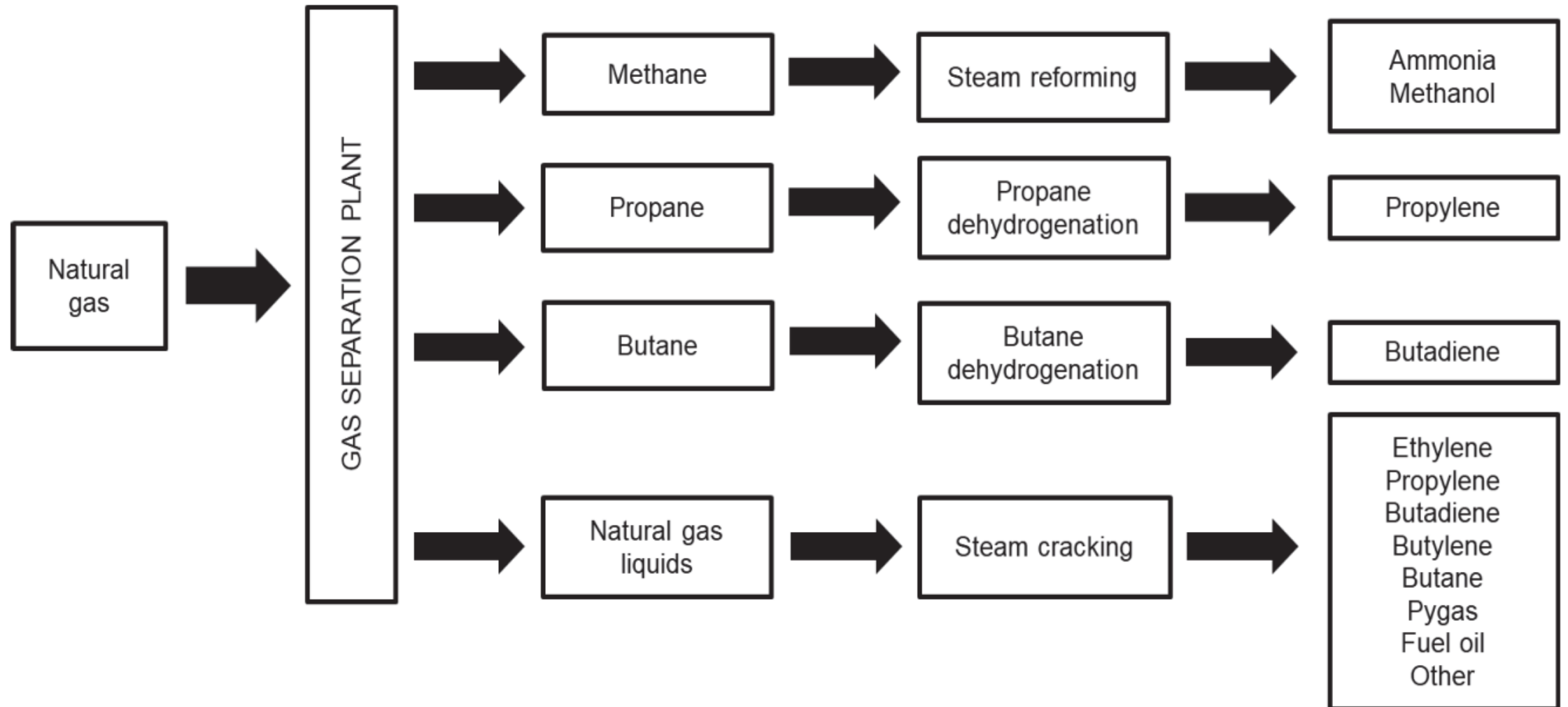


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From Crude Oil to Basic Petrochemicals



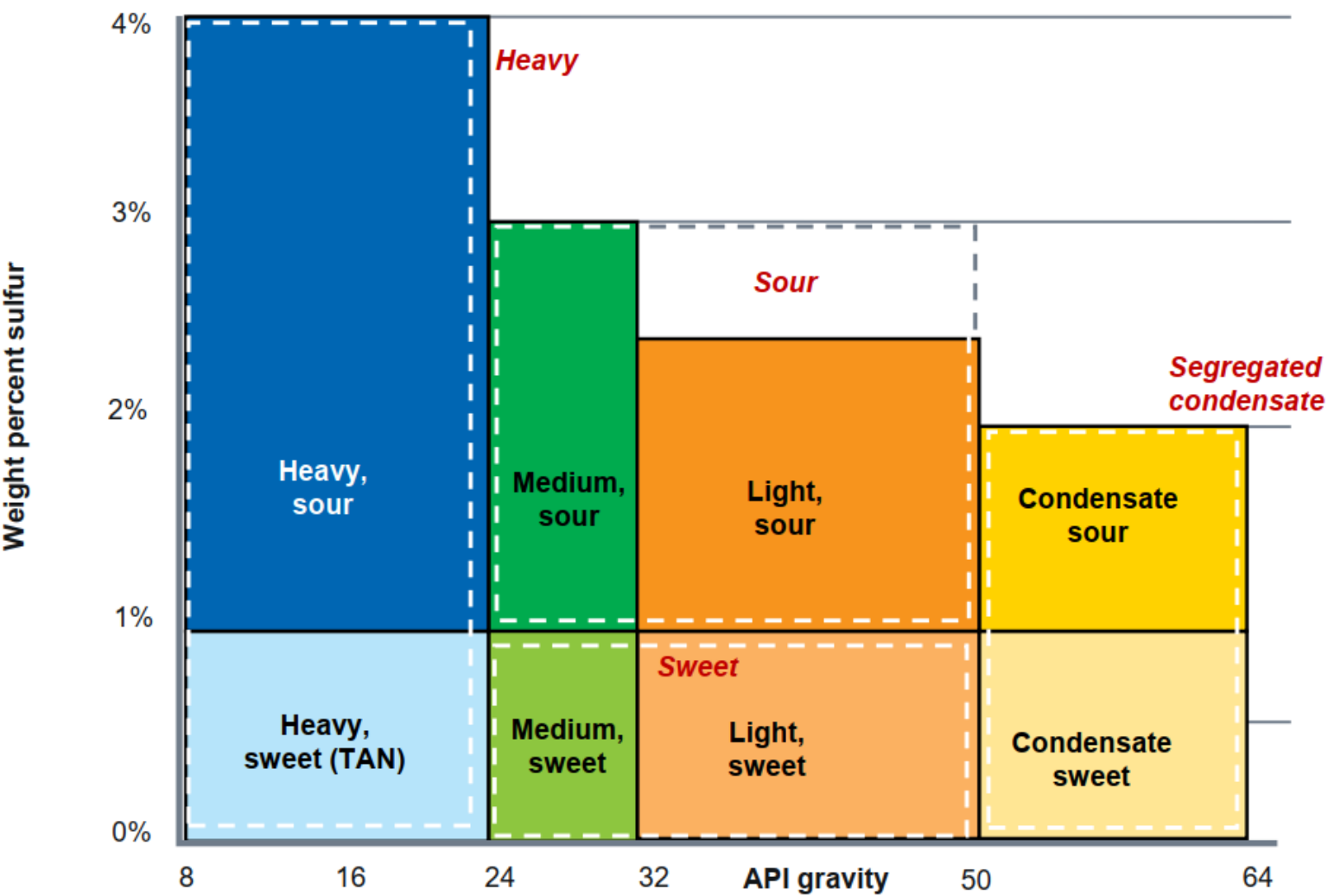
From Natural Gas to Basic Petrochemicals



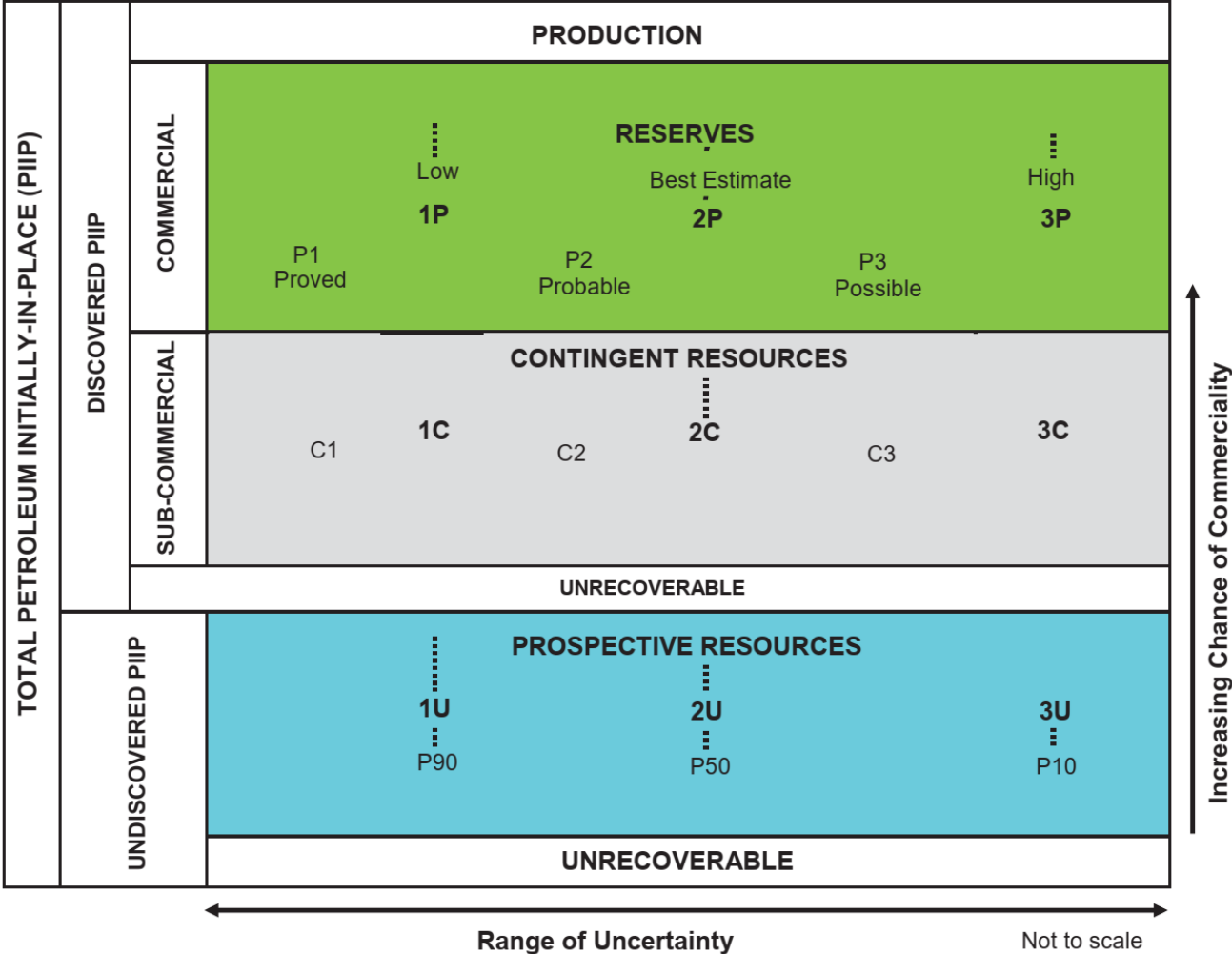
7. The Oil Market

To define a supply and demand framework for short-term and long-term analysis of oil market

Oil Markets And Downstream Crude Oil Grade Map (General)



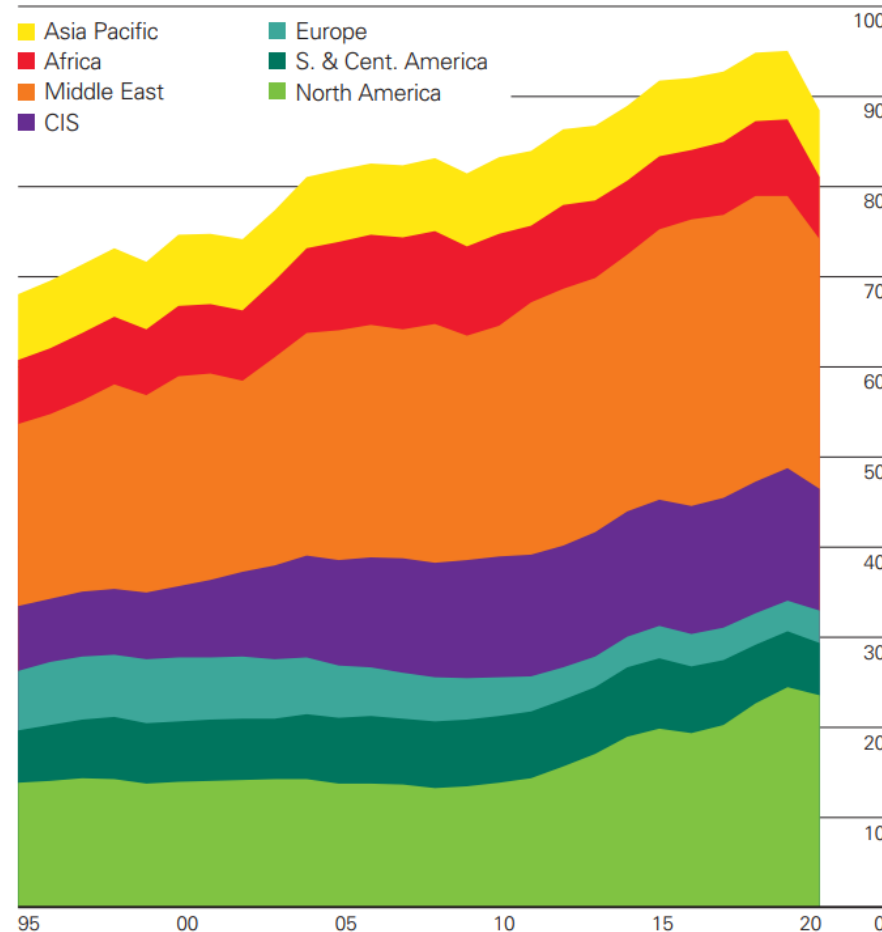
Resources Classification Framework



Oil Production and Consumption by Region

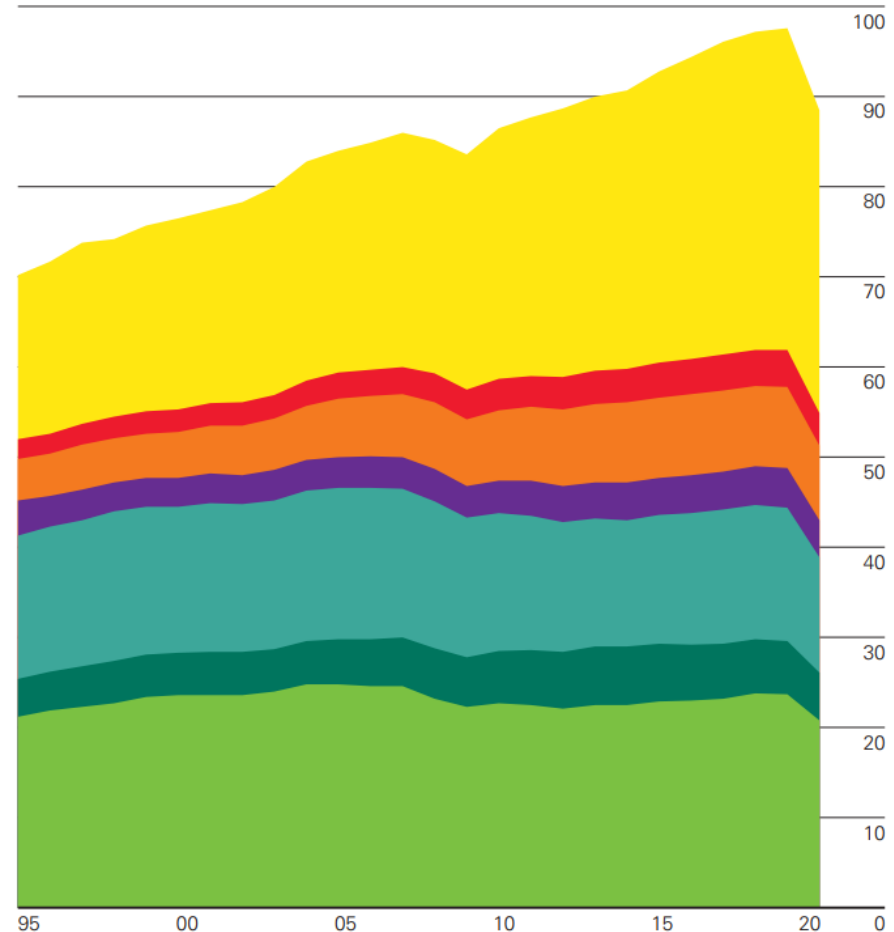
Oil: Production by region

Million barrels daily



Oil: Consumption by region

Million barrels daily



Short-to-medium Term Oil Price Forecast Methodology

Demand

- GDP Growth
- Mobility
- Industry Activity

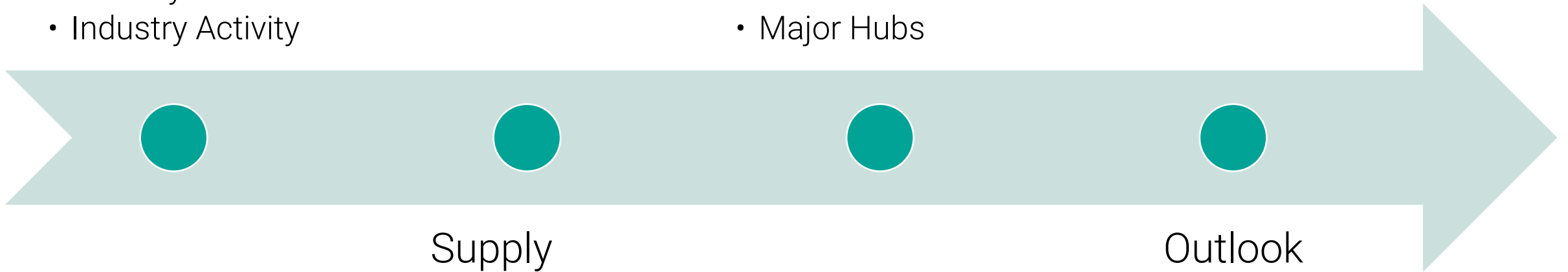
Stocks

- OECD Commercial Stocks
- SPR
- Major Hubs

Supply

- Non-OPEC+
- Shale Oil
- OPEC+

Outlook



Market Balance by OPEC

	2021	1Q22	2Q22	3Q22	4Q22	2022	Change 2022/21
(a) World oil demand	96.92	99.33	98.33	100.65	102.77	100.29	3.36
Non-OPEC liquids production	63.59	65.36	64.94	65.74	66.88	65.73	2.15
OPEC NGL and non-conventionals	5.28	5.35	5.38	5.41	5.43	5.39	0.11
(b) Total non-OPEC liquids production and OPEC NGLs	68.87	70.71	70.32	71.14	72.31	71.13	2.25
Difference (a-b)	28.05	28.63	28.01	29.50	30.46	29.16	1.11
OPEC crude oil production	26.35	28.36	28.62				
Balance	-1.70	-0.27	0.61				

Note: * 2022 = Forecast. Totals may not add up due to independent rounding. Source: OPEC.

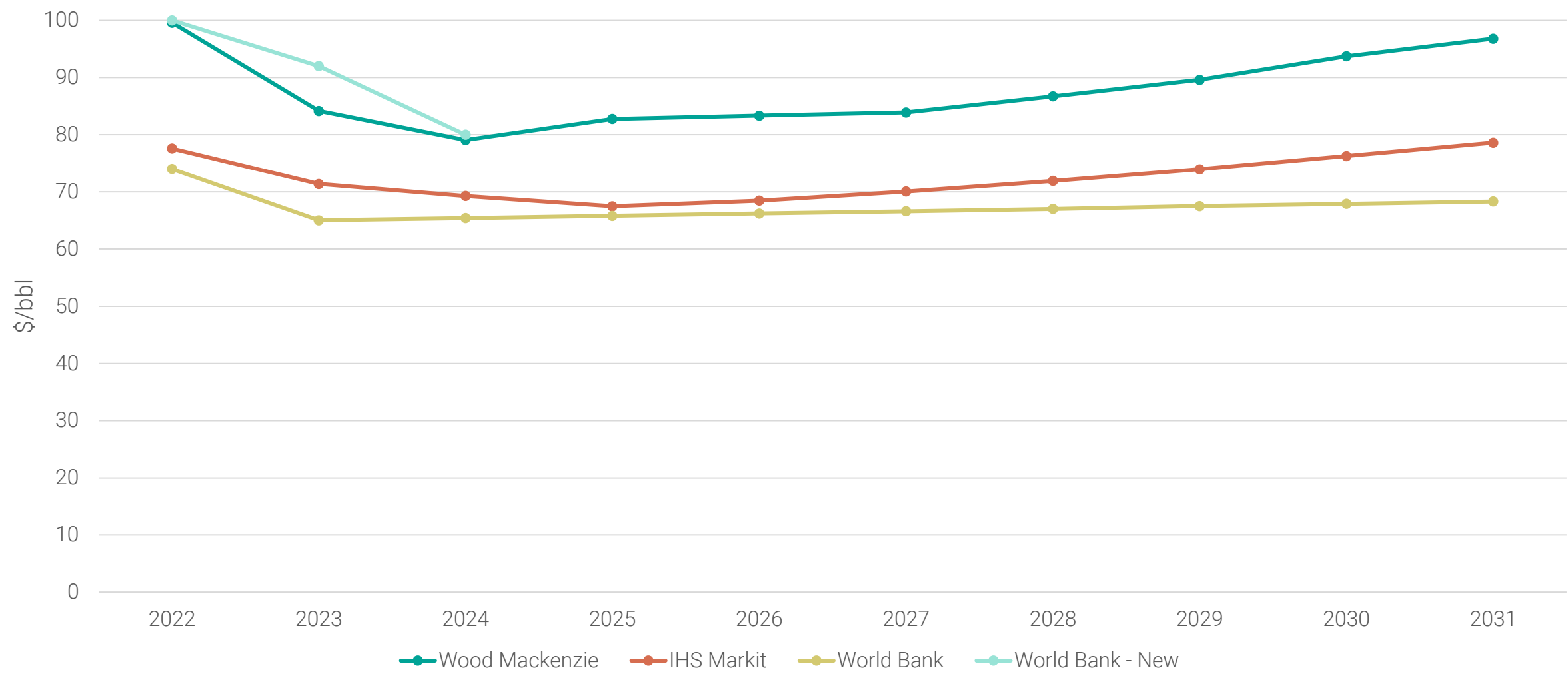
	2022	1Q23	2Q23	3Q23	4Q23	2023	Change 2023/22
(a) World oil demand	100.29	101.72	101.12	103.64	105.40	102.99	2.70
Non-OPEC liquids production	65.73	67.28	67.15	67.37	67.96	67.44	1.71
OPEC NGL and non-conventionals	5.39	5.44	5.47	5.43	5.43	5.44	0.05
(b) Total non-OPEC liquids production and OPEC NGLs	71.13	72.71	72.63	72.80	73.38	72.88	1.76
Difference (a-b)	29.16	29.01	28.50	30.84	32.01	30.10	0.94

Note: * 2022-2023 = Forecast. Totals may not add up due to independent rounding. Source: OPEC.

Long-term Oil Demand Outlook by Sector

								Growth
	2019	2020	2025	2030	2035	2040	2045	2019–2045
Road	44.4	40.1	46.3	46.9	47.1	47.1	47.0	2.6
Aviation	6.7	3.5	7.1	7.7	8.4	8.9	9.4	2.8
Rail/waterways	1.9	1.8	1.9	2.0	2.1	2.1	2.0	0.2
Marine bunkers	4.2	4.0	4.4	4.6	4.7	4.7	4.6	0.5
Transportation	57.2	49.4	59.7	61.2	62.2	62.8	63.2	6.0
Petrochemicals	13.7	12.9	14.7	15.9	16.7	17.0	17.3	3.7
Other industry	12.8	12.7	13.0	13.5	13.5	13.3	13.1	0.3
Industry	26.5	25.6	27.8	29.4	30.2	30.3	30.4	4.0
Resid./Comm./Agric.	11.1	10.8	11.4	12.0	12.2	12.1	11.6	0.5
Electricity generation	4.9	4.9	4.8	4.6	4.3	4.1	3.9	–1.1
Other uses	16.0	15.7	16.1	16.6	16.5	16.1	15.5	–0.5
World	99.7	90.7	103.7	107.2	108.9	109.3	109.1	9.4

Oil Prices Long-term Forecast



8. US Shale Oil

To provide an overview of US shale oil dynamics

An Old Story

مجله ی 29 - توصیه های پسران اخبار بین الملل (انرژی)

چگونه ذخایر نامتعارف، تولید انرژی در آمریکا را متحول کرده است؟

انقلاب رُسی

رامین فروزنده

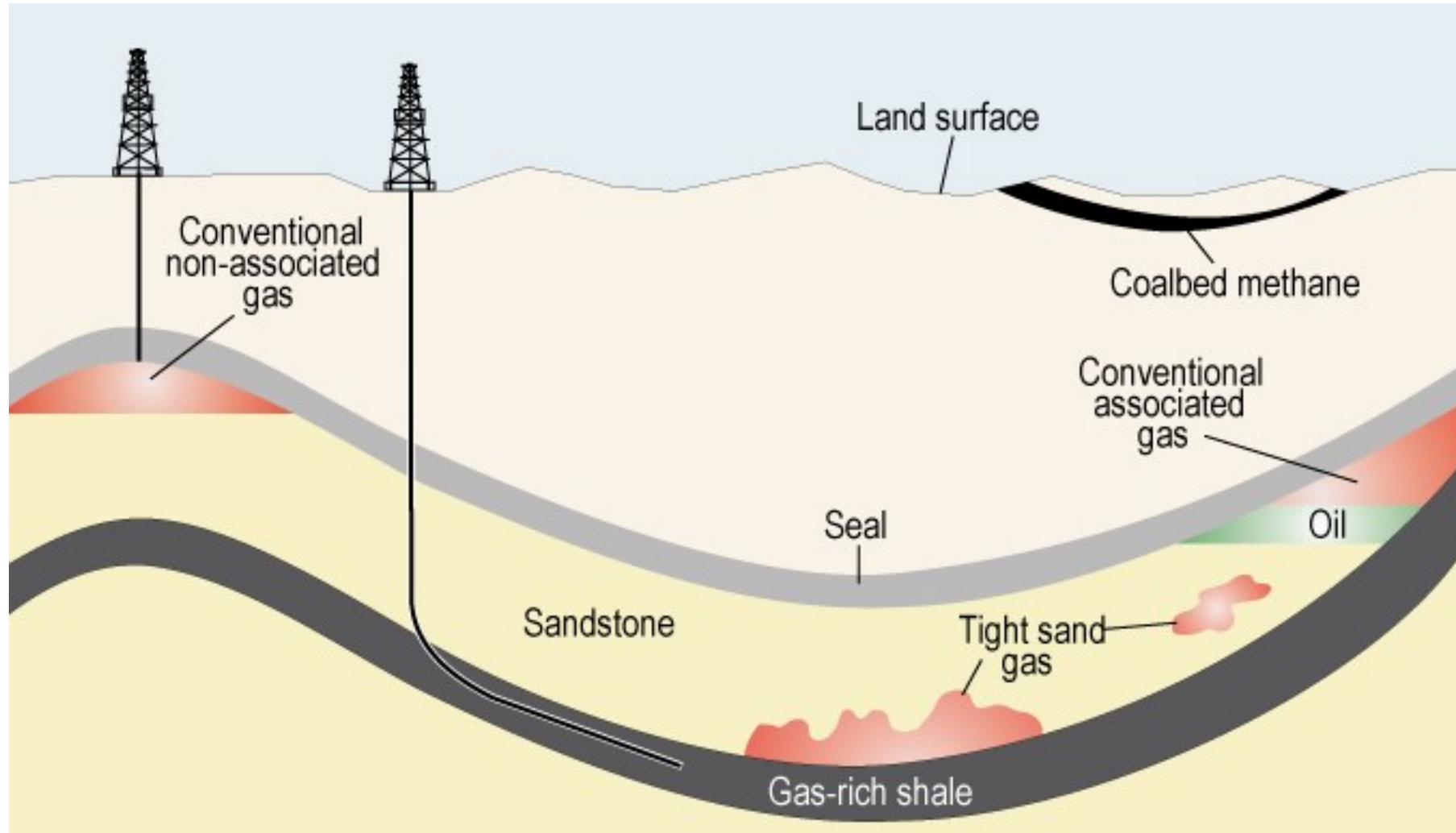
«آمریکا احتمالاً در سال ۲۰۱۳ با پشت سر گذاشتن روسیه و عربستان، به بزرگ‌ترین تولیدکننده سوخت‌های مایع در جهان تبدیل خواهد شد.»



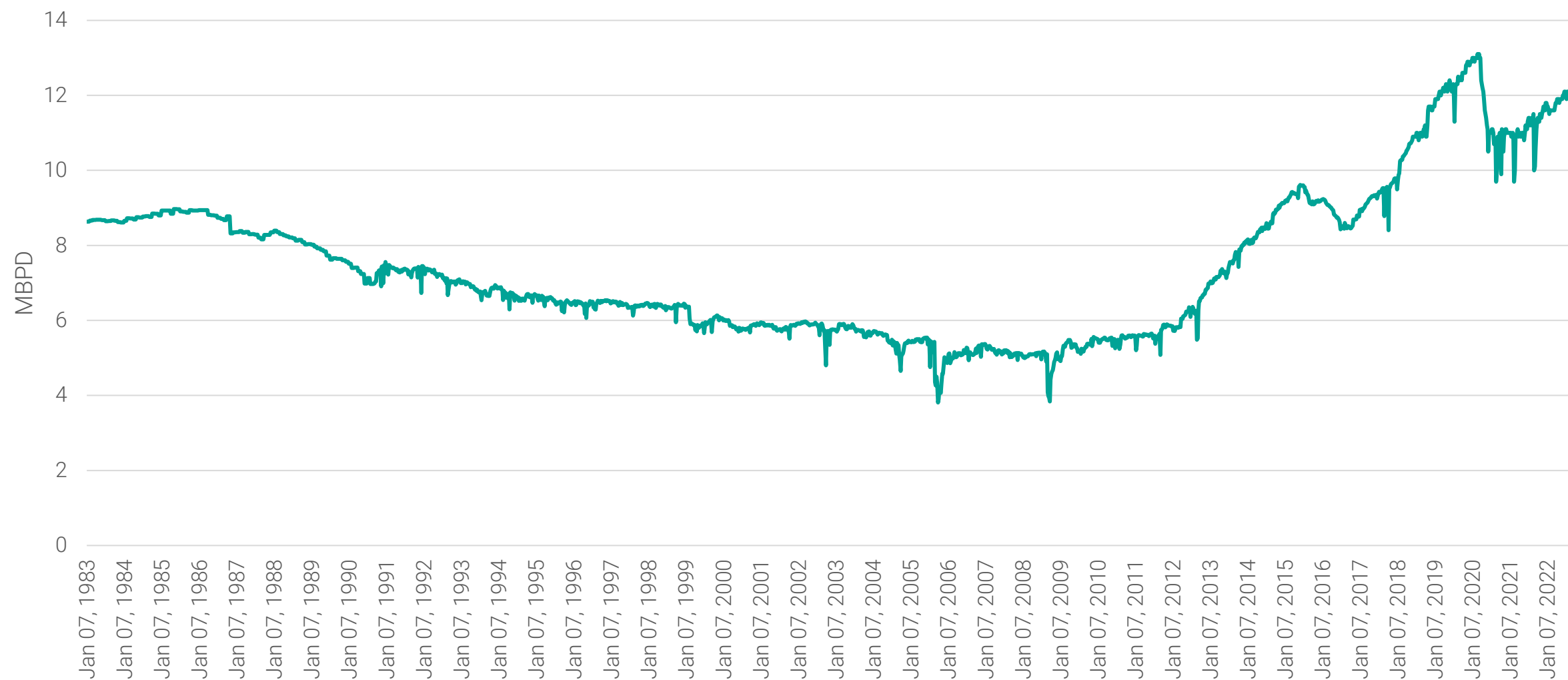
شد.»

«آمریکا احتمالاً در سال 2013 با پشت سر گذاشتن روسیه و عربستان، به بزرگ‌ترین تولیدکننده سوخت‌های مایع در جهان تبدیل خواهد شد.» این جمله، شاید مهم‌ترین پیش‌بینی گزارش جدید شرکت بریتیش پترولیوم باشد؛ به خصوص اگر بدانیم سهم اصلی در افزایش تولید نفت و گاز را در آمریکا، ذخایر نامتعارف خواهند داشت. گزارش چشم‌انداز انرژی 2030 که در اواسط ژانویه سال جدید میلادی منتشر شد، نخستین گزارشی نیست که بر نقش تولید نفت و گاز از منابعی مثل شیل1 (سنگ حاوی ذخایر هیدروکربن که از رُس تشکیل شده است) متمرکز شده است. گفته می‌شود تولید از ذخایر نامتعارف که با افزایش قیمت‌های جهانی انرژی و بهبود فناوری‌های صنعت نفت اقتصادی همراه شده است، چشم‌انداز جدیدی را به روی صنعت نفت و گاز جهان گشوده است که می‌توان از آن به «انقلاب رُسی» یاد کرد.

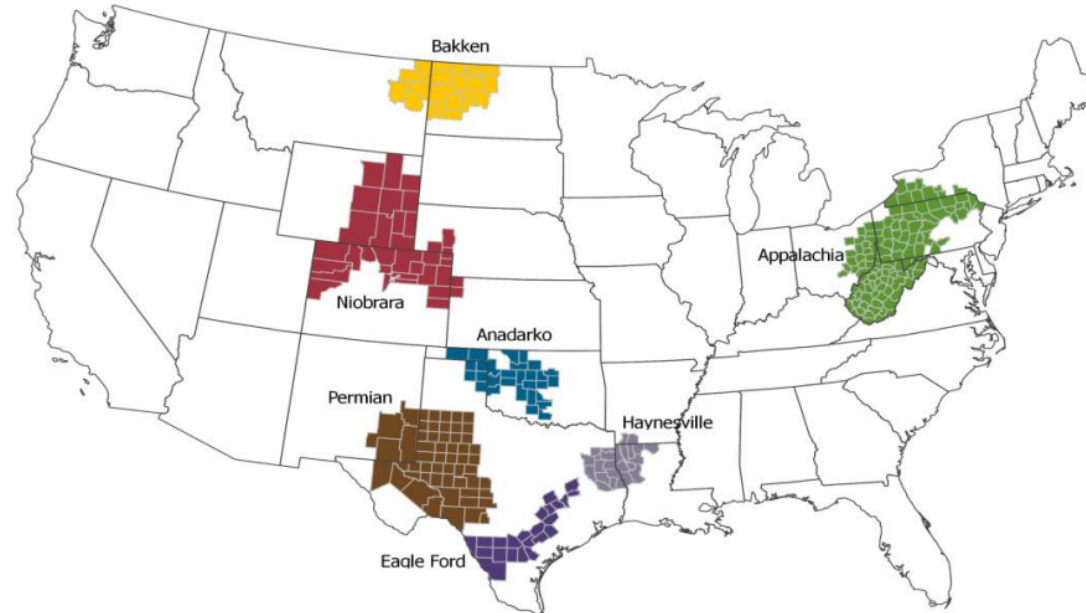
Definition



Weekly US Crude Oil Production



EIA Drilling Productivity Report

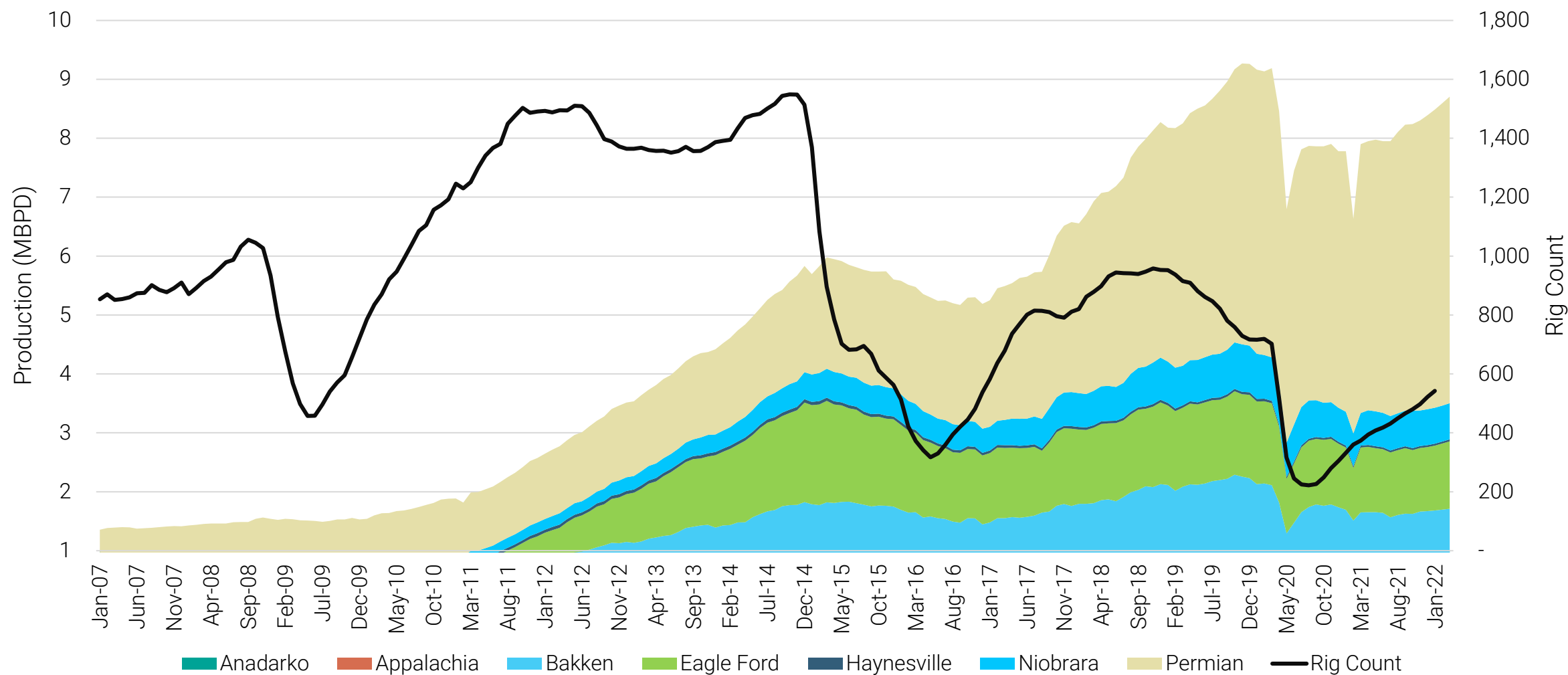


Note:

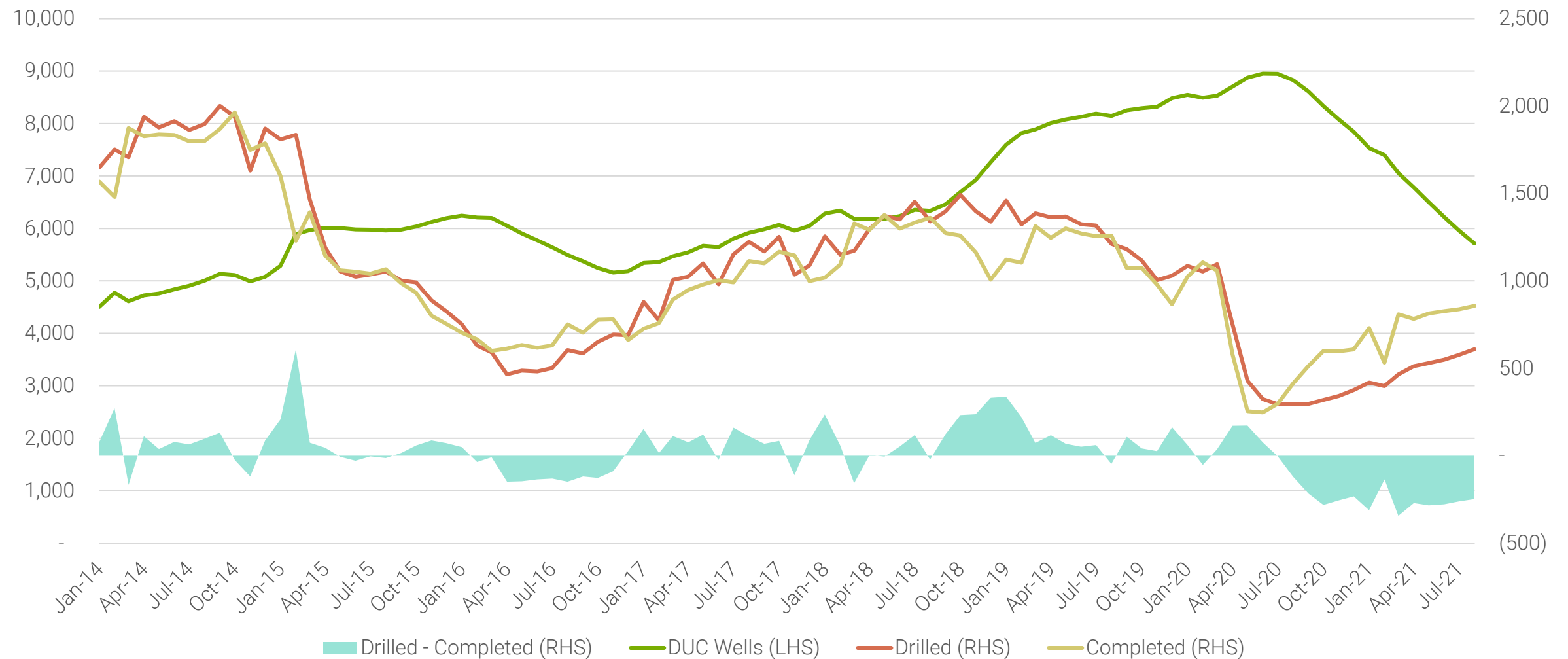
The DPR rig productivity metric *new-well oil/gas production per rig* can become unstable during periods of rapid decreases or increases in the number of active rigs and well completions. The metric uses a fixed ratio of estimated total production from new wells divided by the region's monthly rig count, lagged by two months. The metric does not represent new-well oil/natural gas production per newly completed well.

The DPR metric *legacy oil/gas production change* can become unstable during periods of rapid decreases or increases in the volume of well production curtailments or shut-ins. This effect has been observed during winter weather freeze-offs, extreme flooding events, and the 2020 global oil demand contraction. The DPR methodology involves applying smoothing techniques to most of the data series because of inherent noise in the data.

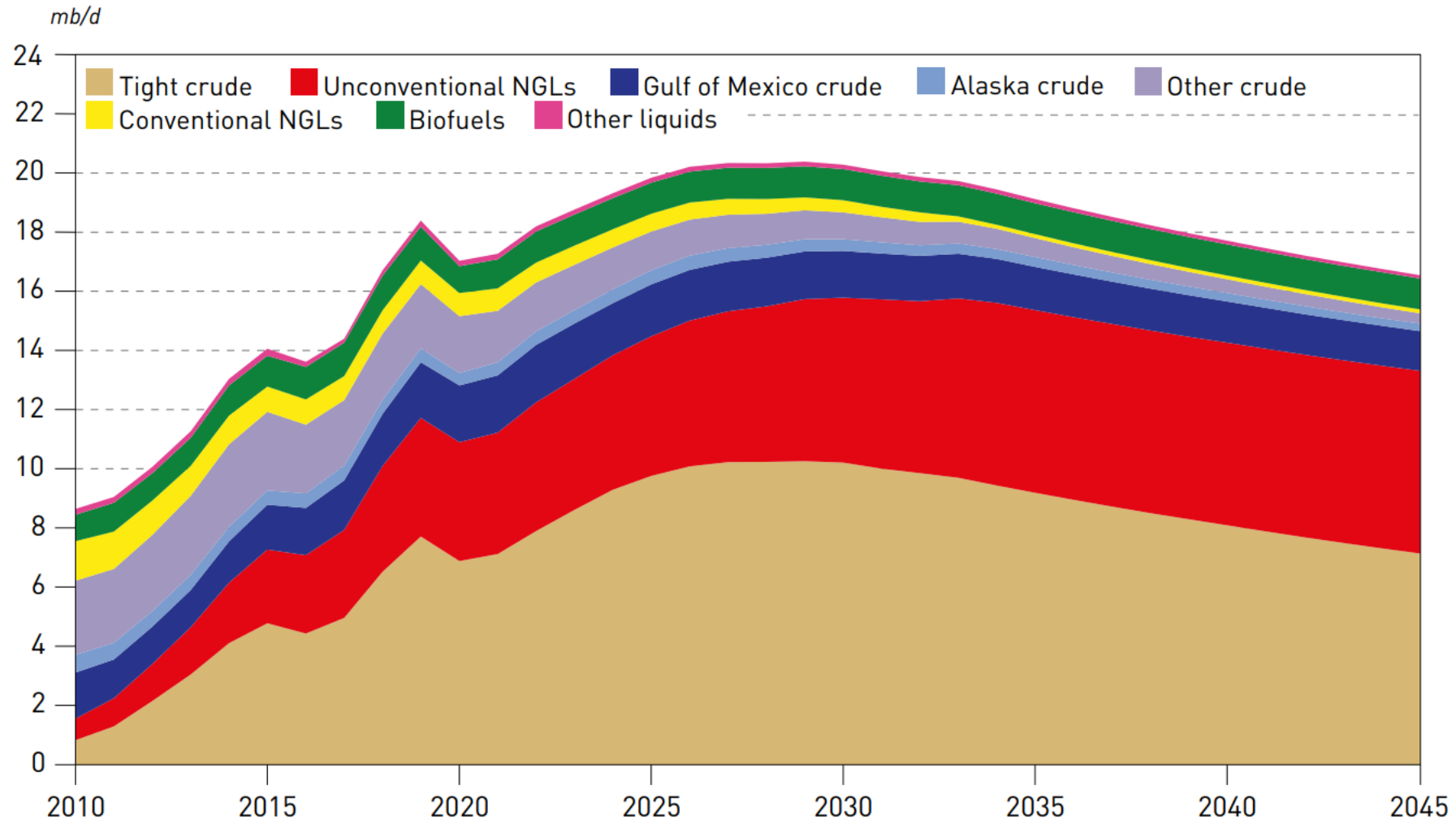
US Tight Oil Production & Total Rig Count



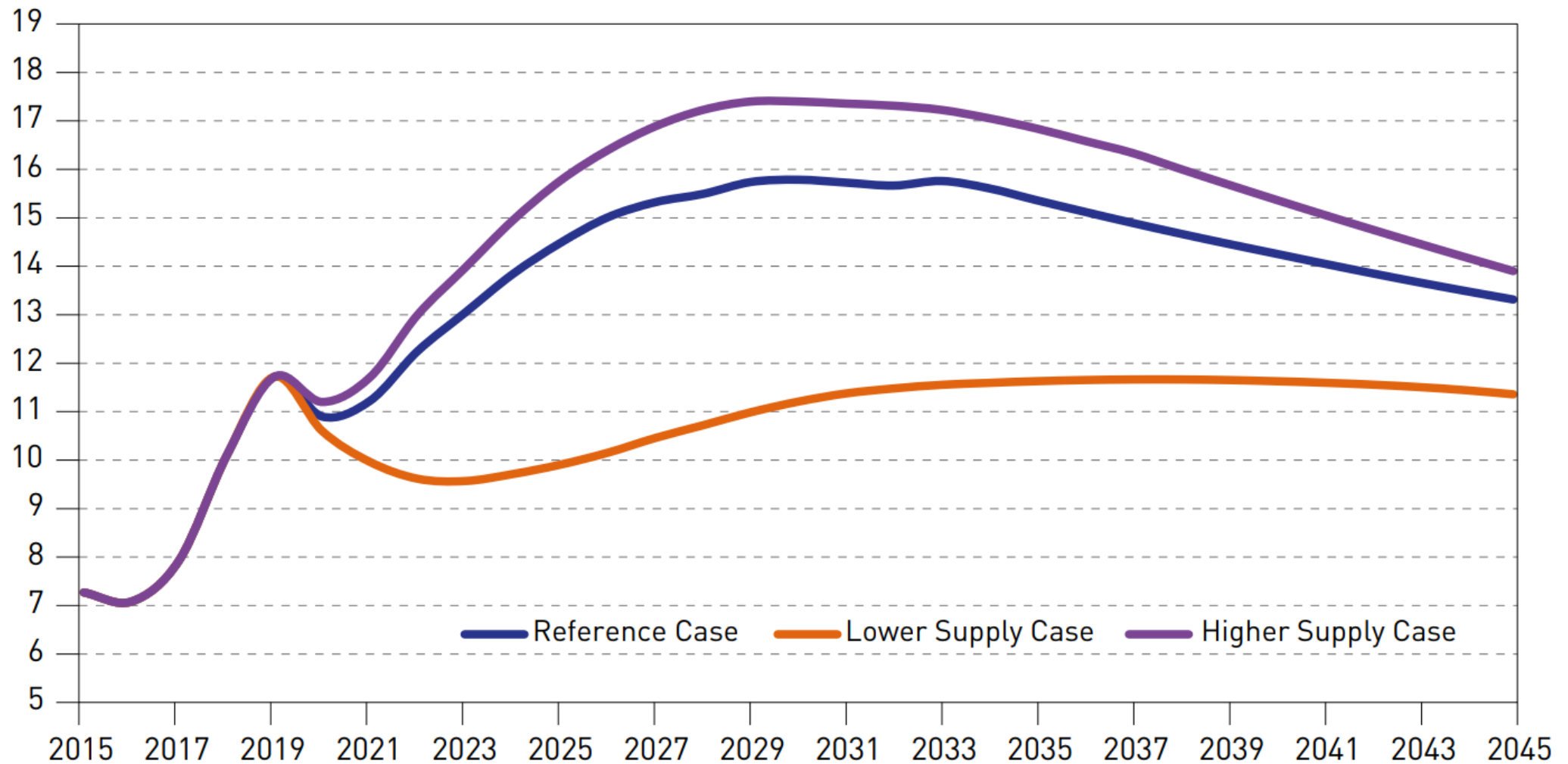
DUC Wells



US Liquids Supply Outlook



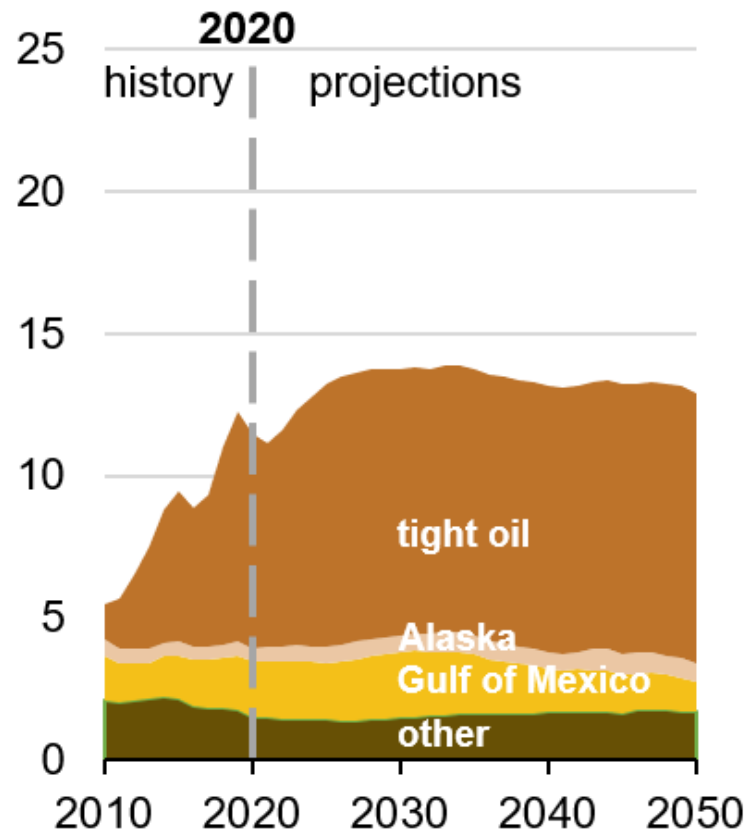
Long-term US Tight Oil Sensitivities



U.S. Crude Oil Production

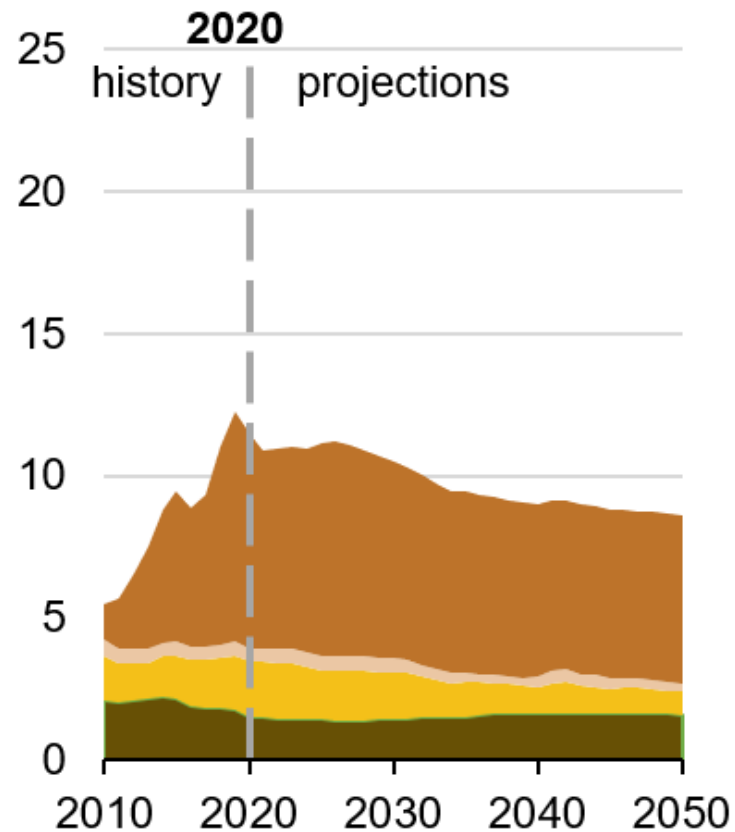
Reference case

million barrels per day



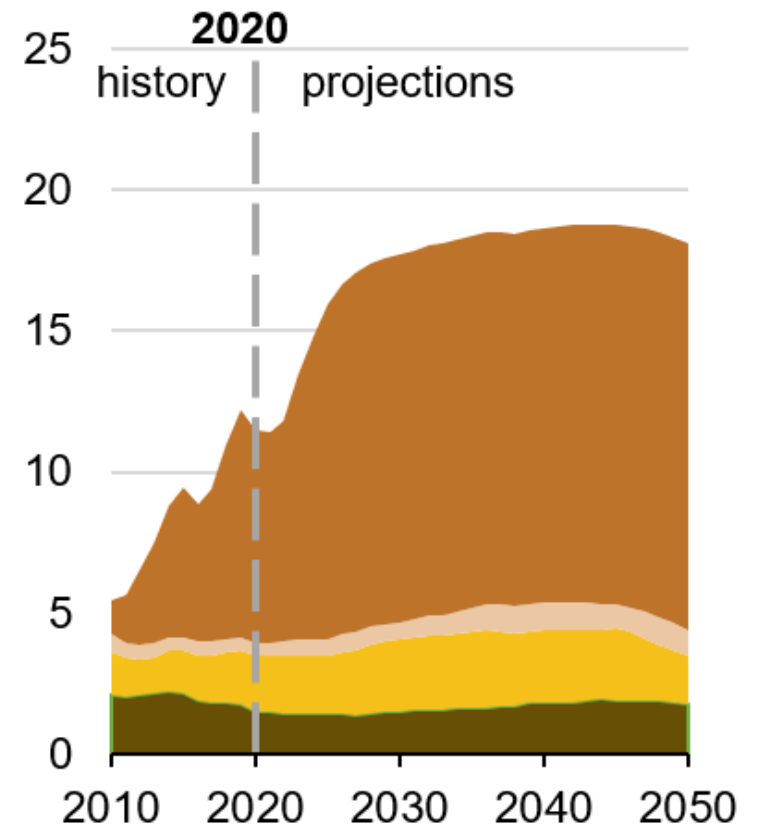
Low Oil and Gas Supply case

million barrels per day



High Oil and Gas Supply case

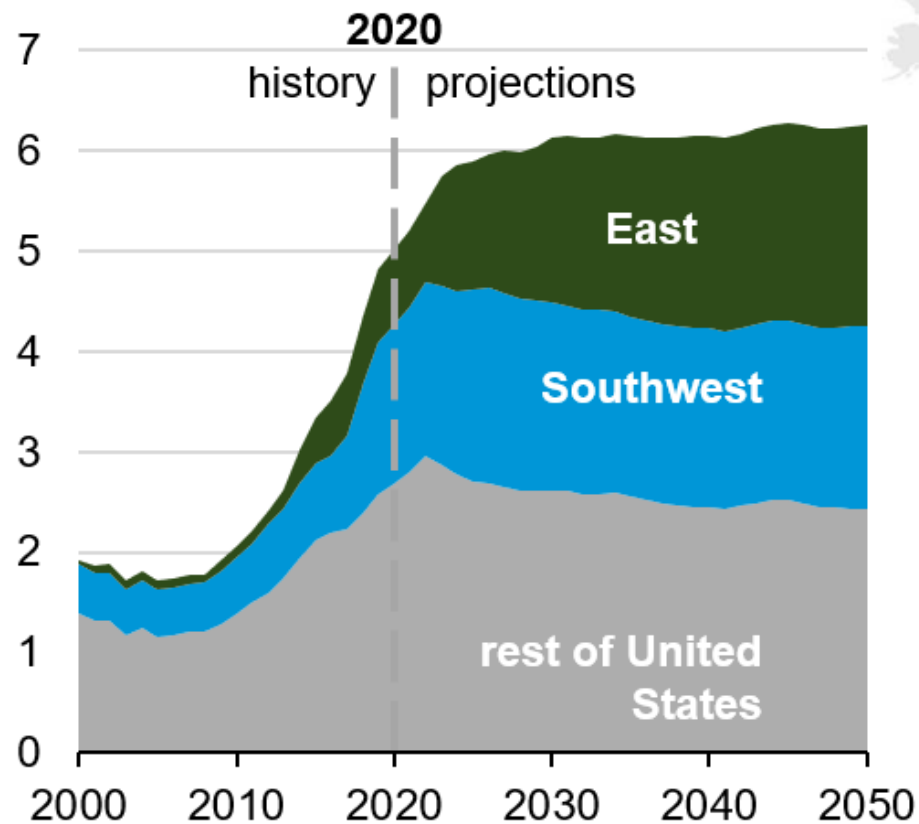
million barrels per day



Natural Gas Plant Liquids Production By Region And Type

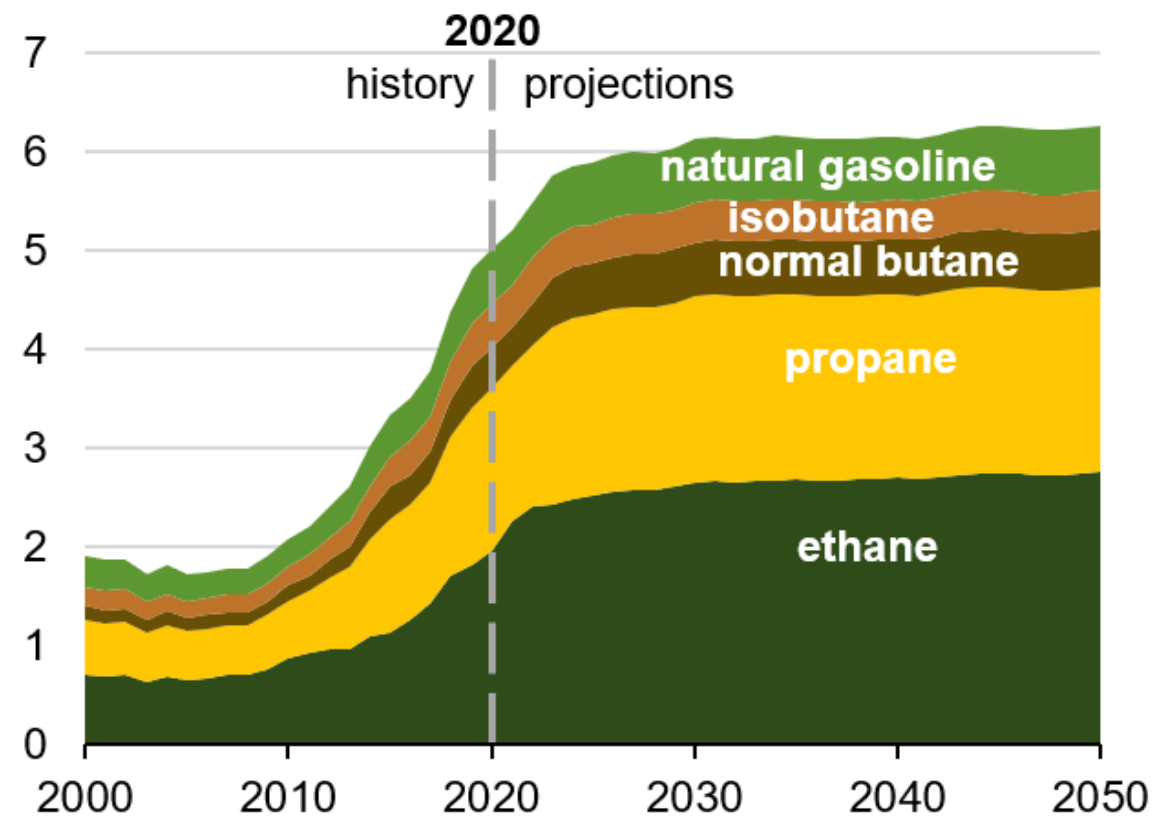
U.S. natural gas plant liquids production by region
AEO2021 Reference case

million barrels per day

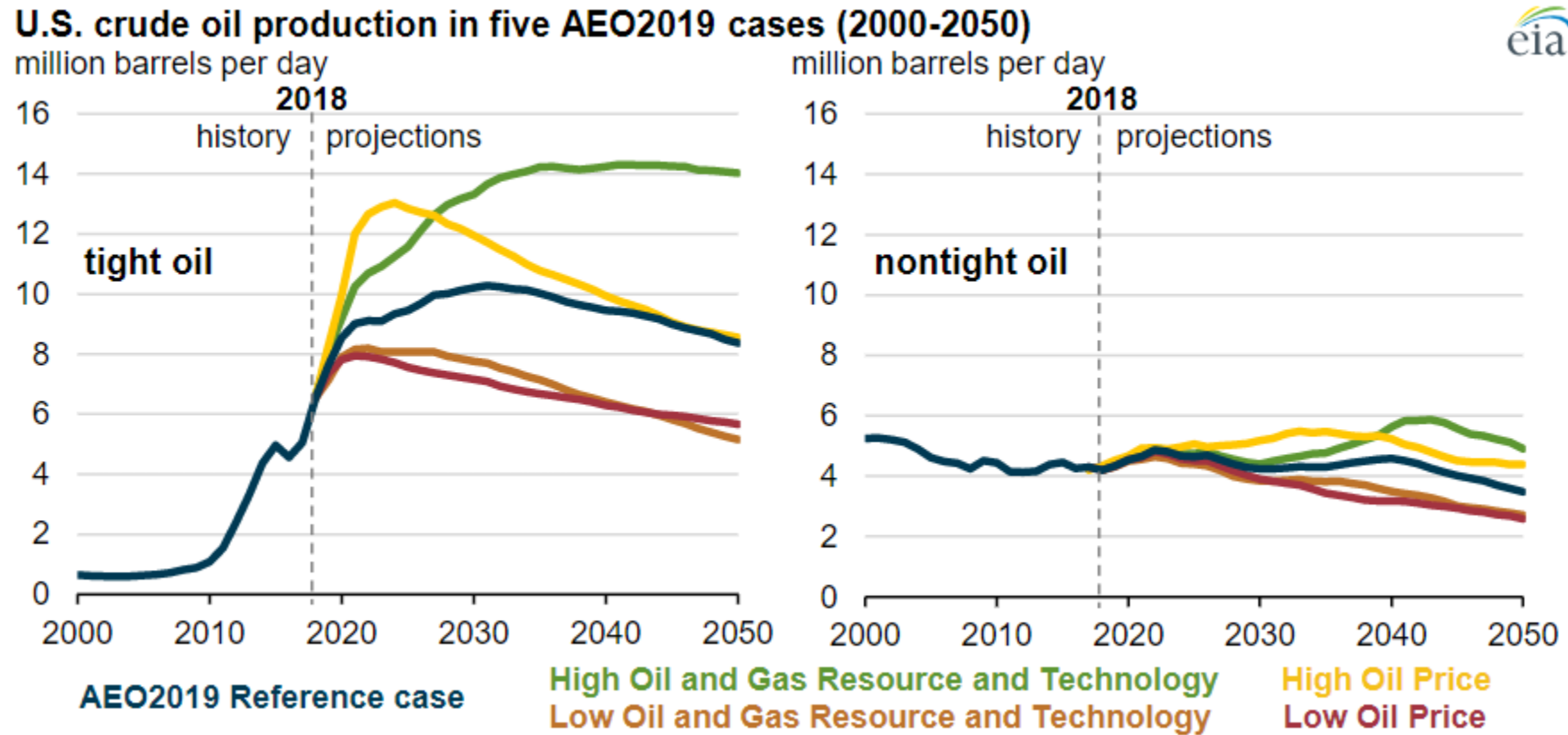


U.S. natural gas plant liquids production by type
AEO2021 Reference case

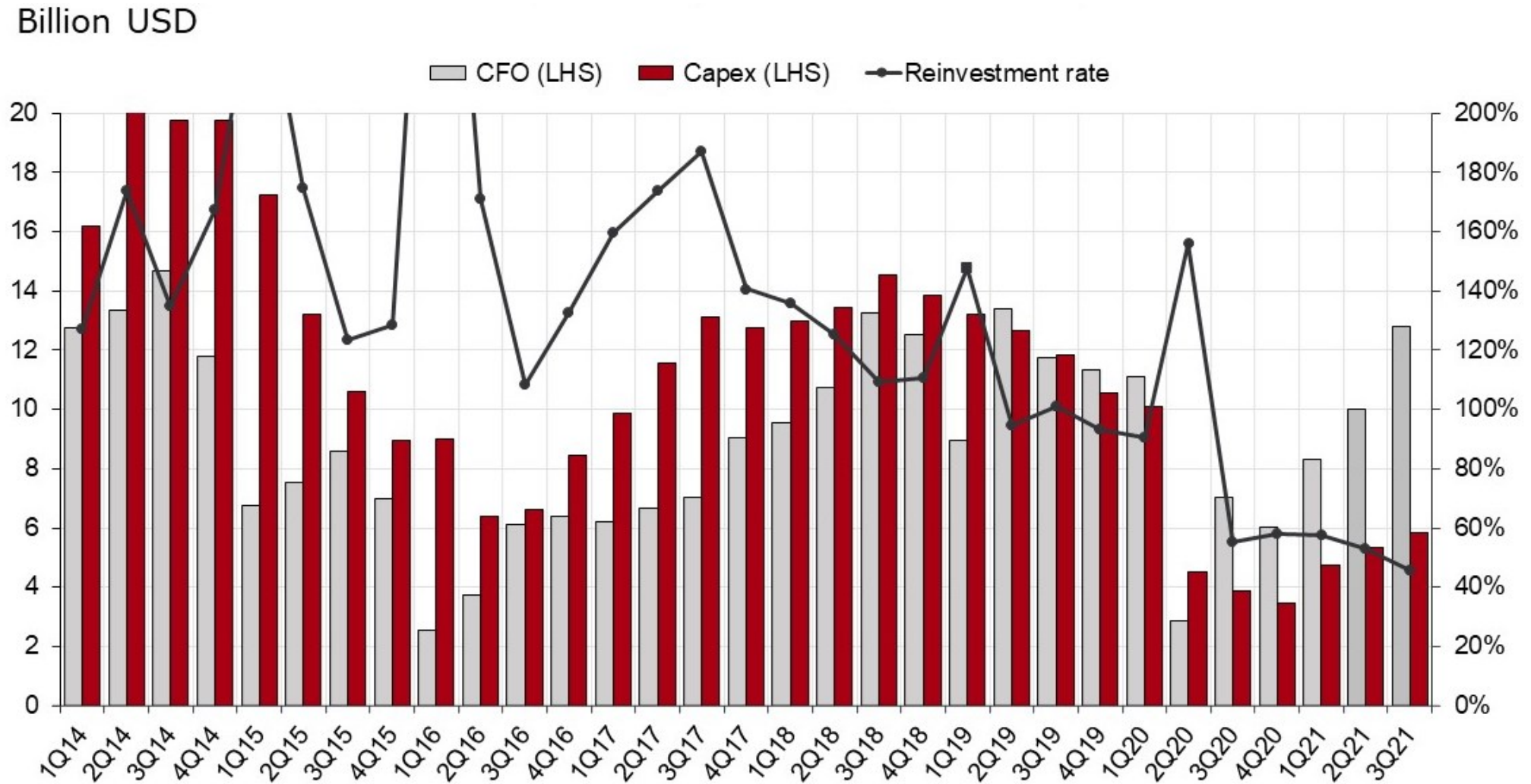
million barrels per day



Tight Oil Development



US Shale Oil CFO and Capex



Breakeven Reduction



Structural

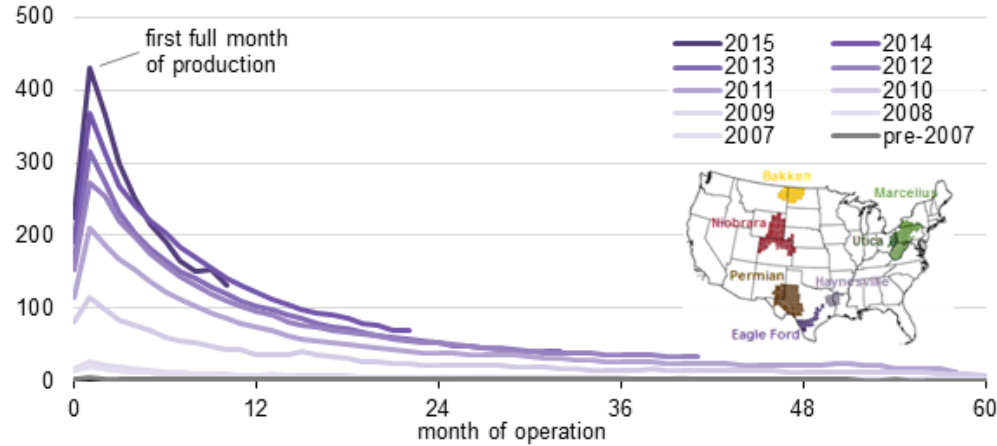
- Wells Productivity
- Drilling & Completion Efficiency

Cyclical

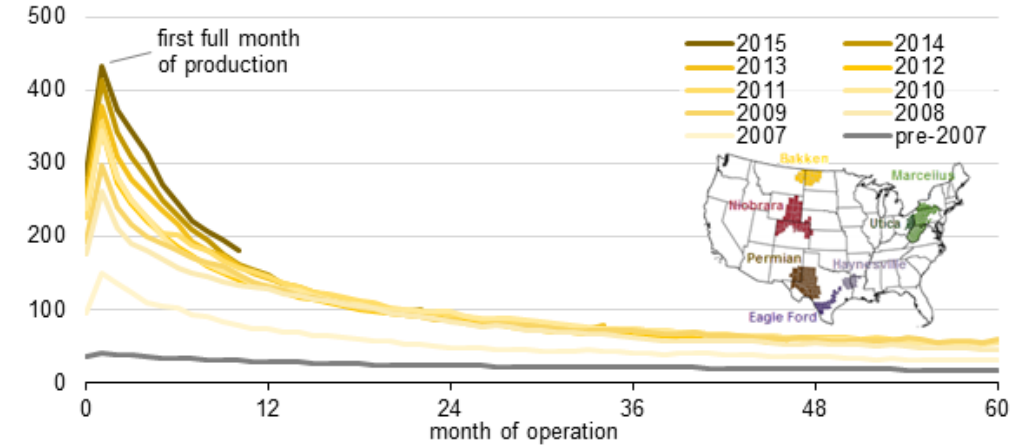
- Cost of Drilling & Operating
- High-grading

Initial Production Rates In Tight Oil Formations

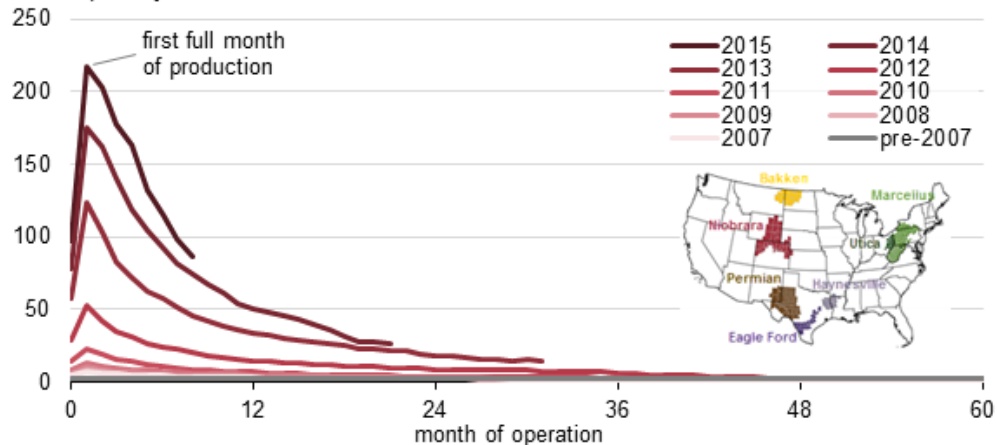
Average oil production per well in the Eagle Ford region
barrels per day



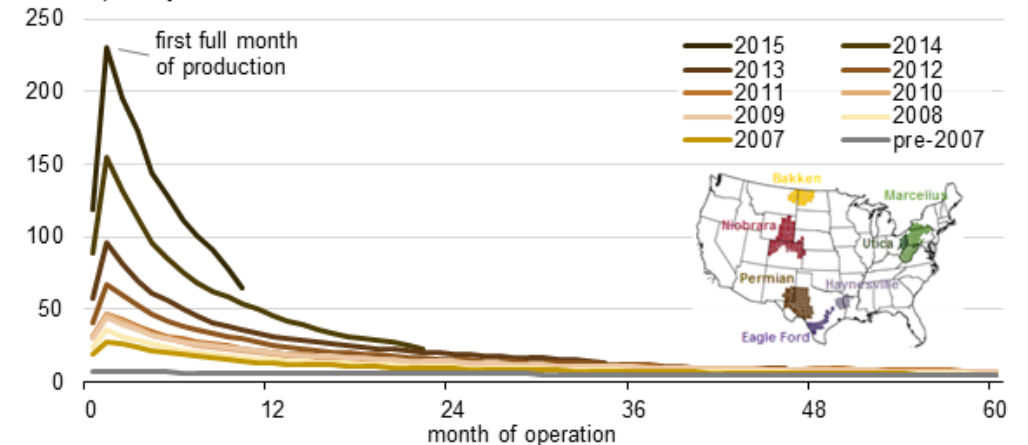
Average oil production per well in the Bakken region
barrels per day



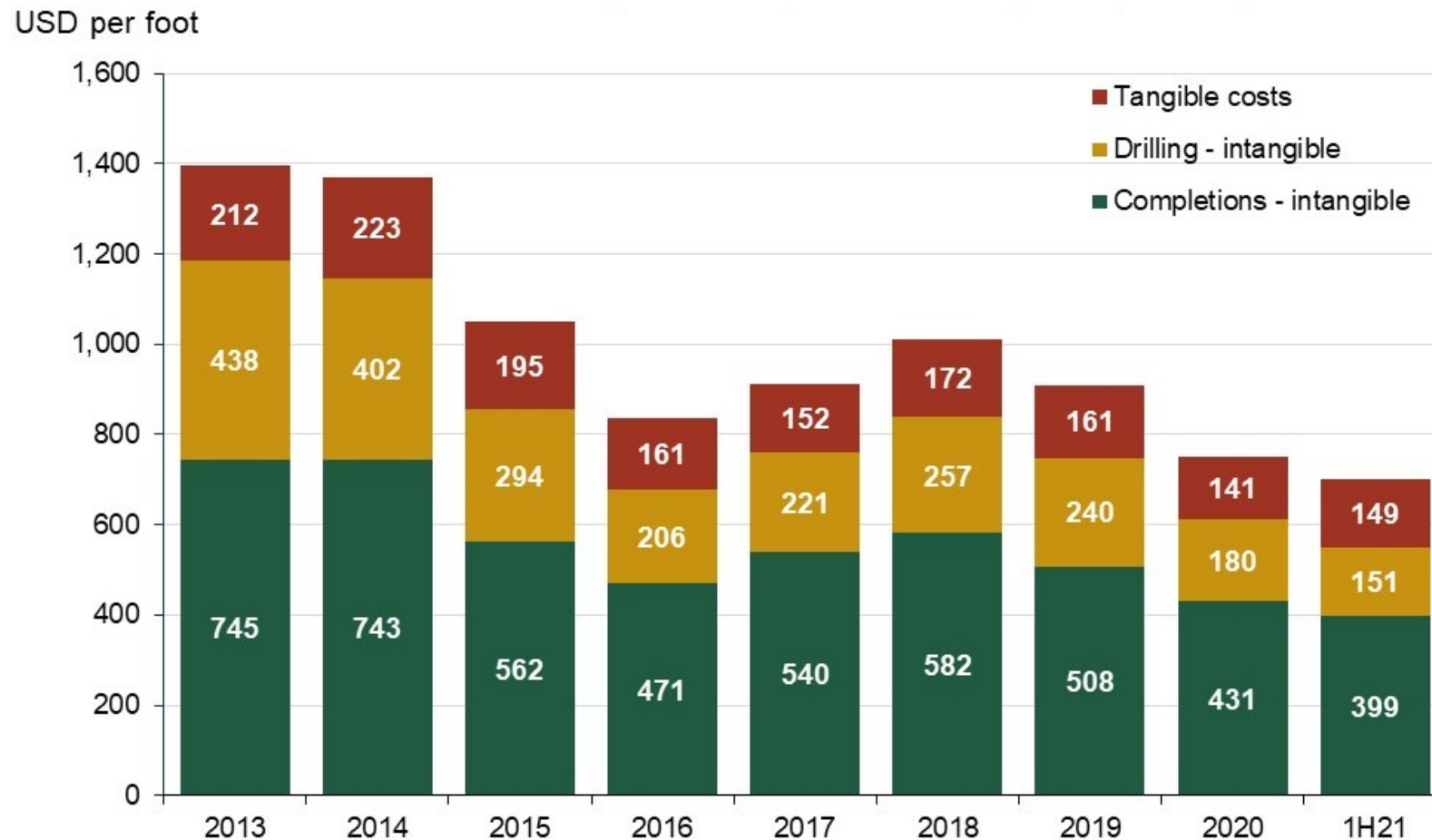
Average oil production per well in the Niobrara region
barrels per day



Average oil production per well in the Permian region
barrels per day



Permian Basin P50 Drilling and Completion Cost by Completion Year

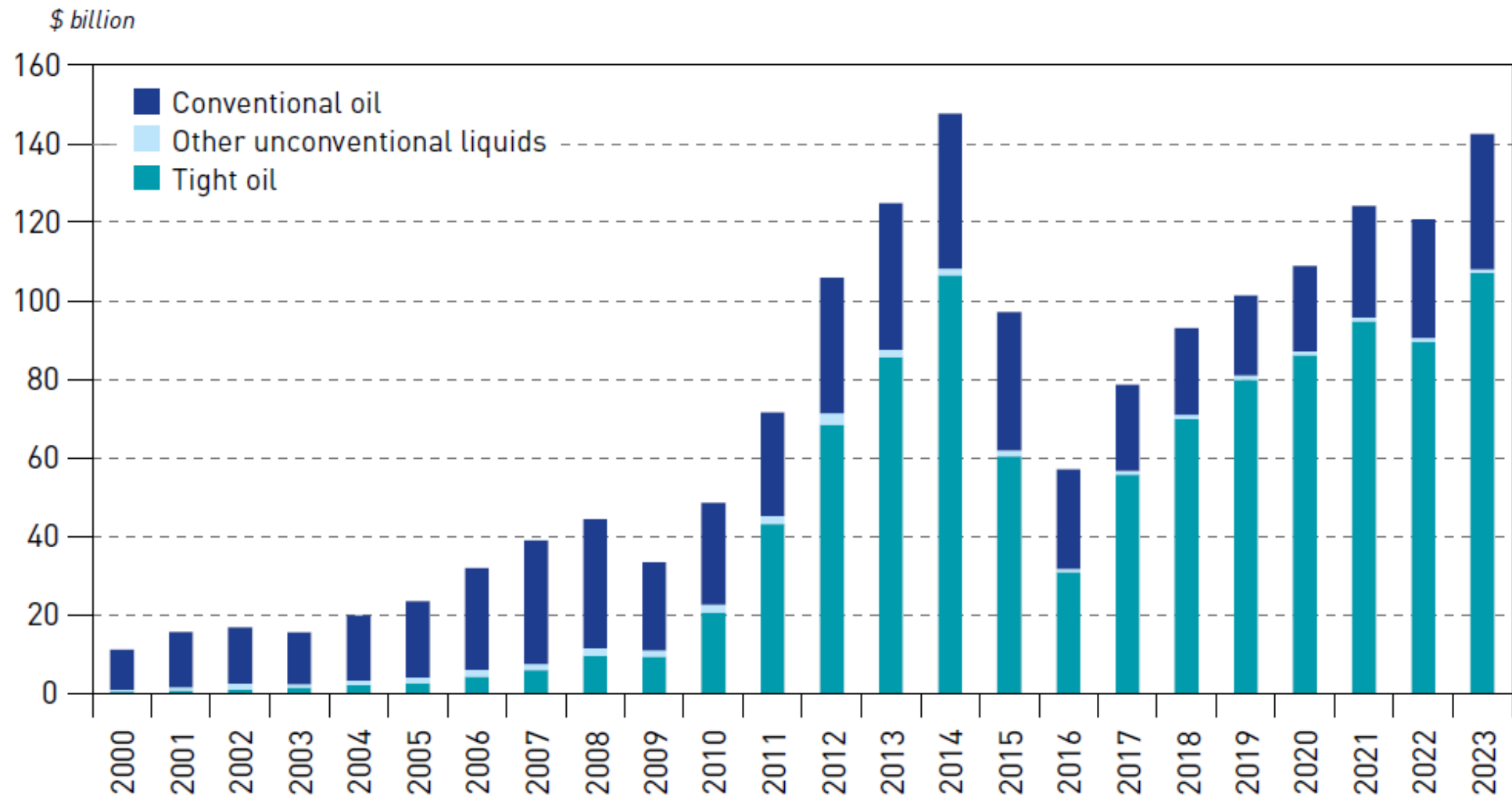


*Tangible cost consist primarily of OCTG and facilities

**The chart includes all horizontal wells with perforated length greater than 3,000'

Source: Rystad Energy ShaleWellCube, July 2021

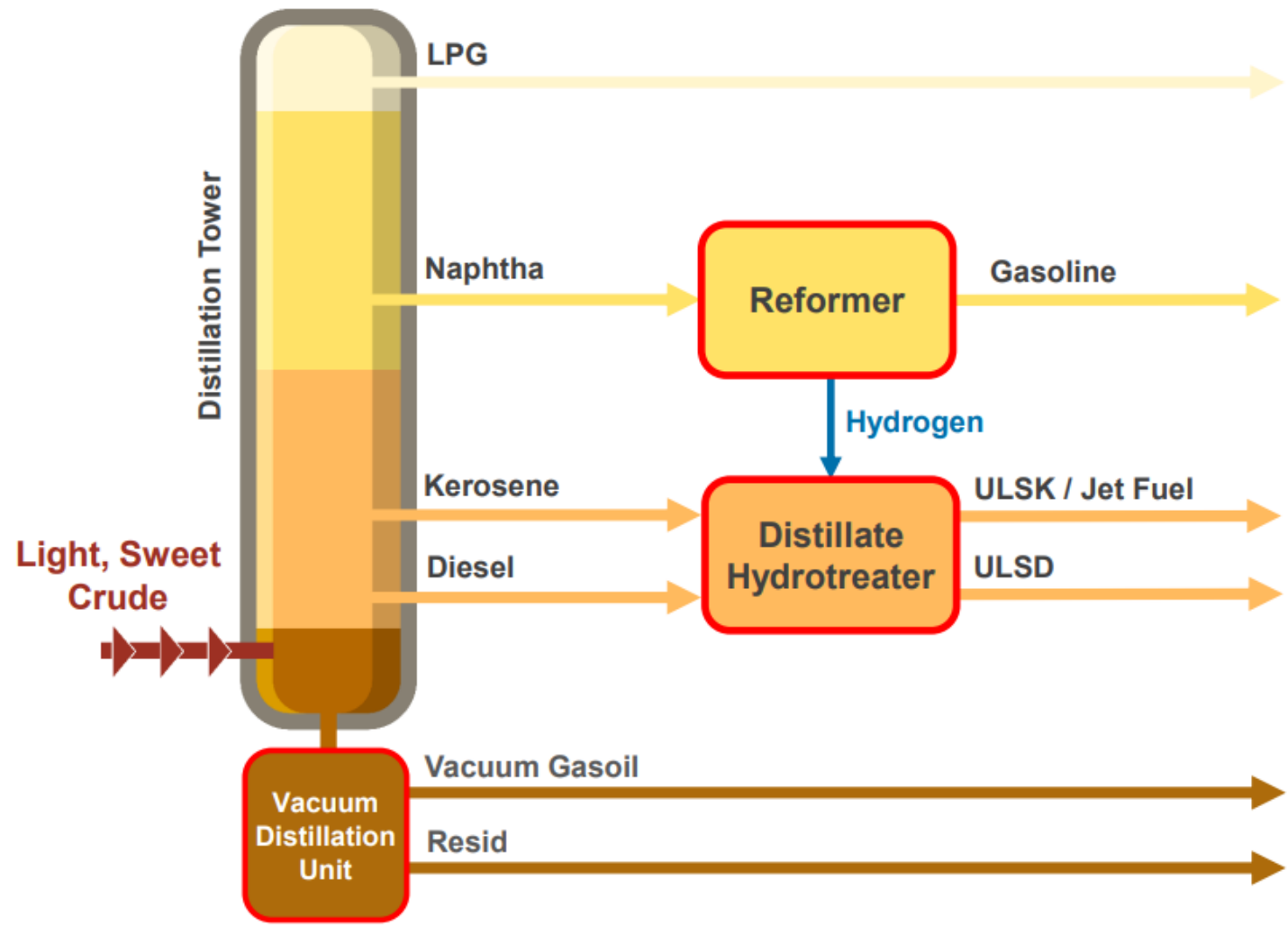
US Upstream Investment



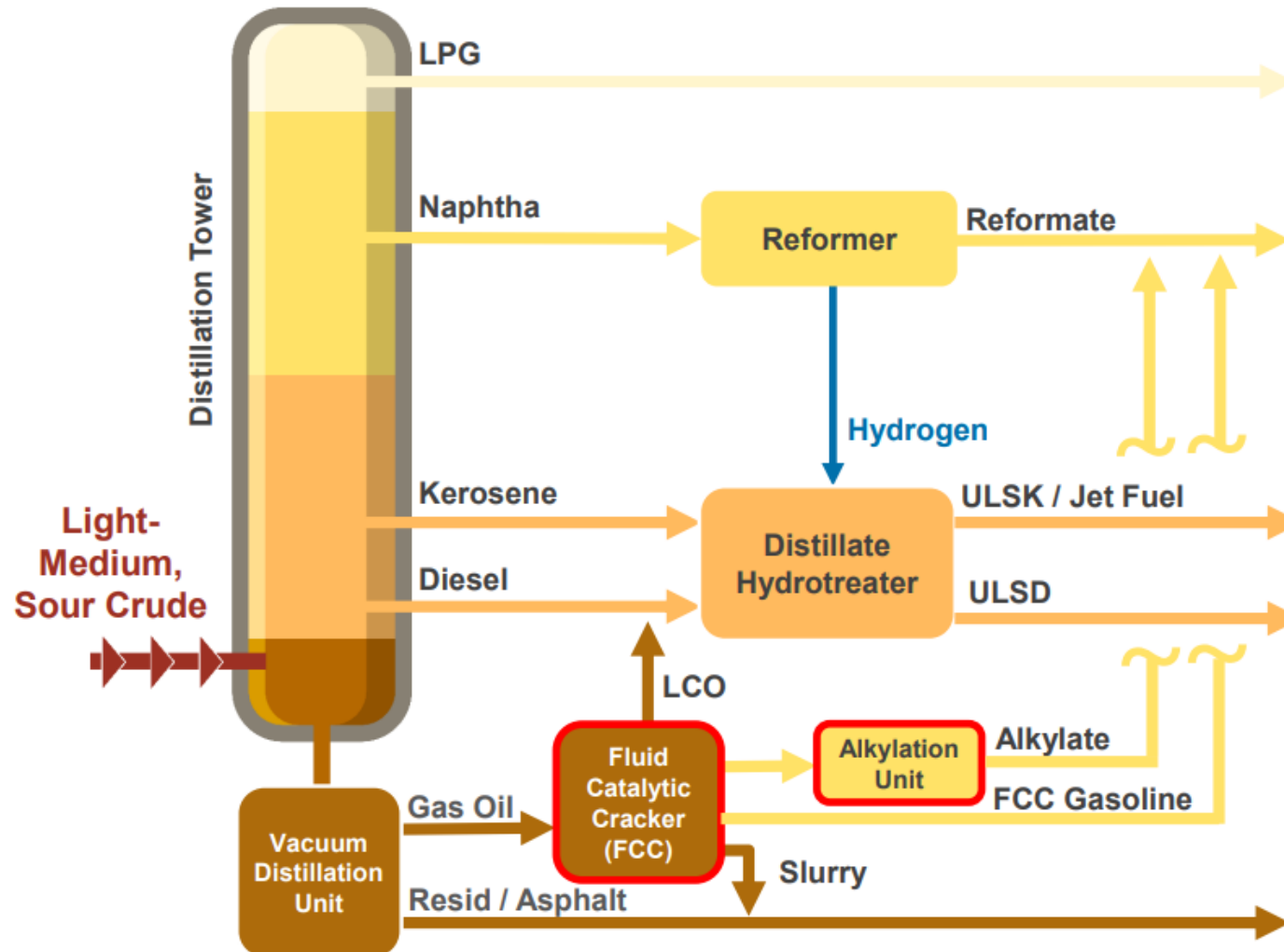
9. Refining & Chemicals

To draw a comprehensive picture of refining and chemicals sectors

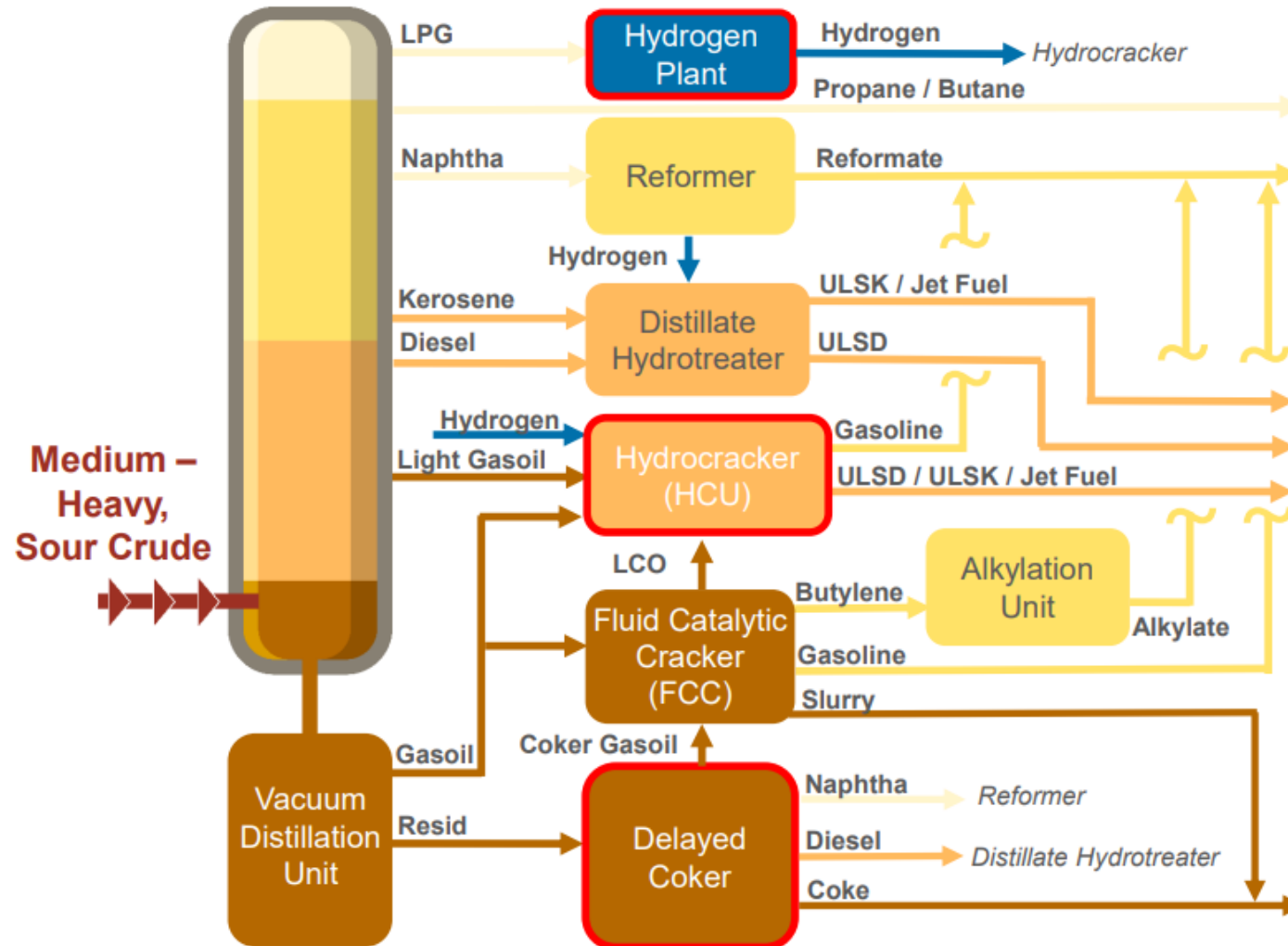
Low Complexity: Hydroskimming (Topping)



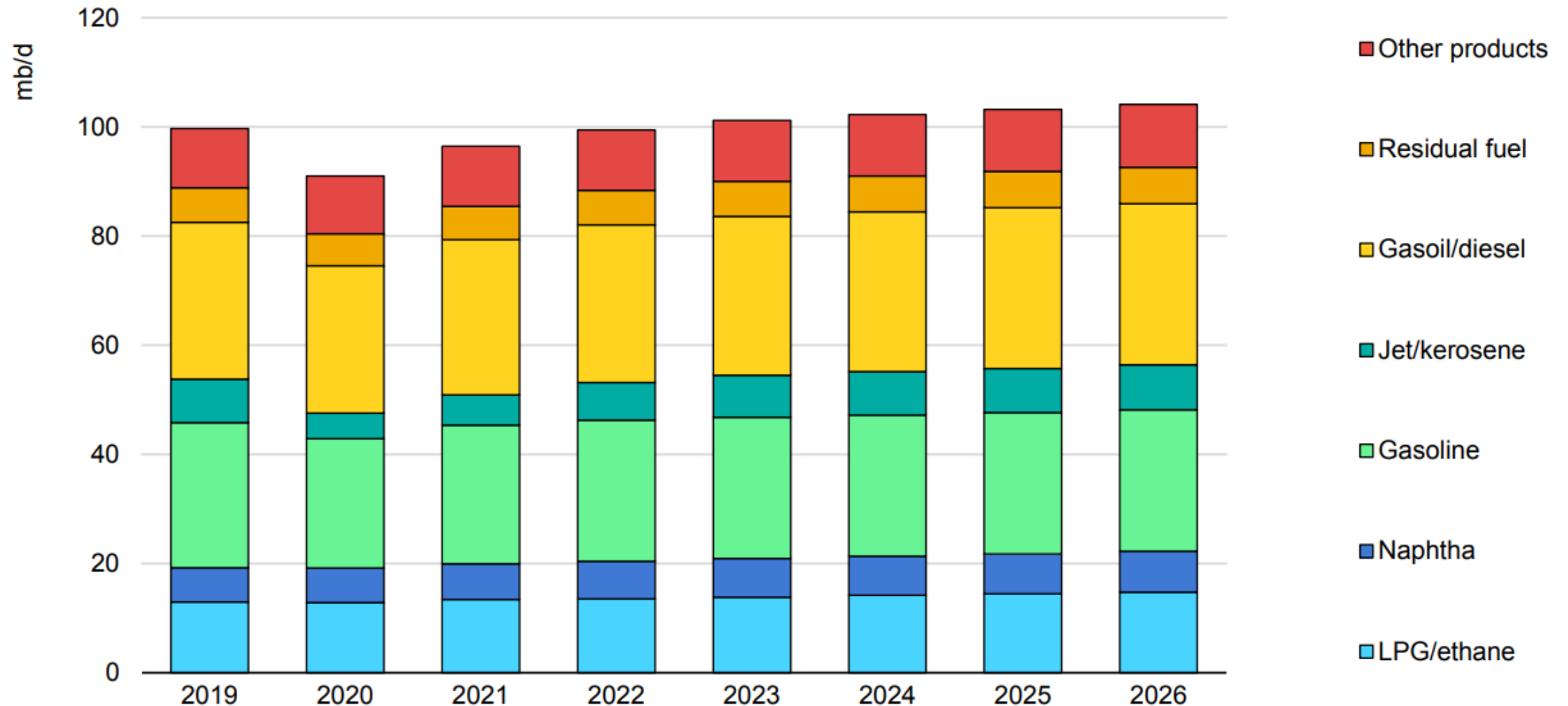
Medium Complexity: Catalytic Cracking



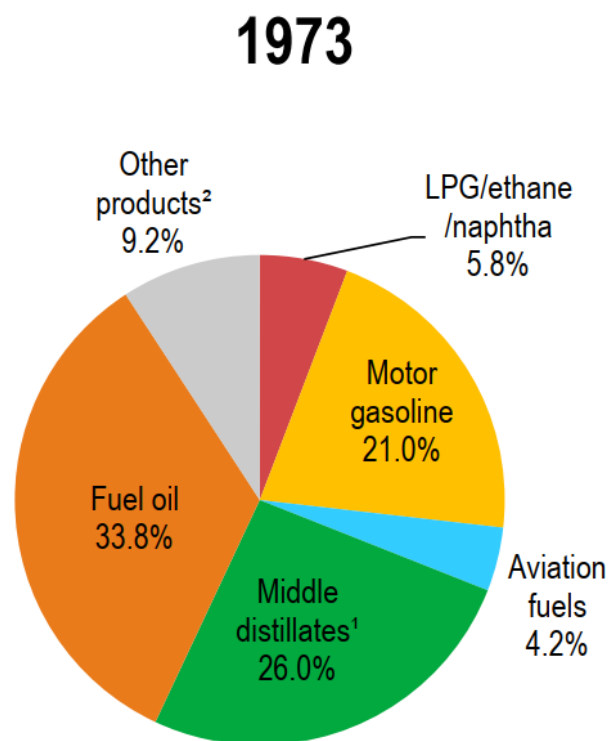
High Complexity: Coking / Reside Destruction



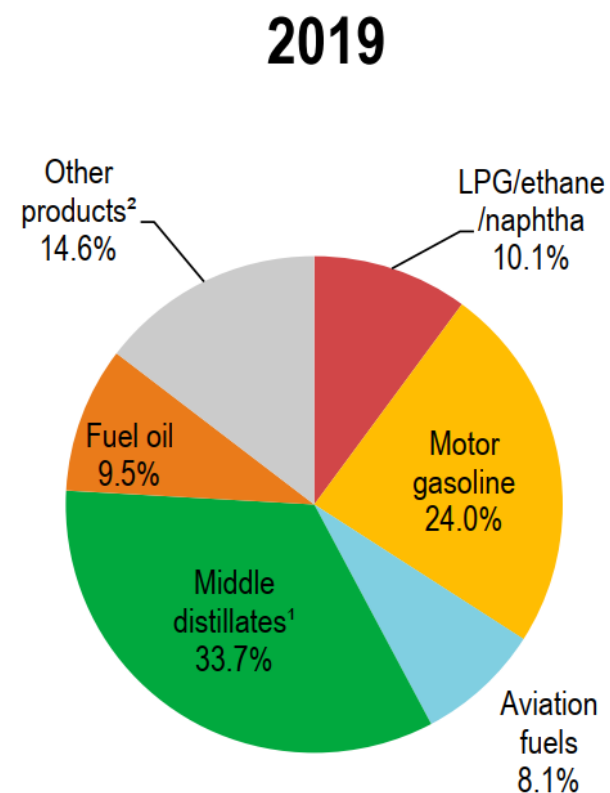
Global Oil Demand by Product



Refinery Output by Product

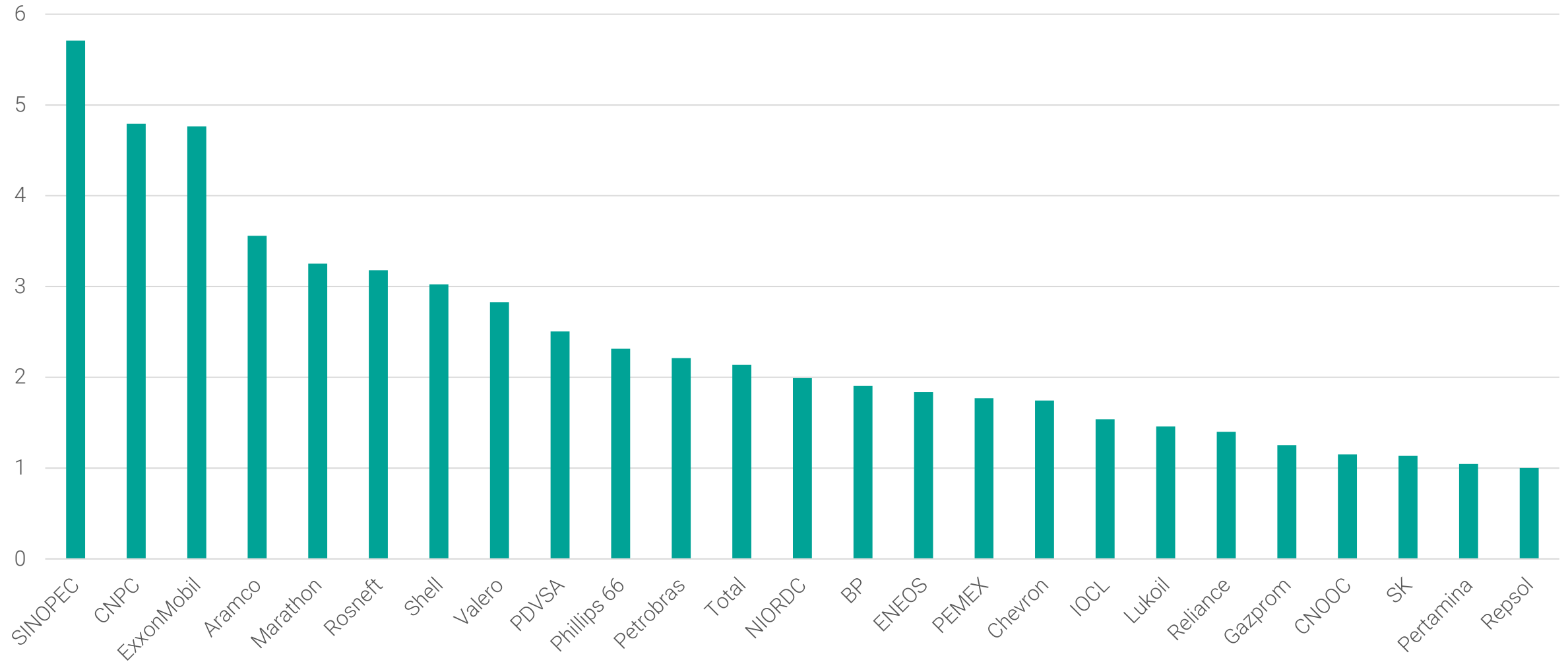


2 719 Mt

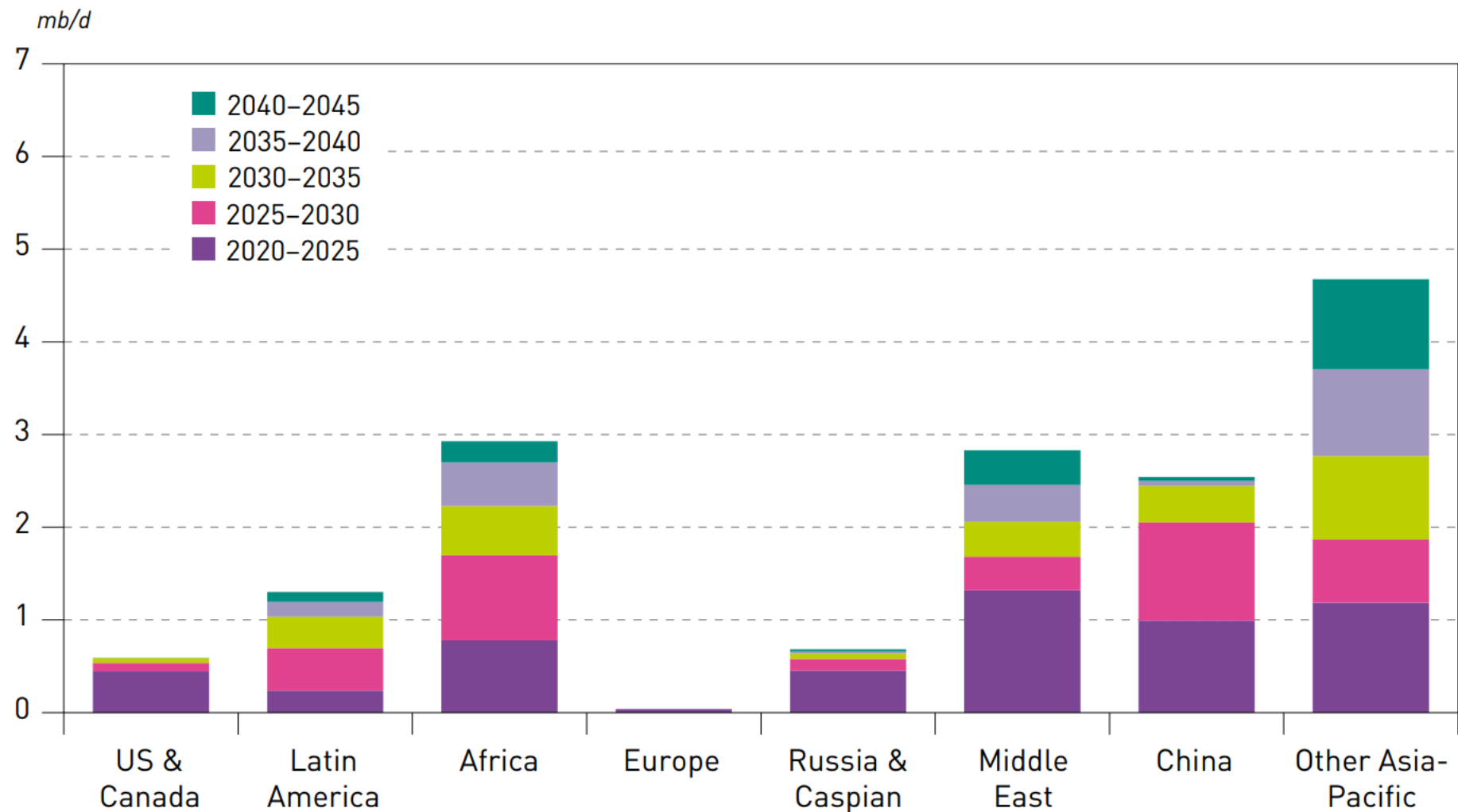


4 159 Mt

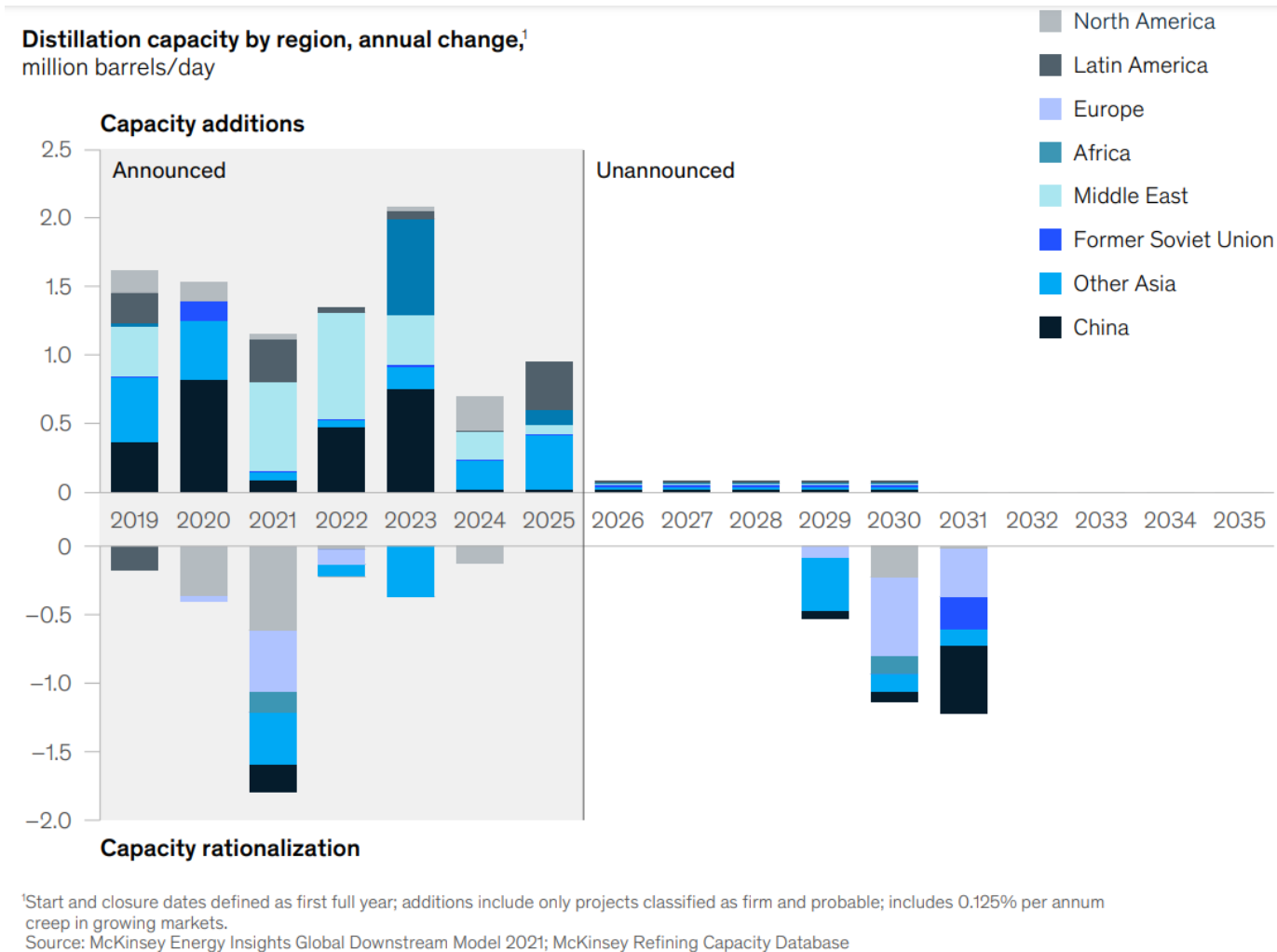
Top Refining Companies by Capacity (MBPD)



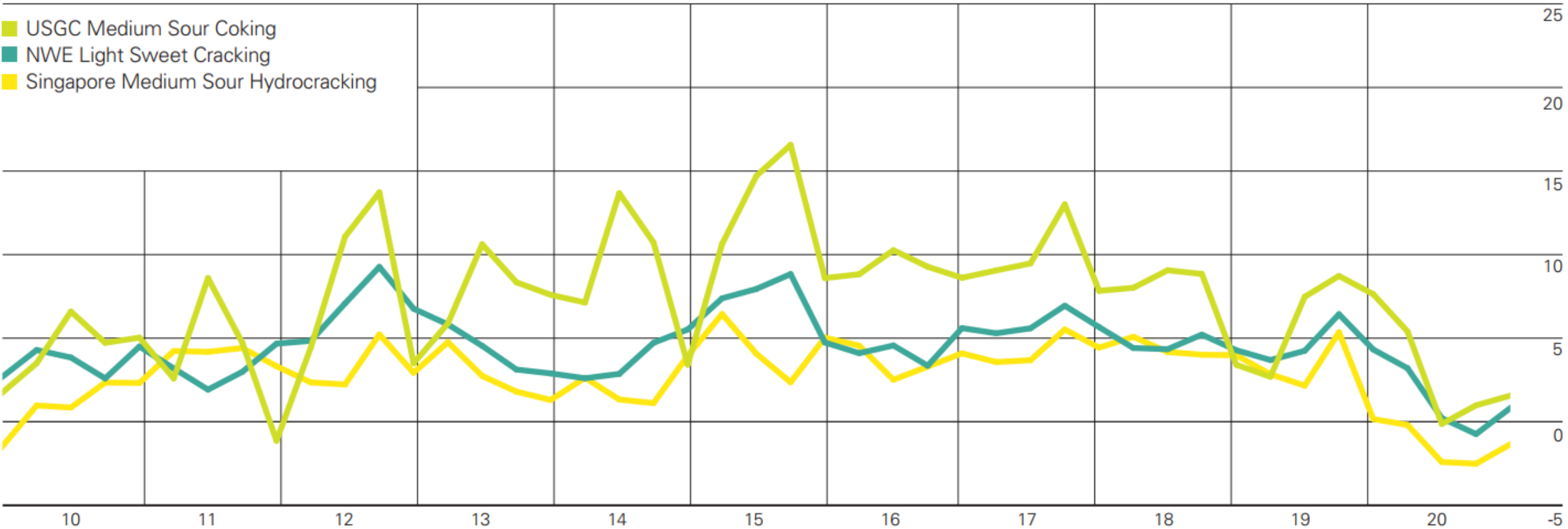
Distillation Capacity Additions (2019–2045)



Distillation Capacity by Region, Annual Change

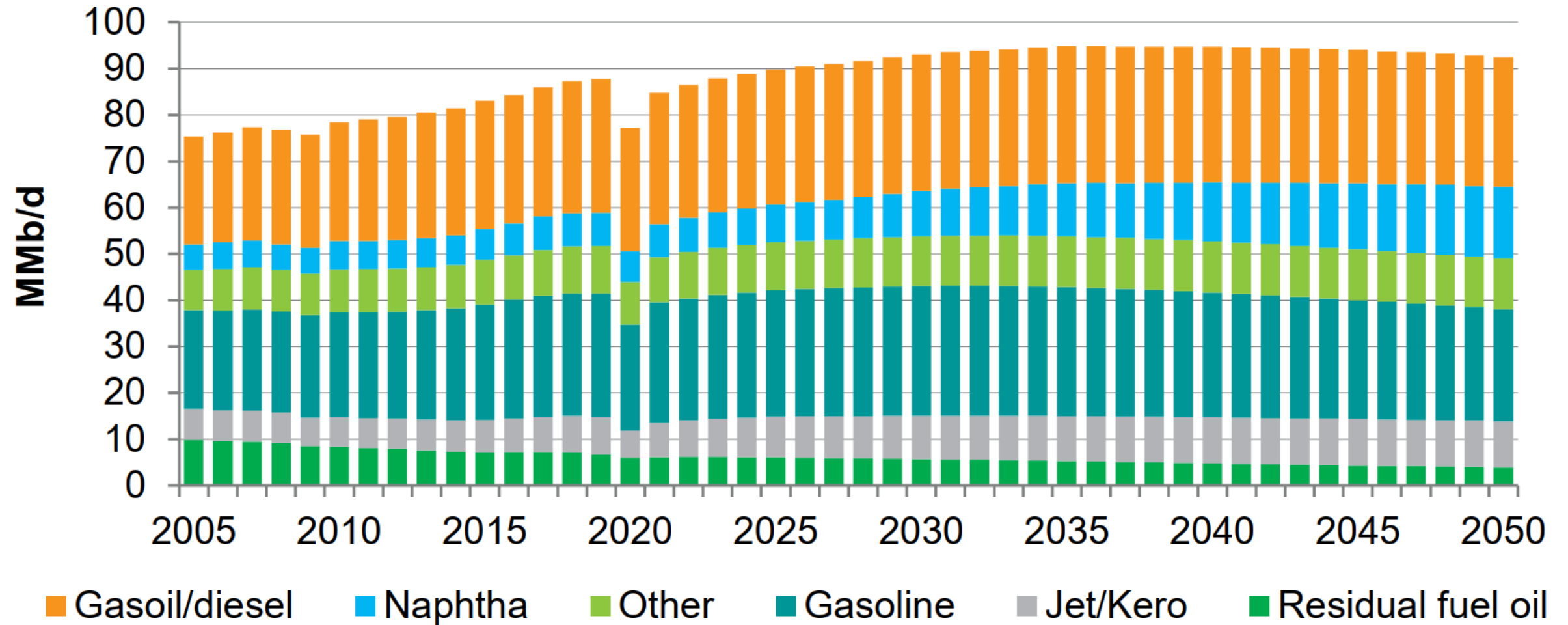


Refining Margins by Region

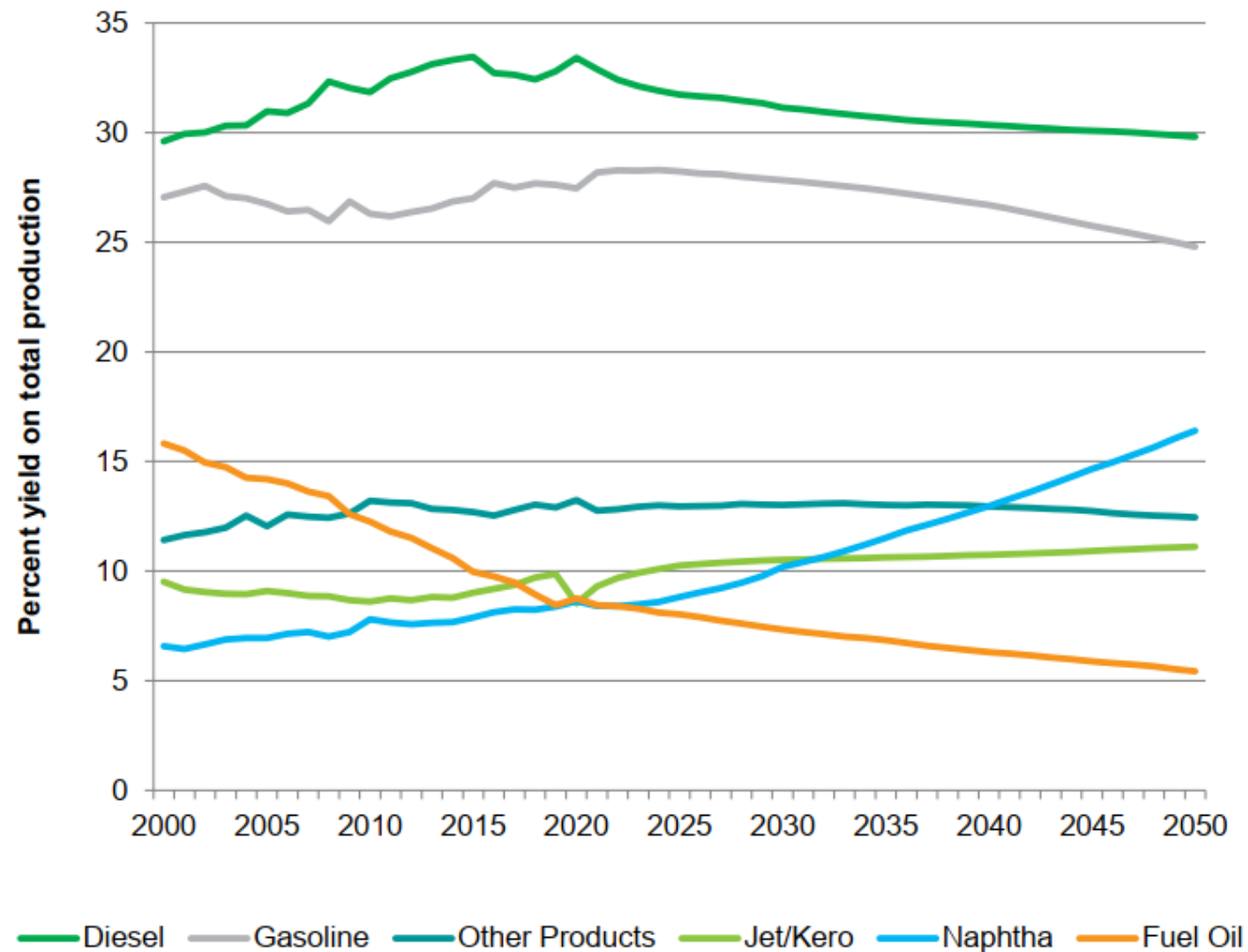


Note: The refining margins presented are benchmark margins for three major global refining centres. US Gulf Coast (USGC), North West Europe (NWE – Rotterdam) and Singapore. In each case they are based on a single crude oil appropriate for that region and have optimized product yields based on a generic refinery configuration (cracking, hydrocracking or coking), again appropriate for that region. The margins are on a semi-variable basis, i.e. the margin after all variable costs and fixed energy costs.

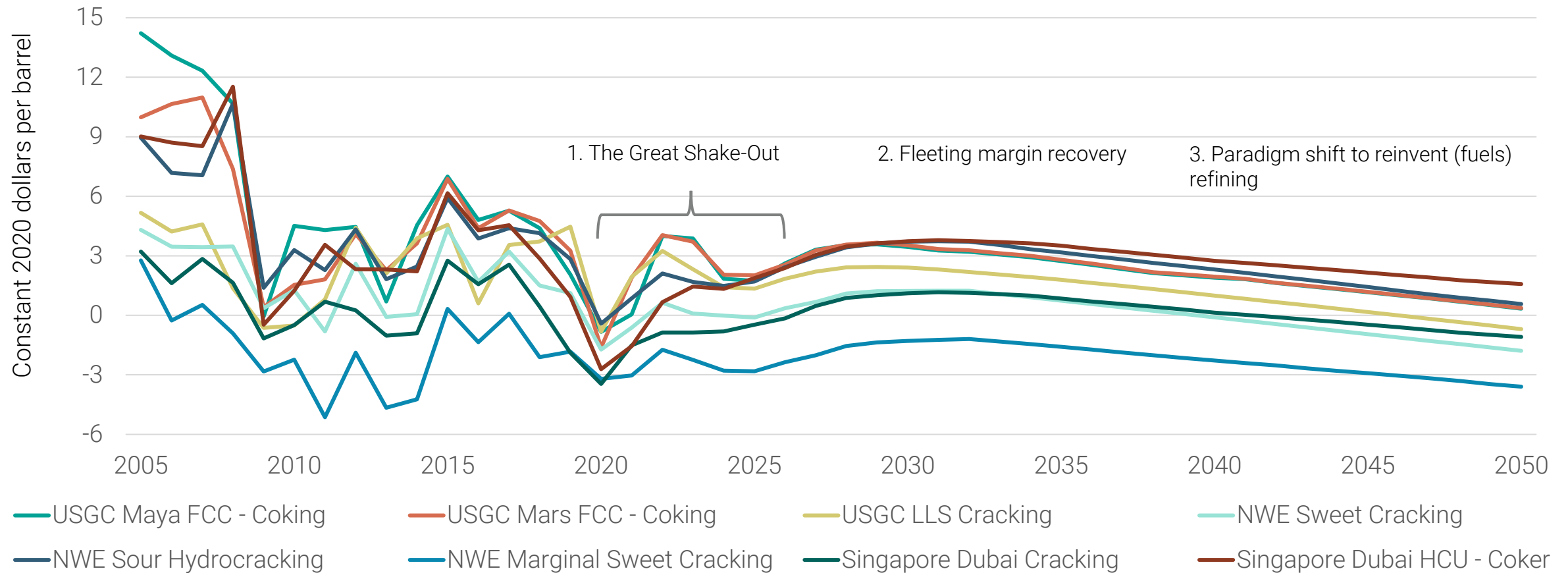
World Refined Product Demand



World Refinery Yields



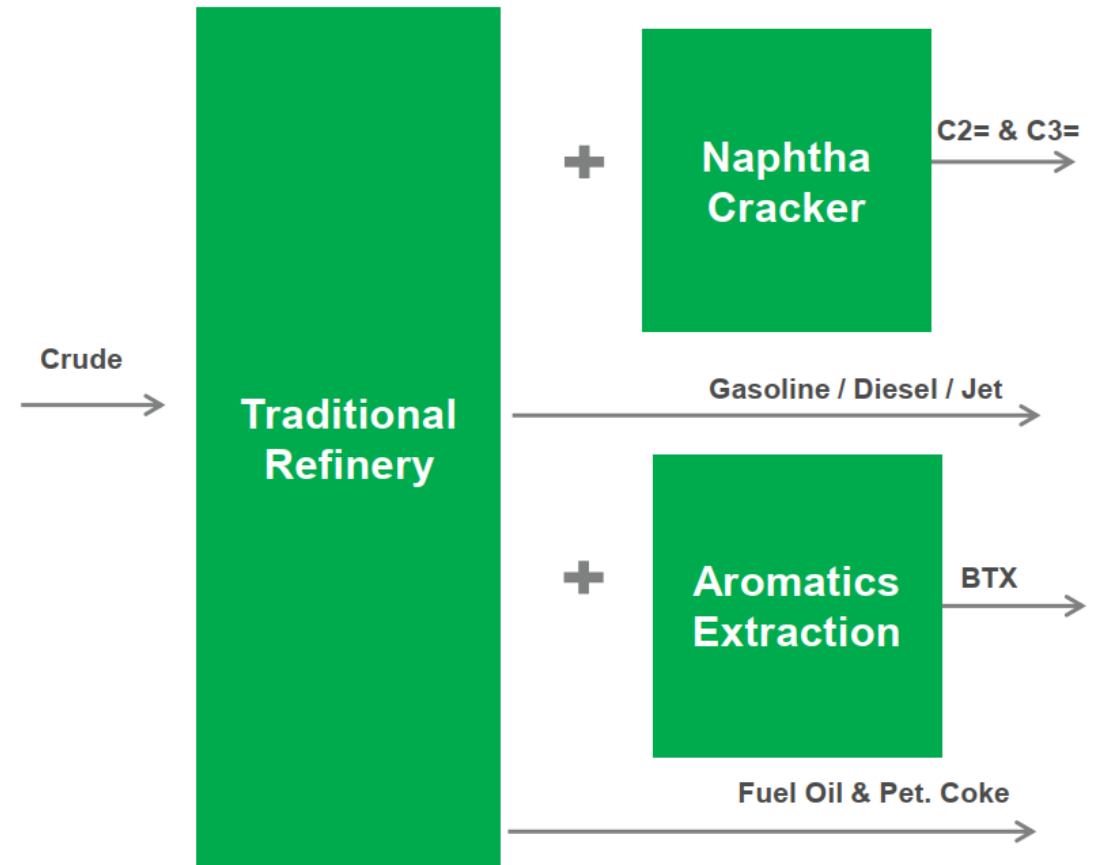
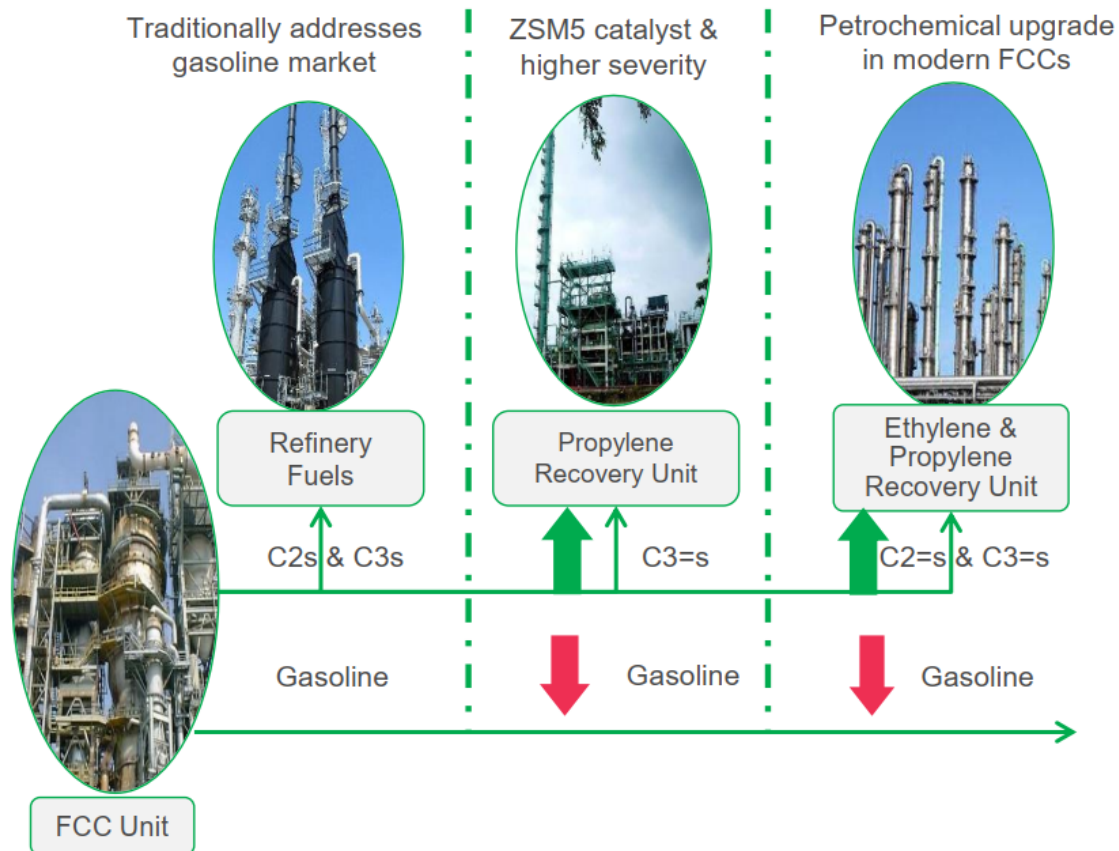
Long-term Benchmark Margin Outlook (USGC Margins Include RIN Costs)



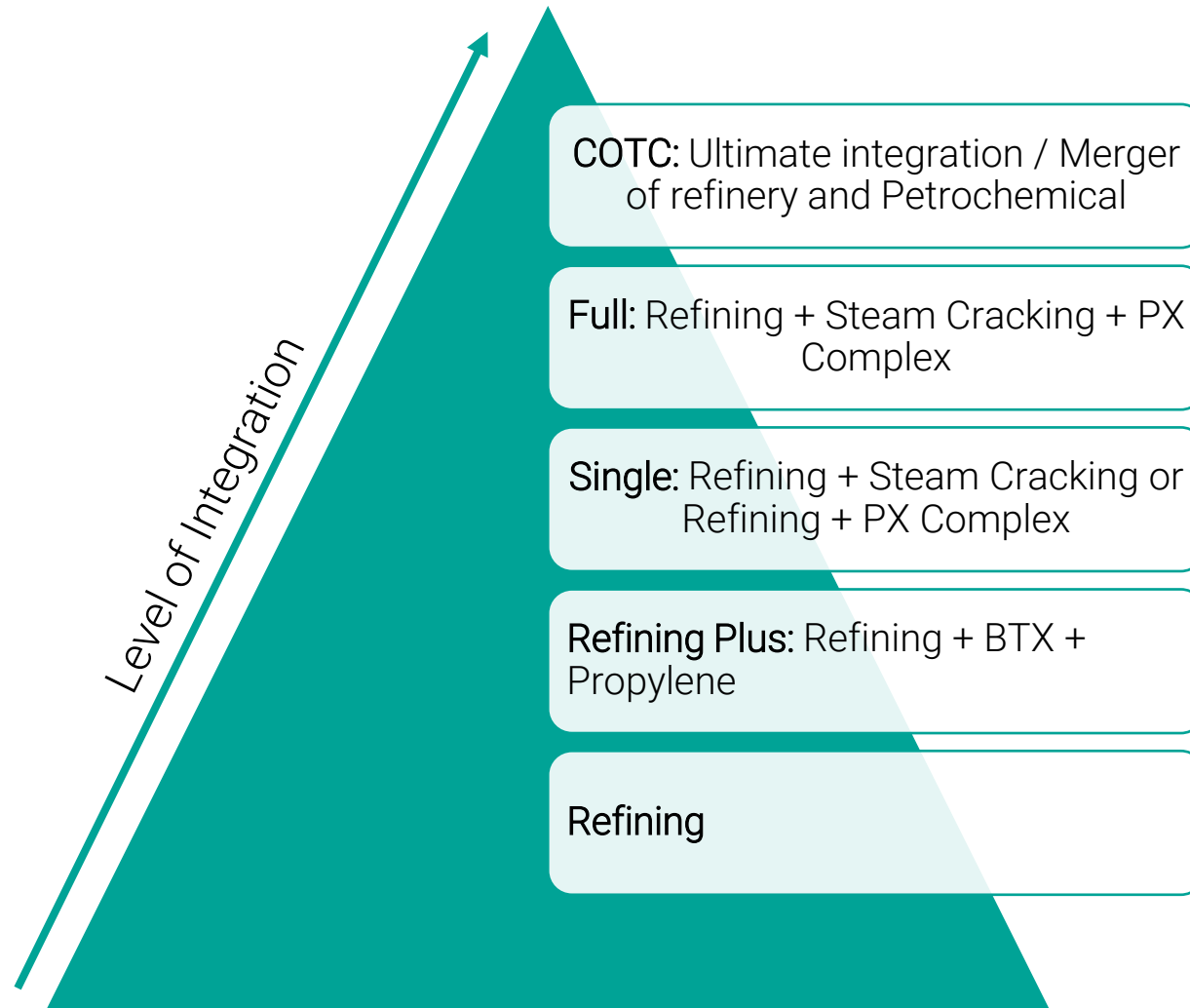
Refining Petrochemical Integration

“Re-inventing” the FCC can potentially be the first move

Long term plan to “bolt-on” petrochemical production



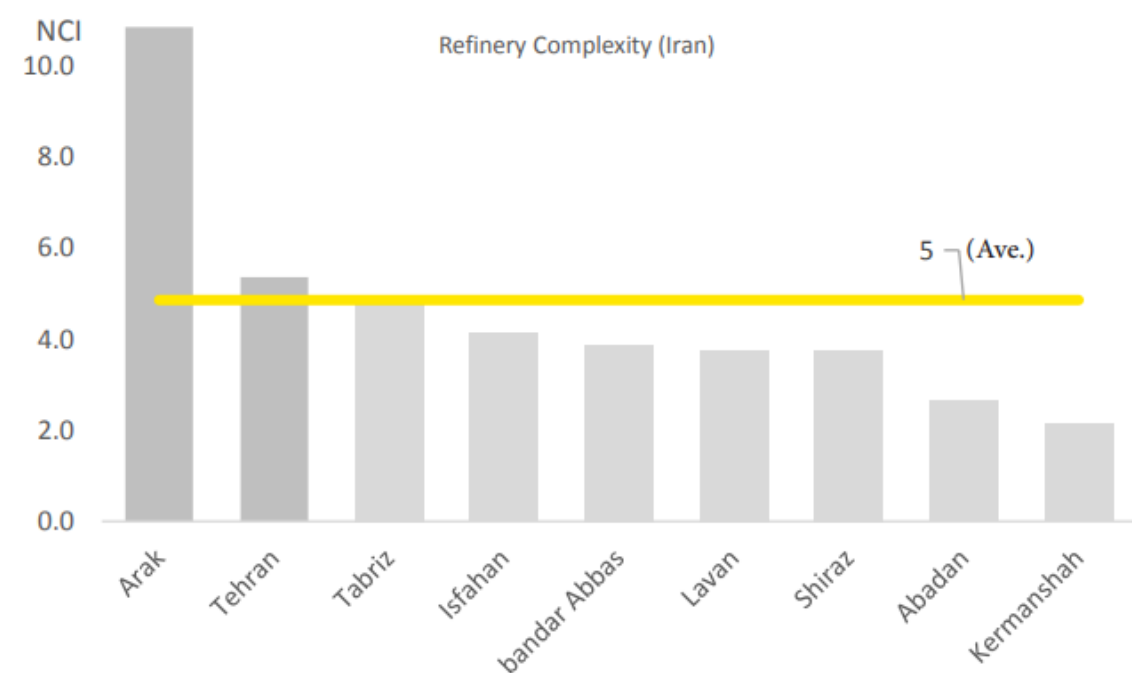
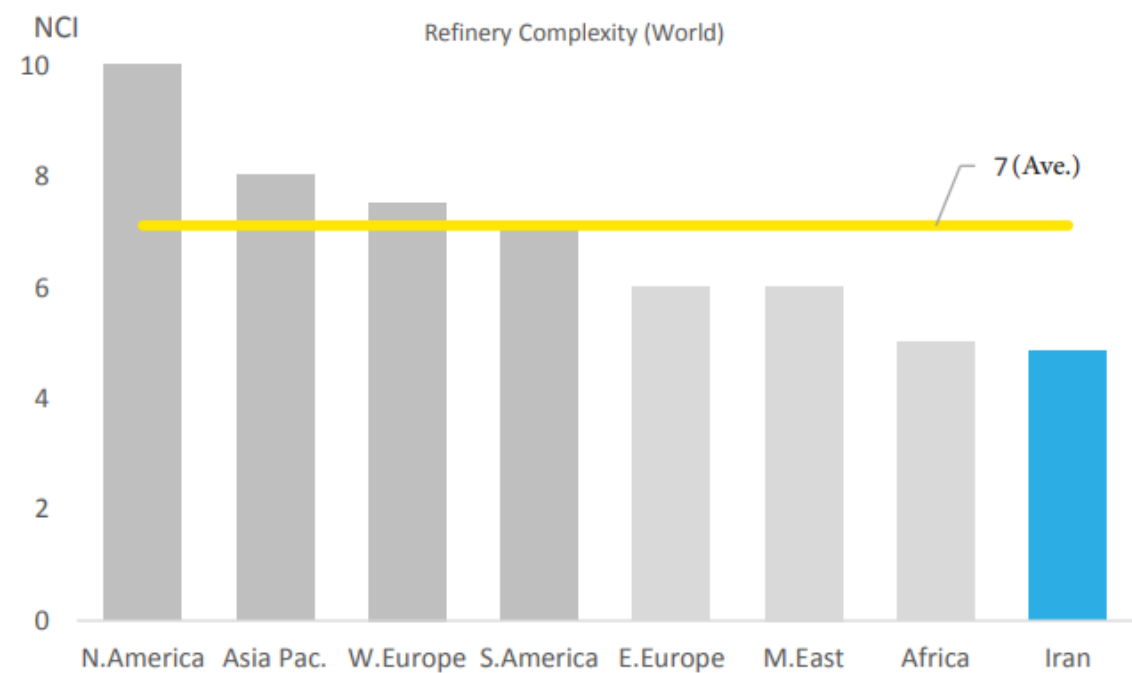
COTC Configures a Refinery to Produce Maximum Chemicals



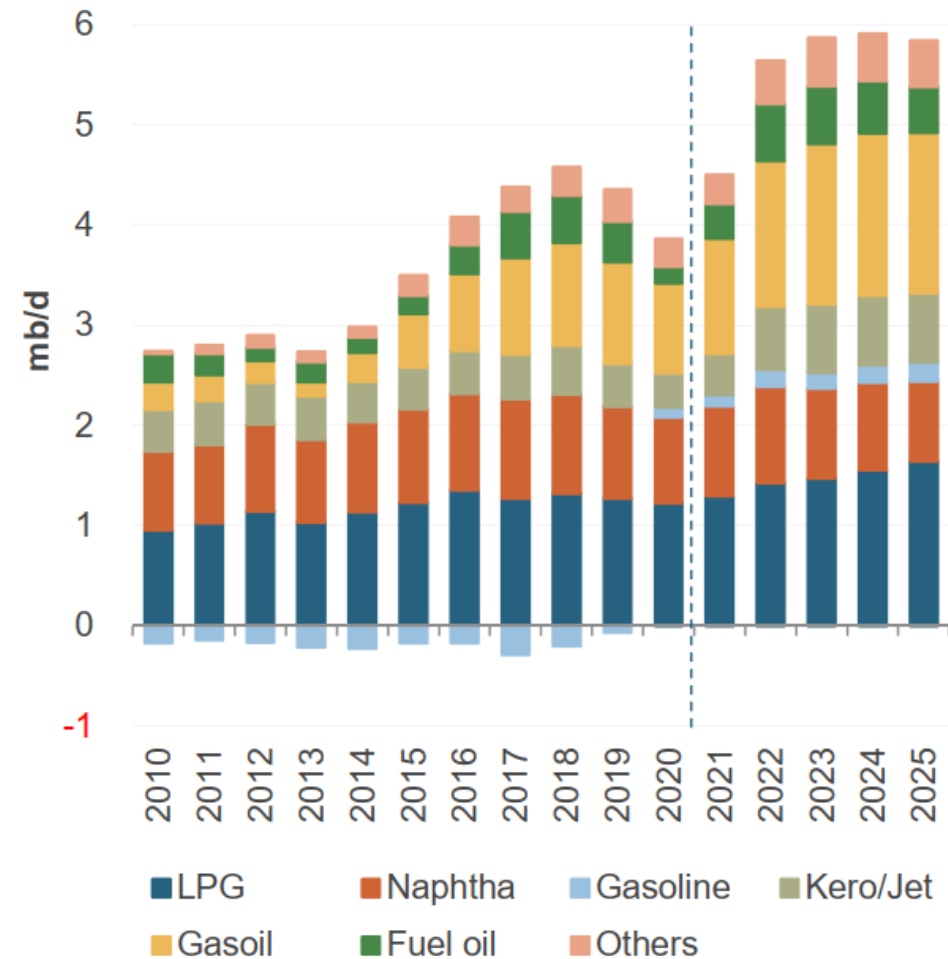
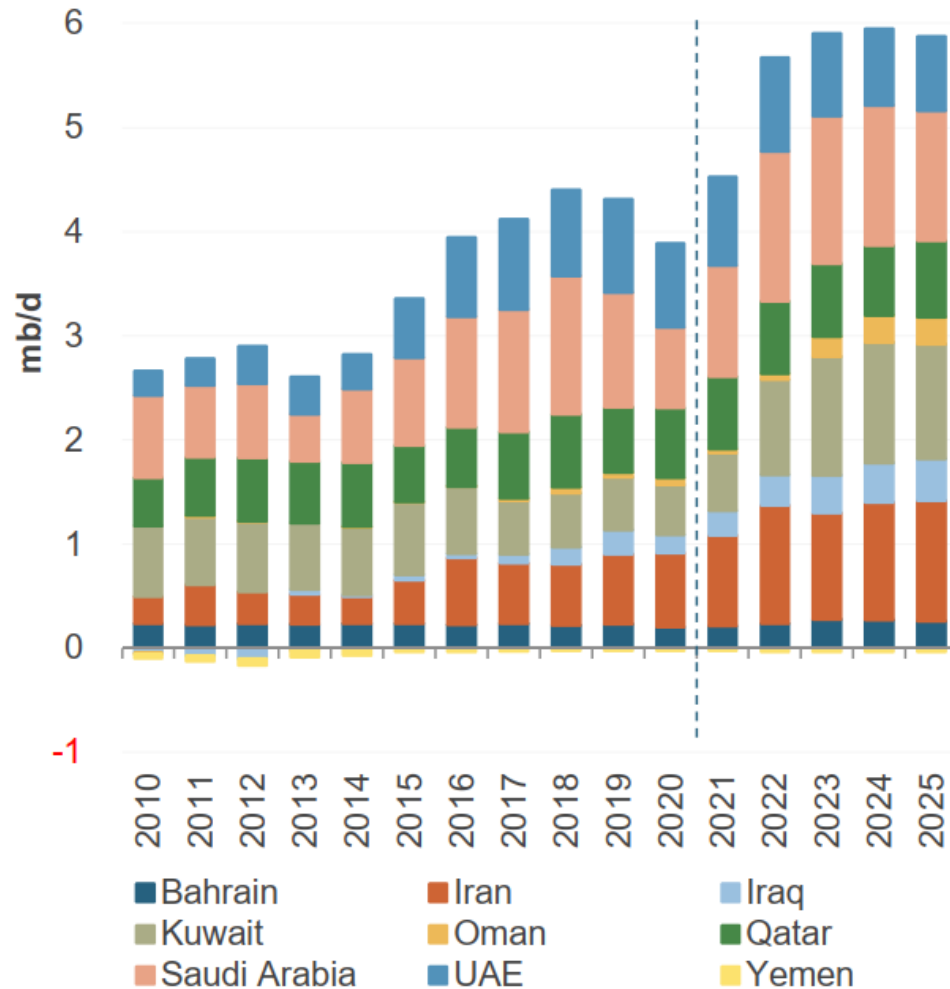
COTC Projects (2019)

Project	Refinery Capacity (MMTPA)	P-Xylene Capacity (MMTPA)	Olefin Capacity (MMTPA)	Est. Chemical conversion/ bbl of oil (%)	Investment (\$bn)	Start Trial Operation
Hengli Petrochemical	20	4.3	1.5	42	11.4	Dec 2018
Zhejiang Petroleum and Chemical (ZPC) Phase 1	20	4.0	1.4	45	12	Est. Q2 2019
Hengyi (Brunei) PMB Refinery-Petrochem	8	1.5	0.5	>40	3.45	Est. 2019
Zhejiang Petroleum and Chemical (ZPC) Phase 2	20	4.8*	1.2	50*	12	Est. 2021
Shenghong refinery and Integrated Petrochem	16	2.8	1.1	60**	11.0	H2** 2021
Aramco/SABIC JV	20	--	3.0	45	20	2025

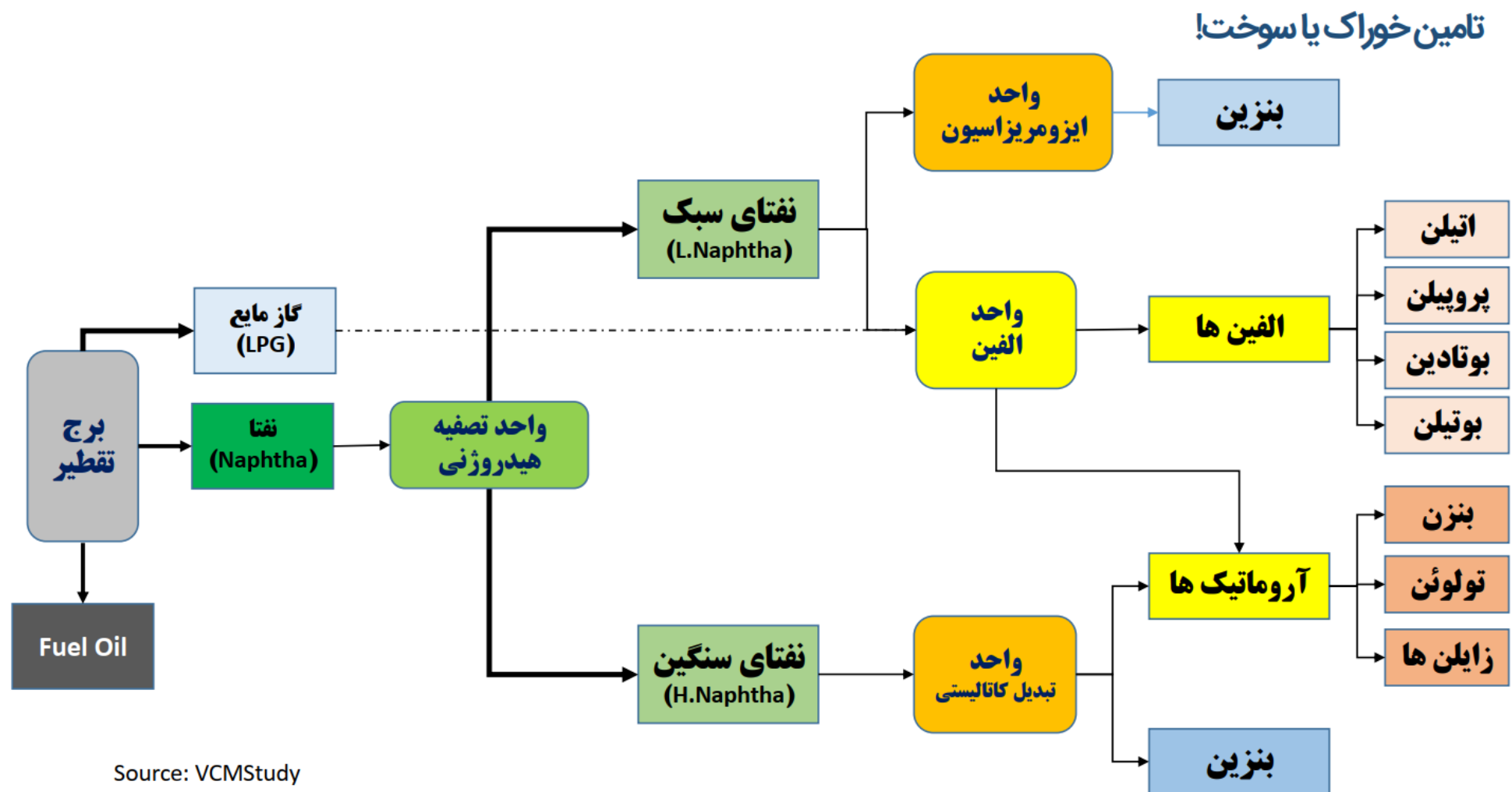
Nelson Complexity Index of Iran Refineries



Middle East Products Net Exports



Iran Refineries: Fuel or Feed

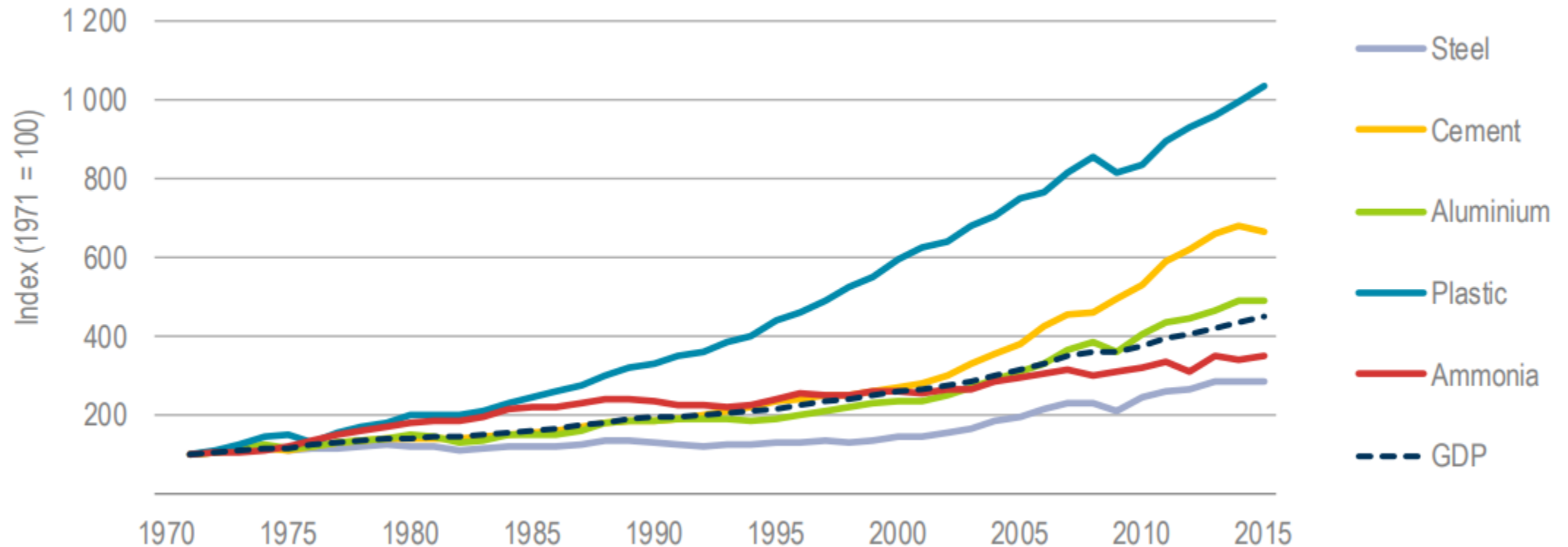


Source: VCMStudy

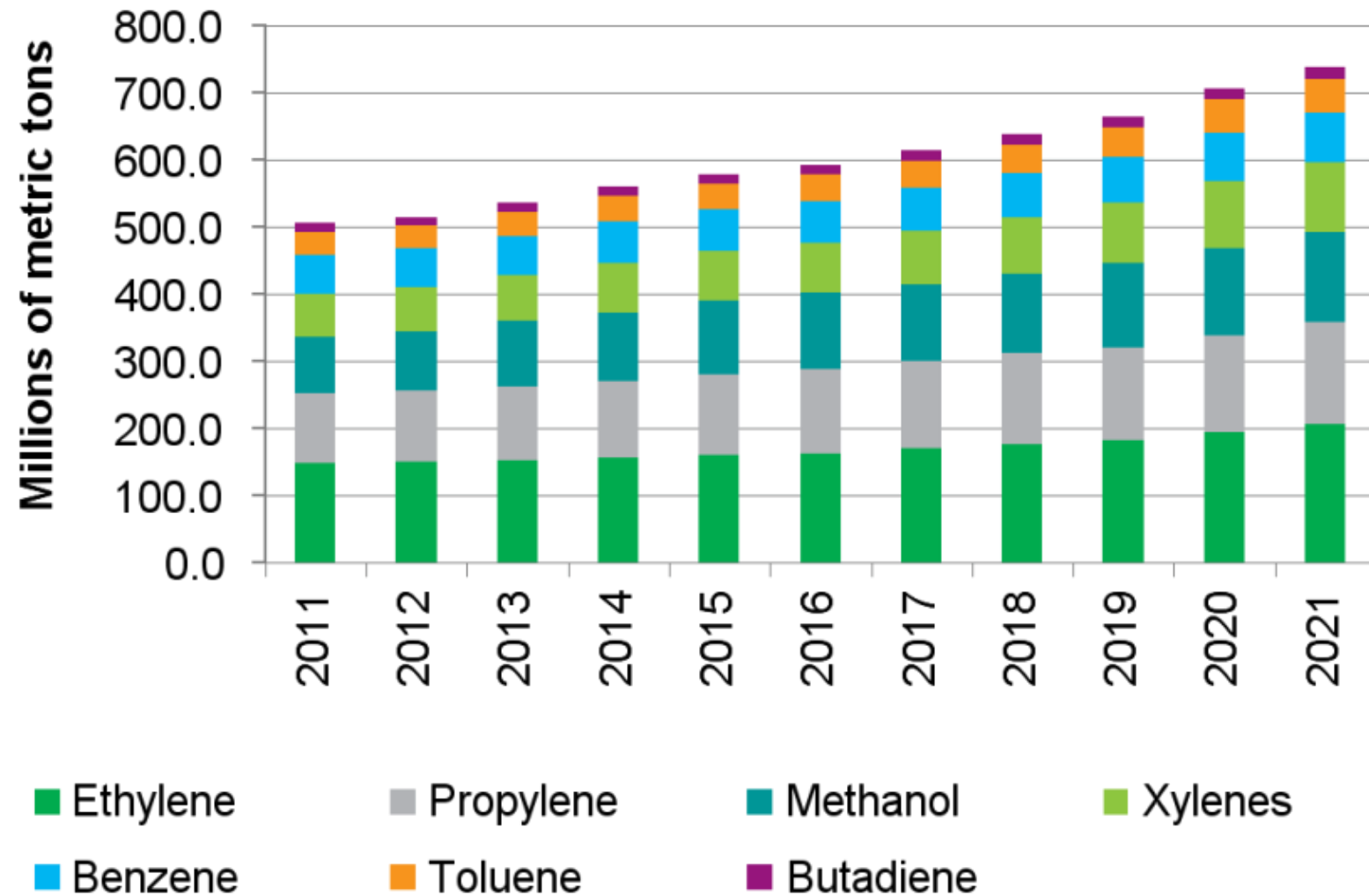
Oil Demand in the Petrochemical Sector

	2019	2020	2025	2030	2035	2040	2045	Growth 2019–2045
OECD Americas	3.5	3.2	3.8	4.1	3.9	3.7	3.5	0.1
OECD Europe	1.9	1.7	1.8	1.8	1.7	1.6	1.5	–0.4
OECD Asia Oceania	2.1	1.9	2.0	2.0	2.0	2.0	2.0	–0.1
OECD	7.4	6.9	7.6	8.0	7.7	7.4	7.0	–0.4
Latin America	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.1
Middle East & Africa	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
India	0.4	0.4	0.5	0.7	0.9	1.0	1.1	0.7
China	1.9	1.8	2.1	2.2	2.4	2.6	2.7	0.8
Other Asia	1.3	1.3	1.5	1.7	1.9	2.0	2.1	0.8
OPEC	1.2	1.2	1.4	1.7	2.2	2.5	2.7	1.5
Russia	0.9	0.9	1.1	1.1	1.1	1.1	1.1	0.1
Other Eurasia	0.0	0.0	0.1	0.1	0.1	0.0	0.1	0.0
Non-OECD	6.2	6.0	7.1	8.0	9.0	9.7	10.3	4.1
World	13.7	12.9	14.7	15.9	16.7	17.0	17.3	3.7

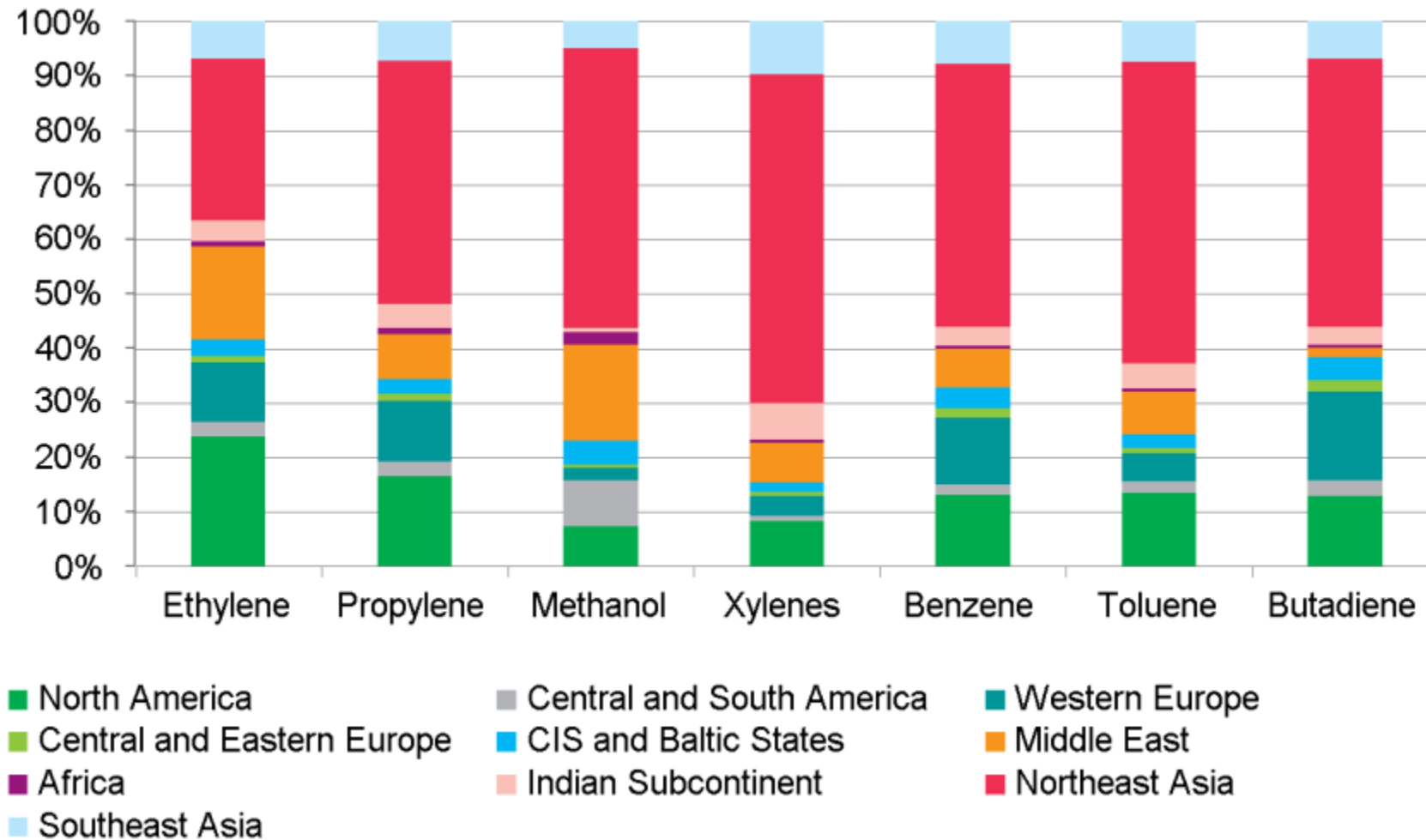
Production Growth for Selected Bulk Materials and GDP



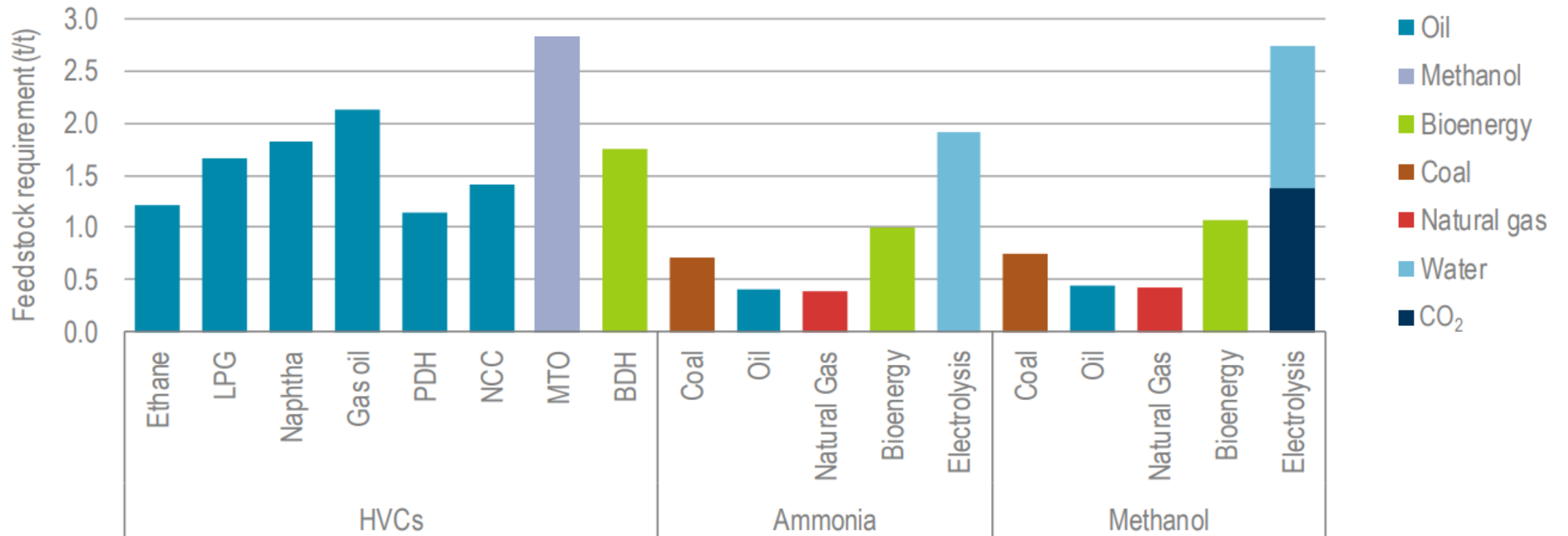
World Capacity for Primary Petrochemicals



Regional Share of Capacity for Primary Petrochemicals

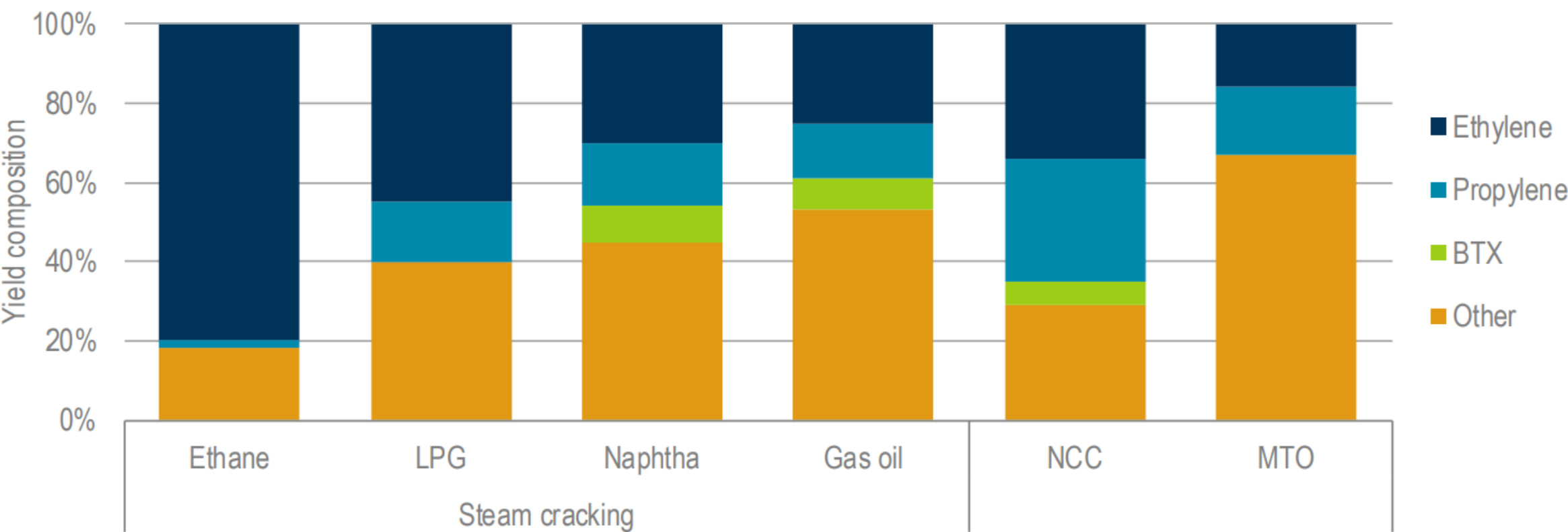


Feedstock Options by Chemical Product

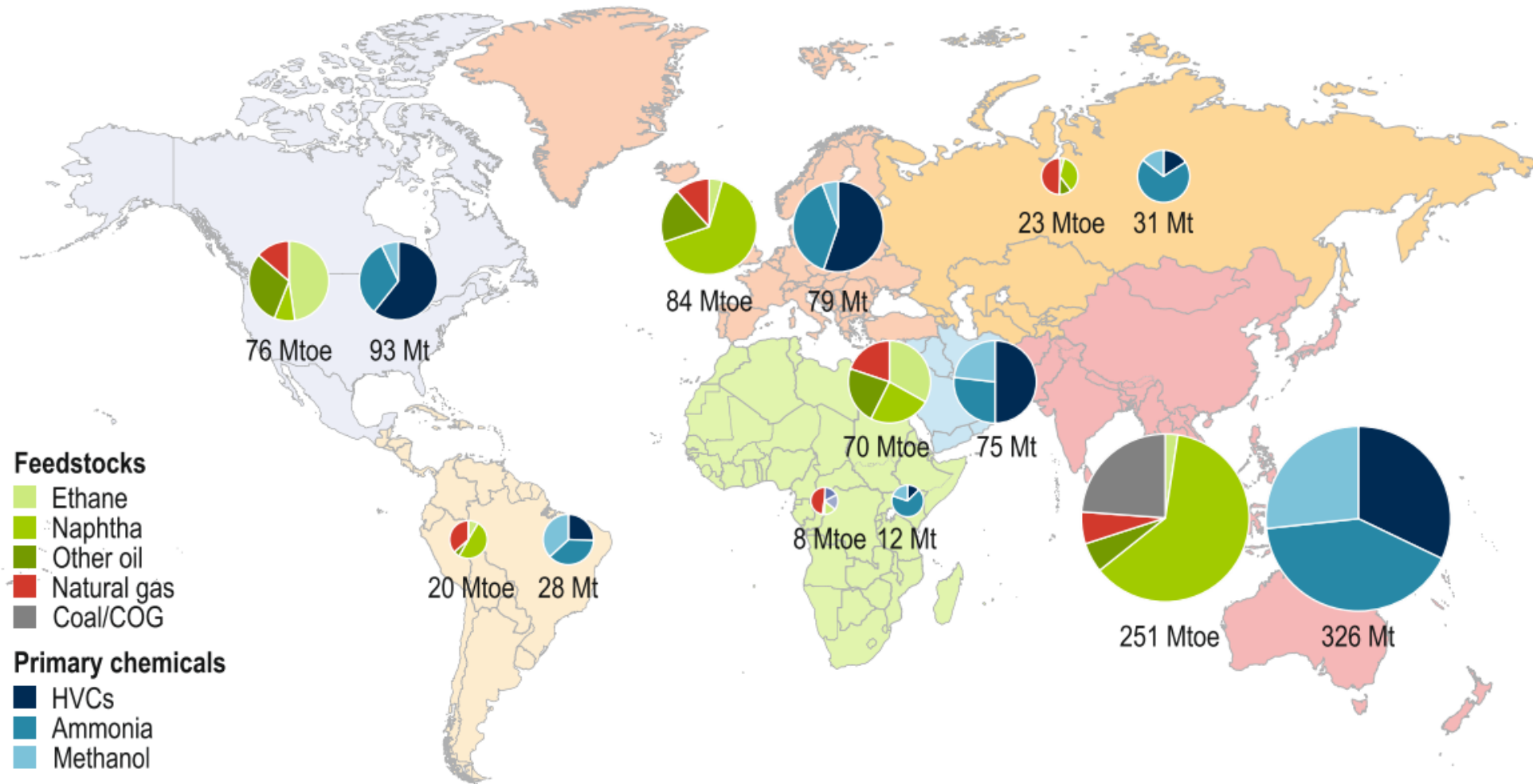


Notes: BDH = bioethanol dehydration; LPG = liquefied petroleum gas; NCC = naphtha catalytic cracking. The quantity pertaining to BDH is in terms of bioethanol.

Yield of Individual HVCs in Multi-product Processes

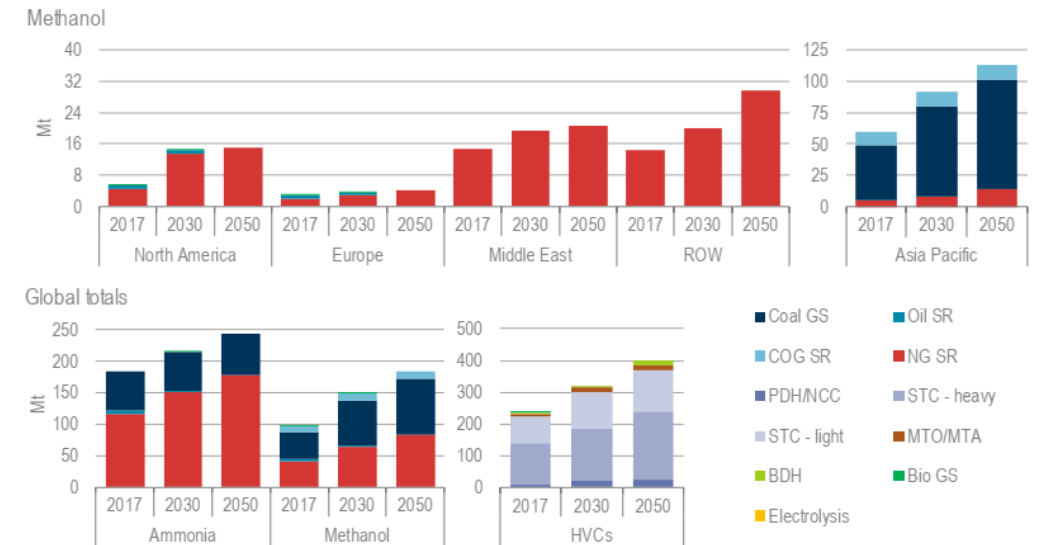
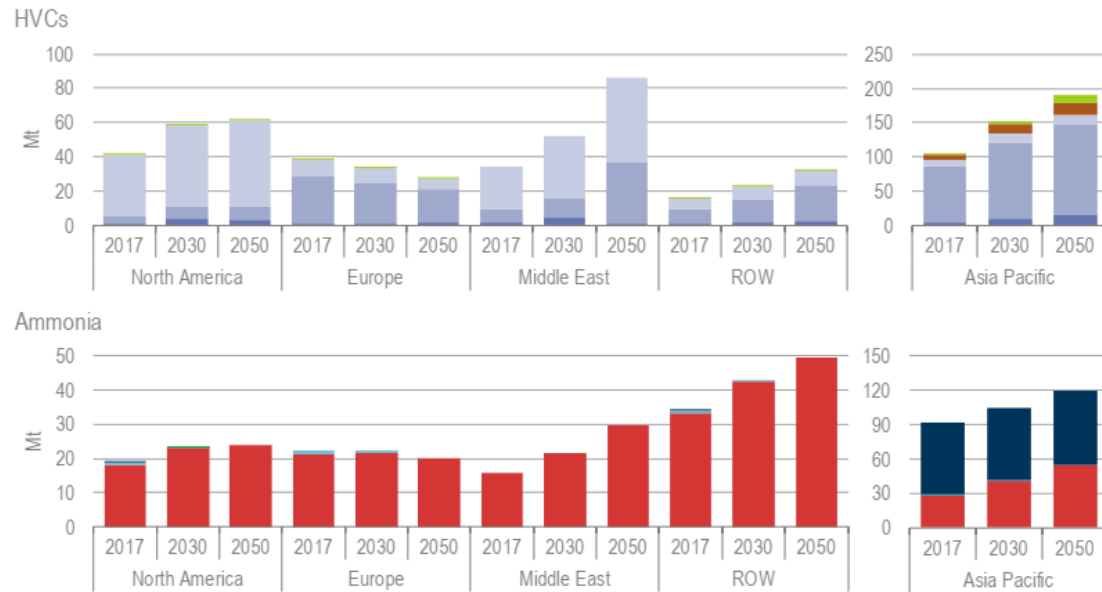


Primary Feedstock Use and Chemical Production by Region



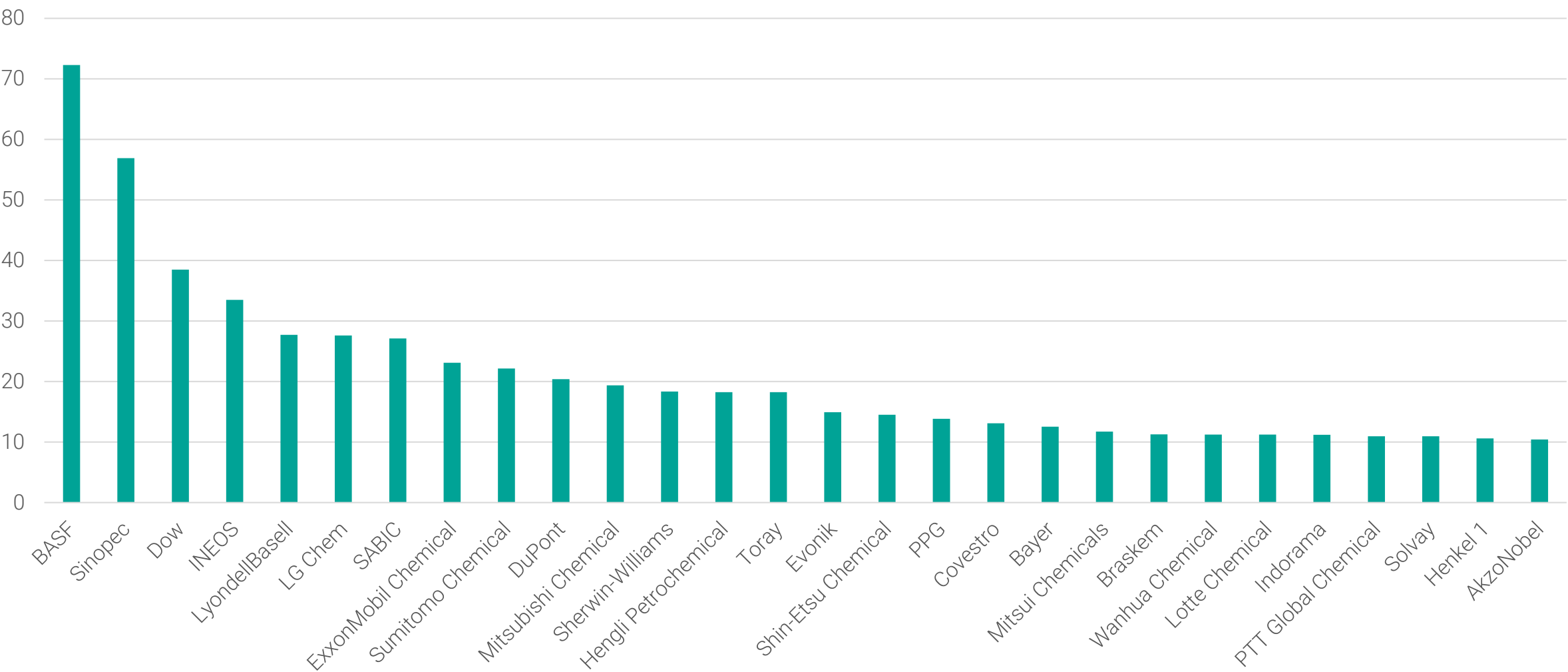
This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.

Production Routes for Primary Chemicals in the RTS



Notes: Tabulated results are provided in the online annex. Bio = bioenergy; GS = gasification; SR = steam reforming; STC - heavy = naphtha and gas oil steam cracking; STC - light = ethane and liquid petroleum gas steam cracking.

The ICIS Top 100 Chemical Companies 2020 (\$B)



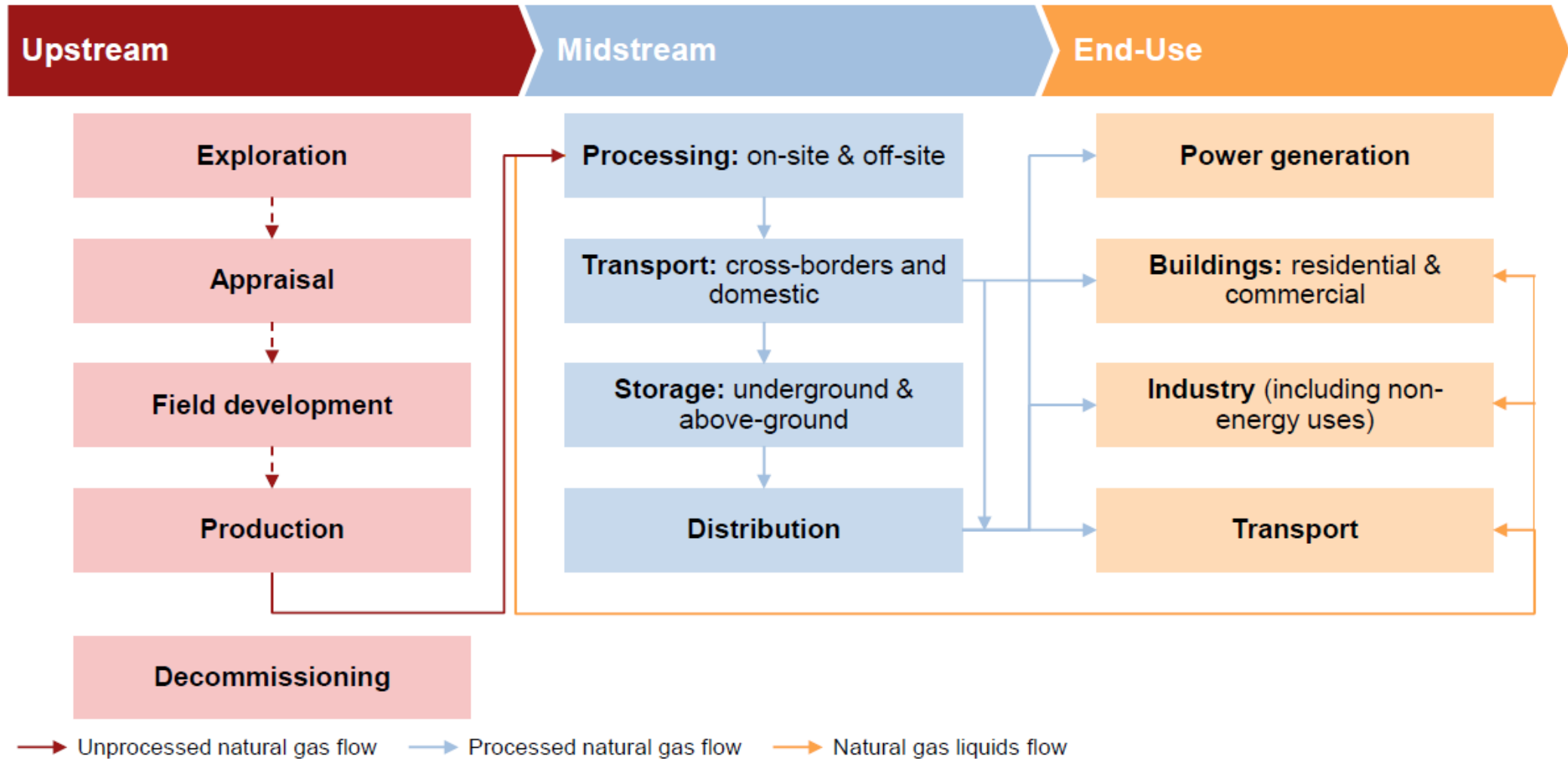
The ICIS Top 100 Chemical Companies 2020

Rank 2019	Company	Sales 2019% change		Operating profit 2019% change		Net income 2019% change		Total Assets 2019% change		R&D 2019% change		Capex 2019% change		Employees 2019% change	
\$m, change in reporting currencies															
1	BASF	66,594	-1.5	4,549	-32.2	9,454	78.9	97,619	0.5	2,423	8.2	4,310	6.2	132,061	-3.9
2	Sinopec ²	63,244	-6.9	2,463	-36.5	-	-	-	-	-	-	-	-	-	-
3	Dow ¹	42,951	-13.4	-395	-	-1,272	-	60,524	-27.7	765	-4.4	1,961	-6.2	36,500	-32.4
4	LyondellBasell	34,727	-11.0	4,116	-21.3	3,397	-27.6	30,435	7.6	111	-3.5	2,694	28.0	19,100	-1.8
5	SABIC ²	32,488	-19.0	3,680	-59.1	-	-	74,933	-3.2	-	-	-	-	-	-
6	INEOS ²	32,103	-8.6	2,485	-39.0	-	-	-	-	-	-	-	-	23,015	13.9
7	ExxonMobil ²	27,416	-15.5	-	-	592	-82.3	-	-	-	-	1,933	29.4	-	-
8	LG Chem	24,793	1.6	776	-60.1	326	-75.2	29,470	17.6	949	8.7	1,793	1.4	-	-
9	DuPont ¹	21,512	-4.8	194	-70.4	498	-87.0	69,396	-63.1	955	-10.7	1,492	19.9	35,000	-
10	Sumitomo Chemical ³	20,480	-4.0	1,265	-24.8	501	-64.3	33,588	15.1	-	-	1,108	-31.1	-	-

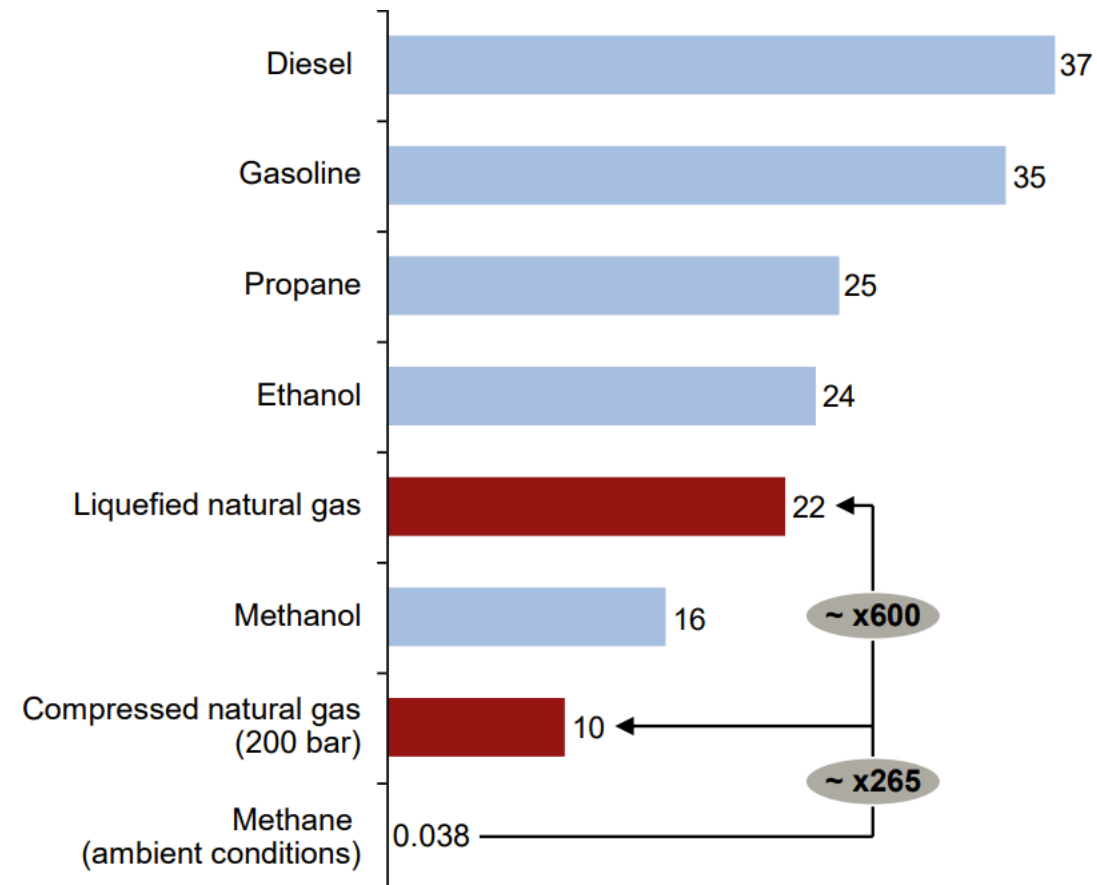
10. Gas and LNG

To Provide a comprehensive review of gas and LNG markets

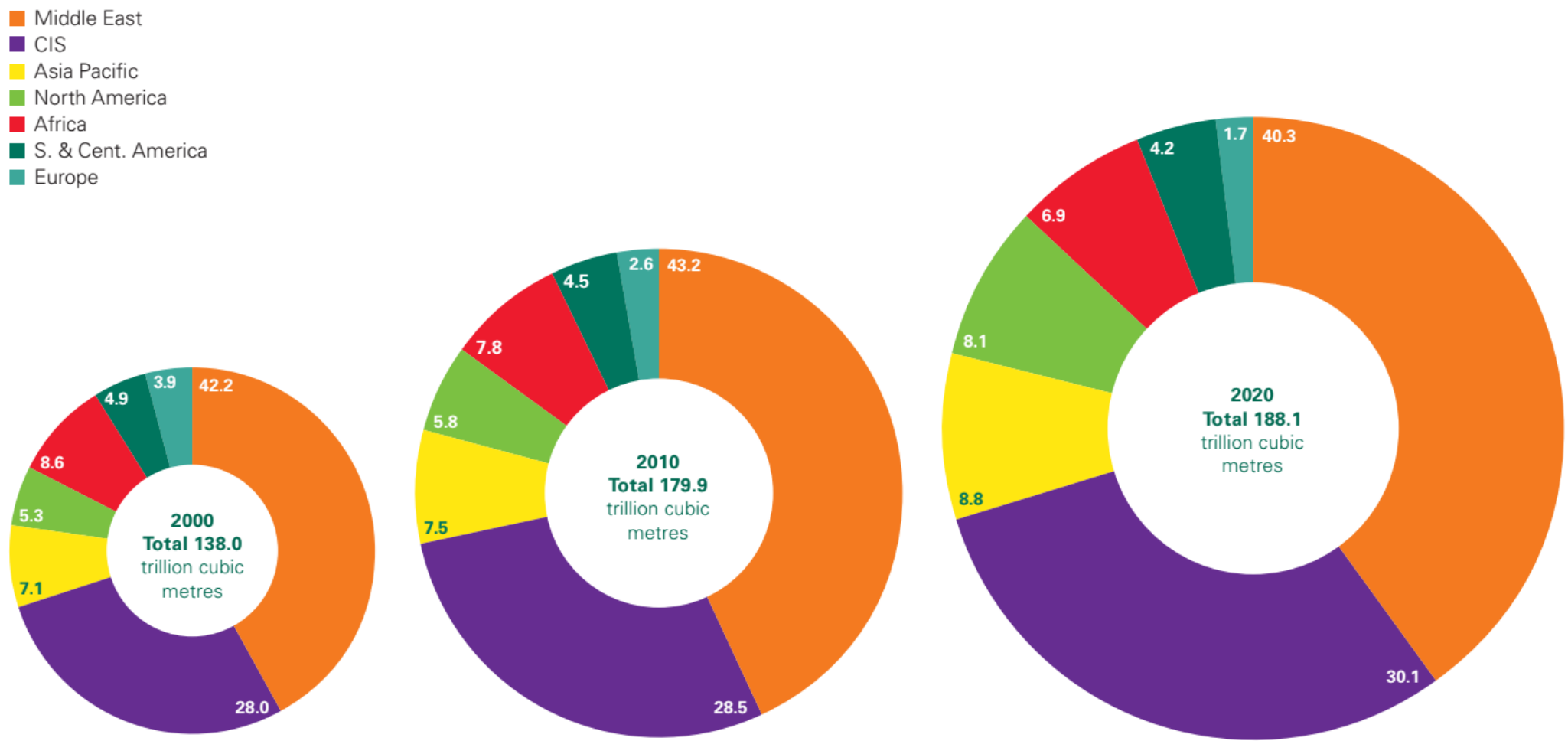
Natural Gas Value Chain



Volumetric energy density of chemical fuels (MJ/liter)



Distribution of Proved Reserves



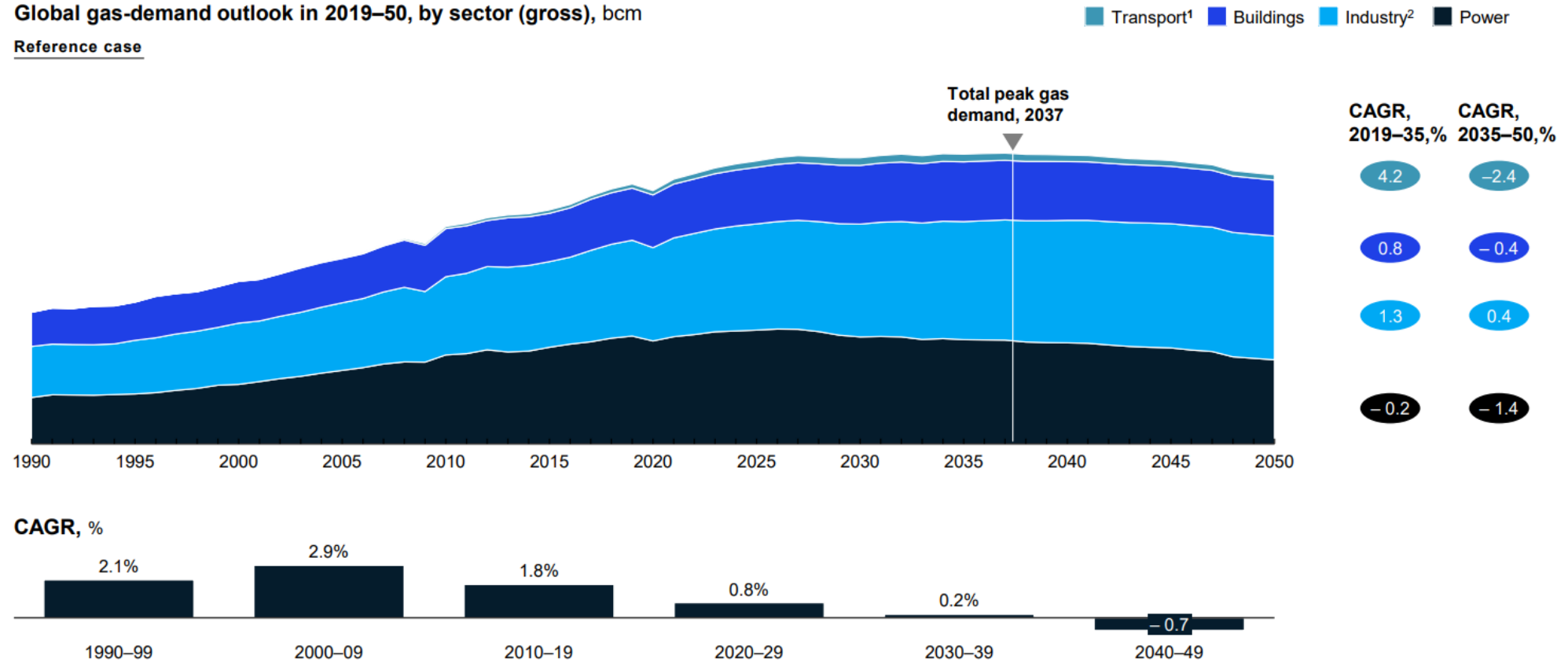
BP Statistical Review of World Energy 2021

Global Gas-demand Outlook by Sector

In the 2021 Global Energy Perspective reference case, gas demand peaks in 2037 but will decline slowly afterward.

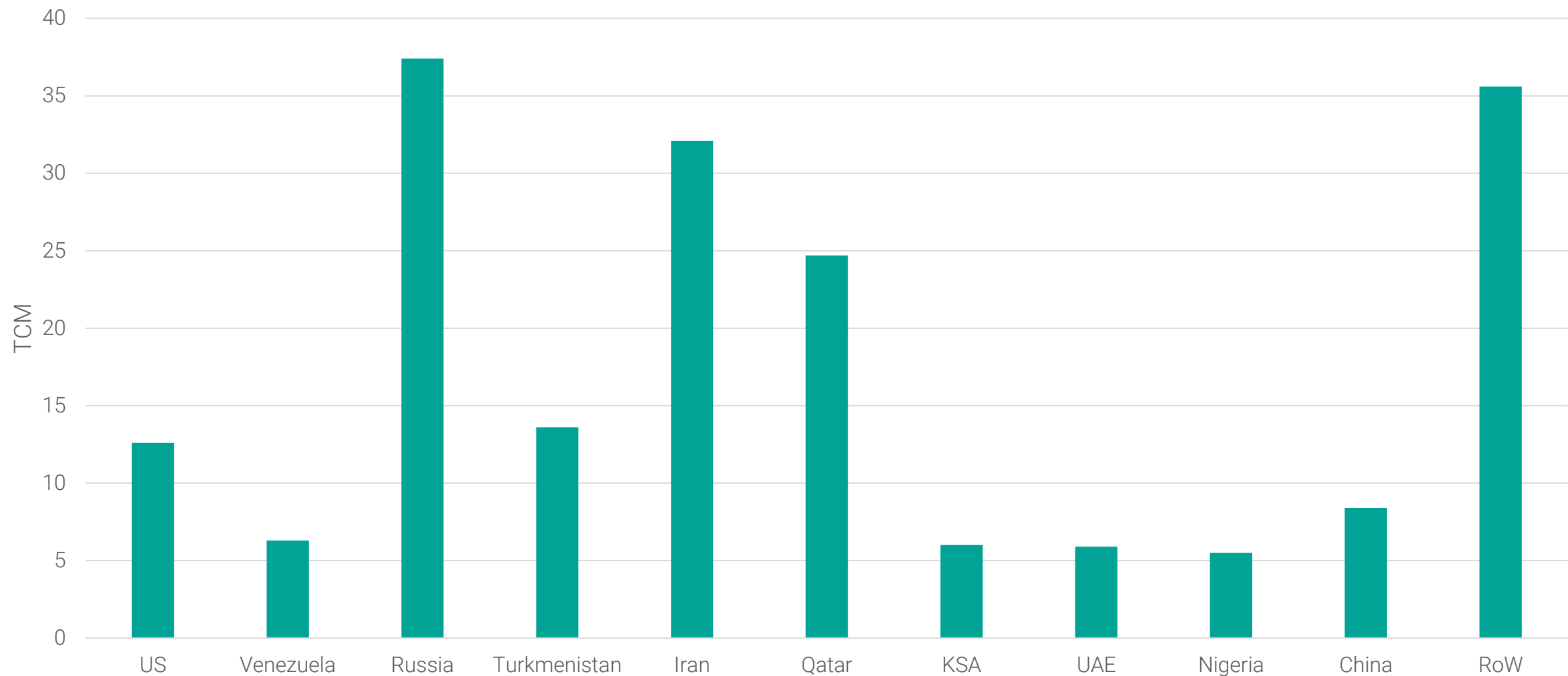
Global gas-demand outlook in 2019–50, by sector (gross), bcm

Reference case



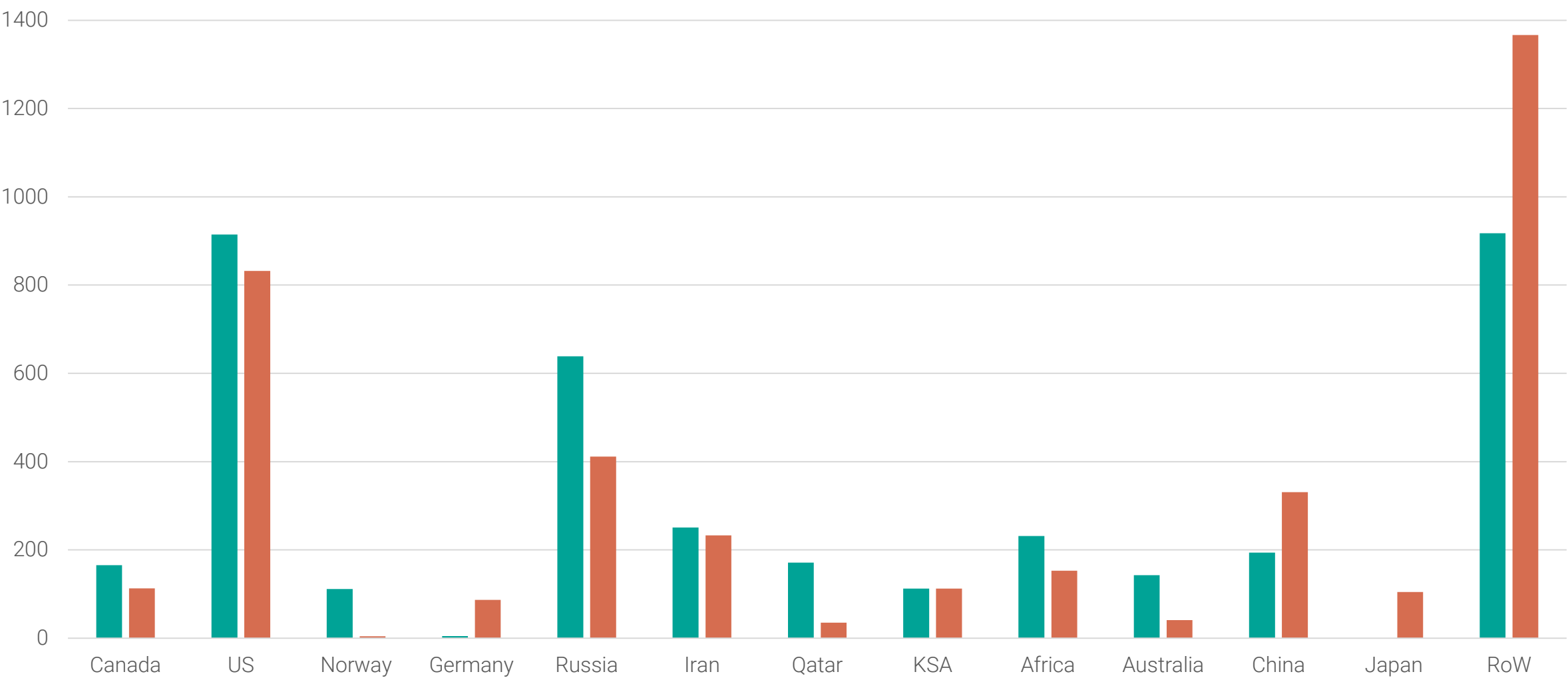
1. Does not include gas use for pipeline transport (approximately 75 bcm in 2019).
2. Includes "other" energy sector.

Top Countries by Reserves



BP Statistical Review of World Energy 2021

Top Countries by Production and Consumption (BCM)



BP Statistical Review of World Energy 2021

Producers, Net Exporters and Net Importers of Natural Gas

Producers	bcm	% of world total
United States	949	23.6
Russian Federation	722	18.0
Islamic Rep. of Iran	235	5.9
People's Rep. of China	191	4.8
Canada	184	4.6
Qatar	167	4.2
Australia	148	3.7
Norway	116	2.9
Saudi Arabia	99	2.5
Algeria	92	2.3
Rest of the world	1 111	27.5
World	4 014	100.0

2020 provisional data

Net exporters	bcm
Russian Federation	230
Qatar	127
Norway	111
Australia	103
United States	77
Turkmenistan	56
Canada	47
Algeria	41
Nigeria	27
Malaysia	22
Others	176
Total	1 017

2020 provisional data

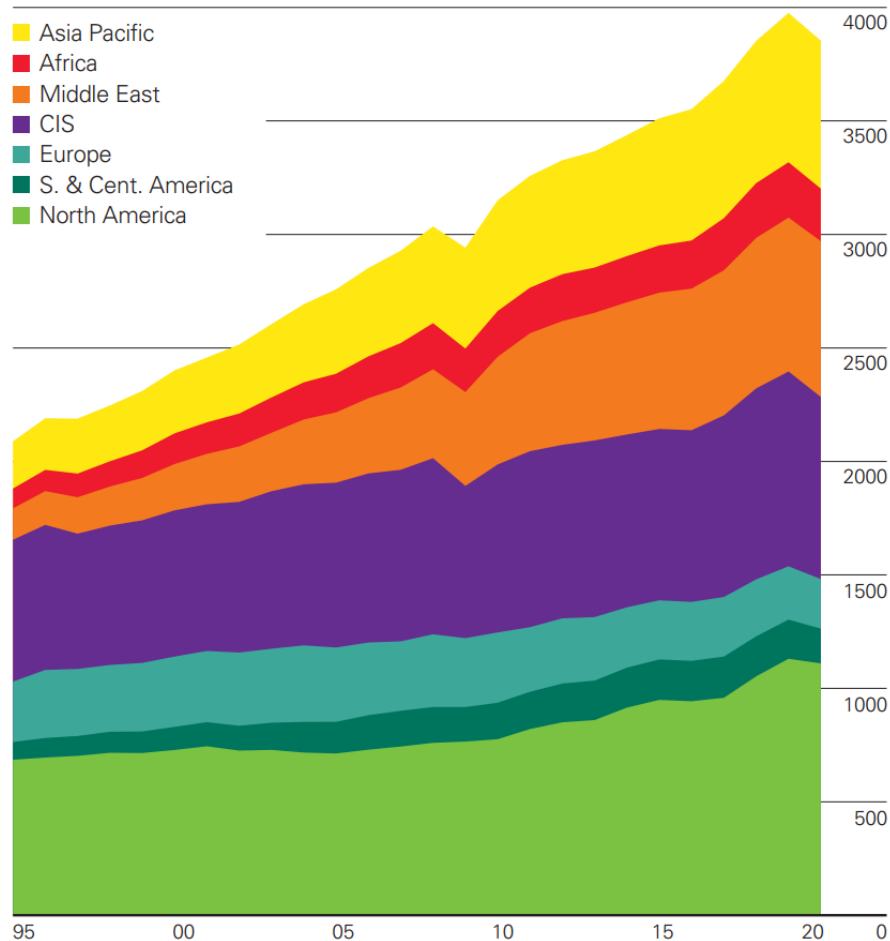
Net importers	bcm
People's Rep. of China	125
Japan	105
Germany	83
Italy	66
Mexico	64
Korea	54
Turkey	47
France	37
United Kingdom	34
India	34
Others	324
Total	973

2020 provisional data

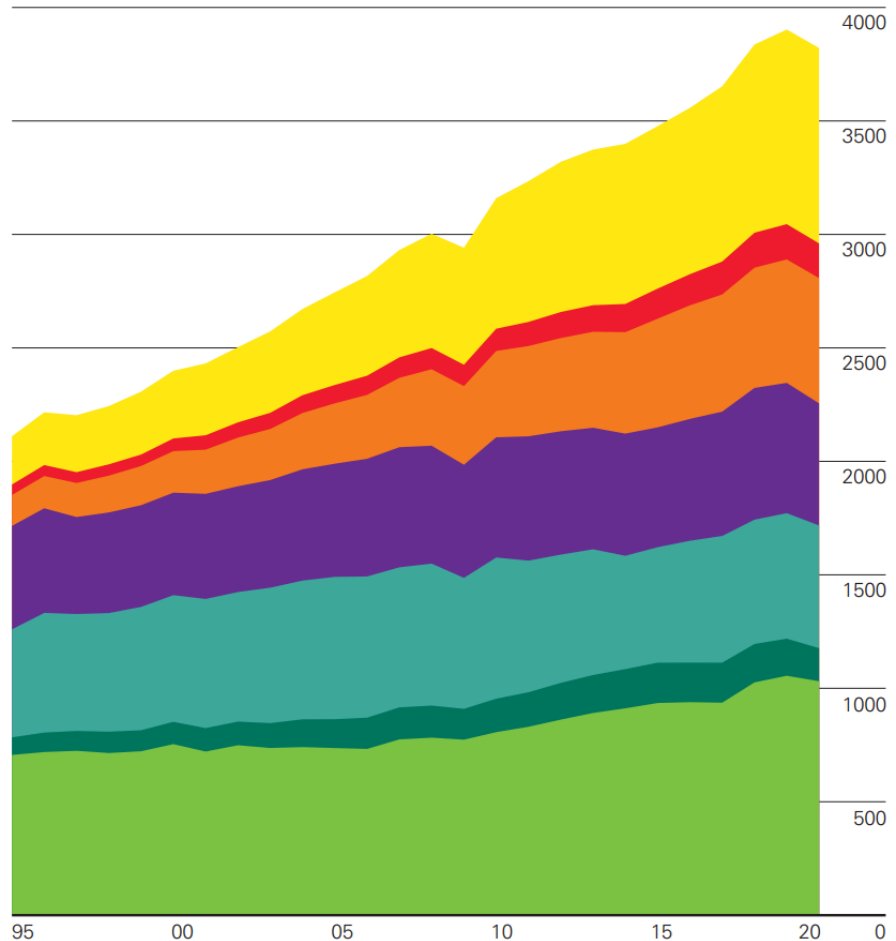
The Geopolitics of Gas

Natural gas: Production by region

Billion cubic metres

**Natural gas: Consumption by region**

Billion cubic metres



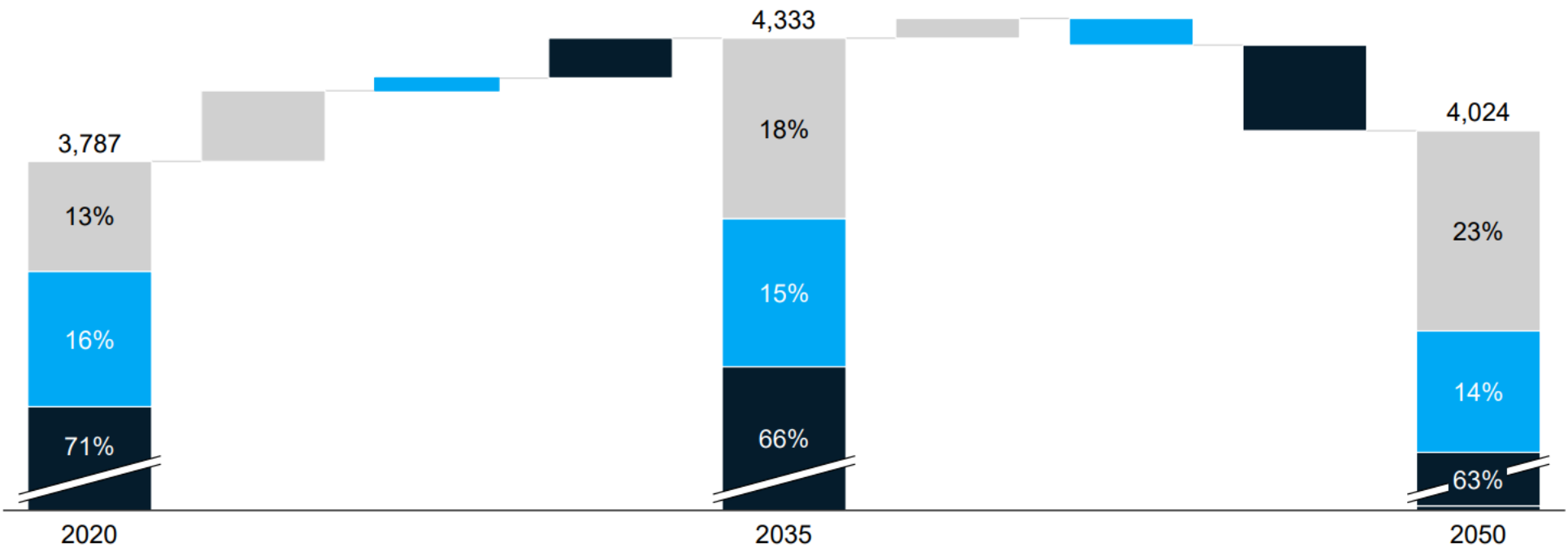
Global Domestic Consumption (BCM)

The share of LNG in the global gas supply will increase consistently, as it meets demand growth and replaces declining pipeline and domestic gas.

Global domestic consumption (piped and LNG gas and import projections), bcm

LNG¹ Pipeline-import flows Domestic gas

Reference case



1. Including LNG flows within country for Indonesia and Malaysia.

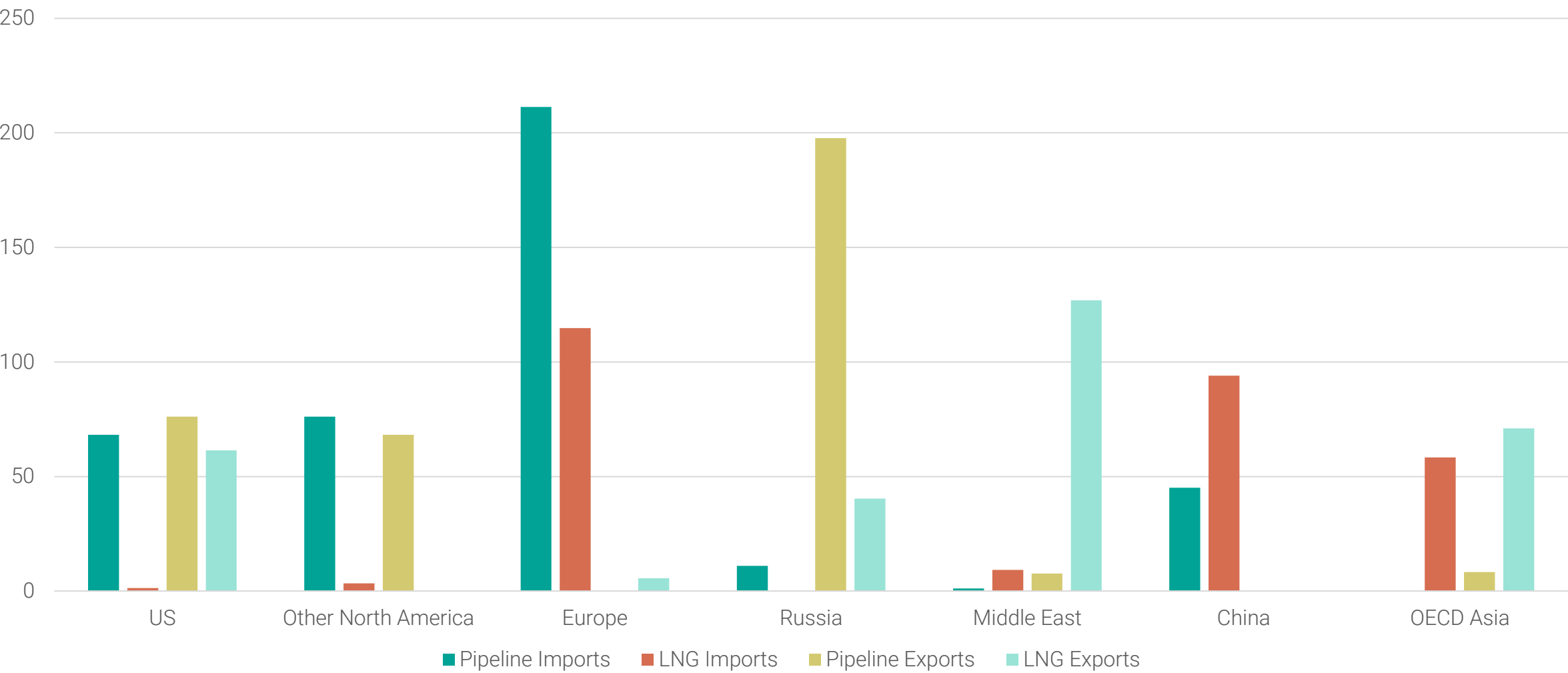
Natural Gas Inter-regional Trade (BCM)

Inter-regional
Trade
940.1

Inter-regional
Pipeline Trade
452.2

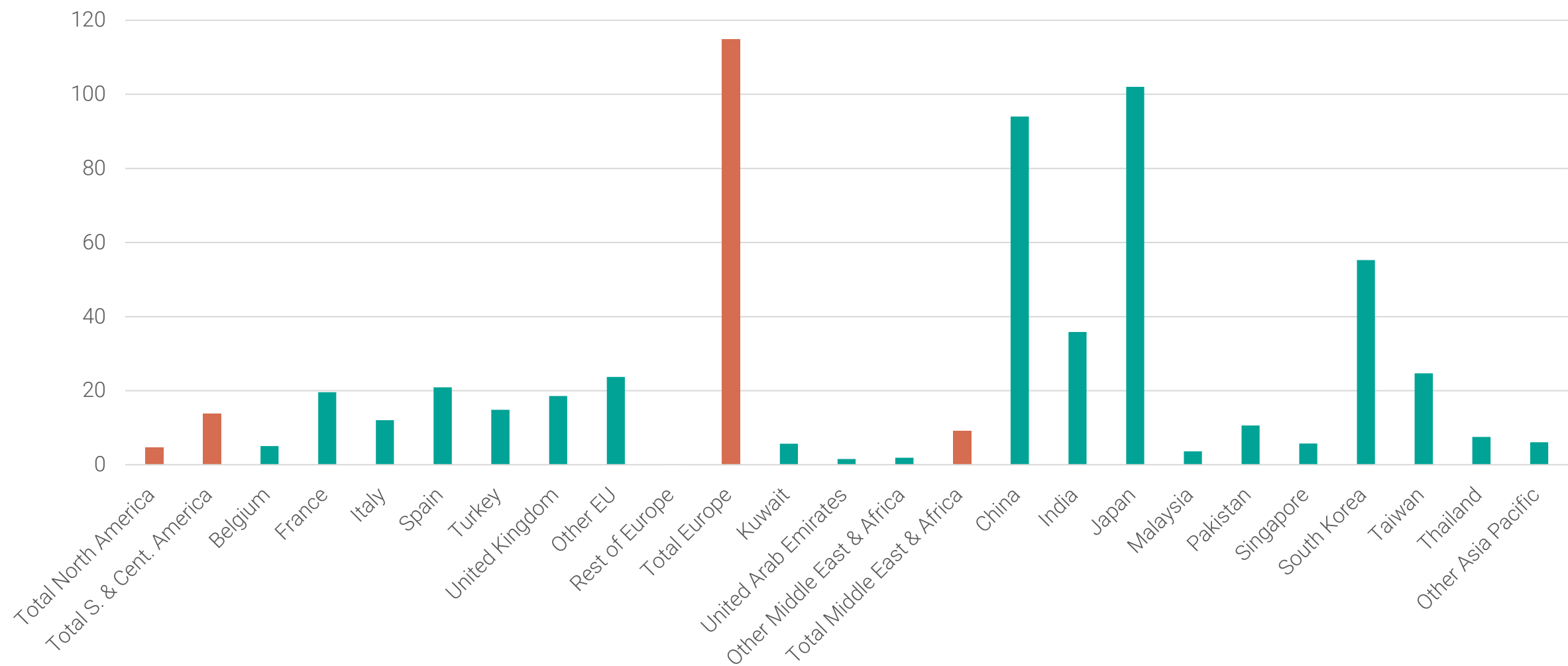
LNG Trade
487.9

Natural Gas Major Inter-regional Trade Movements (BCM)

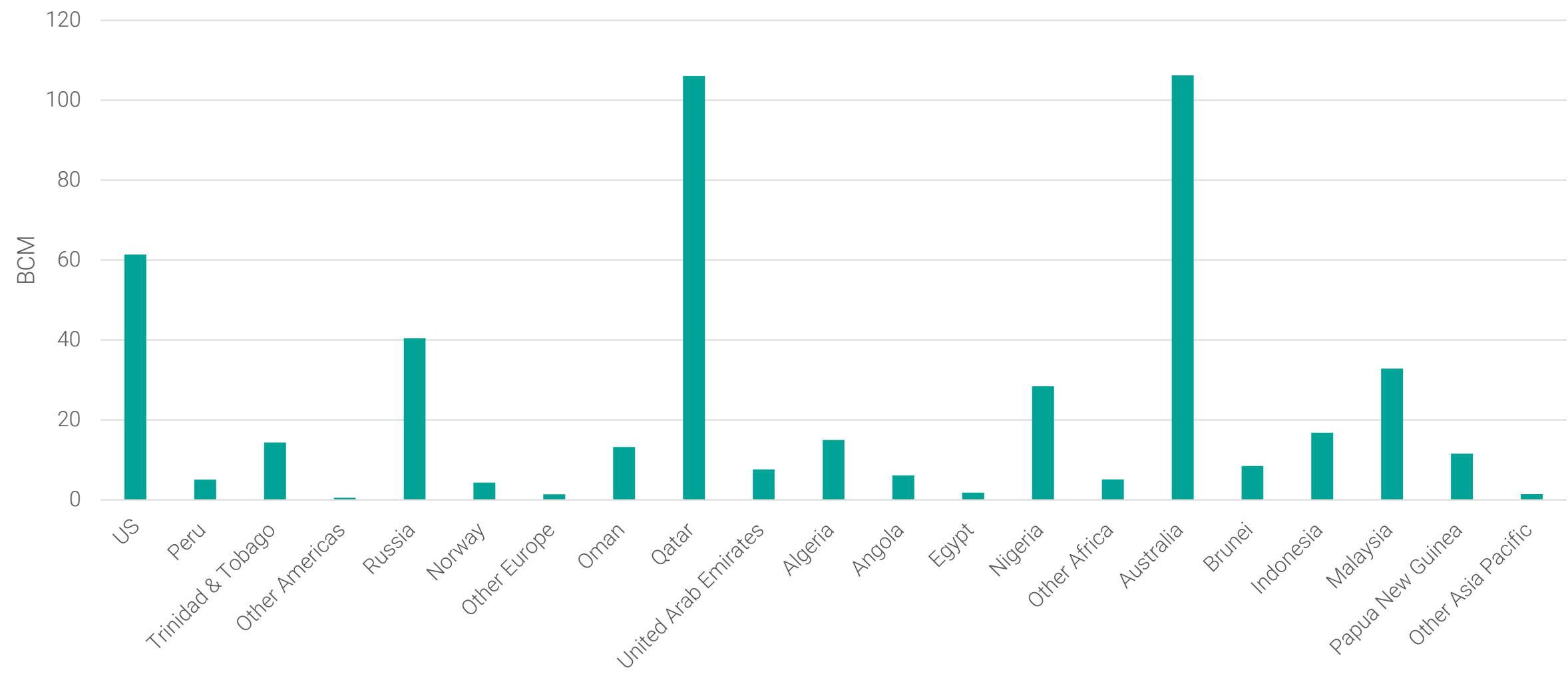


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Key LNG Importers (BCM)

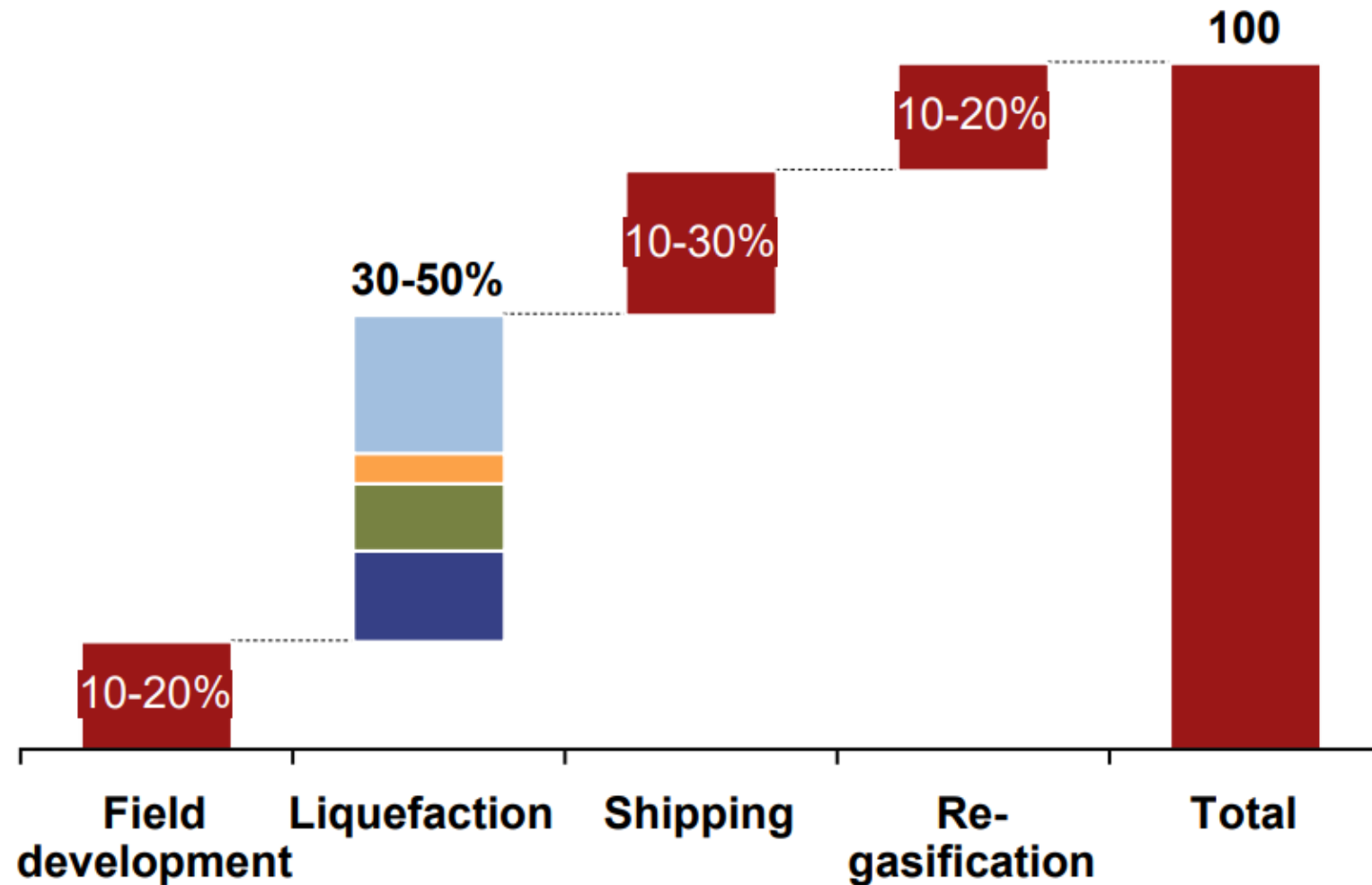


Key LNG Exporters

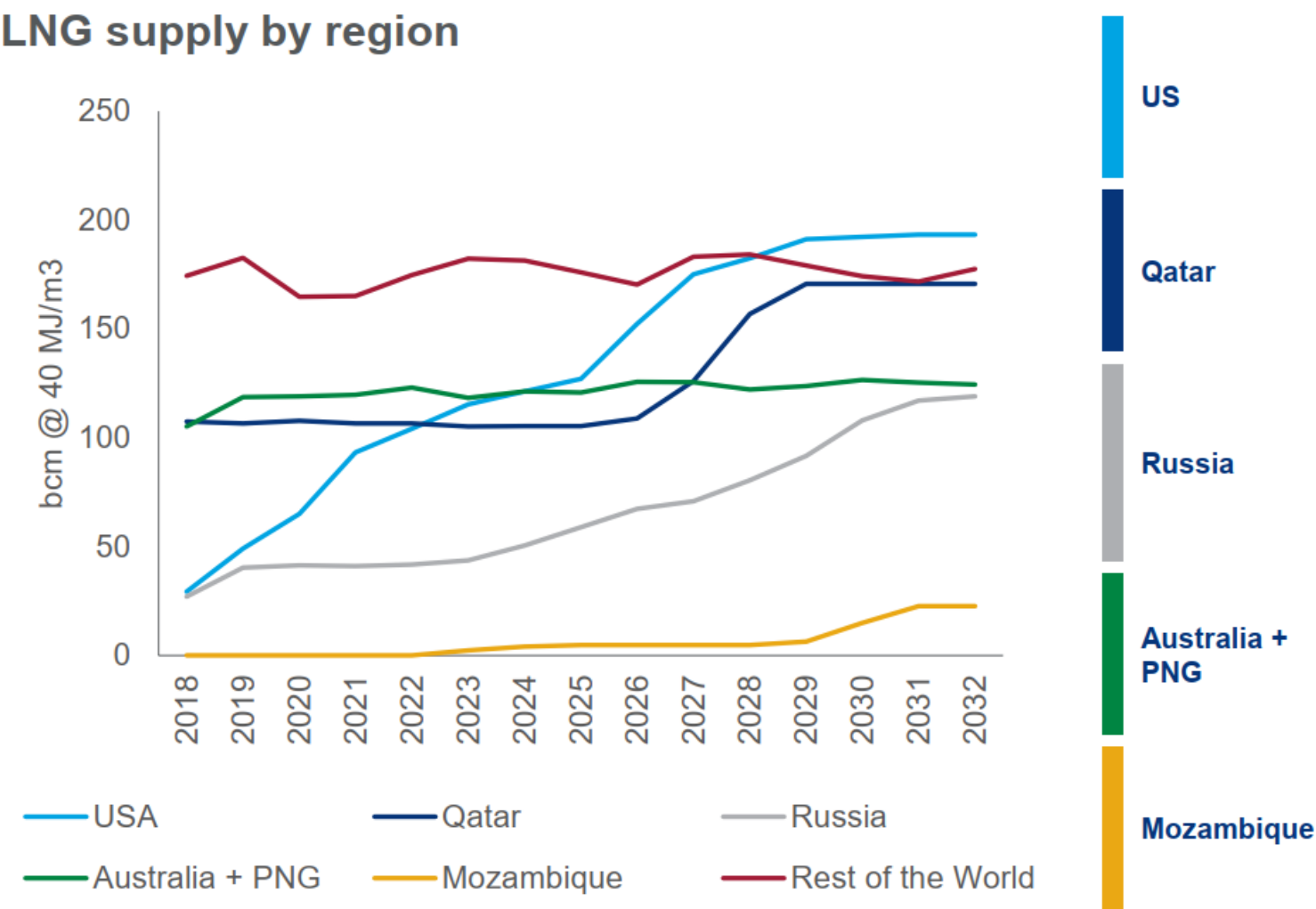


BP Statistical Review of World Energy 2021

Typical Cost Breakdown Of LNG Value Chain

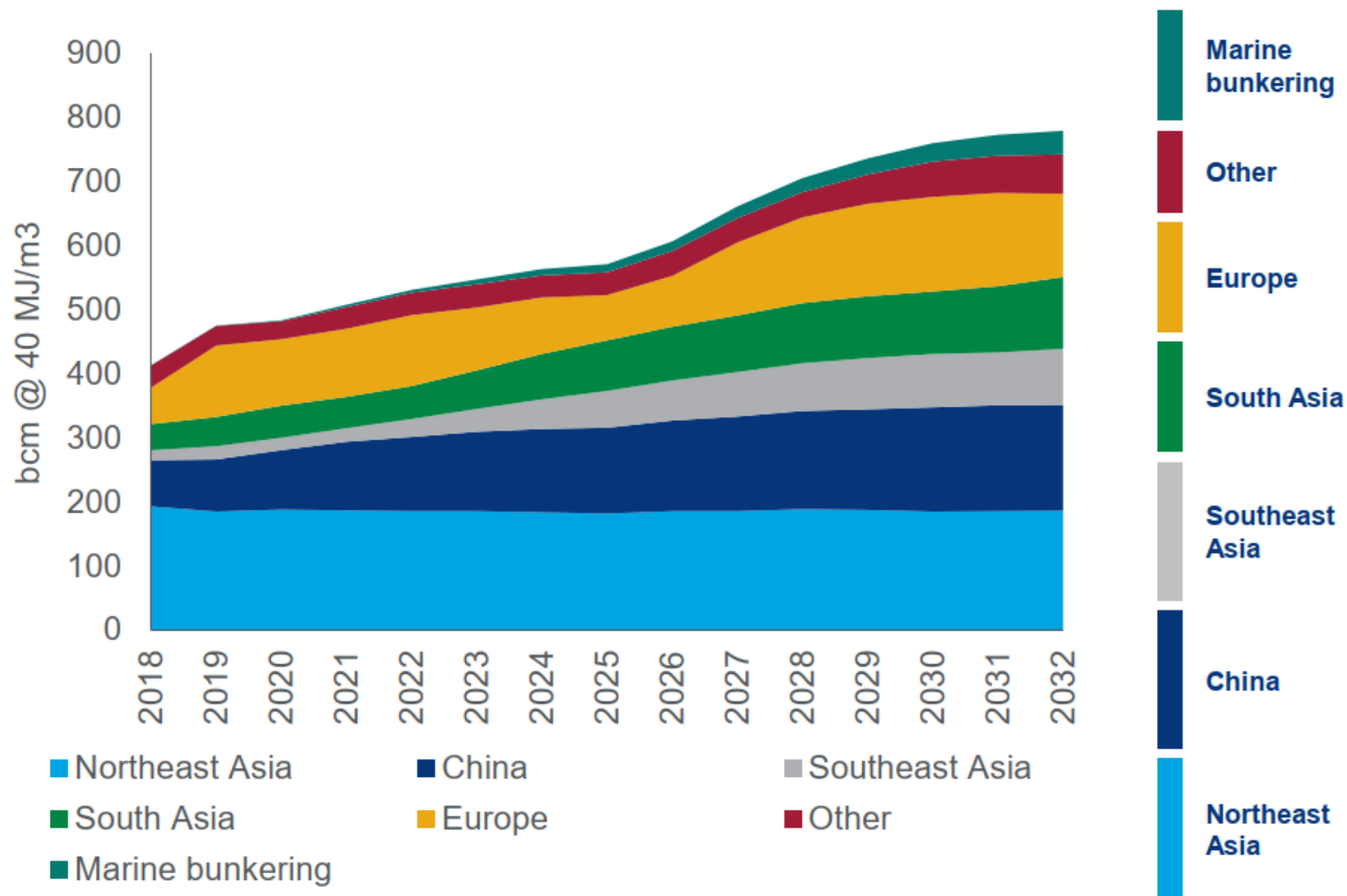


LNG Supply by Region



Wood Mackenzie Global Gas investment horizon outlook to 2032 November 2021

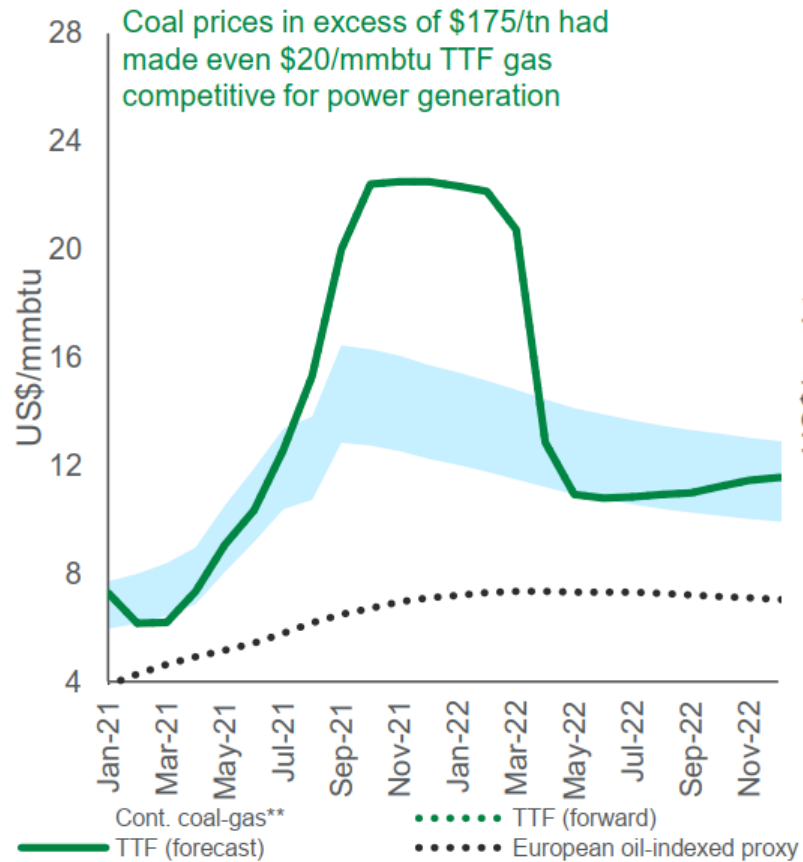
Global LNG Demand



Wood Mackenzie Global Gas investment horizon outlook to 2032 November 2021

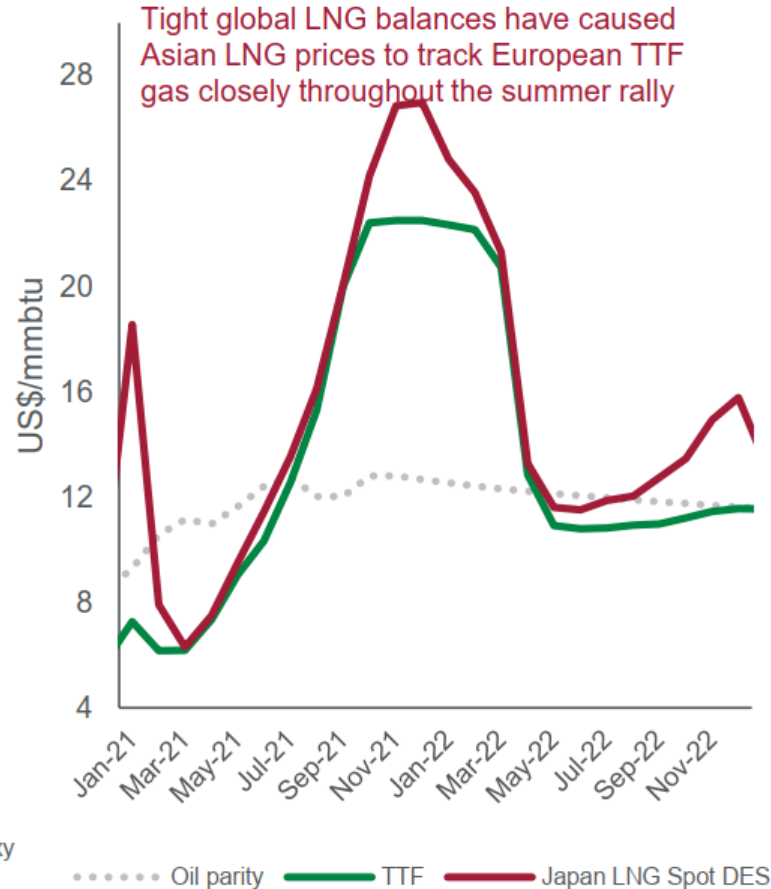
Domino Effect: High Coal Prices, Tight LNG Markets, Lift Fuel-oil Cracks

1. Tight coal and gas market

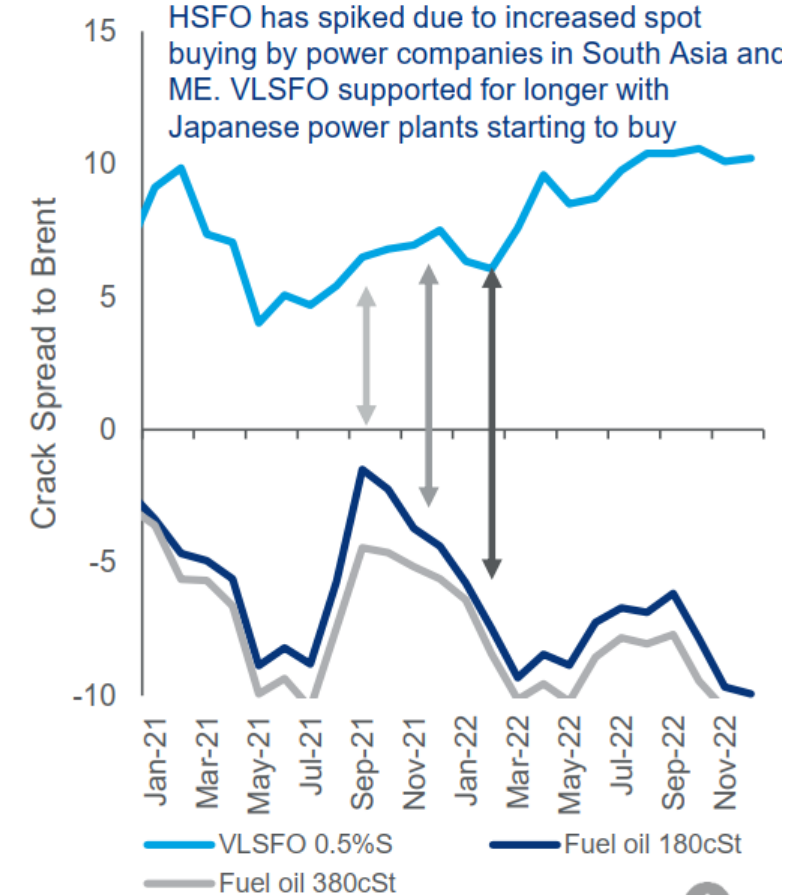


Source: Wood Mackenzie, the Argus Media group, GIE (AGSI)

2. Competition for LNG

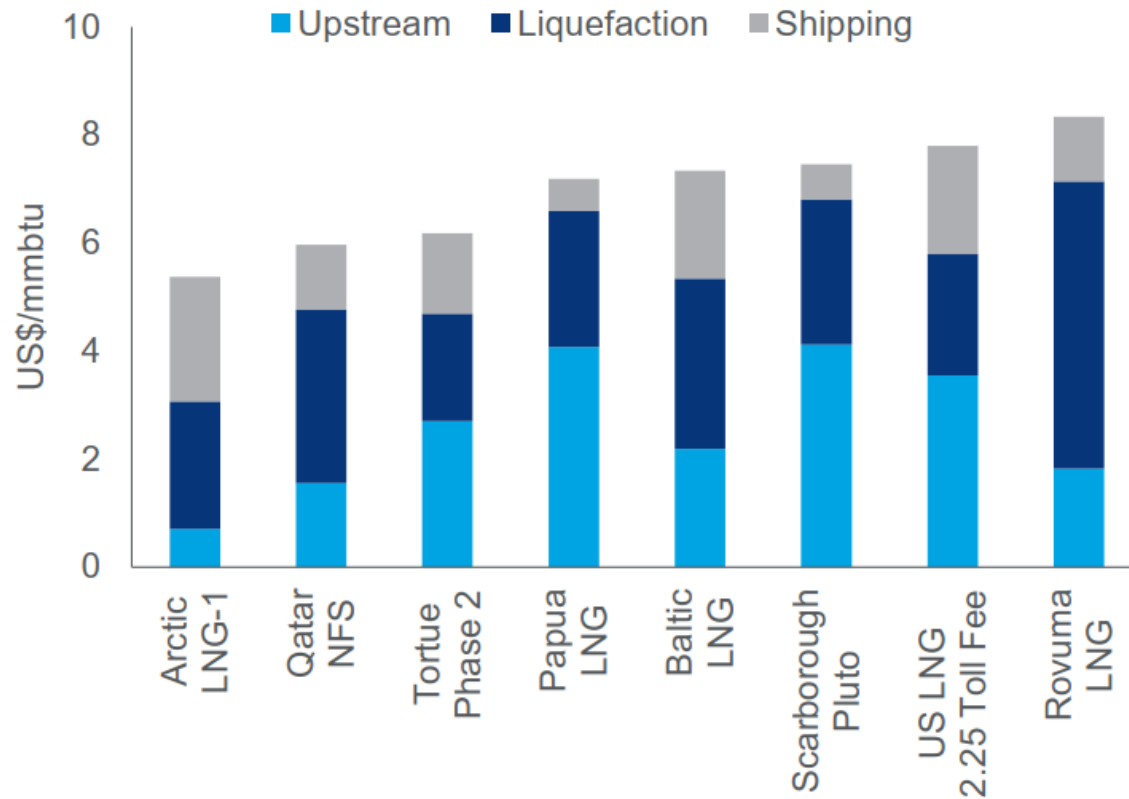


3. Pressure on Fuel Oil cracks



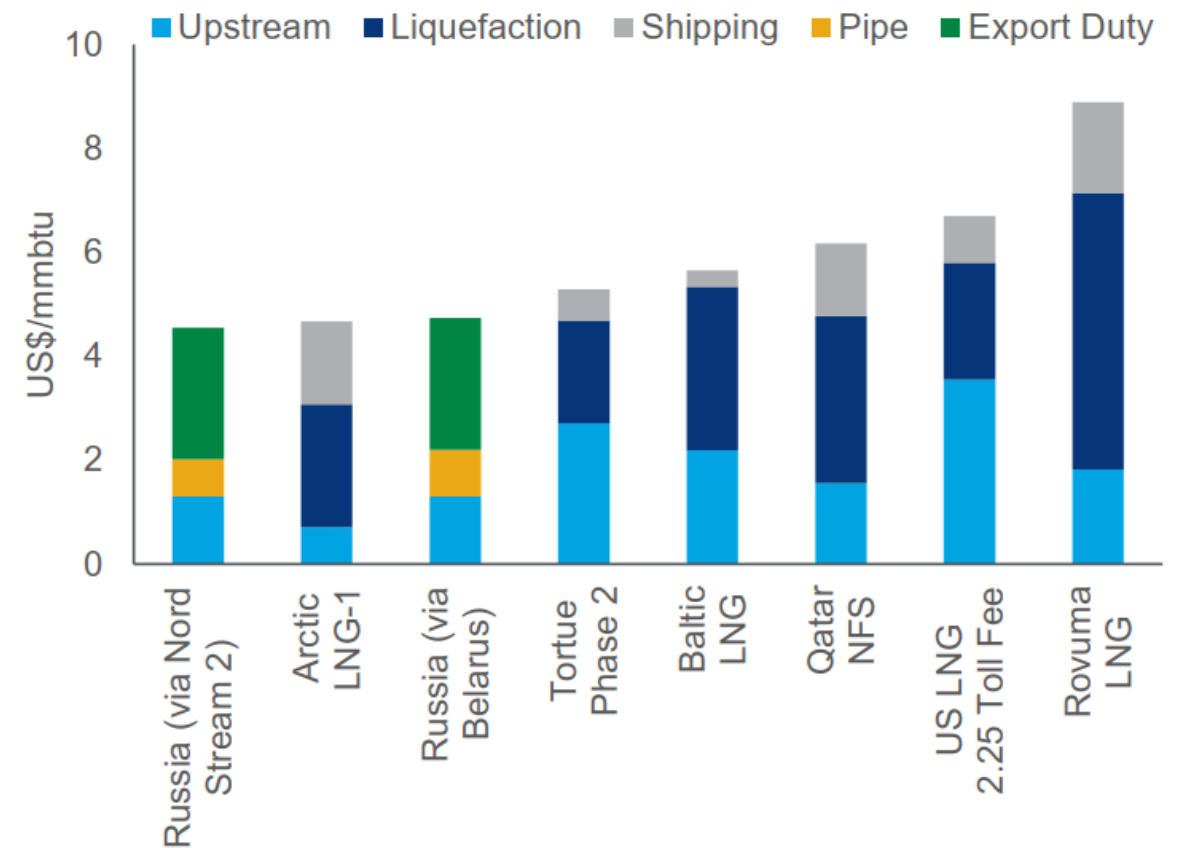
The Breakeven Prices of Gas Projects

LNG breakeven cost stack DES Northern Asia



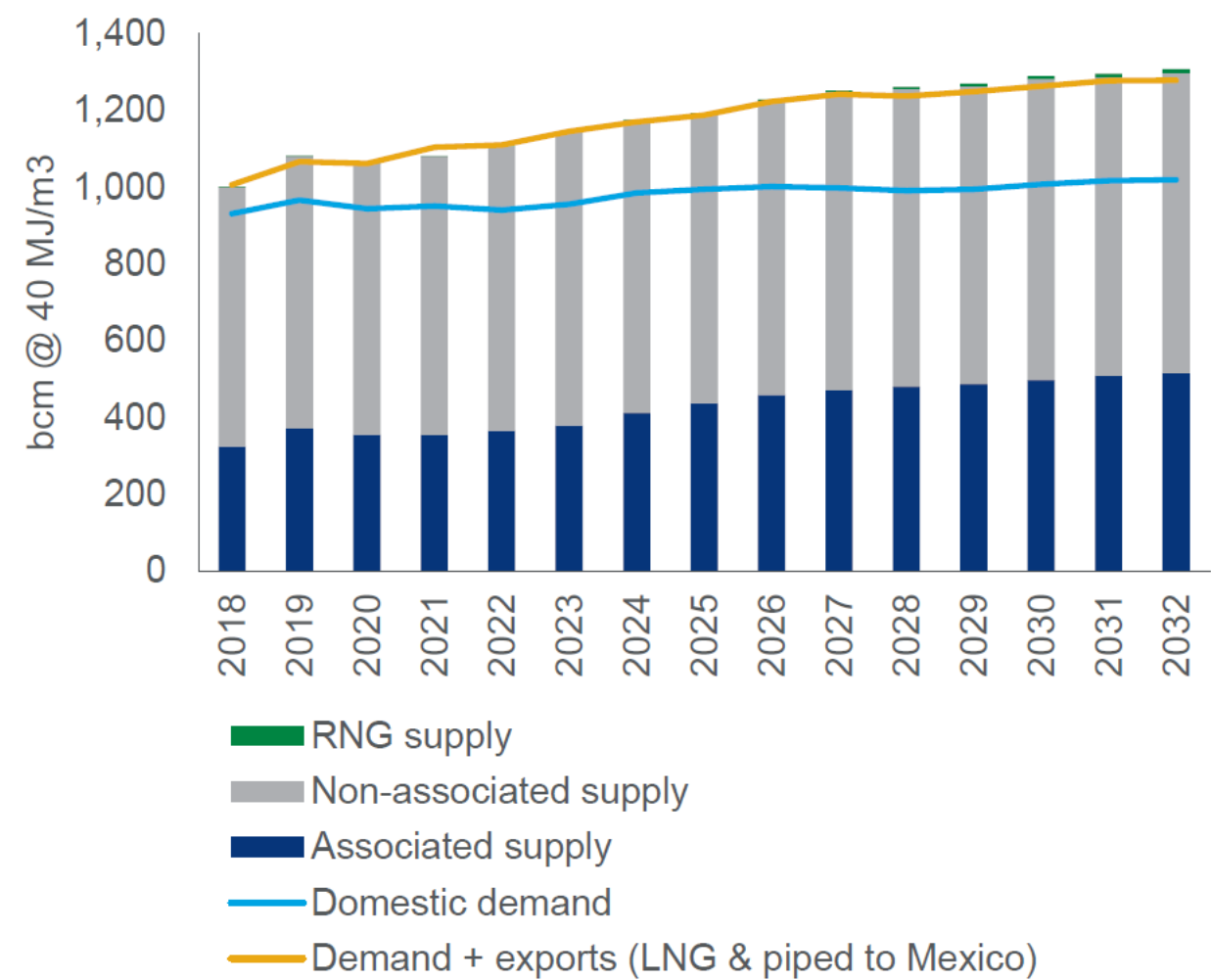
Source: Wood Mackenzie LNG Tool Q4 2021

LNG and pipe breakeven cost stack DES NW Europe



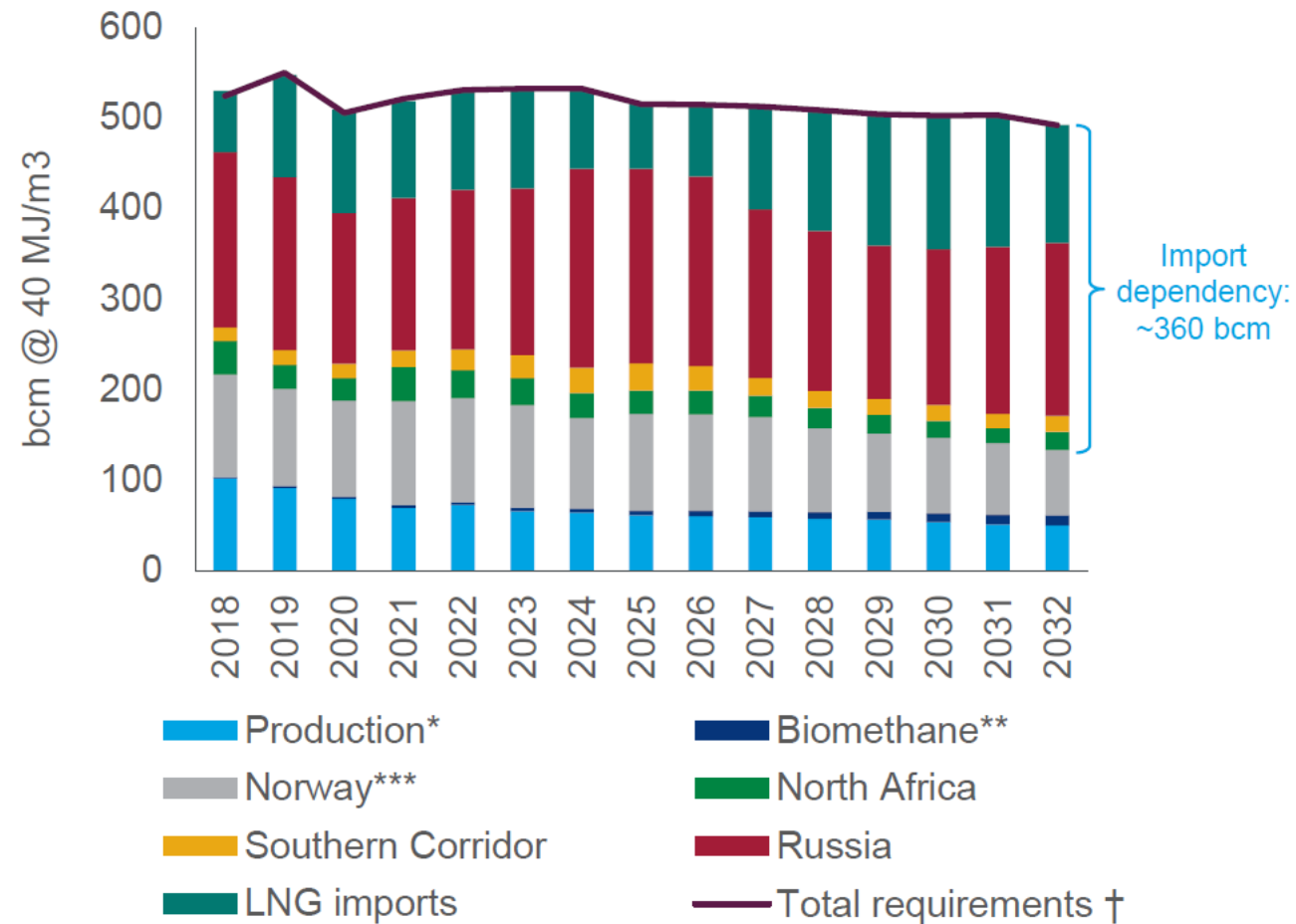
Wood Mackenzie Global Gas investment horizon outlook to 2032 November 2021

North America Gas Balance

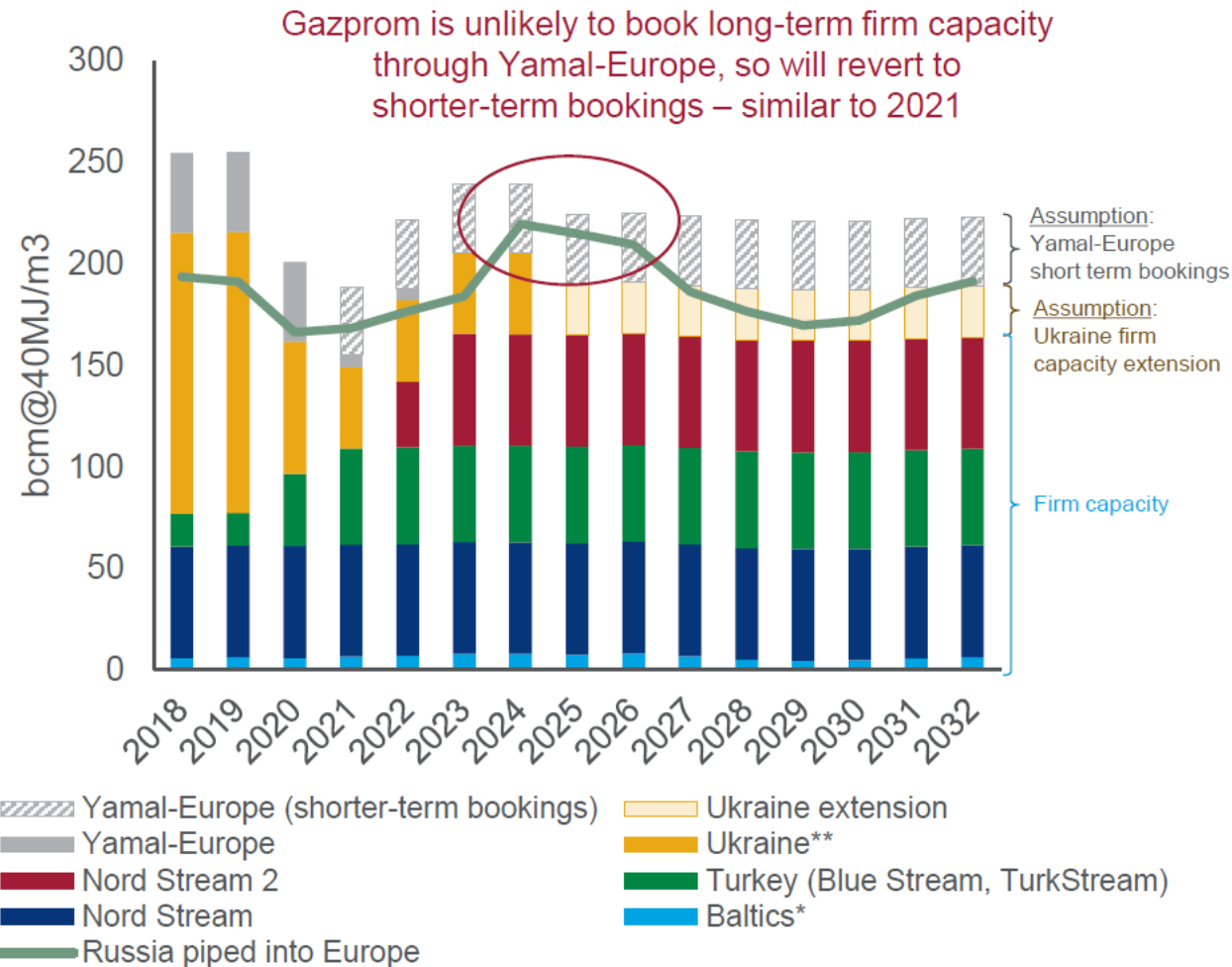


Wood Mackenzie Global Gas investment horizon outlook to 2032 November 2021

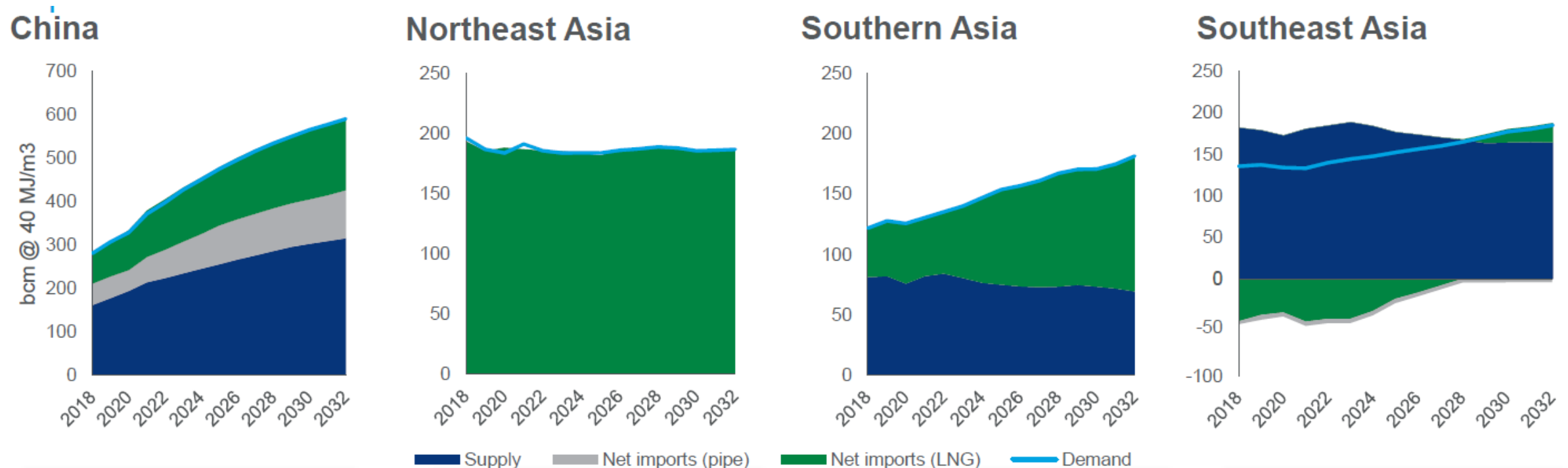
Europe Gas Balance



Russia Piped Capacity and Flows to Europe

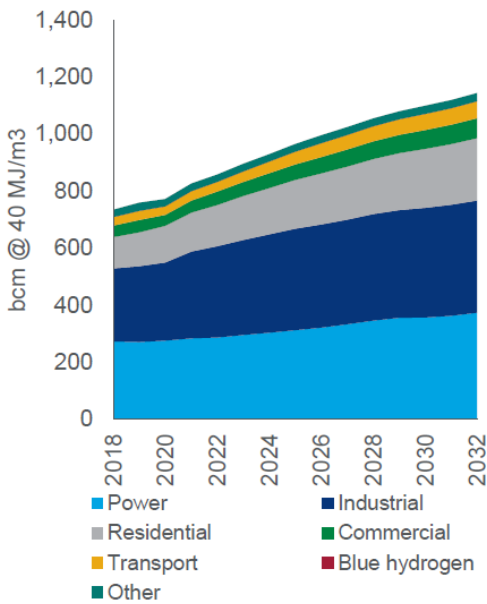


Asia Gas Balance

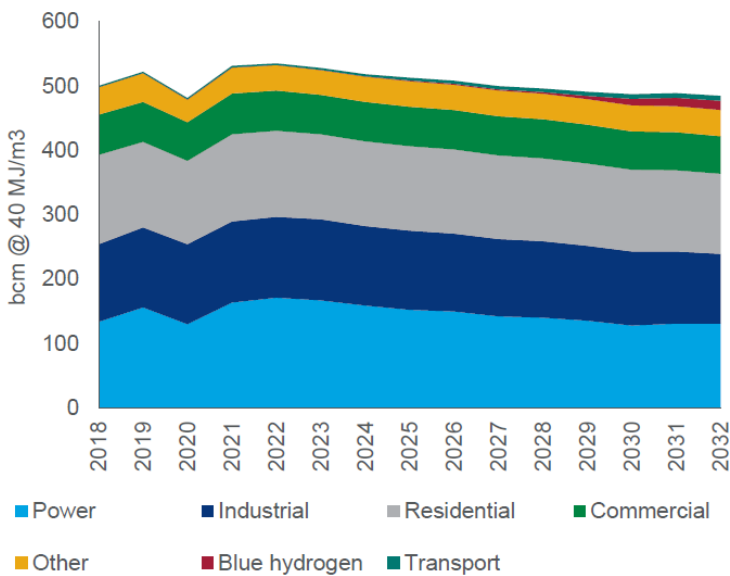


Regional Gas Demand by Sector

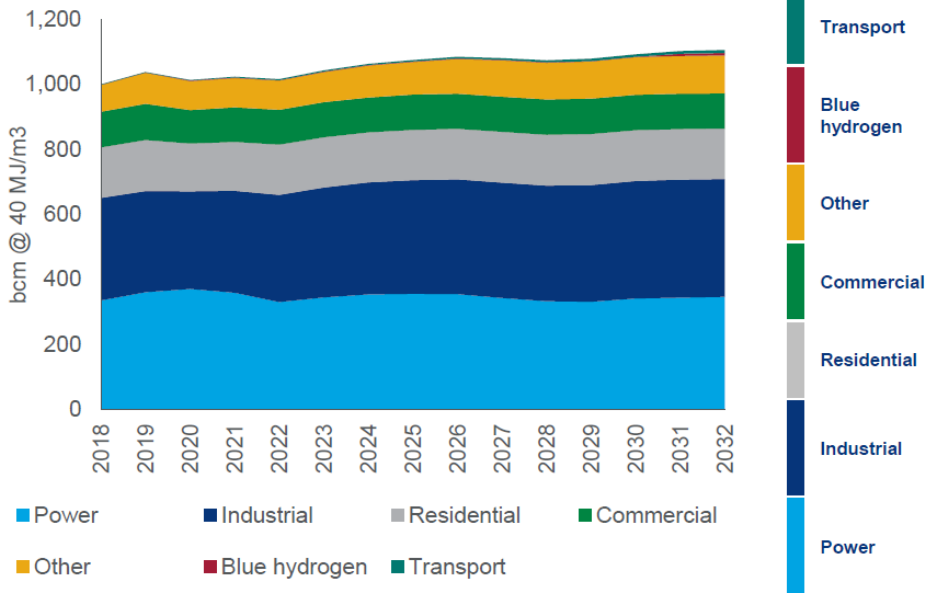
Asia gas demand by sector



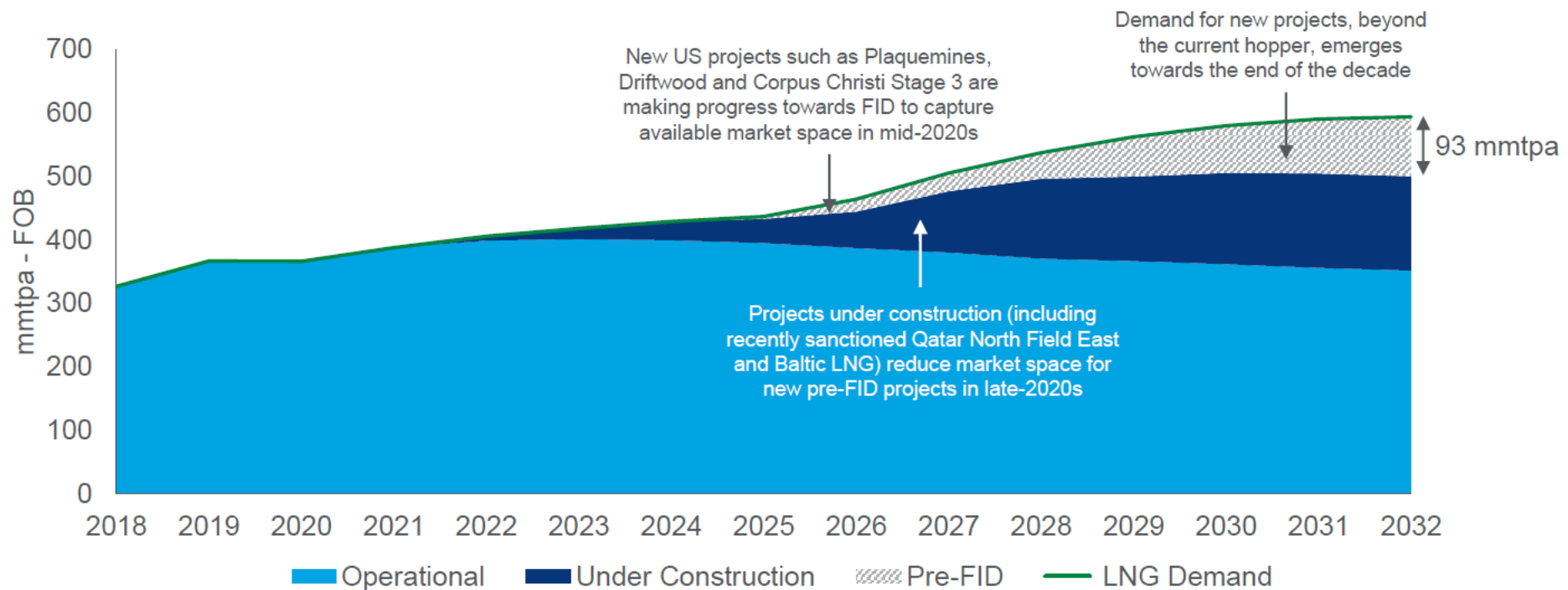
Europe gas demand by sector



North America gas demand by sector



LNG Supply and Demand by Project Development Status



Gas and LNG Investment Requirements to 2032

	Upstream	Liquefaction	Shipping	New pipeline developments*	Regas	Value of uncontracted LNG demand
	US\$ billion capex	US\$ billion capex	US\$ billion capex	Bcm/yr capacity	US\$ billion capex	US\$ billion
Global	1,510	175	120	490	48	620
Asia	● 150		● 120	● 90	• 38	● 490
Europe	• 60			• 16	4	● 130
North America	● 630**	• 50		● 315	0.5	
Middle East	● 210	• 30			0.5	
Russia and the Caspian	● 170	• 25			0	
RoW	● 290	• 70		• 70	5	

Wood Mackenzie Global Gas investment horizon outlook to 2032 November 2021

Global Gas Markets

Gas-on-gas markets



☐ US

Indexed to energy prices



☐ EU

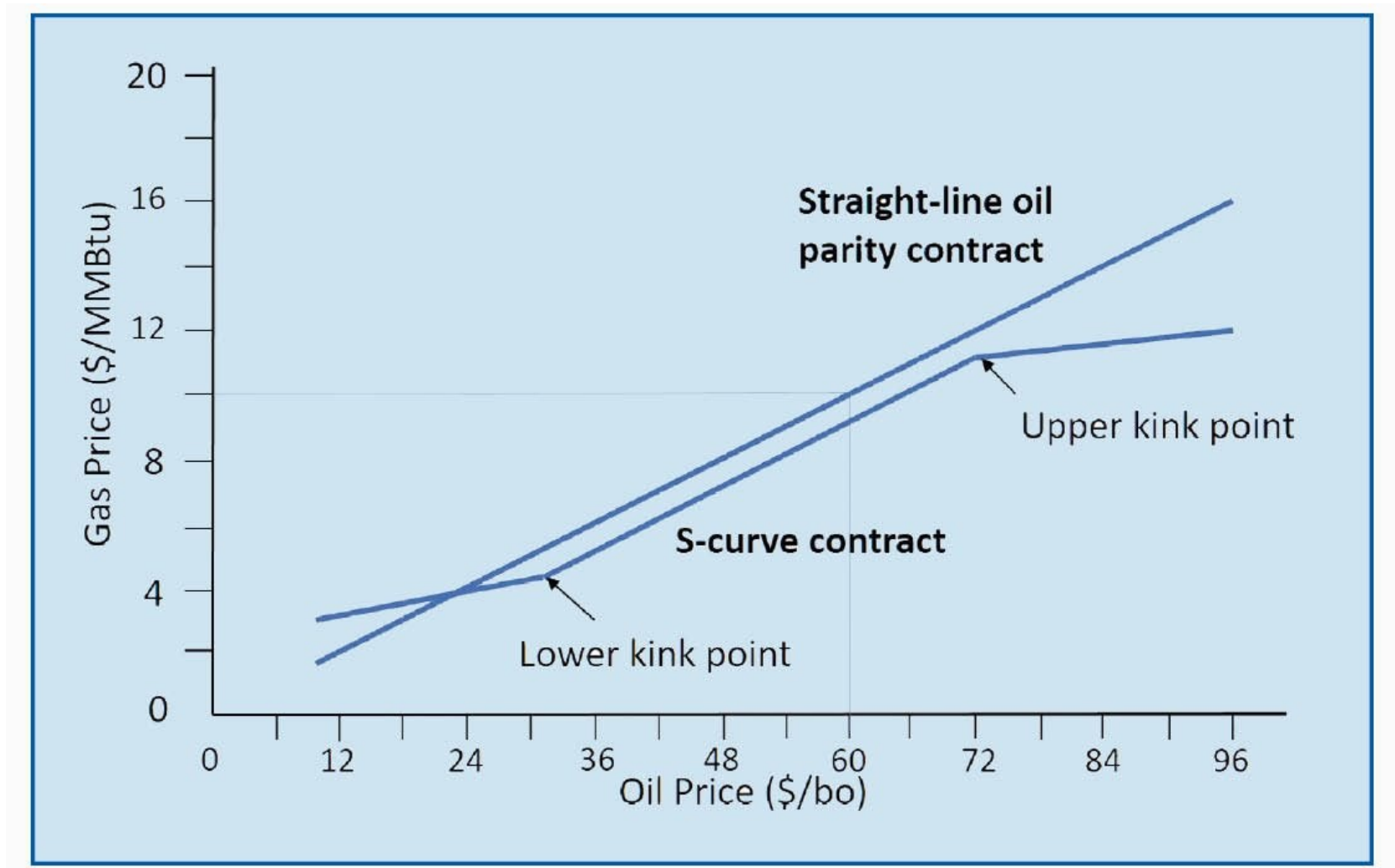
☐ Asia

Regulated

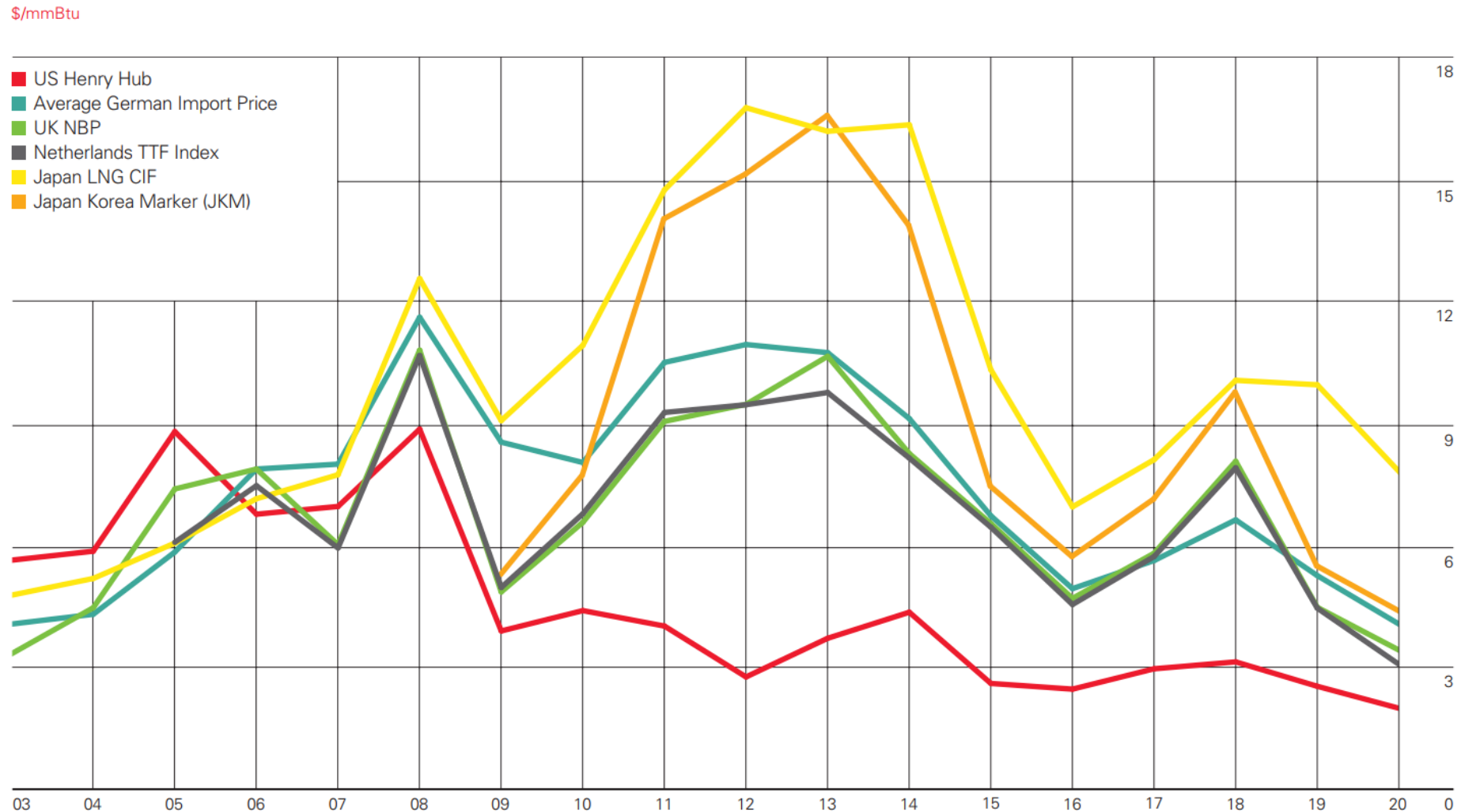


☐ Middle East

Oil Parity



Gas Prices



BP Statistical Review of World Energy 2021

LNG Prices in Asia



¹Metric million British thermal units.

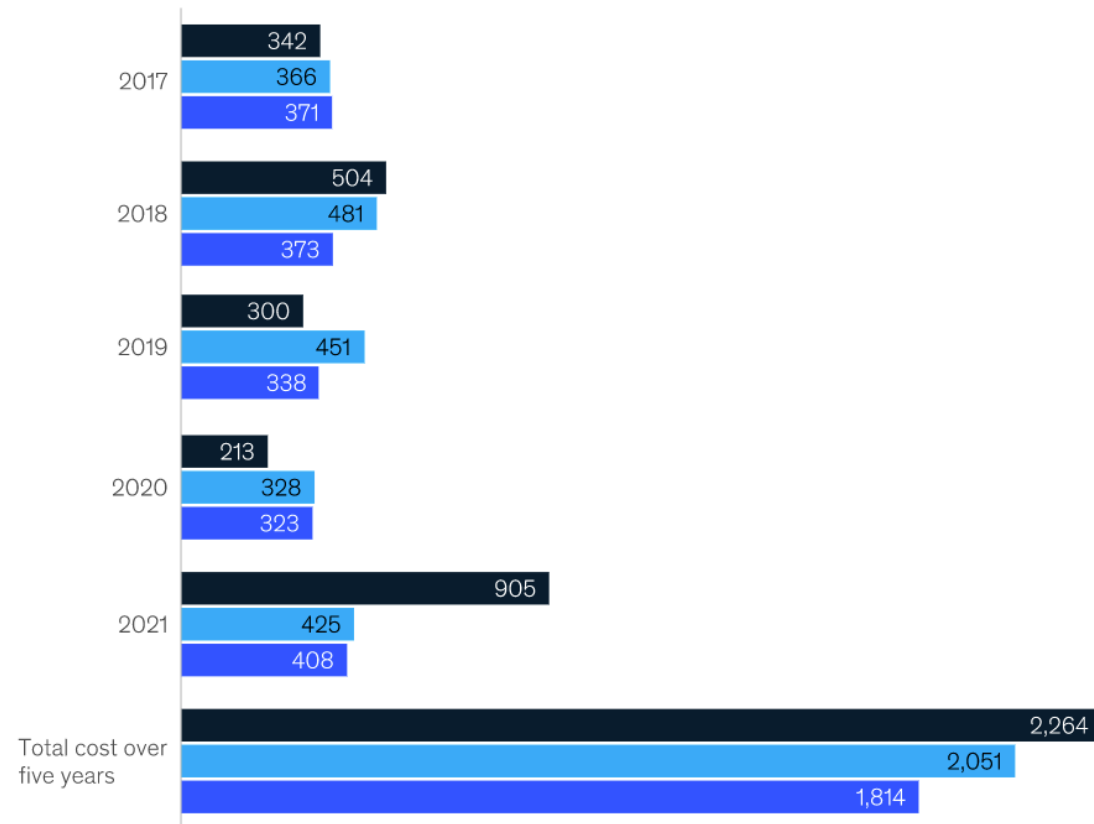
Source: Bloomberg

McKinsey Reflecting on 2021 global LNG and European pipeline flows 2021

LNG Cost Comparisons

■ Japan Korea Marker
 ■ Legacy oil-indexed contract price (12.5% × Brent Crude price + \$0.50)
 ■ 115% HH + \$2.5 + shipping¹

Cost comparison for 1 MMTPA² of LNG, \$ millions



¹Assumes \$1.2 for shipping from Gulf Coast to Japan through Panama Canal.

²Million metric tons per annum; 51.8 metric million British thermal units (MMBTU) per ton of LNG.

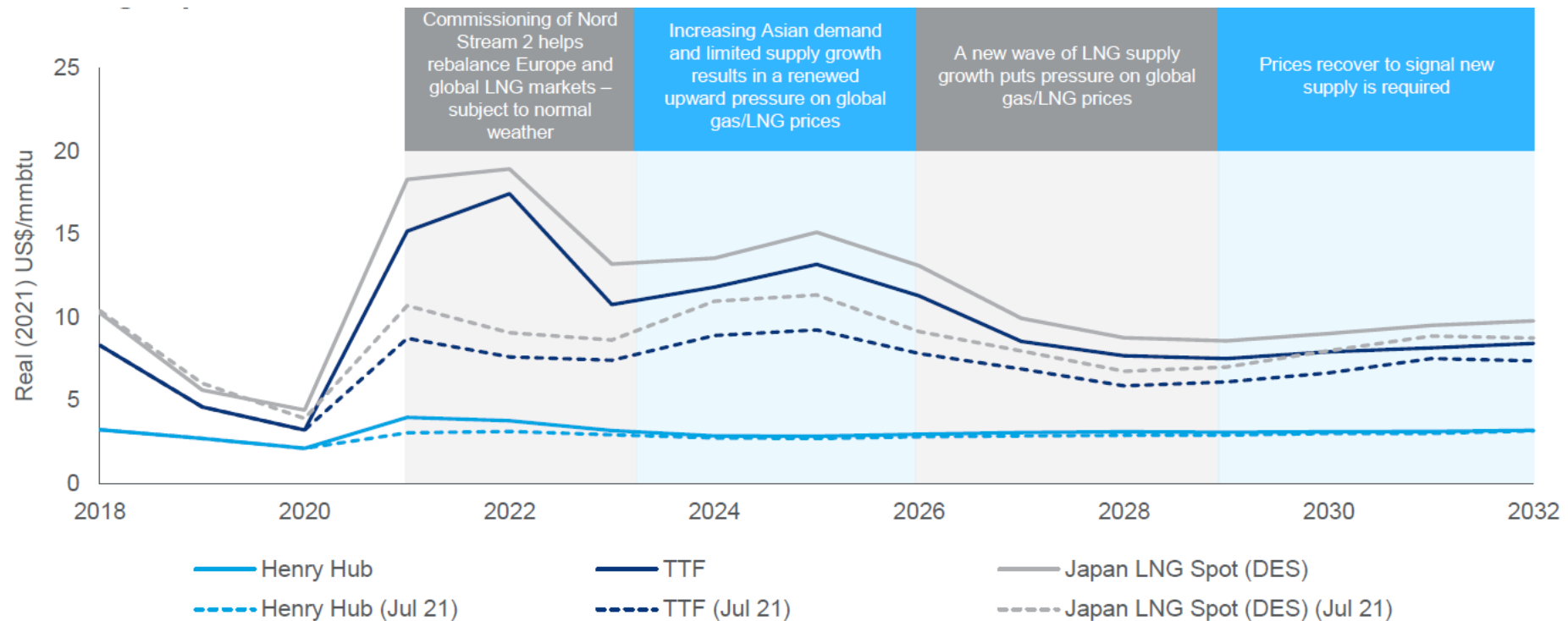
Source: Bloomberg

McKinsey Reflecting on 2021 global LNG and European pipeline flows 2021

Price Economics Logic (\$/MMBTU)

	Residual cash costs ²		Cash cost		Full cost	
Henry Hub (price setter)	Base		Base		Base	Abundant supply drives gas towards coal competition pricing
+						
Liquefaction cost	0.4–0.5	Tolling ToP fixed fee	+0.8	LNG cash cost in short-term oversupplied market (opex)	+2.2–2.7	LNG full costs in a balanced market (opex and capex)
Shipping cost	+0.5	Bunker fuel/boil off only	+1.7	Short-term charter rates	+1.8–2.2	Full cost shipping (opex and capex) to Tokyo Bay
Delivered LNG to Asia	Base +0.9-1.0	Near-term cash costs	Base +2.5	Short-term cash costs	Base + 4–5	Full cost

Global Gas Price Outlook

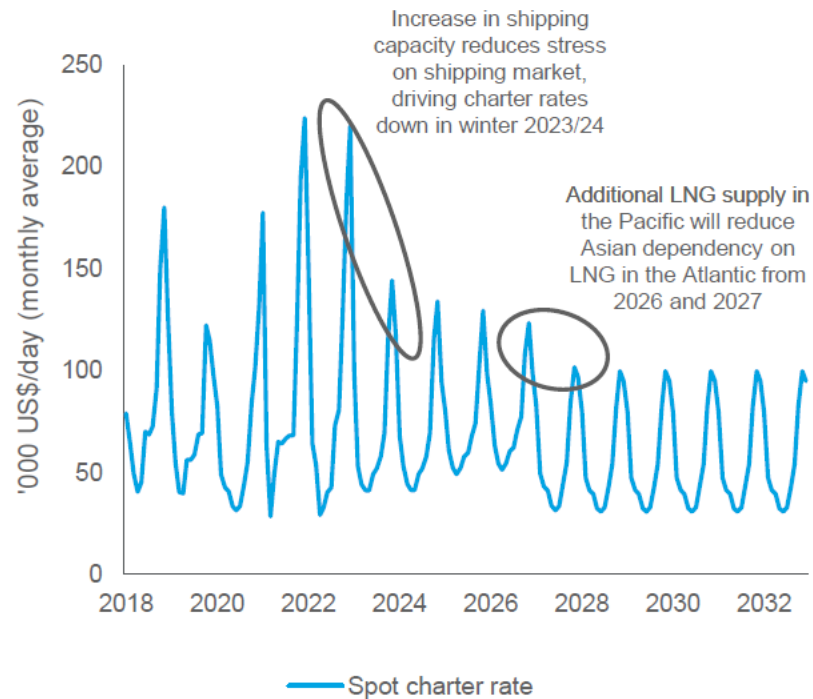


LNG Price Asia vs TTF

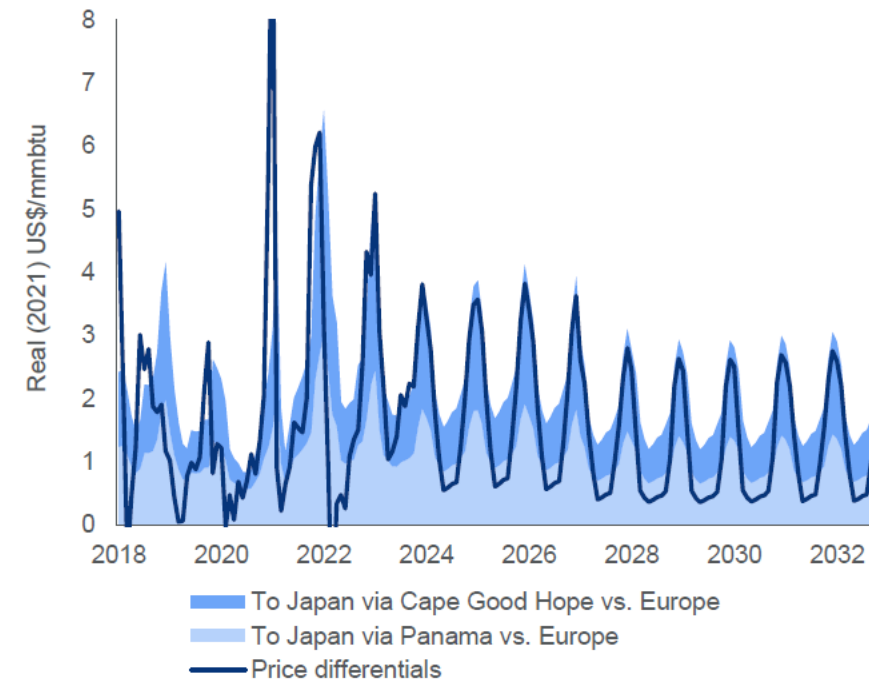
Japan LNG Spot DES (Asia) – price differentials vs TTF will soften from 2024 as increasing shipping capacity drives down spot charter rates

However, price differentials will remain relatively high as the “marginal cargo” will need to go through the Cape of Good Hope as requirements of US LNG to Asia remains sustained

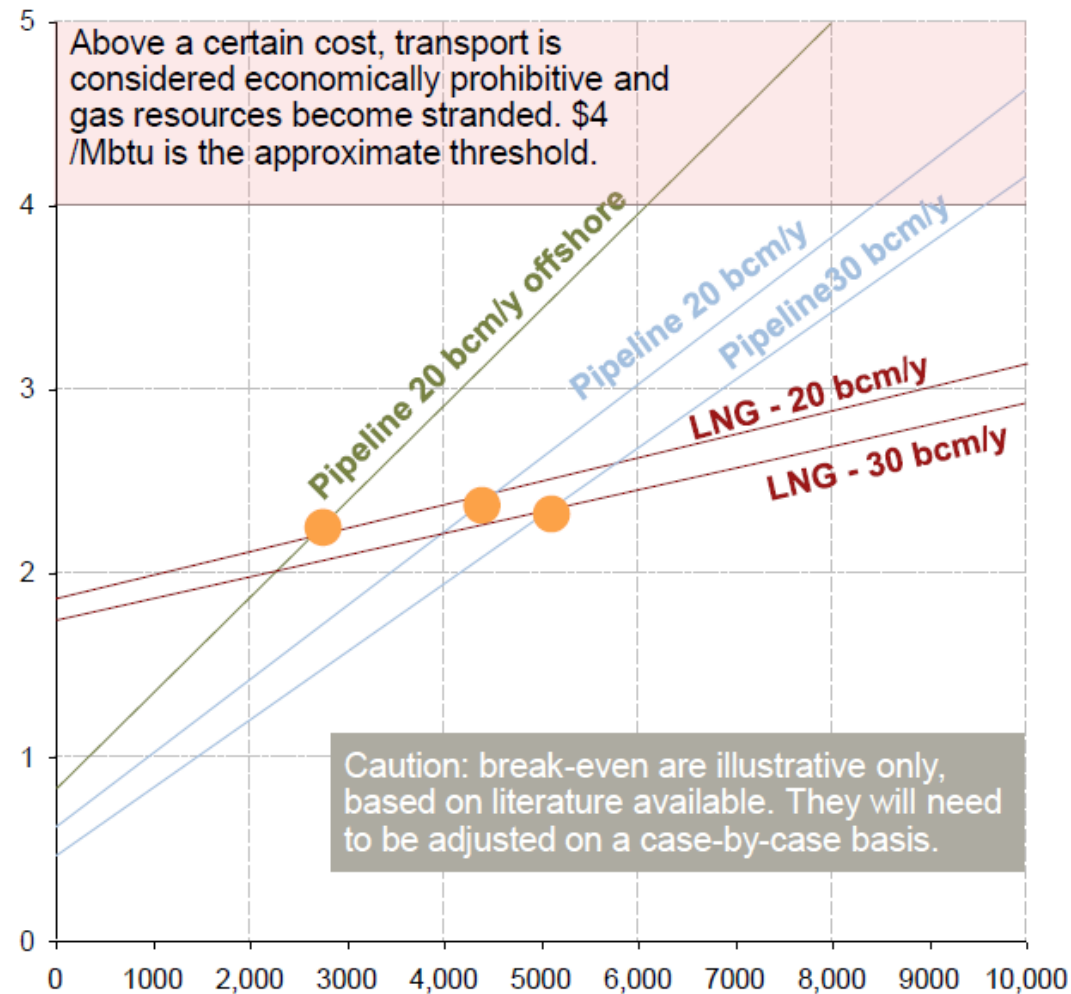
LNG shipping spot charter rates



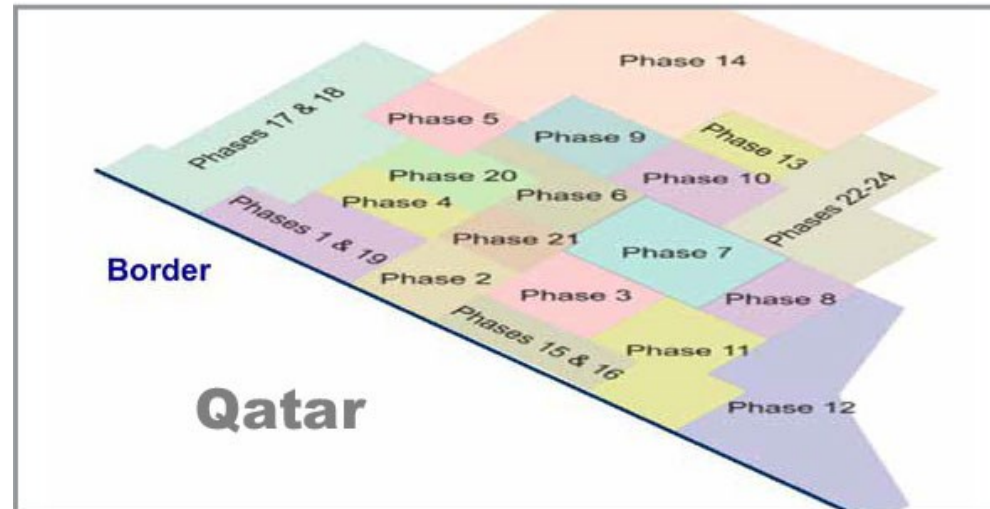
Price differentials (Japan spot DES – TTF) vs shipping differentials (from the US)



Cost of Transportation: Pipeline vs LNG



South Pars



Major LNG Projects

Pars LNG

Phase 11

Total, PETRONAS, and NIGEC

10 mmtpa

Cancelled

Iran LNG

Phase 12

NIOC and OPIC

10.5 mmtpa

Delayed

Persian LNG

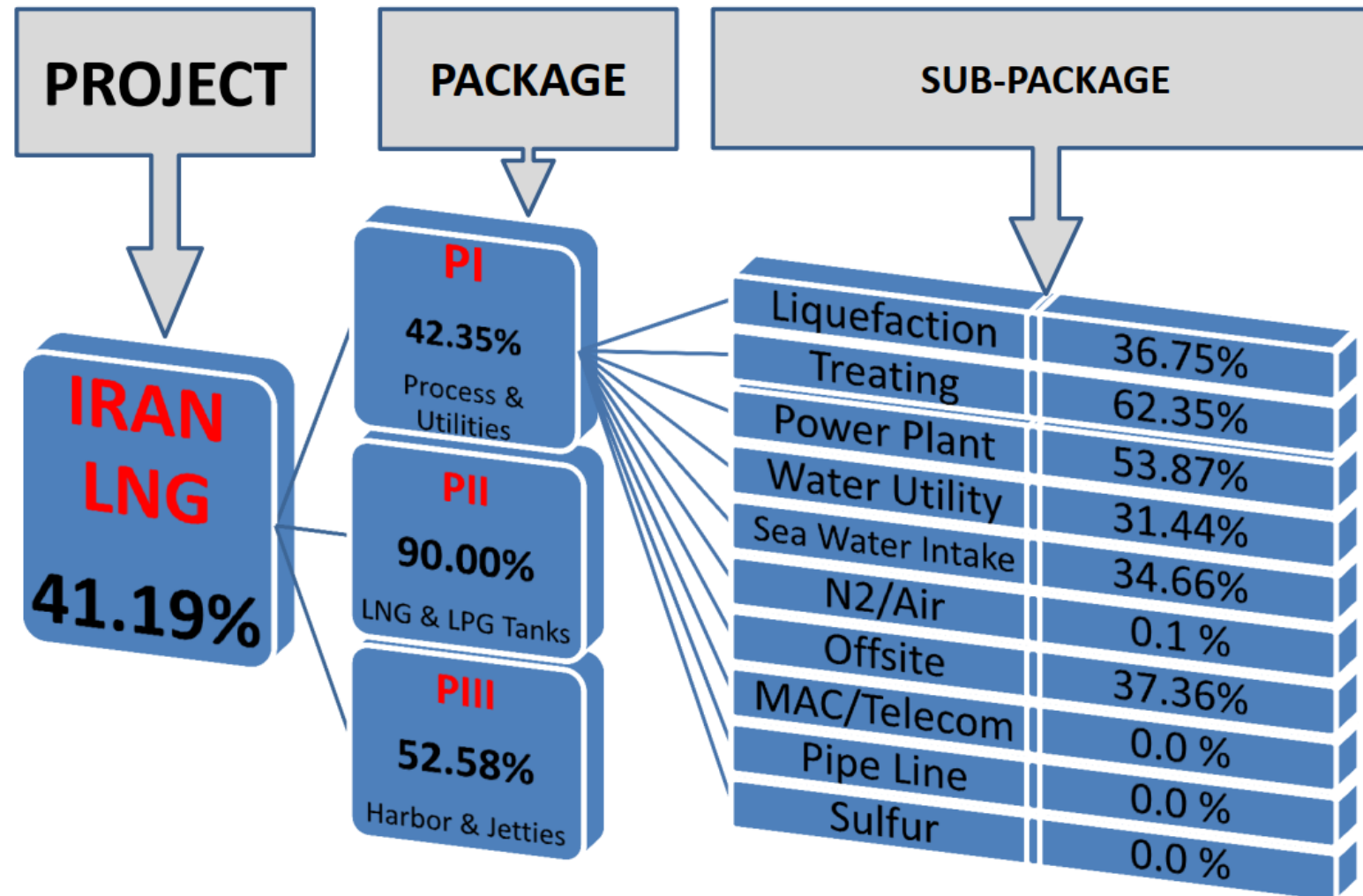
Phases 13 and 14

Shell, Repsol, and NIOC

16 mmtpa

Cancelled

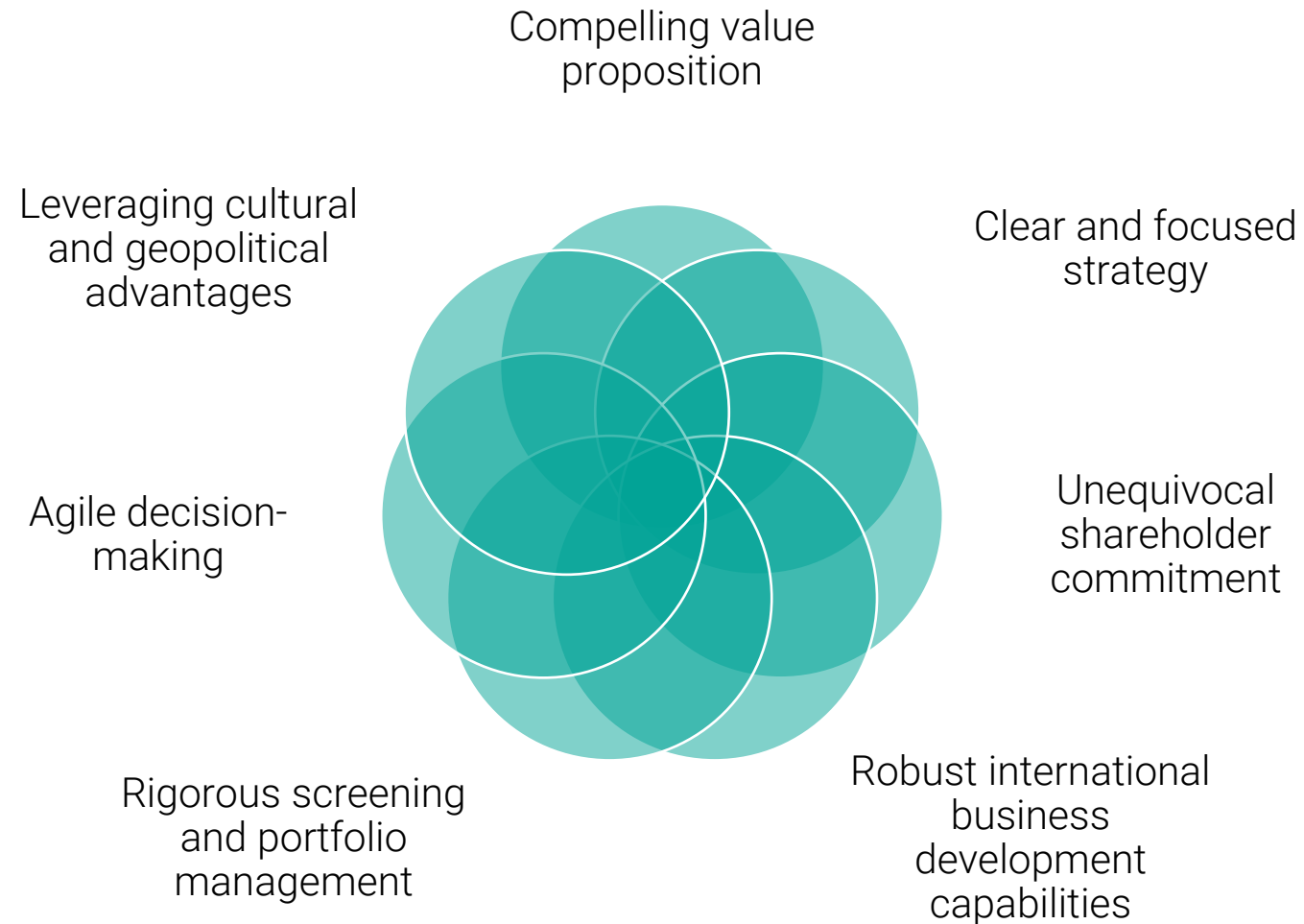
Iran LNG Update



11. Business Strategies

To provide examples of some emerging business strategies developed by oil and energy companies

Key Success Factors for Internationalization of NOCs



Main Decisions

Business model

- What do we want to be known for in the future?

Growth objectives & portfolio structure

- How big do we want to be?

Operatorship targets

- What is our target balance between operatorship and non-operatorship of portfolio assets?

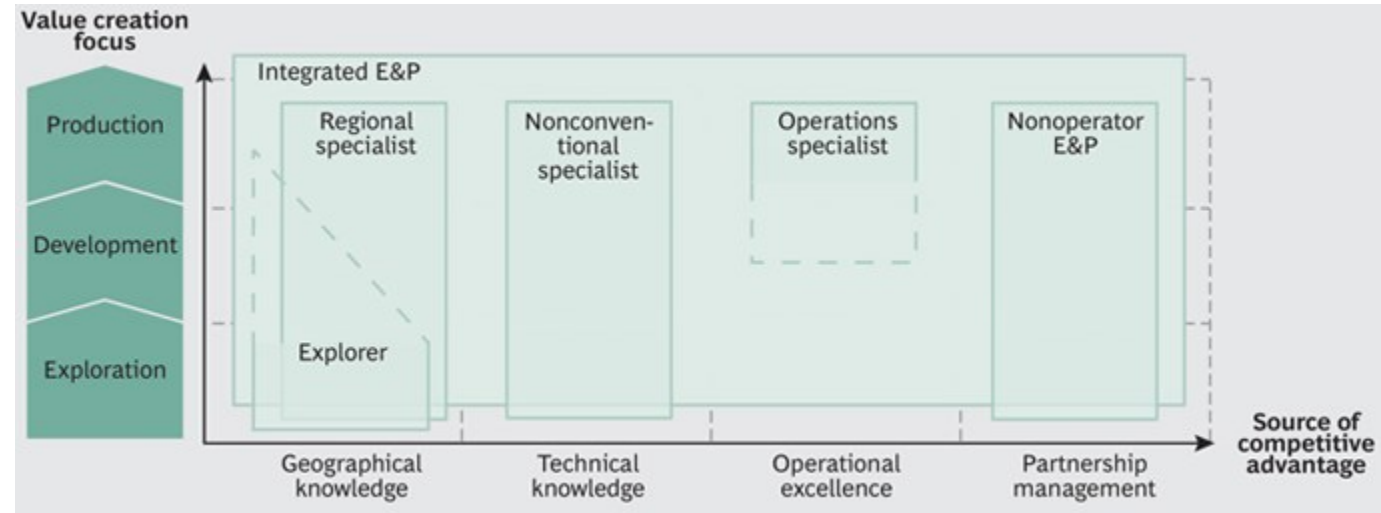
Risk appetite

- What is our appetite for risk?

Financing approach

- What financing approach is needed to support our growth strategy?

6 business models



6 E&P Business Models

Integrated E&P players (Anadarko, Premier Oil, & Apache):

- Balanced portfolio across technologies, geographies, and phases life cycle.

Explorers (Cairn Energy, Kosmos Energy, & Cove Energy)

- Concentrate on exploration of frontier areas and early monetization of discoveries.

Regional specialists (Pacific Rubiales Energy, Afren, & Pluspetrol):

- Specific countries with established presence & high degree of familiarity.

Nonconventional specialists (Chesapeake Energy, Canadian Oil Sands, & Husky Energy):

- Such as heavy oil, shale oil, and oil sands.

Operations specialists (including Perenco, Black Elk Energy, & Occidental Petroleum):

- Efficient extraction from existing fields.

Non-operator E&P players (Mitsui & Co. & Galp Energia)

- Use their relationships with NOC's and governments to gain access to high-quality assets & manage those assets but do not act as operators.

Deloitte Upstream Diversification Index

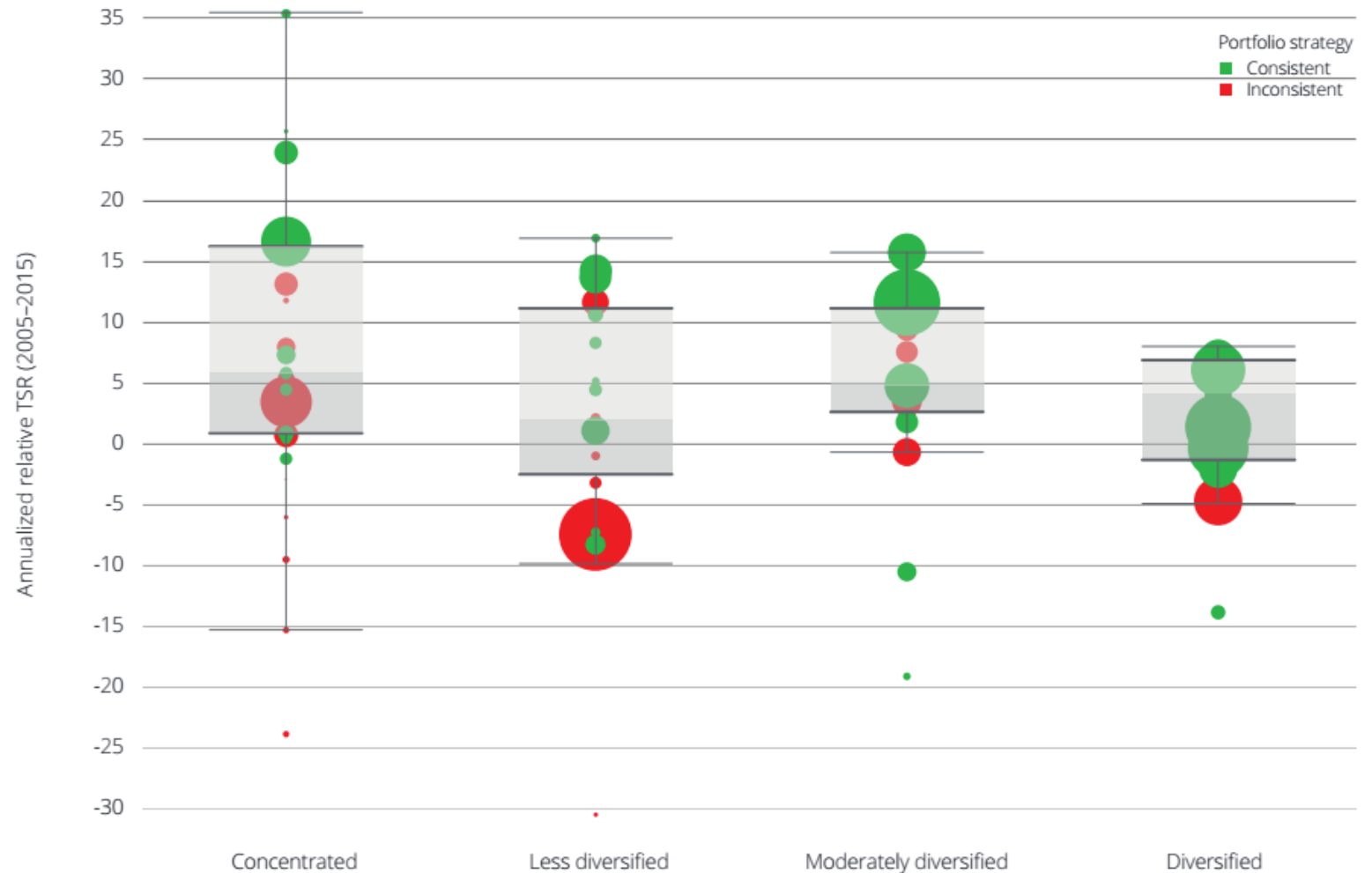
Production Mix

Region

Resource

Basin

Investment Cycle



Oil and Gas Capability Areas

Capability Area	Description	Example
E&P value chain	Capabilities with respect to a particular part of the E&P value chain	Occidental Enhanced oil recovery
Core region	Capabilities with respect to operating in a particular geographic area	Lundin Norwegian North Sea
Play types	Capabilities regarding exploration in particular geological play types	Tullow Oil Rift basins, stratigraphic traps
Technology	Capabilities in application of a particular specific technology	Statoil Harsh environments
Operational	Capabilities to combine various technologies and operating practices	EOG U.S. shale plays
Product	Capabilities relating primarily to one particular product	BG Gas value chain
Partnerships	Capabilities in establishing and leveraging partnerships	Wintershall Gazprom partnership
Political situation	Capabilities to operate under particular political circumstances	BP Russia
Commercial situation	Capabilities to secure assets in particular commercial situations	Apache Bilateral negotiations

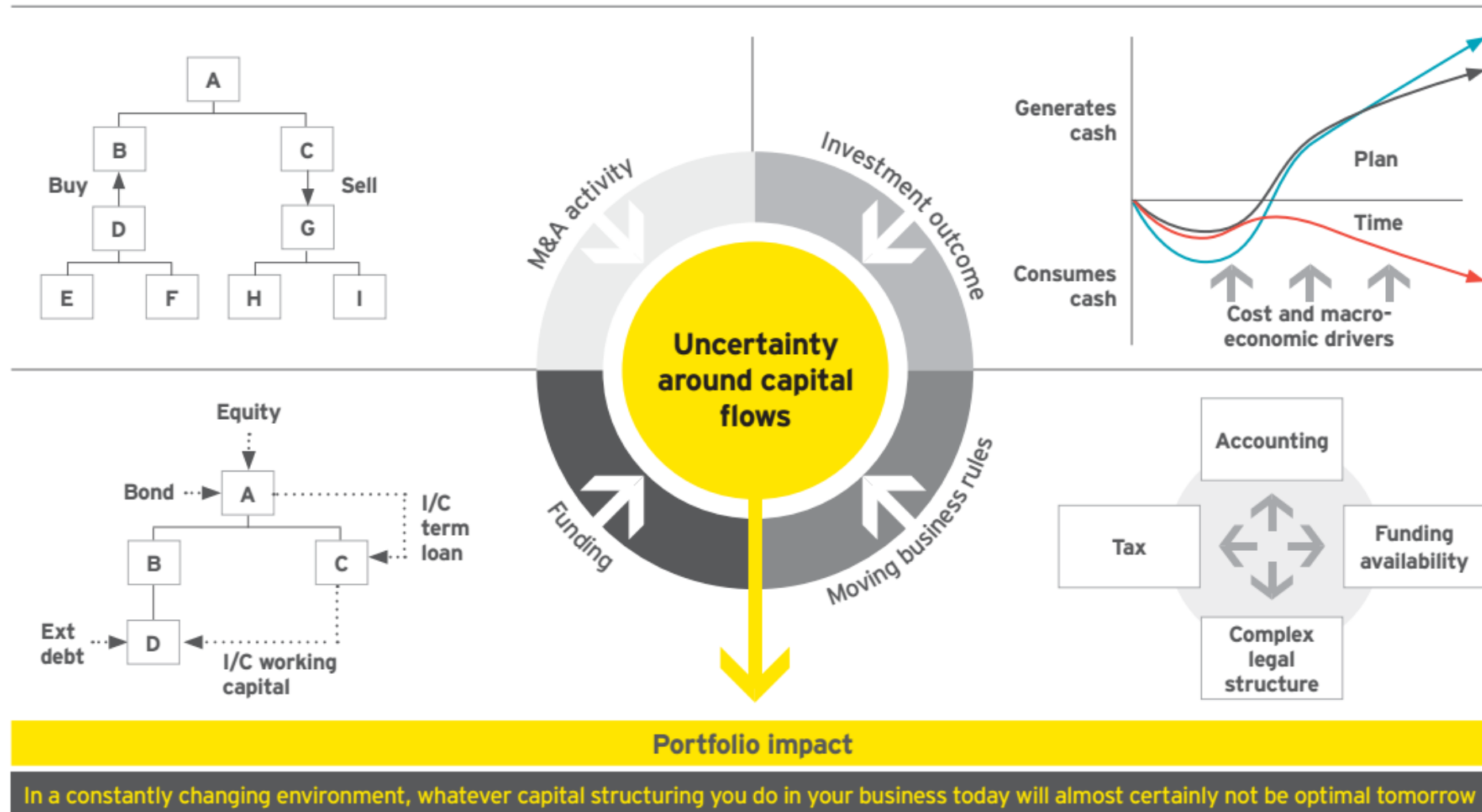
Portfolio Management Components



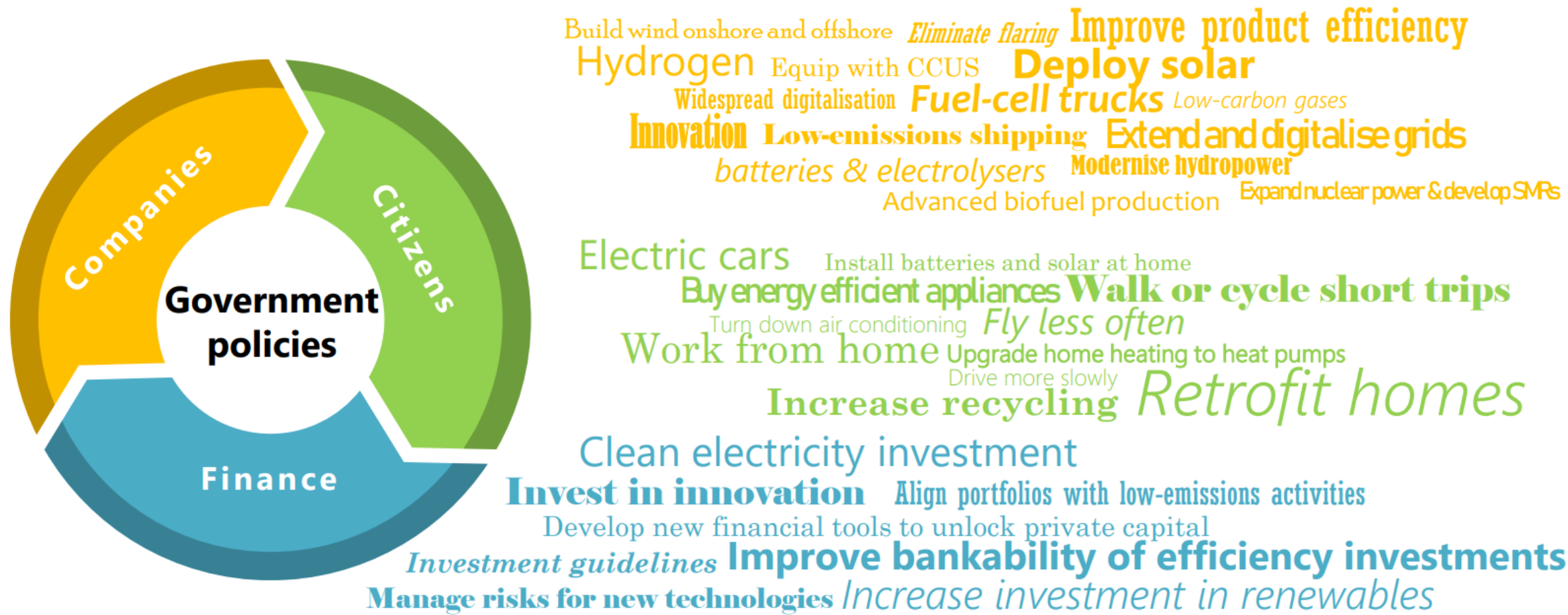
Optionality

- A company has optionality if it can quickly, effectively & efficiently shift its focus from underperforming businesses, assets & projects to better-performing ones that fit with its current strategy and enhance the overall value of the portfolio.
- A company will best leverage its optionality if it can:
 - Proactively identify potential changes in its operating environment and review the impact of these changes on its project and portfolio
 - Rapidly decide on a suitable course of action that would at the very least preserve, but ideally enhance, the value of its portfolio
 - Act in a timely, cost-efficient and effective manner

Optionality at the Corporate Level



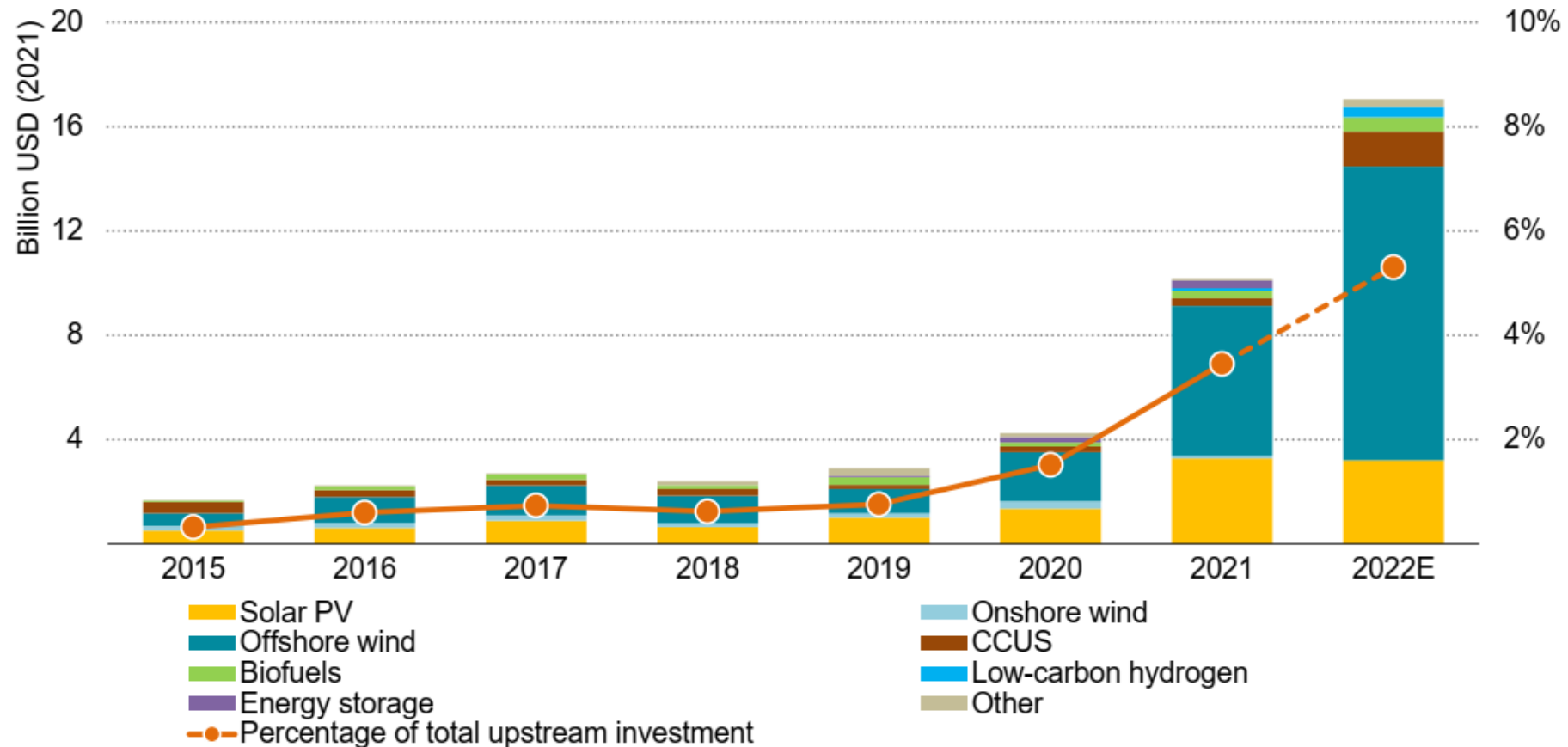
Net-Zero by 2050 Demands Unprecedented Efforts



Current Diversification Options by Selected International Oil Companies and NOCs

Company	Activity and investment in selected alternative businesses						
	Solar PV and wind generation	Geothermal	Electricity services	Bioenergy	CCUS	Low-carbon hydrogen	Nature-based solutions
BP	●	●	●	●	●	●	●
Eni	●		●	●	●	●	●
Shell	●	●	●	●	●	●	●
TotalEnergies	●		●	●	●	●	●
Chevron		●		●	●	●	
ExxonMobil				●	●	●	
ConocoPhillips					●		
Saudi Aramco	●				●	●	
ADNOC	●				●	●	
CNPC	●	●		●	●	●	●
Sinopec	●	●			●	●	
CNOOC	●				●	●	

Capex by Selected Oil and Gas Companies on Clean Energy Technologies



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Notes: Includes the majors, ADNOC, CNPC, CNOOC, Equinor, Gazprom, Kuwait Petroleum Corporation, Lukoil, Petrobras, Repsol, Rosneft, Saudi Aramco, Sinopec and Sonatrach. The estimated clean capex in 2022 is based on investment spending announced to 31 March 2022 and assumes that this pace of investment is maintained throughout the year.

Changes to Follow

Resource Abundance and Importance of Customer Preference



More Competitive and Productive Landscape For The Industry



Major Changes in Global Economy Shape and Living Standards



Lower for Longer Prices and Peak Demand for Liquid Fuels



Digitalization of the World Economy with Effects on the Industry



Increasing Pressure From Regulators and Society to Lower Emissions



Strategic Decisions

Focus on Core Competencies

Deploy key internal capabilities and divesting non-core assets through bold M&A actions (DNO, BP, Perenco)

Diversification and Internationalization

Expand into other geographical areas to investment in new opportunities (QE, Petronas)

Low-carbon Investment

Investment in low-carbon energy (gas and renewables), and in carbon capture and hydrogen (BP)

Integration and Consolidation

Mergers of upstream and downstream assets to build an integrated energy company (Aramco, OQ, ADNOC)

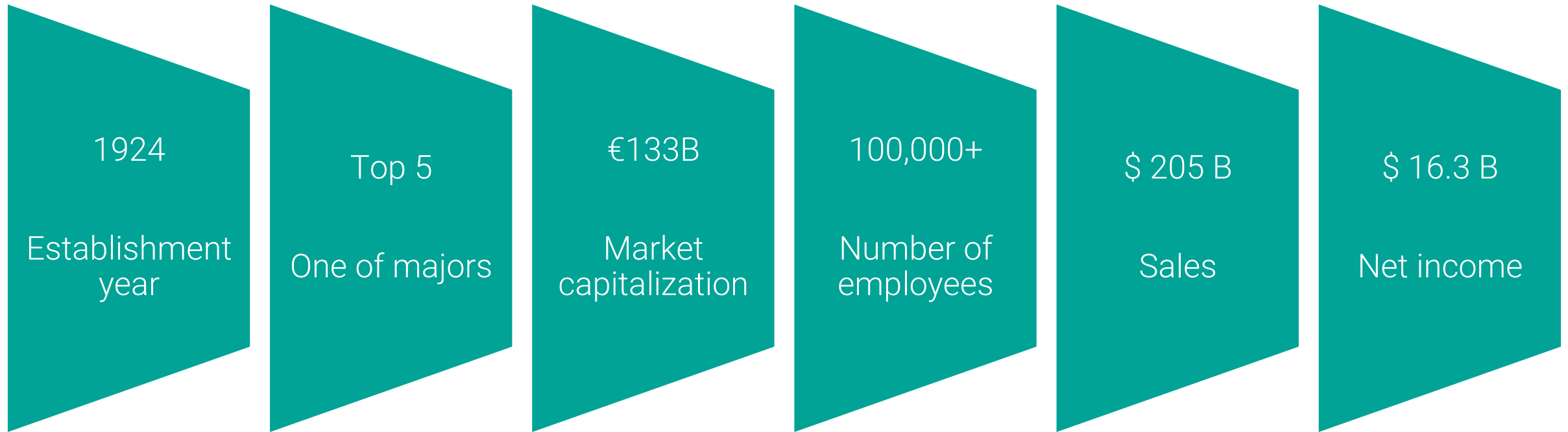
Partnership

Leverage technical and financial capabilities to be present through whole energy value chain (ADNOC)

12. Total Energies

To review key transition elements in Total Energies during past decade

History



1954



1960



1970



1982



2003



2021

2016 Transformation

- Integrating climate into strategy and Cost reduction
- Creation of the Gas, Renewables & Power Segment
 - The new Gas, Renewables & Power segment will spearhead Total's ambitions in the electricity value chain by expanding in downstream gas, renewable energies and energy efficiency.
- Creation of a new Total Global Services segment
 - This new segment is being created to sustainably improve efficiency across all businesses by globally pooling support services (Accounting, Purchasing, Information Systems, Training, Human Resources Administration and Facilities Management).
- Corporate headquarters refocused on strategic functions
 - People & Social Responsibility
 - Strategy & Innovation

ONE Total

Total Global Services generating results



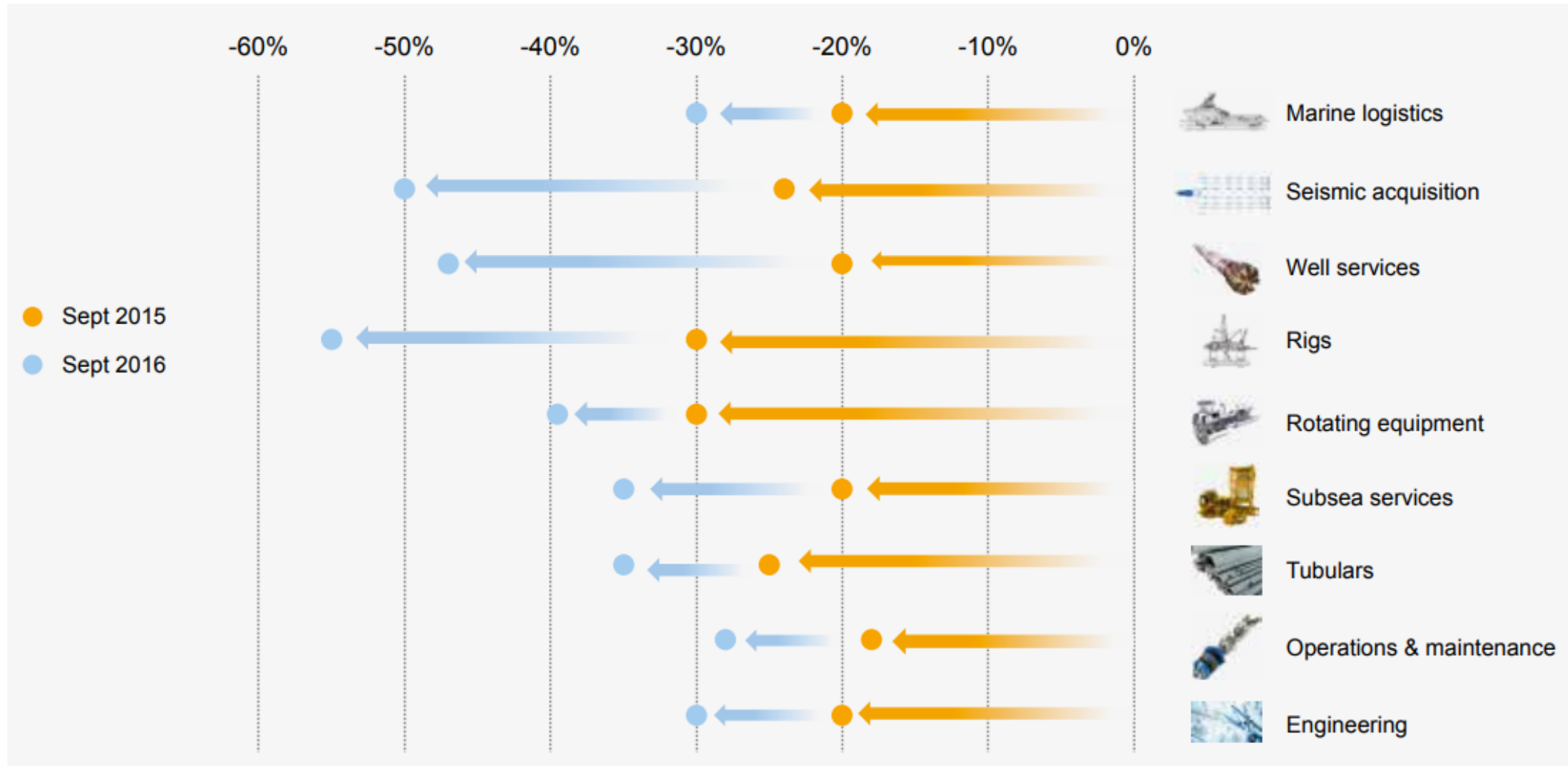
- **~400 M\$ savings in 2017** (Opex + Capex), targeting **1 B\$ by 2020**
- **40% of procurement negotiated globally**
- **Bundling contracts** with major vendors to create economies of scale

ONE TOTAL

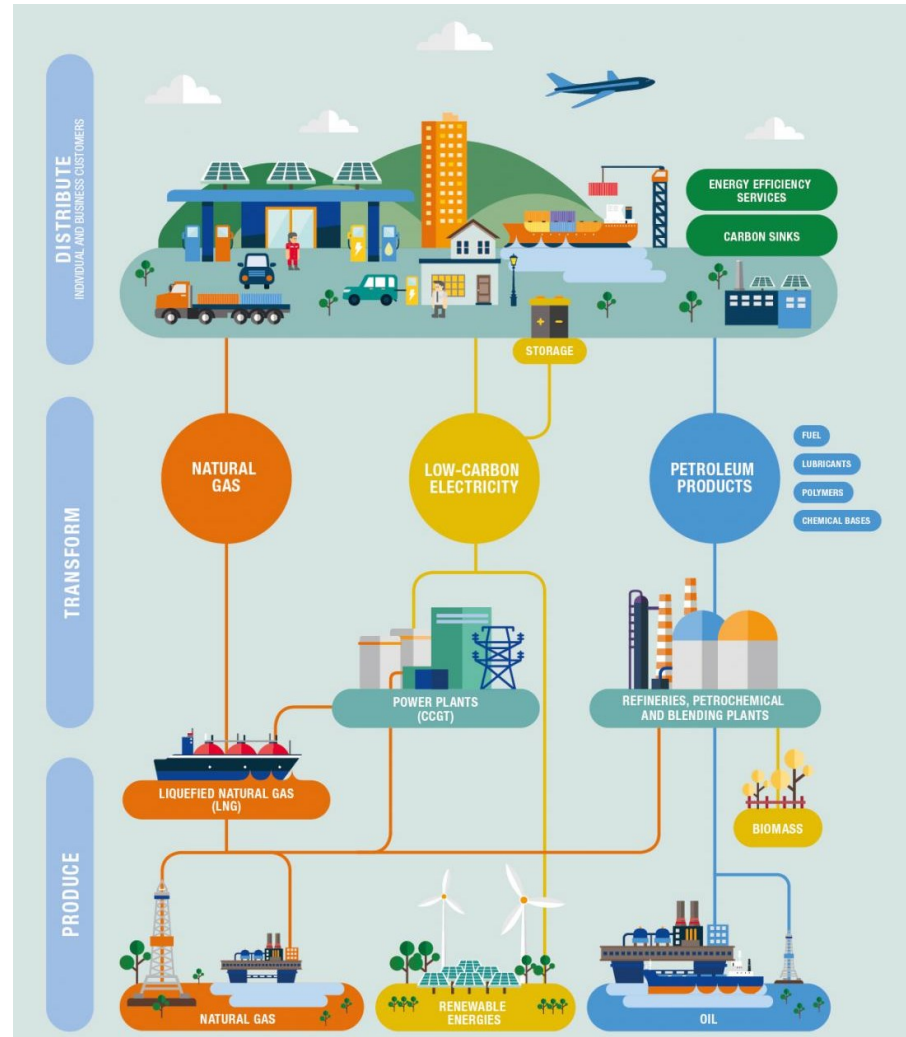


- **One Total Chair** per country
- **Cross-segment** support functions
- Group-wide **simplification program**

Cost Reduction



Integrated Business Model



Sustainable Energy Challenge

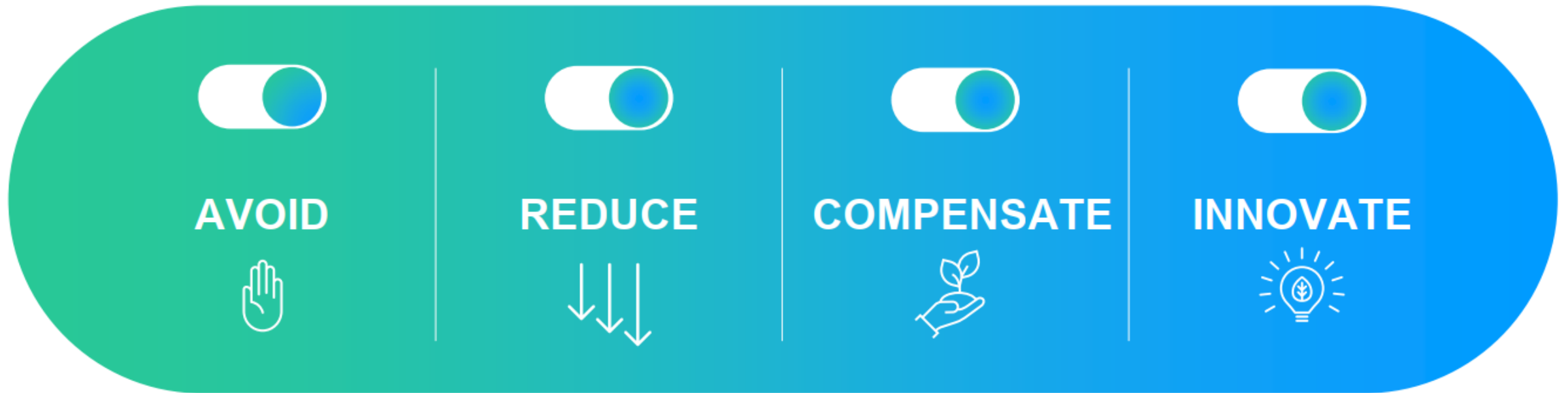
1

**Ensuring a reliable,
affordable, accessible
energy supply for a
growing world
population**

2

**Protecting the planet and
its inhabitants from the
adverse effect of greenhouse
gas emissions and their impact
on climate change**

Decarbonization Levers

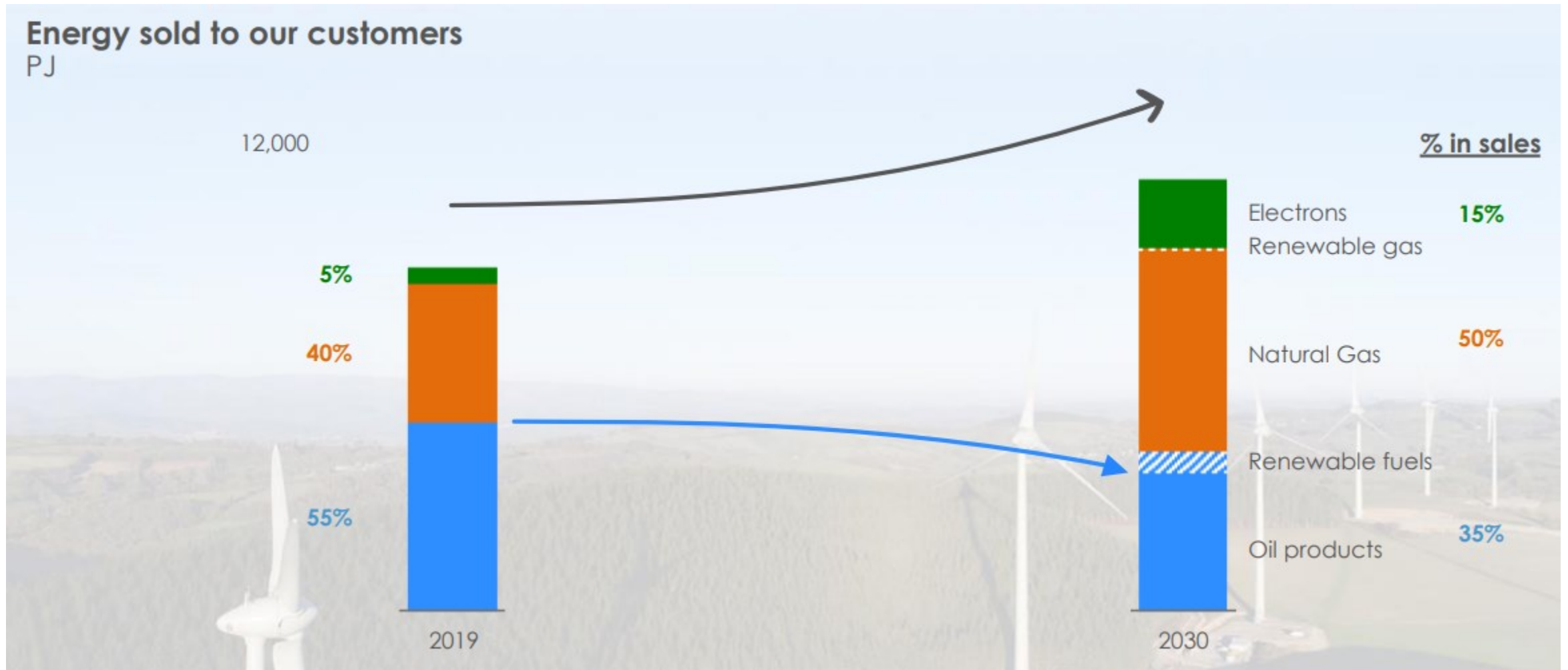


Transforming Total Into a Broad Energy Company

	Gases • Grow LNG (#2 player) and develop renewable gas (biogas / clean H₂) • Promote natural gas for power and mobility
	Renewables & Electricity • Accelerate investments in low carbon electricity primarily from renewables • Integrate along the electricity chain (production, storage, trading, supply)
	Liquids • Focus investments on low cost oil and renewable fuels (biofuels, SAF...) • Adapt refining capacity and sales to demand in Europe
	Carbon Sinks • Invest in carbon sinks (NBS and CCUS)

Total will become TotalEnergies
creating long-term value for shareholders

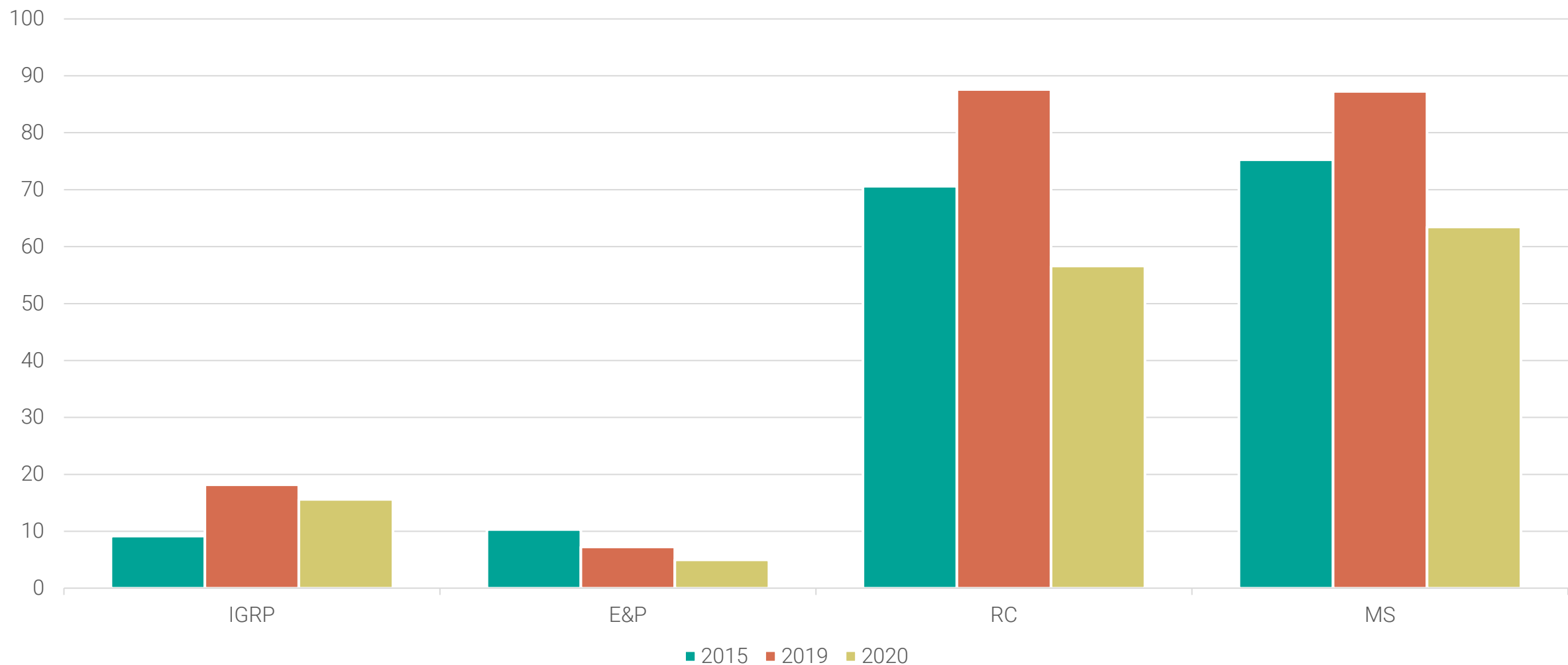
Growing Sales While Adapting to Demand



ESG Ambitions

ENVIRONMENT	SOCIAL	GOVERNANCE
		
Climate ambition to Net Zero Biodiversity new commitments Advocacy consistent with our climate ambition	Responsible employer: no lay-offs despite crisis 2025 new diversity ambition 30% women in all management bodies	Environmental and social challenges integrated in all Board decisions CEO compensation: • reduced during crisis • linked to ESG factors (25% of variable part and LTI)

Sales by Business Segment, Excluding Inter-segment Sales (\$ B)



Net Operating Income (\$ B)



“The Stone Age did not end for lack of stone, and the Oil Age will end long before the world runs out of oil.”

Sheikh Zaki Yamani

