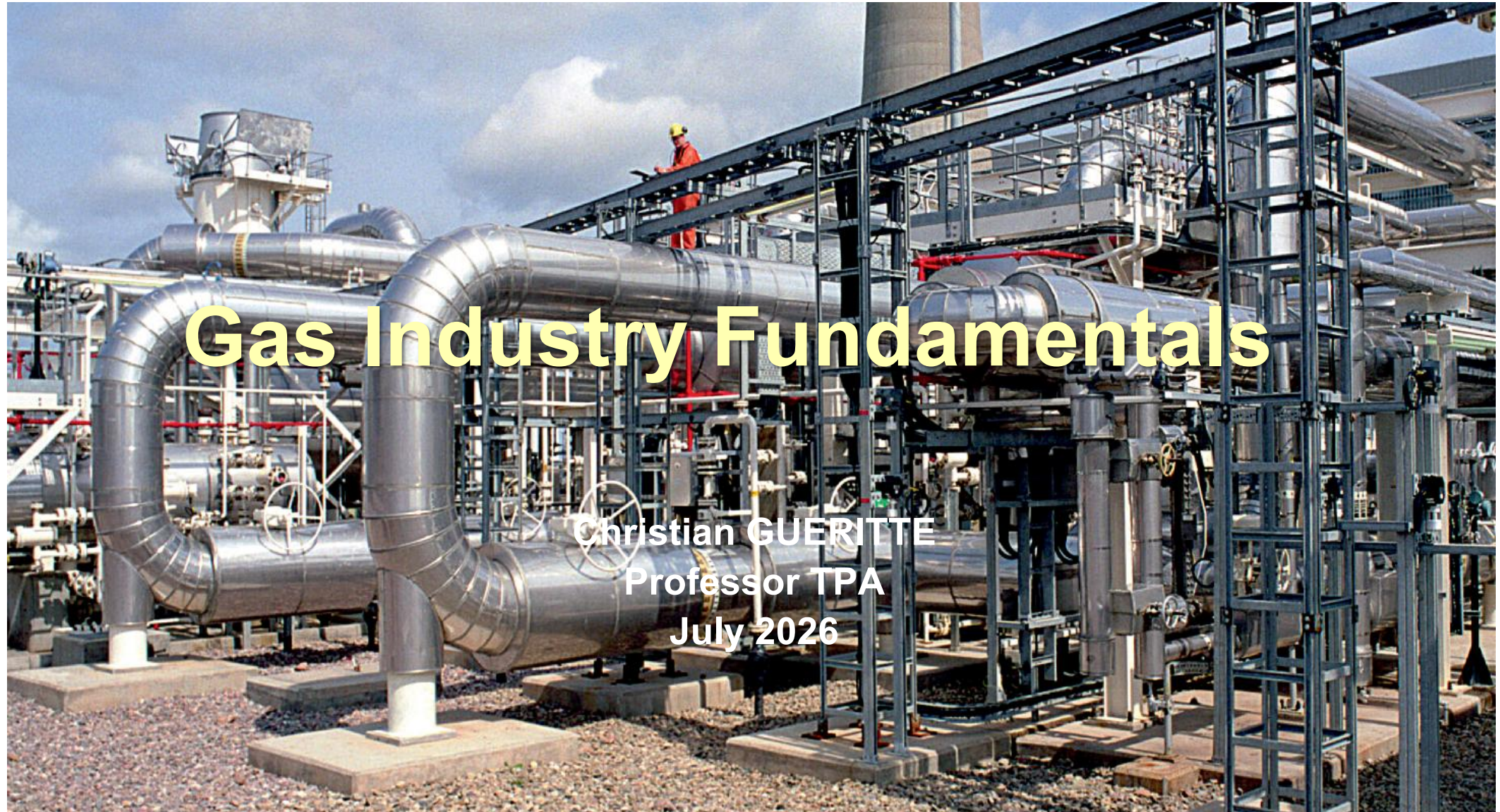


BOOK 5



Gas Industry Fundamentals

Christian GUERITTE
Professor TPA
July 2026





TPA

Sharing Experience

Building bridges between the oil industry and academic circles by delivering technical or business-related presentations by professors or experts.



OIL & GAS and ENERGY GLOBAL ISSUES

A Toolbox to understand the World of Energy in the Global Economy

The Toolbox is updated twice a year and benefits from the contributions of TPA Professors:

Coordination: GUÉRITTE Christian

LUC Benoît, PERSILLON Philippe, CORDIER Jean-Pierre, PAPÉE Jean, MULLER Isabelle, DEUTSCH Denis, FOURCADE Bernard, MICHAUD Olivier, SAINCRY Daniel, FOURNIÉ François, CHOUX Jean-Claude, BERA Jean, GUYS Philippe, DE MERVILLE Eric, DUMAY Jean-Michel, VALDELIÈVRE Michel, FONTAINE Jean-Marc, FERRIER Jérôme, BITEAU Jean-Jacques, PETTEAU Pascal, NOSJEAN Nicolas



Natural Gas



OVERALL TABLE OF CONTENTS

BOOK 1 Projects Economic Evaluation and Investment Decision

BOOK 2 Energy Industry Fundamentals

BOOK 3 Climate Change Challenges

BOOK 4 Oil Industry Fundamentals

BOOK 5 Gas Industry Fundamentals

BOOK 6 Unconventional Hydrocarbons

BOOK 7 Renewables (except hydropower)

BOOK 8 Hydropower

BOOK 9 Coal Industry Fundamentals

BOOK 10 Nuclear Industry Fundamentals



TABLE OF CONTENTS

1. General considerations
2. Resources, reserves
3. Conventional and Unconventional Gaseous Hydrocarbons
4. Production, Consumption: past and present
5. Production, Consumption: perspectives
6. A zoom on Liquefied Natural Gas (LNG)
7. Three independant world markets
8. The Gas chain components and their economics: Production & Processing
9. The Gas chain components and their economics: Transportation
10. The Gas chain components and their economics: Storage
11. Technology and innovation
12. Competing fuels and Gas prices
13. Evolution of national Gas markets towards liberalization & globalization
14. Example of challenging Gas projects: Shtokman & Yamal



1

General considerations



TABLE OF CONTENTS

- 1. General considerations**
- 2. Resources, reserves**
- 3. Conventional and Unconventional Gaseous Hydrocarbons**
- 4. Production, consumption: past and present**
- 5. Production, consumption: perspectives**
- 6. A zoom on Liquefied Natural Gas (LNG)**
- 7. Three independant world markets**
- 8. The gas chain components and their economics: Production & Processing**
- 9. The gas chain components and their economics: Transportation**
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- 11. Technology and innovation**
- 12. Competing fuels and Gas prices**
- 13. Evolution of national gas markets towards liberalization & globalization**
- 14. Example of challenging gas projects: Shtokman & Yamal**



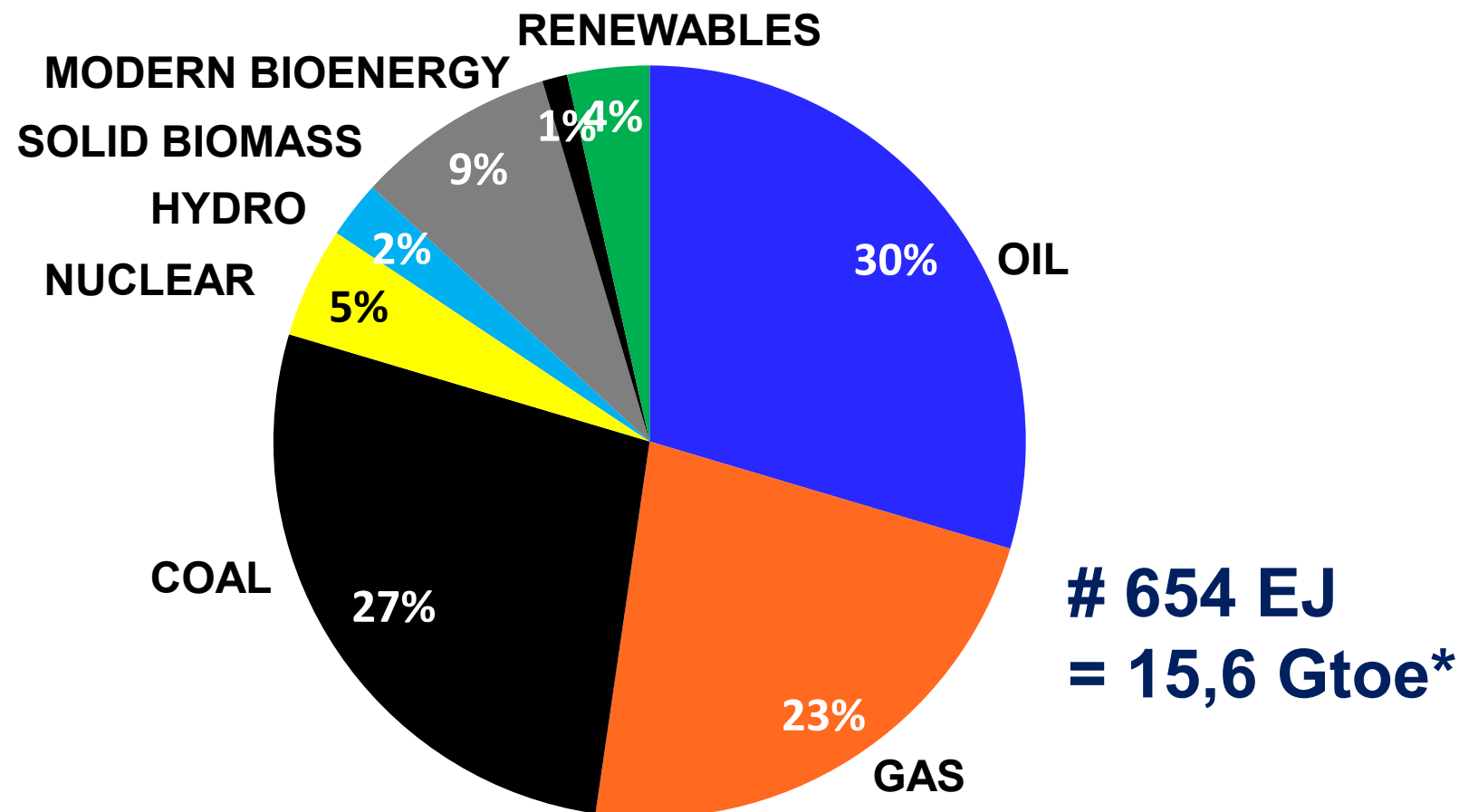
Some conversion factors for the Gas Industry

- 1 cubic feet = 0,02832 m³
- 1 Btu = 1 055 J
- 1m3 # 38 000 Btu
- 1m3 # 6,3 boe
- 1 boe # 6 Mbtu
- 1t LNG # 1 300 m³ Natural Gas
- 1m3 LNG # 600 m³ Natural Gas
- 1 000 m³ Natural Gas # 0,86 toe
- 1 000 m³ Methane = 0,71 t Methane



World Primary Energy Demand – 2024

+ 2,0% vs 2023



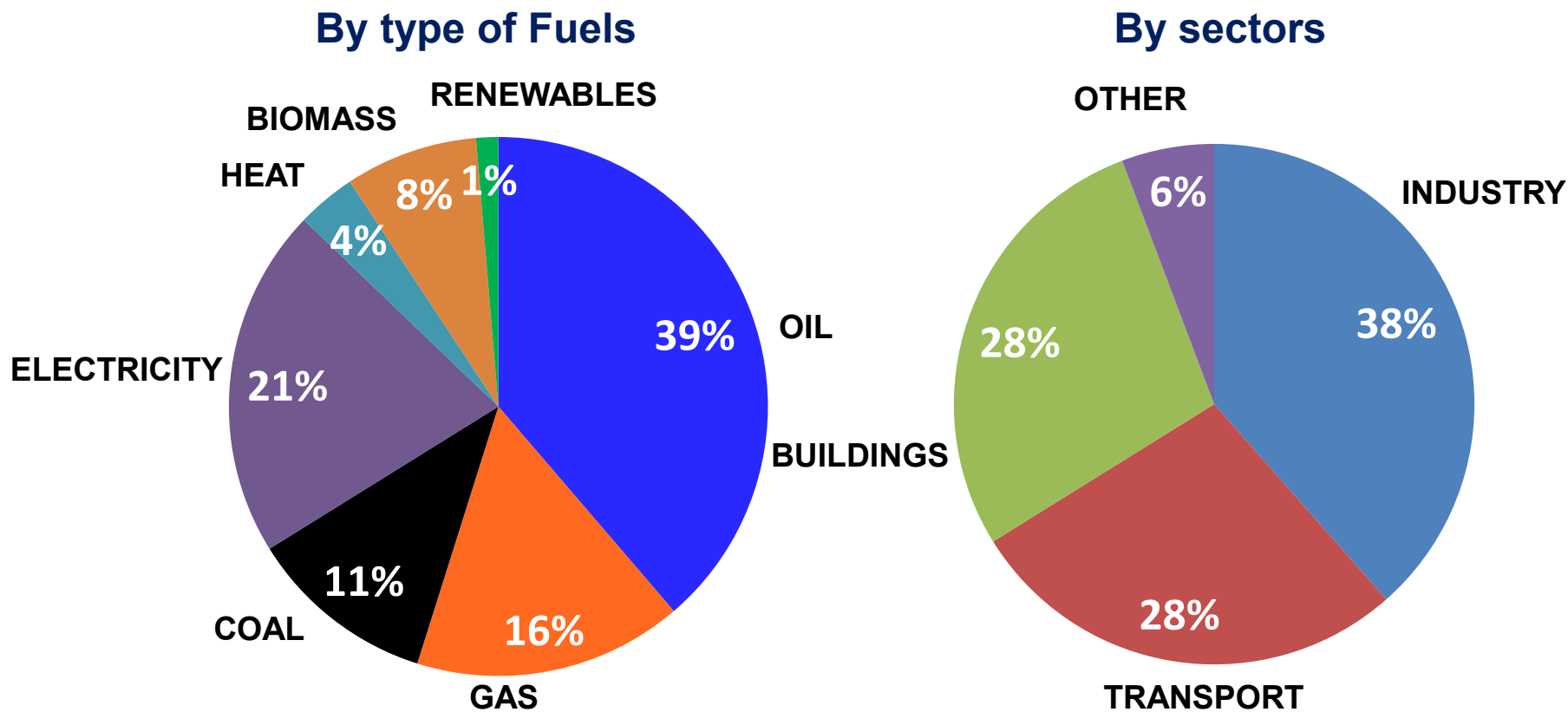
* out of which electricity generation # 6,5 Gtoe # 31 100TWh (eq. Primary Energy)

Source: Data from IEA WEO 2025. Nota: Sums might not be equal to 100% due to rounding

Solid Biomass: tradit. wood & charcoal & solid residues. Modern Bioenergy: liquid & gaseous bioenergy (biofuels & biogases) Renewables: Solar, Wind, Geothermal, Marine Energy,...



Total Final Consumption – 2024 + 2,0% vs 2023



453 EJ = 10,8 Gtoe

Nota: Sums might not be equal to 100% due to rounding

OTHER relates to agricultural sector & other non-energy use

Source: Data from IEA WEO 2025



Oil chain vs Gas chain

Oil Chain

- ◆ Short and loose chain
- ◆ Interruptions easy to compensate
- ◆ Built-in market mechanisms because oil is easily tradable

Gas Chain

- ◆ Long and firm chain
- ◆ Physically fixed links from wellhead to burner tip
- ◆ Interruption: no gas downstream / no money upstream
- ◆ Higher investment in the chain
- ◆ Few built-in market mechanisms, but fixed capacities

The marketing process of natural gas is then fundamentally different from that of oil



Basic issues in the Gas business

- ◆ Natural gas transportation is characterized by very large economies of scale.
- ◆ Share of transportation/distribution costs in overall natural gas supply costs is large.
- ◆ Storage costs of natural gas are high and economic only for very large volumes.
- ◆ There are environmental and efficiency advantages for natural gas, but this energy source can always be substituted by other fuels.
- ◆ Apart from some liberalized mature gas areas, the gas chain characteristics call for a stable access to gas supplies and a secured market valorization.
- ◆ Natural Gas Trade relies in particular on Long-Term Contracts. Spot markets also exist and take more and more importance (Henry Hub, NBP, TTF....)
- ◆ As from 20 years ago, the activity of Shale Gas production (US) has had an important effect on the international gas market.
- ◆ Price is only one of the commercial conditions which ensure the long-term balance between the interests of the partners in the commercial agreements.
- ◆ In term of CO₂ emissions, Natural Gas is emitting twice less emissions than coal par delivered energy for electricity generation.
- ◆ In the framework of the Energy Transition program and the combat against Climate Change, Natural Gas is a good candidate to replace Coal which emits twice more CO₂ per produced kWh_e.

Nota: NBP : National Balancing Point
TTF : Transfer Title Facility



Main Gas advantages

Natural gas is an abundant, secure, and flexible energy source.



Availability

There are sufficient global deposits widely distributed across the world to meet projected demand.



Accessibility

A dependable global network of pipelines and a booming LNG market make access to gas easy and secure.



Affordability

Gas is an affordable source of energy that enables balance between meeting environmental challenges and continuing to grow the economy.

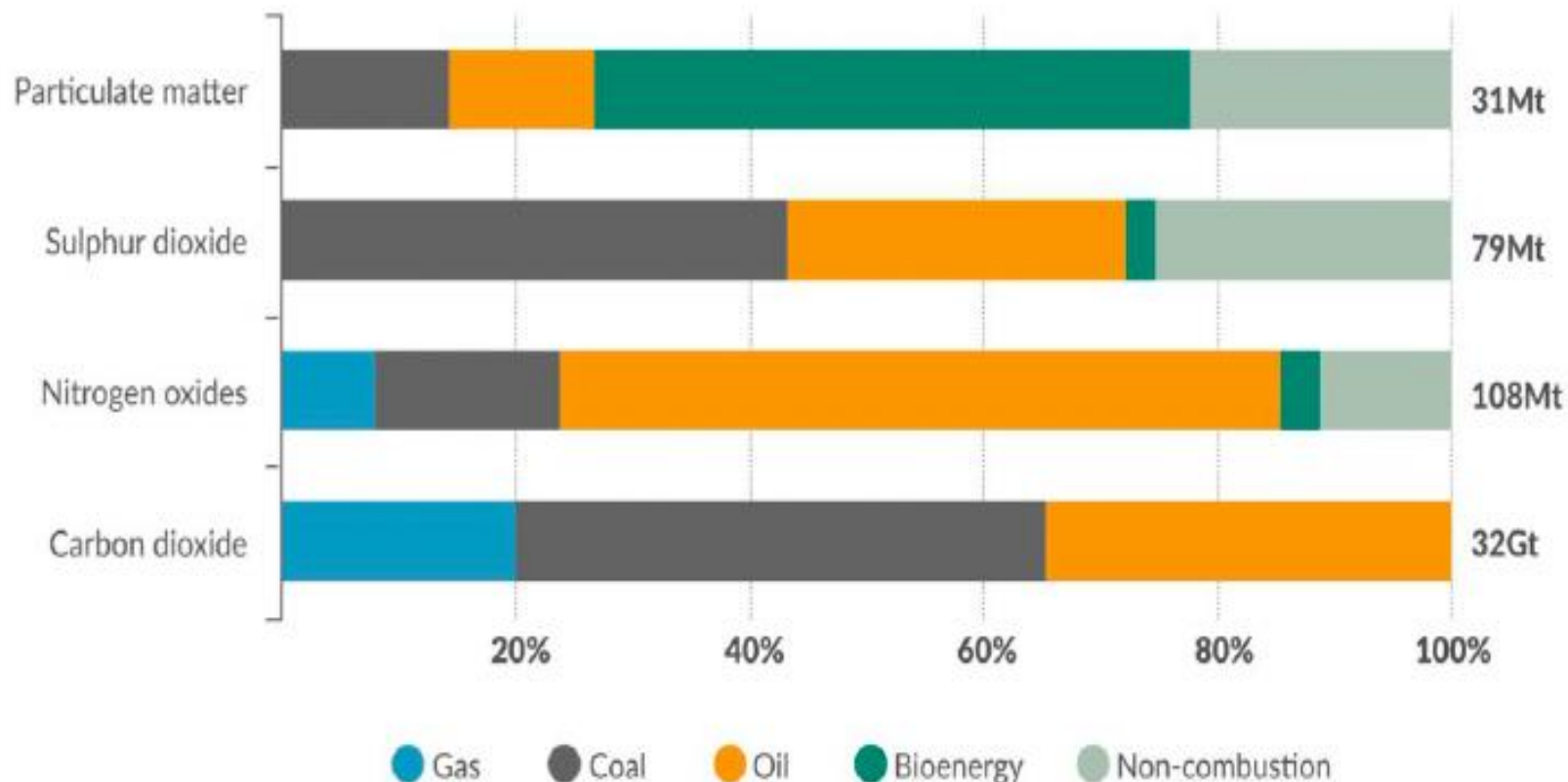


Reliability

Gas is a highly reliable source of energy, with an advanced infrastructure delivering over 99.9% reliability, while LNG and storage provide dependable long-term security of supply.



Share of Natural Gas in Energy related Air Pollutants and CO₂



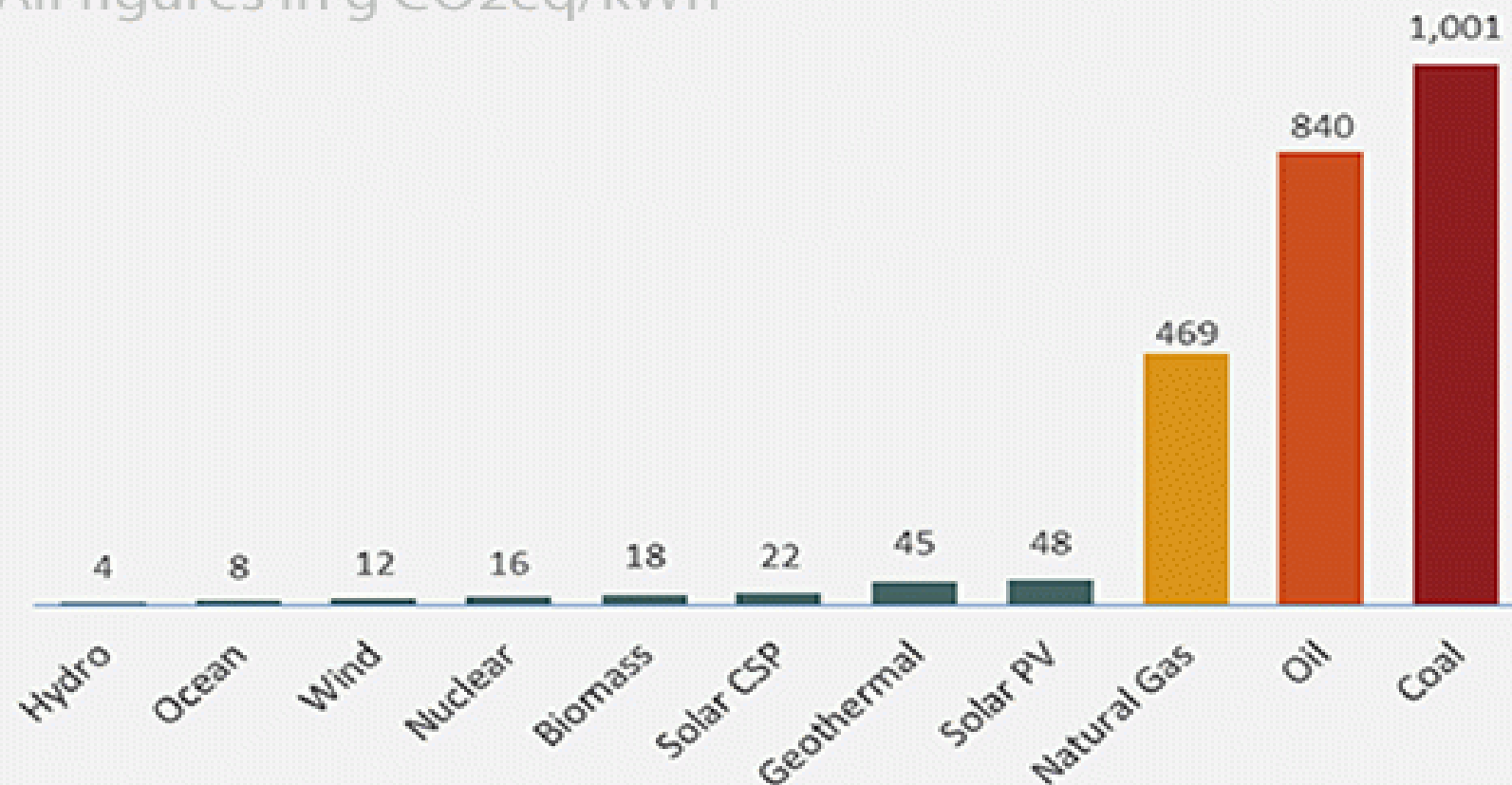
Source: IEA World Energy Outlook, 2017



Life Cycle GHG Emissions, g CO₂eq per kWh_e

The Carbon Intensity of Electricity Generation

All figures in g CO₂eq/kWh



Note: Data is the 50th percentile for each technology from a meta study of more than 50 papers
Source: IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation



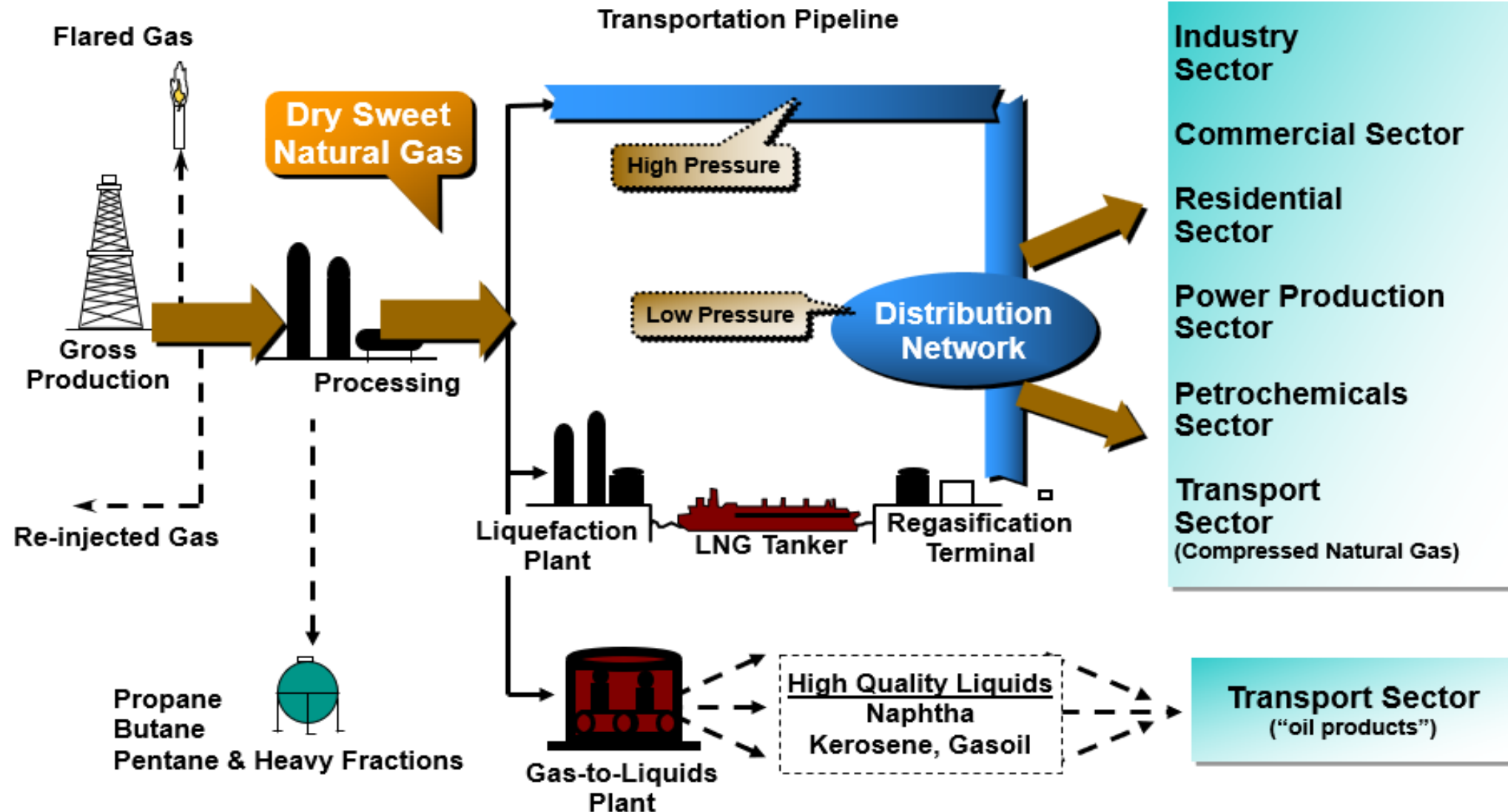
Thanks to Natural Gas, Improvement of Air Quality – An illustration



Source: IGU

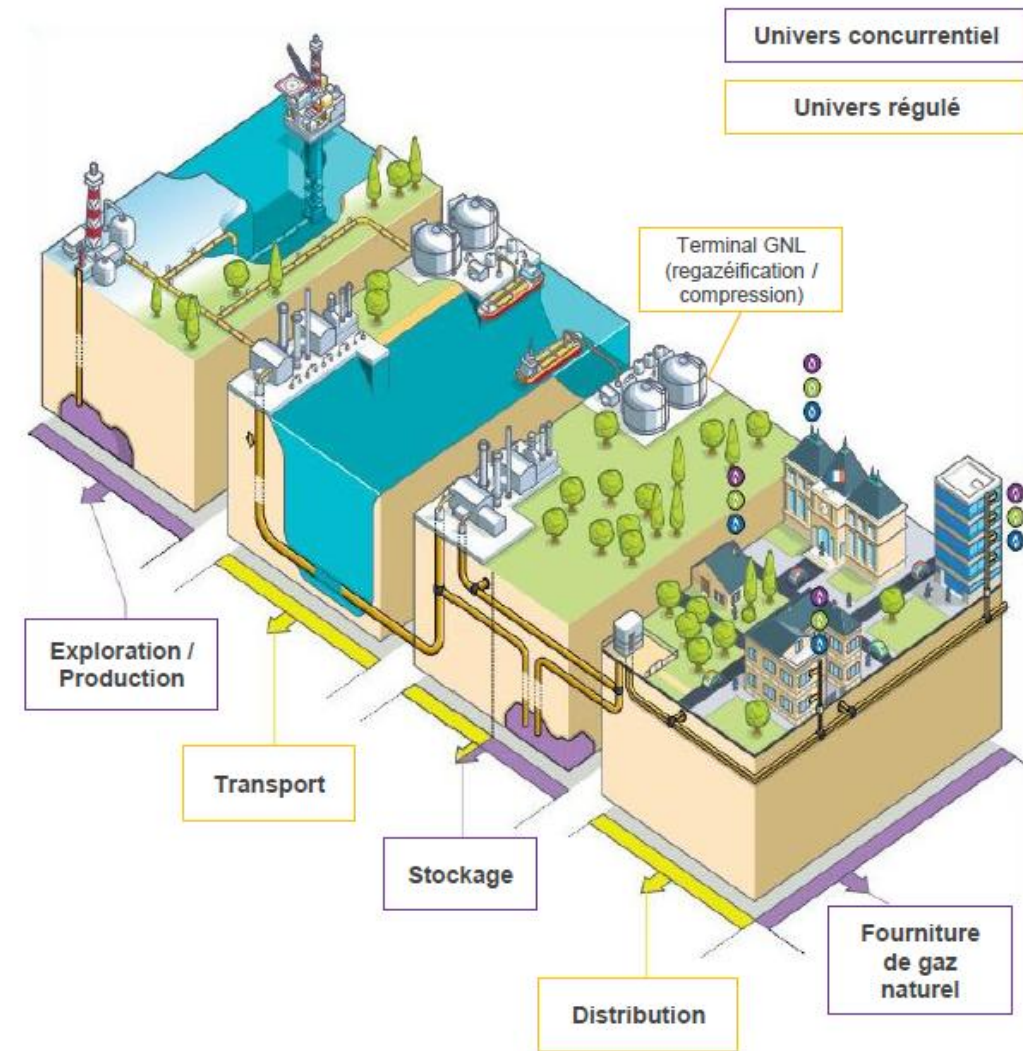


Natural Gas chain



La chaîne gazière

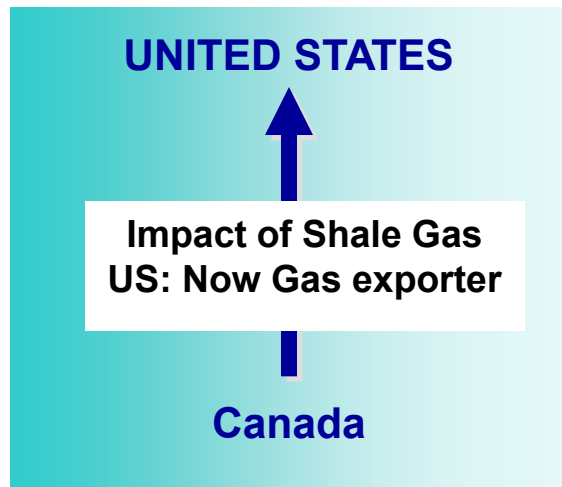
- Exploration/Production
 - Le gaz naturel provient de gisements terrestres ou marins.
- Transport
 - Le gaz naturel est transporté par voie terrestre via un réseau de gazoducs, ou par voie maritime sous forme liquéfiée (GNL) par méthaniers.
- Stockage
 - Le gaz naturel est stocké dans des réservoirs souterrains. Le stockage permet d'ajuster la distribution de gaz naturel à la demande client.
- Distribution
 - Le gaz naturel est acheminé des points de stockage aux clients via un réseau de base et moyenne pression.



Regional Natural Gas markets

- ◆ Natural Gas is condemned to rigid, expensive infrastructures, which limit trade over very long distances. Cost of transport 10 times more expensive than oil
- ◆ No world Gas market but various national and regional gas markets
- ◆ Three Main Regional Gas Markets with marginal links
- ◆ Spot prices trading business is becoming more and more important

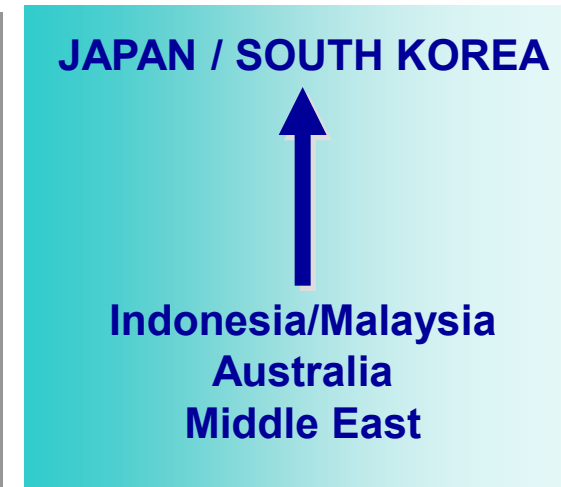
NORTH AMERICA



EUROPE



EAST ASIA



**With this world market structure,
Gas is in Competition with Regional Energy References.
No Mutual Price Adjustment and thus No International Gas Price Marker**



2

Resources, reserves



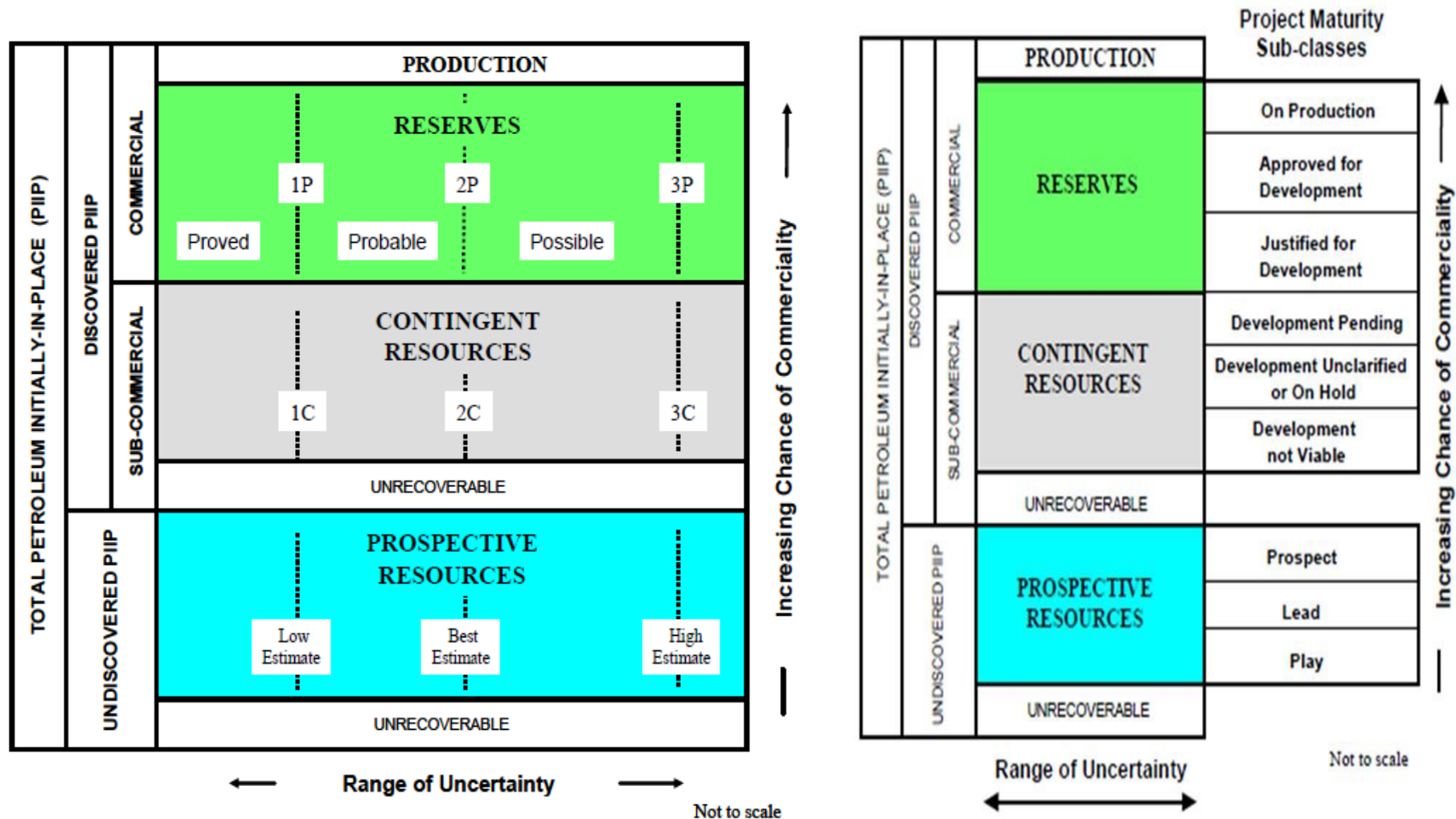
TABLE OF CONTENTS

1. General considerations
2. Resources, reserves
3. Conventional and Unconventional Gaseous Hydrocarbons
4. Production, consumption: past and present
5. Production, consumption: perspectives
6. A zoom on Liquefied Natural Gas (LNG)
7. Three independant world markets
8. The gas chain components and their economics: Production & Processing
9. The gas chain components and their economics: Transportation
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12. Competing fuels and Gas prices
13. Evolution of national gas markets towards liberalization & globalization
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Some definitions

Categories of petroleum Reserves and Resources (SPE)



Source: SPE 2011



**Evaluation of Reserves and Resources may
vary according to various sources**



Nota concerning BP publication

BP has terminated their publication of BP Statistical Review of World Energy in 2023.

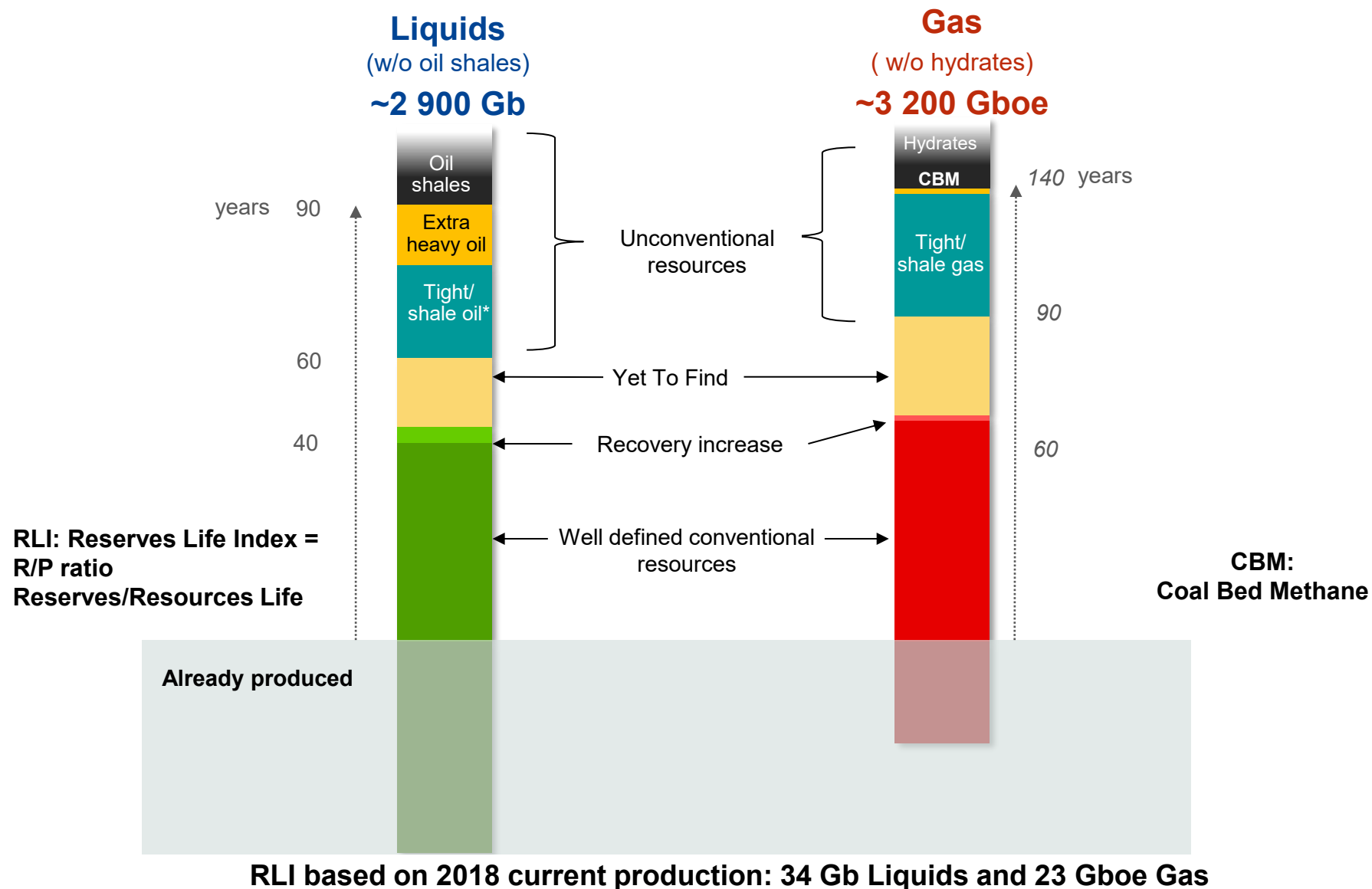
The publication has been handed over to Energy Institute (Aberdeen University membership)

In this publication, the evolution of World Hydrocarbons – Oil & Gas reserves is no longer published.

The last figures are those at 31/12/2020



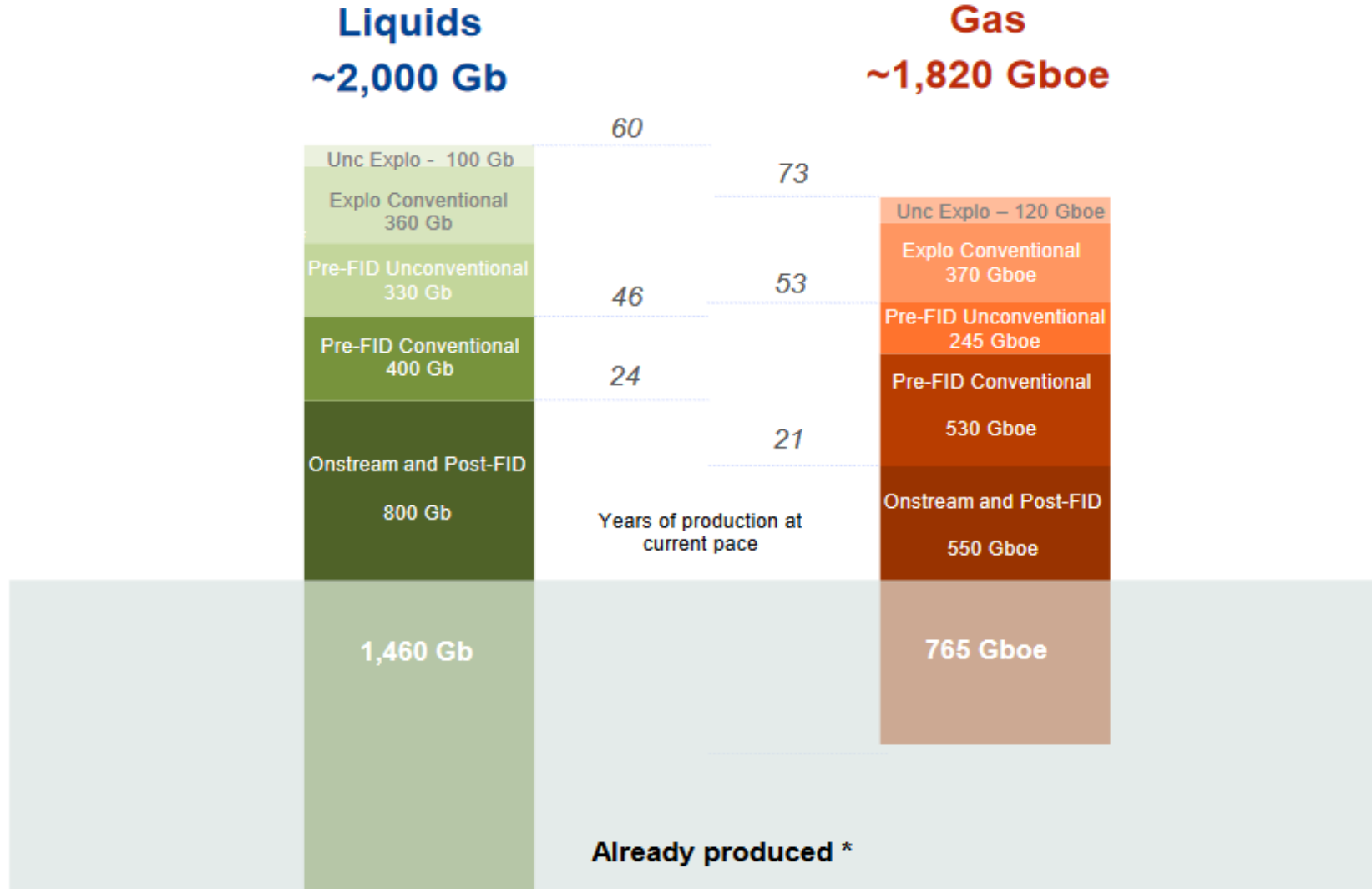
Reminder - World Oil & Gas Resources at 01/01/2019



Source: Total October 2019



World Oil & Gas Resources at 01/01/2023 by TTE – Different classification



Source: TotalEnergies E&P Data Book 2023

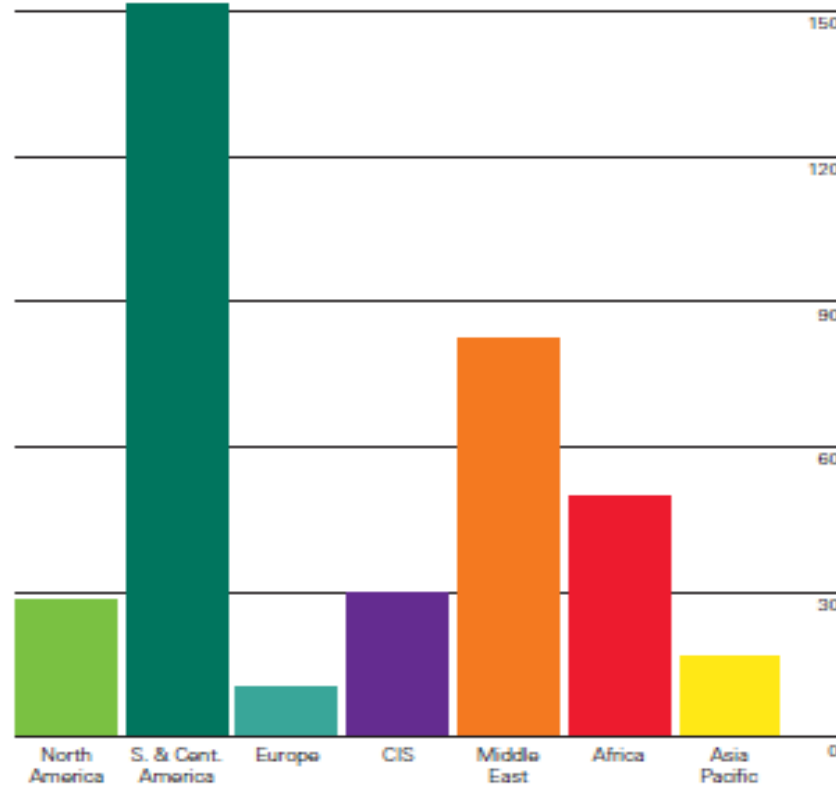


R/P (« Proved Reserves ») Ratios (BP Proved Reserves (1P) more in line with 2P)

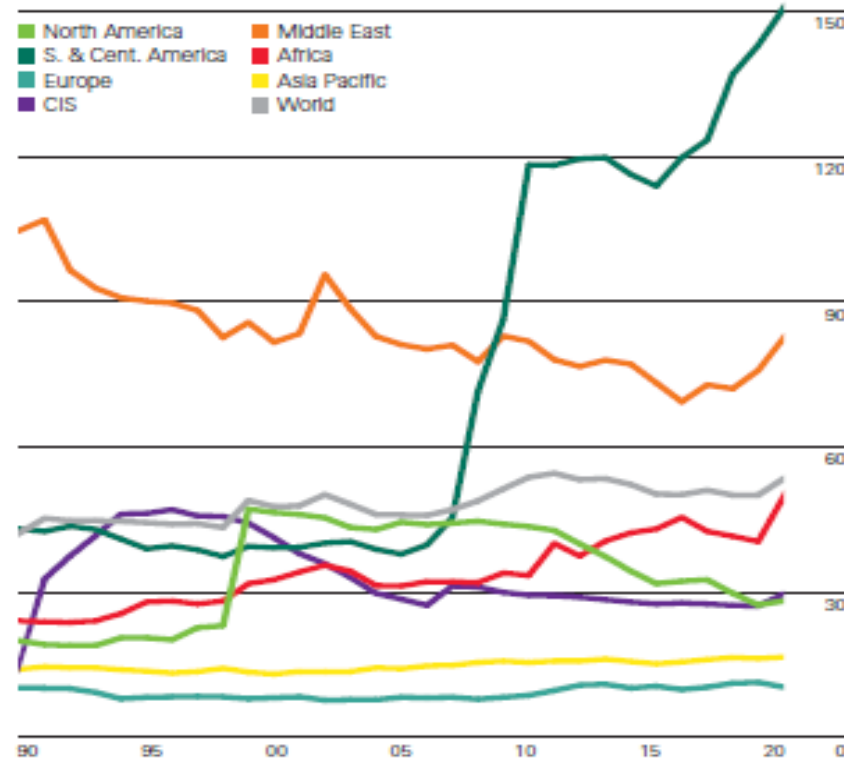
Gas R/P World # 50/70 years*

Reserves-to-production (R/P) ratios
Years

2020 by region



History



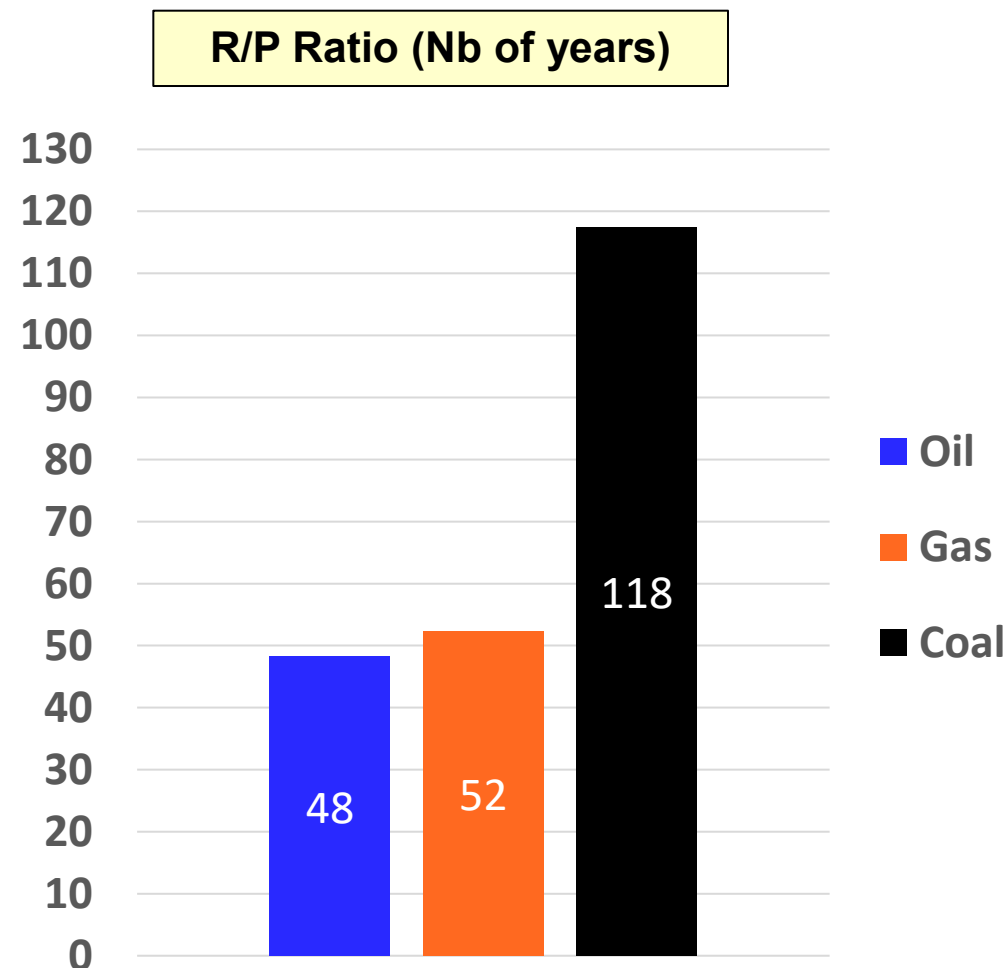
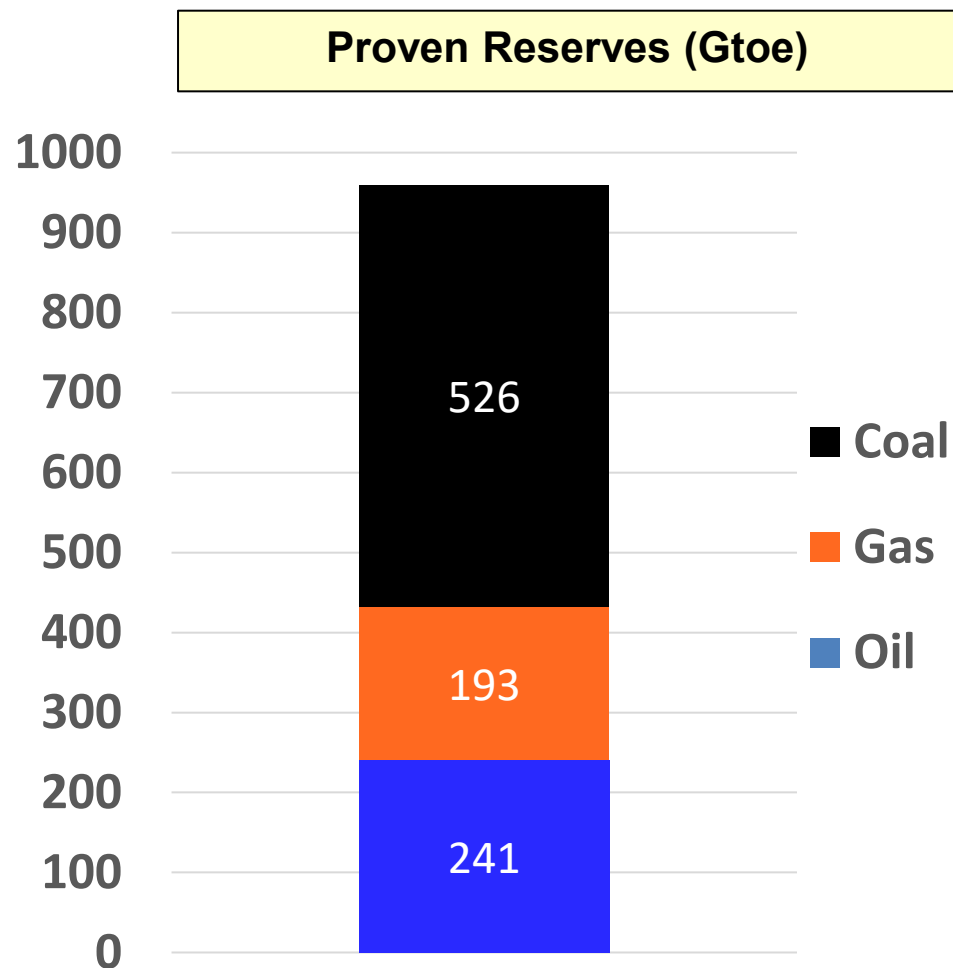
Global proved oil reserves were 1732 billion barrels at the end of 2020, down 2 billion barrels versus 2019. The global R/P ratio shows that oil reserves in 2020 accounted for over 50 years of current production. OPEC holds 70.2% of global reserves. The top countries in terms of reserves are Venezuela (17.5% of global reserves), closely followed by Saudi Arabia (17.2%) and Canada (9.7%).

Source: BP Statistical Review 2021
*R/P varies vs sources



Fossil Fuels – « Proven Reserves » end 2024

960 Gtoe # 7,0 Tboe (Drastic decrease in China Coal Reserves vs end 2016)



Source:: Data from IEA 2025



Conventional and Unconventional Gas Resources End 2024 (T.m3)

Natural gas (trillion cubic metres)	Proven reserves	Resources	Conventional gas	Tight gas	Shale gas	Coalbed methane
North America	19	143	49	9	78	7
Central and South America	9	84	28	15	41	-
Europe	5	45	18	5	18	5
Africa	19	100	50	10	40	0
Middle East	84	119	99	9	11	-
Eurasia	69	165	127	11	10	17
Asia Pacific	19	136	42	21	53	20
World	224	792	413	80	250	49

Notes: NGLs = natural gas liquids; EHOB = extra-heavy oil and bitumen. The breakdown of coal resources by type is an IEA estimate. Coal world resources exclude Antarctica.

Sources: BGR (2024); CEDIGAZ (2025); Energy Institute (2024); OGI (2024); US EIA (2025); USGS (2012a and 2012b); IEA databases and analysis.



Conventional and Unconventional Gas Resources End 2024 (T.m³)

IEA WEO 2025:

Remaining Recoverable Resources end 2023:

Conventional : 413 T.m³ # 14 600 Tcf

Tight Gas : 80 T.m³

Shale Gas : 250 T.m³

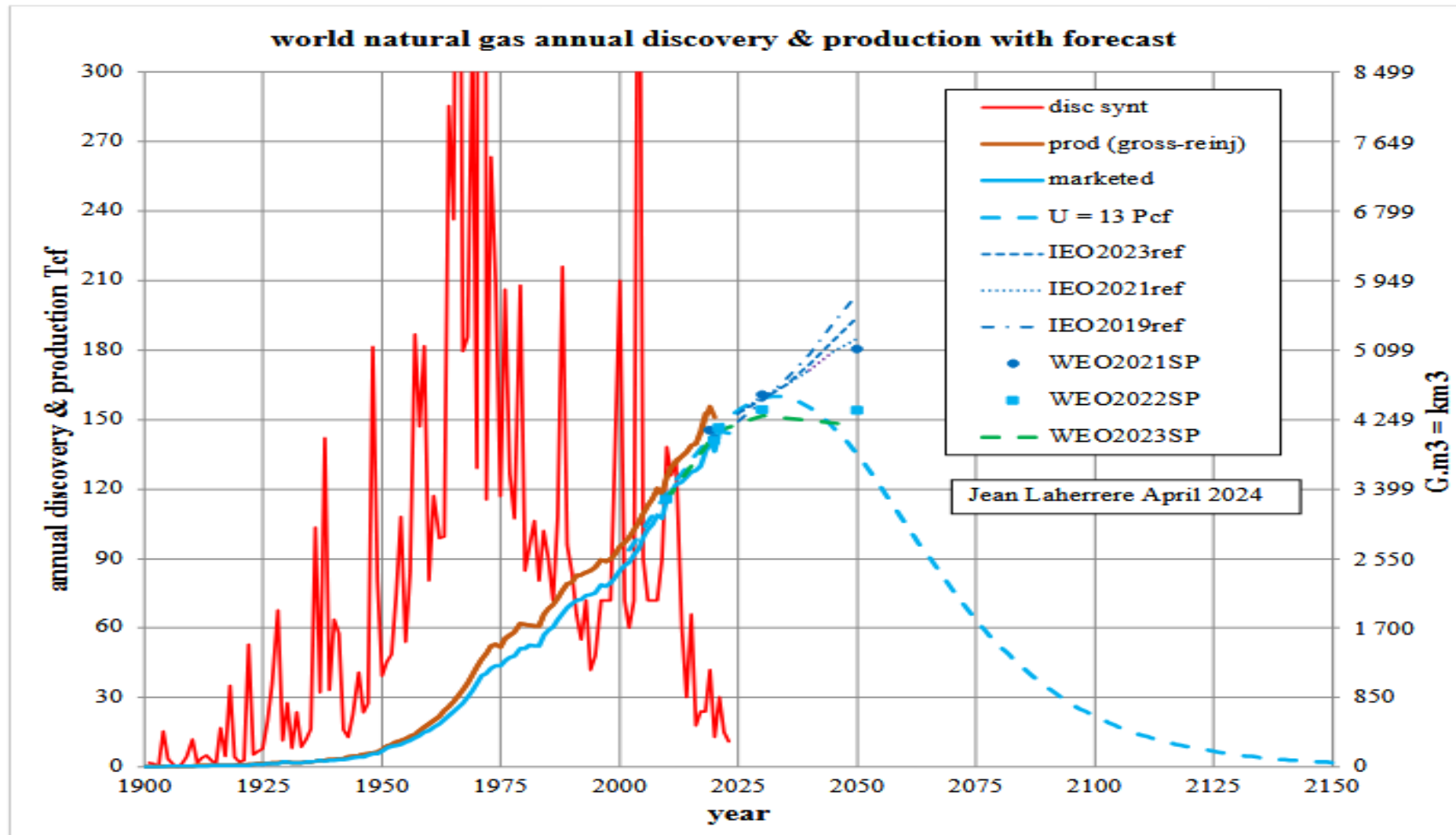
CBM : 49 T.m³

Unconventional : 379 T.m³ # 13 400 Tcf

Total # 792 T.m³ # 28 000 Tcf



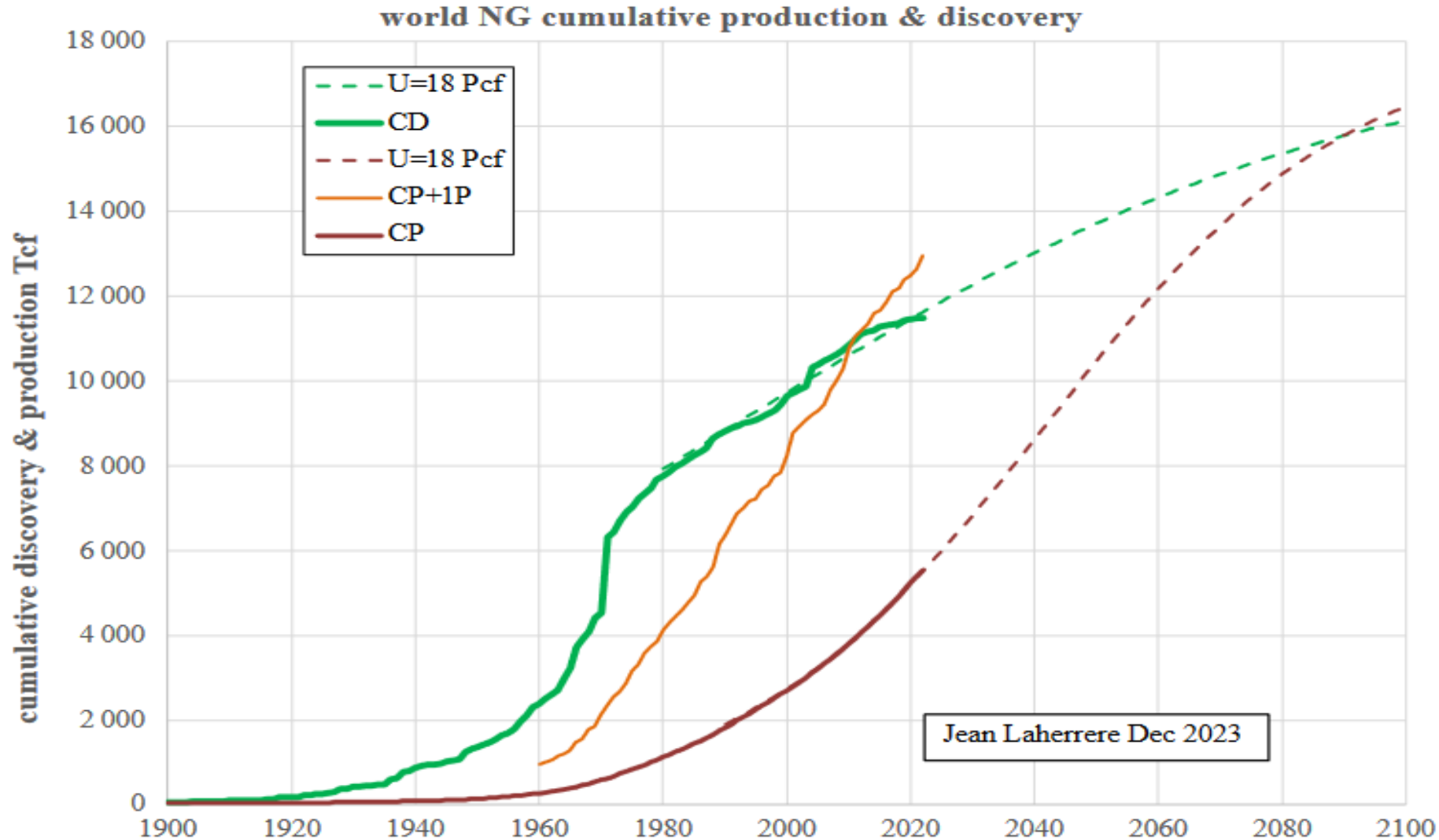
World Gas Discoveries and Production Perspectives



Source: Jean Laherrère April 2024



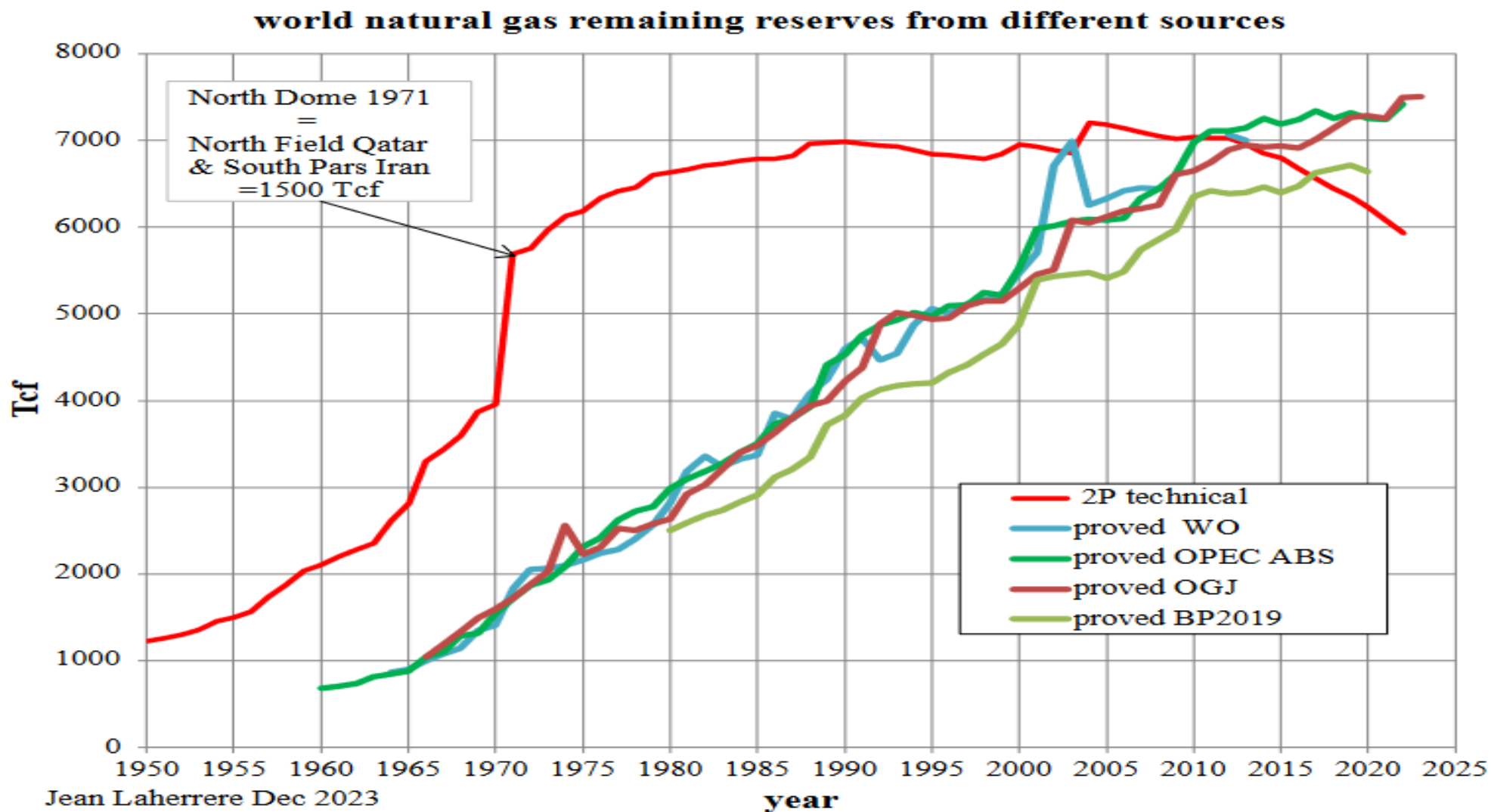
World Gas Discoveries and Production Perspectives



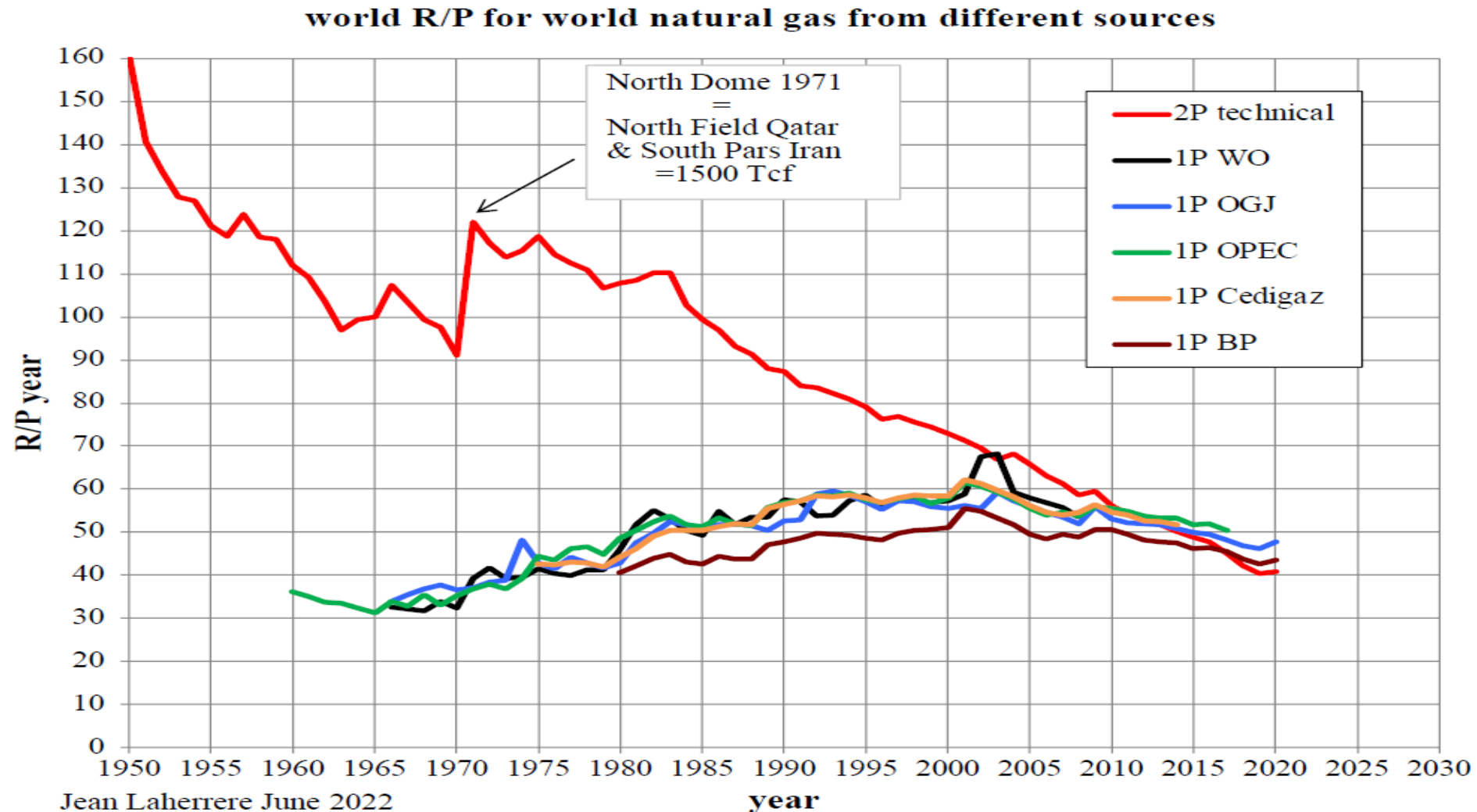
Source: Jean Laherrère December 2023



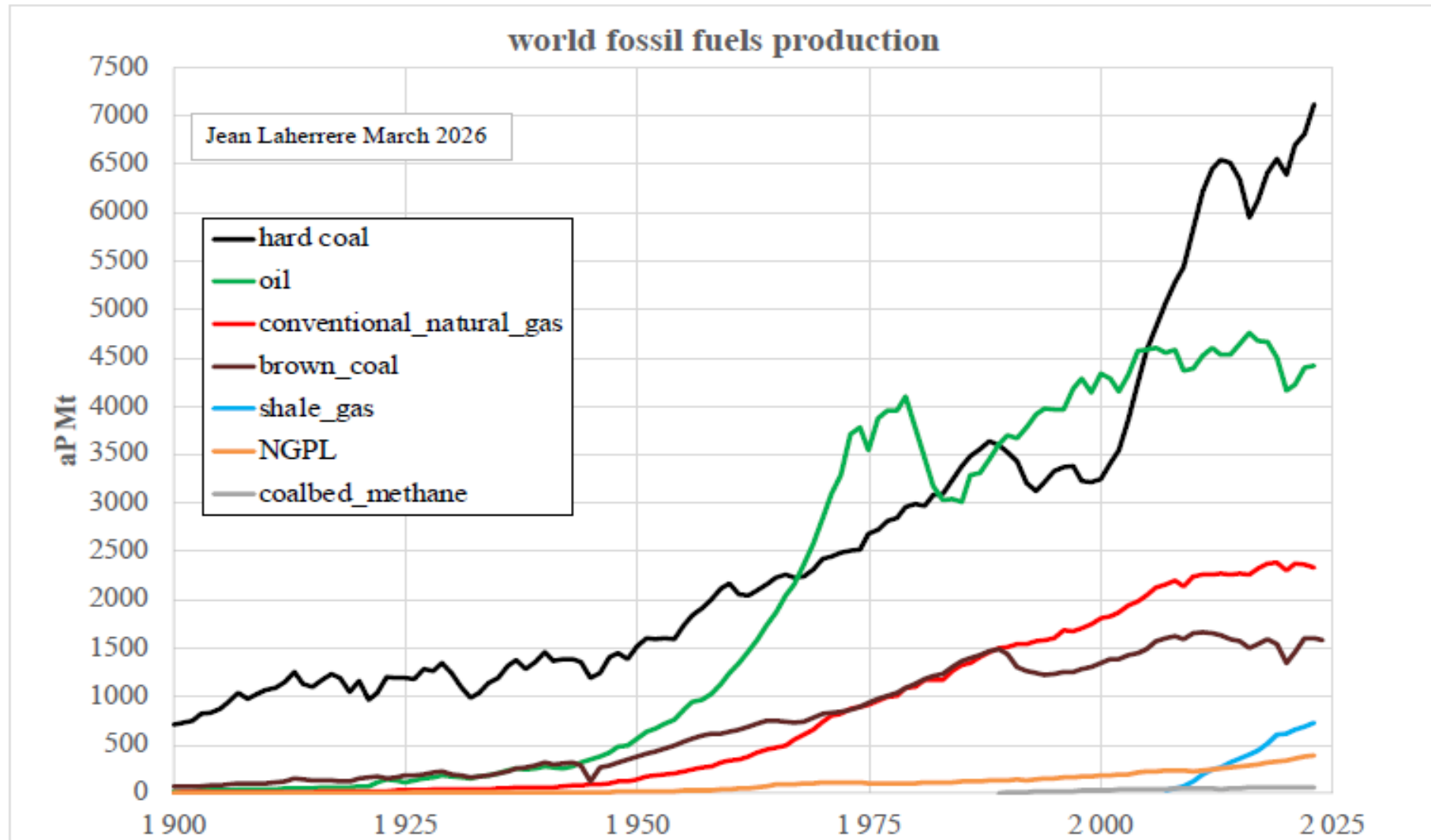
Proved Reserves (1P) and 2P Reserves



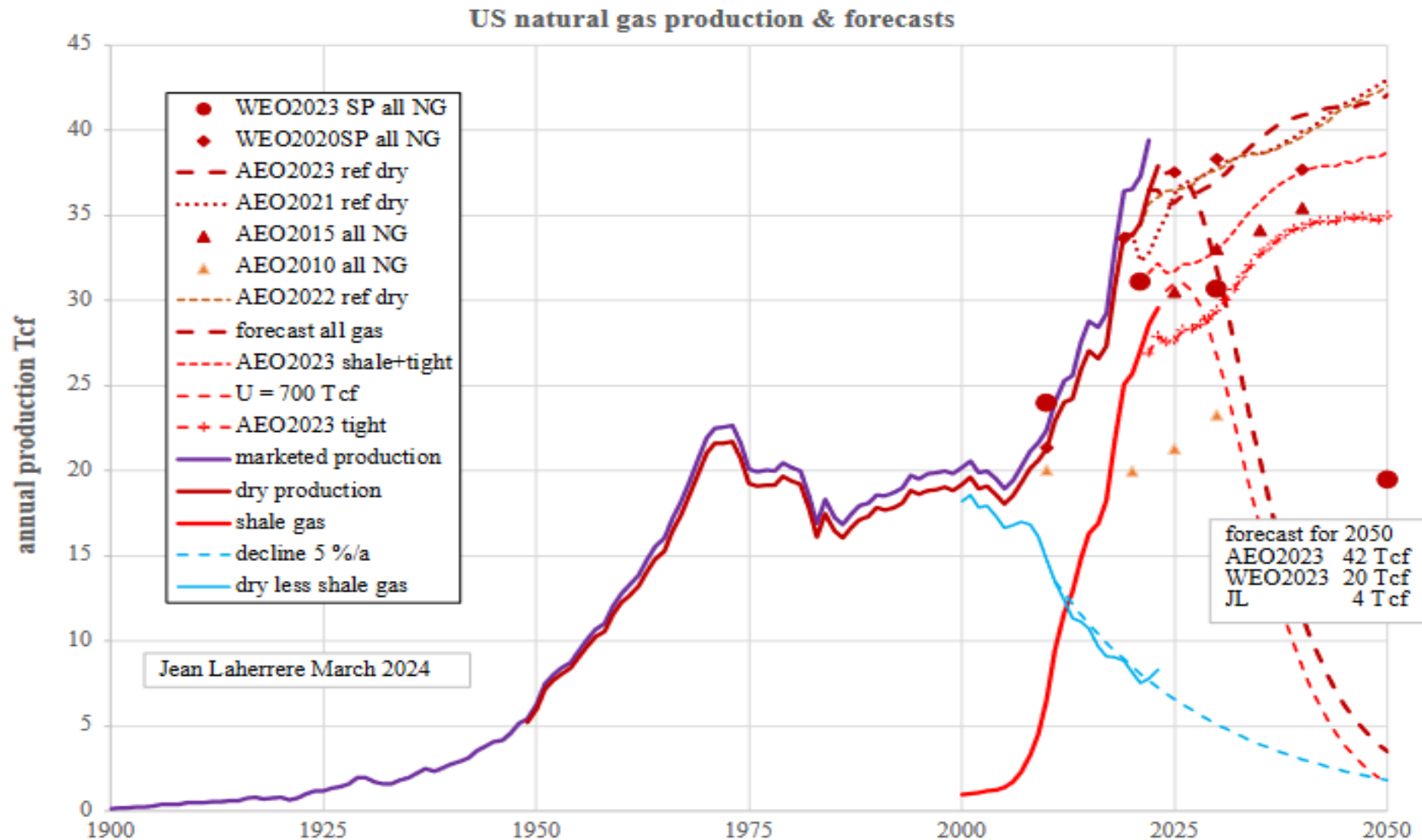
R/P Ratio: Proved Reserves and 2P Reserves



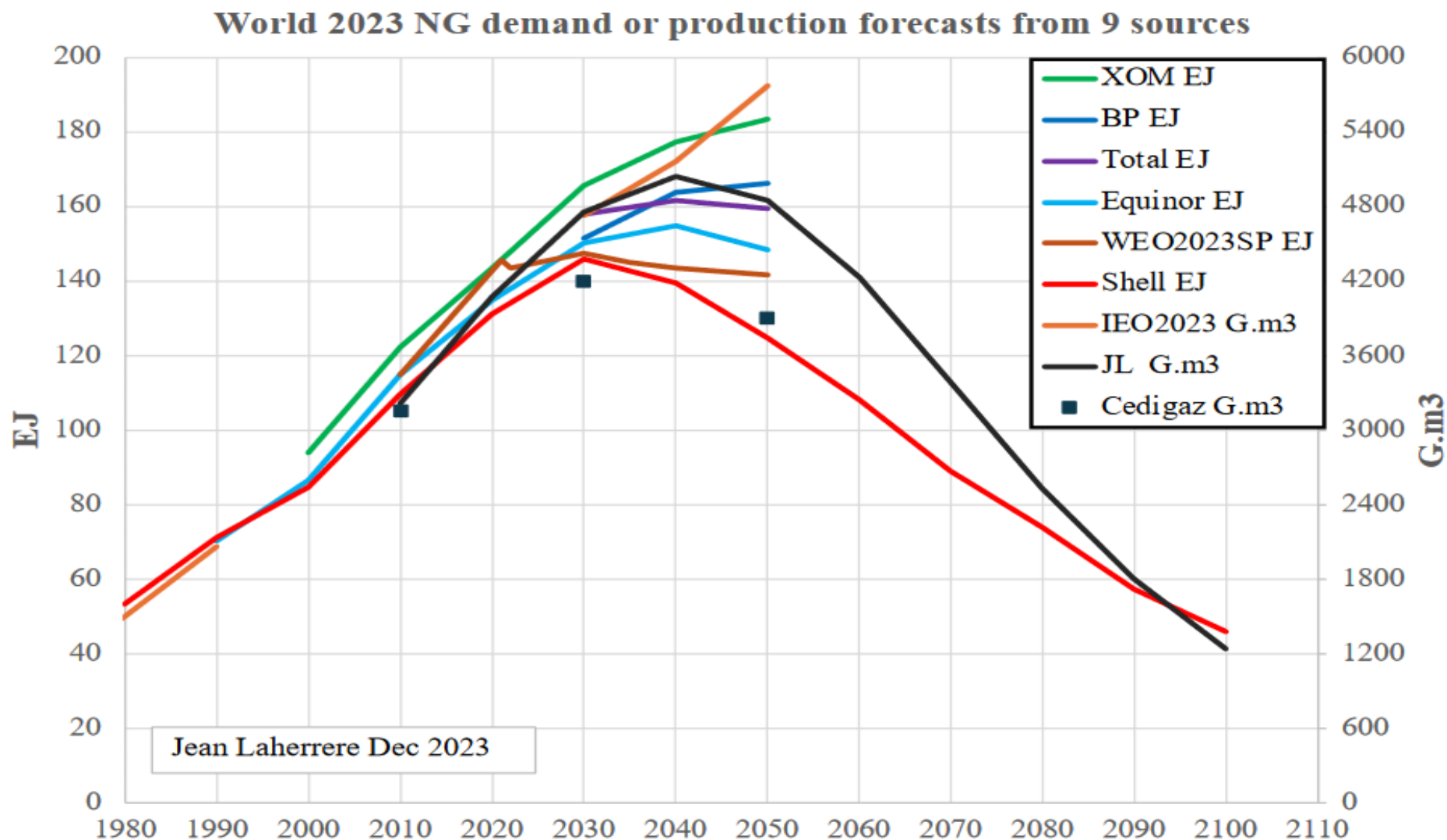
World Fossil Fuels & Gas Production (Mt)



World Gas Production & Forecasts

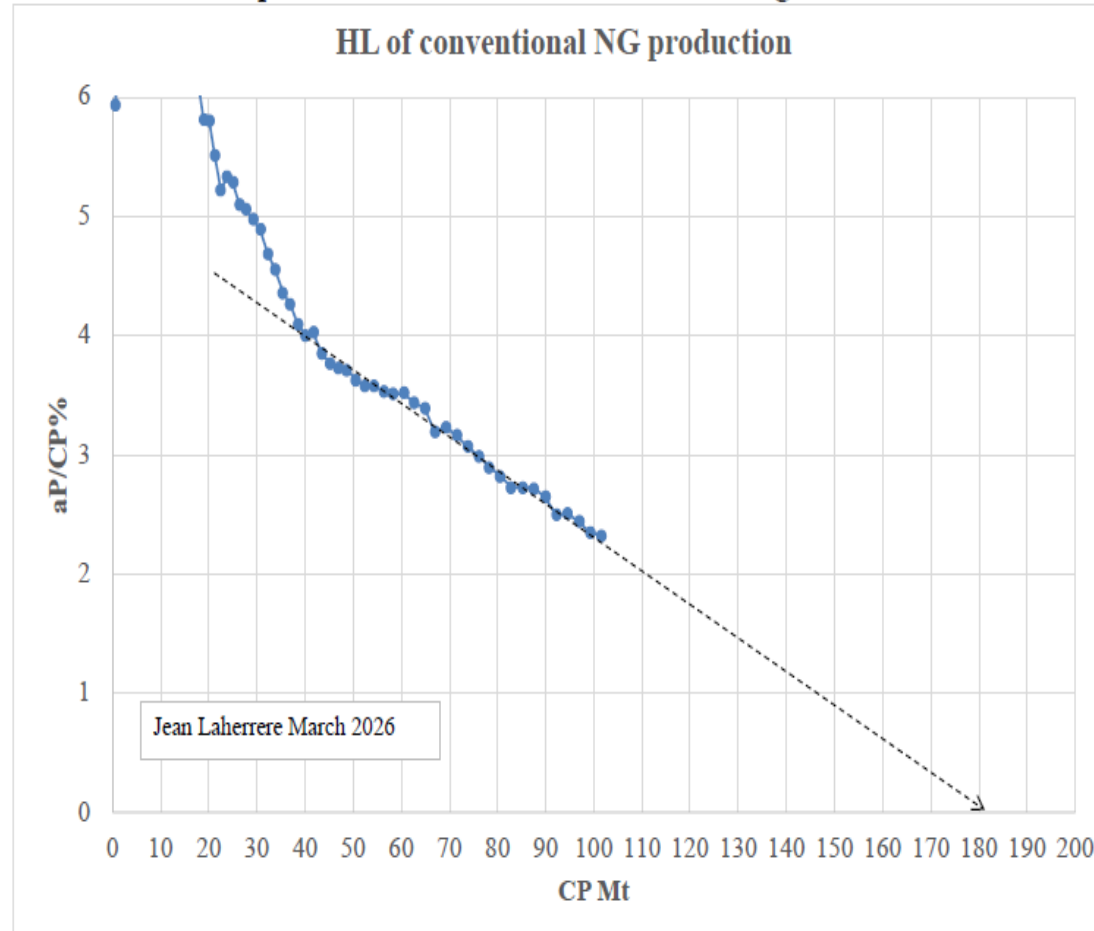


World Gas Production & Forecasts

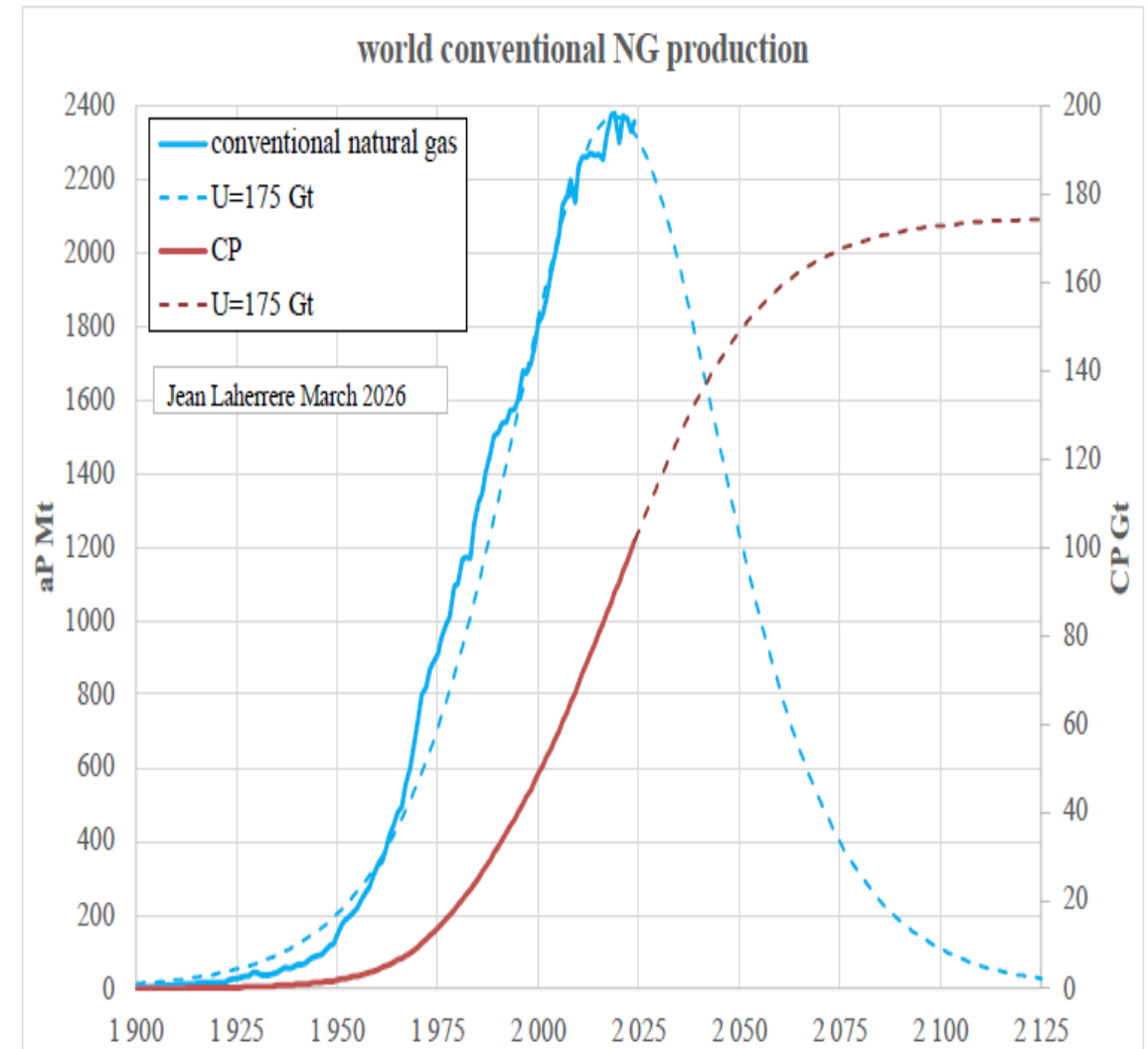


World Conventional Gas Production – HL & Annual Production & Forecasts

HL of conventional NG production is linear since 2000 trending toward 180 GT

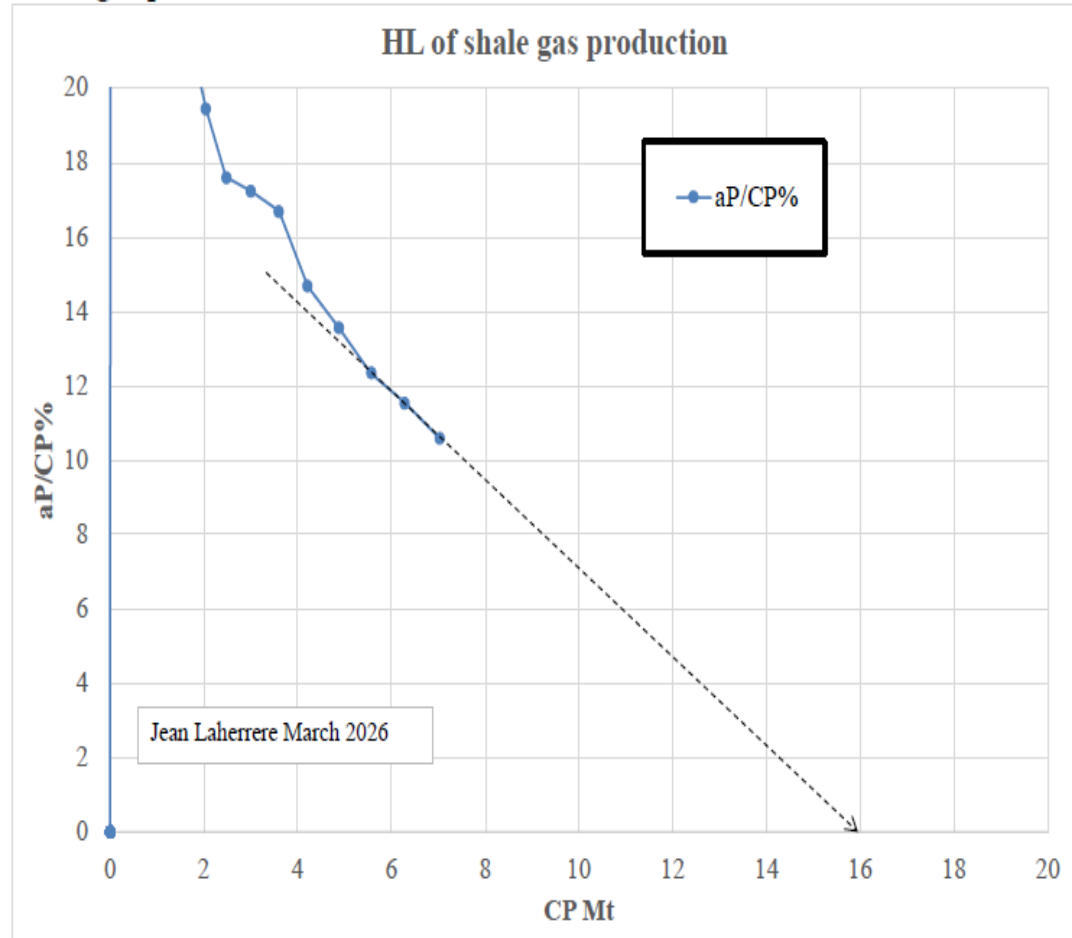


For 180 Gt ultimate conventional NG production is presently peaking (in fact 2019)

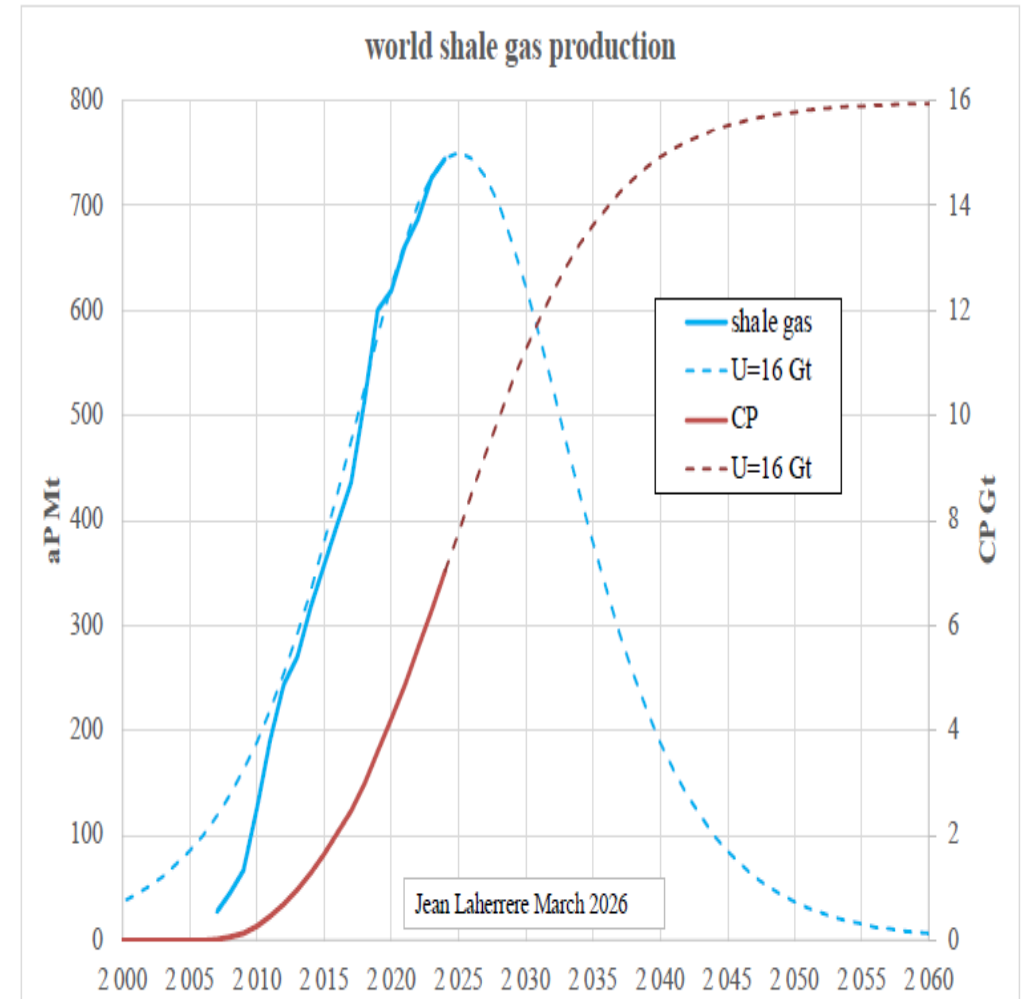


World Shale Gas Production – HL & Annual Production & Forecasts

HL of shale gas production trends towards 16 GT



For a 16 Gt ultimate, shale gas production is about peaking!

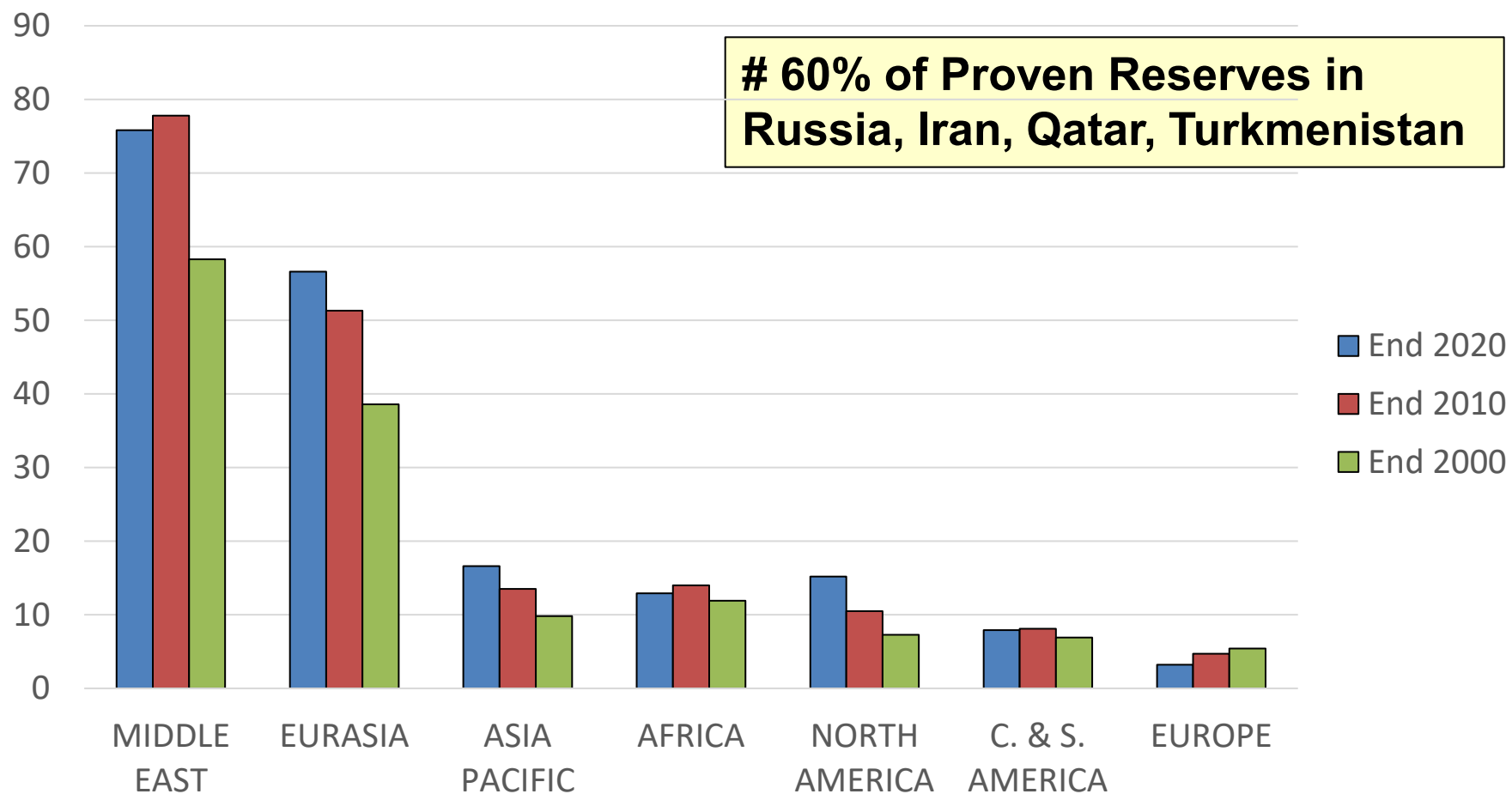


In 2040, shale gas production would be about 2010 production



World Proven Gas Reserves – Regional shares Evolution 2020/2010/2000

Proven Gas Reserves at end 2020 # 188 T.m3 # 6 600 Tcf

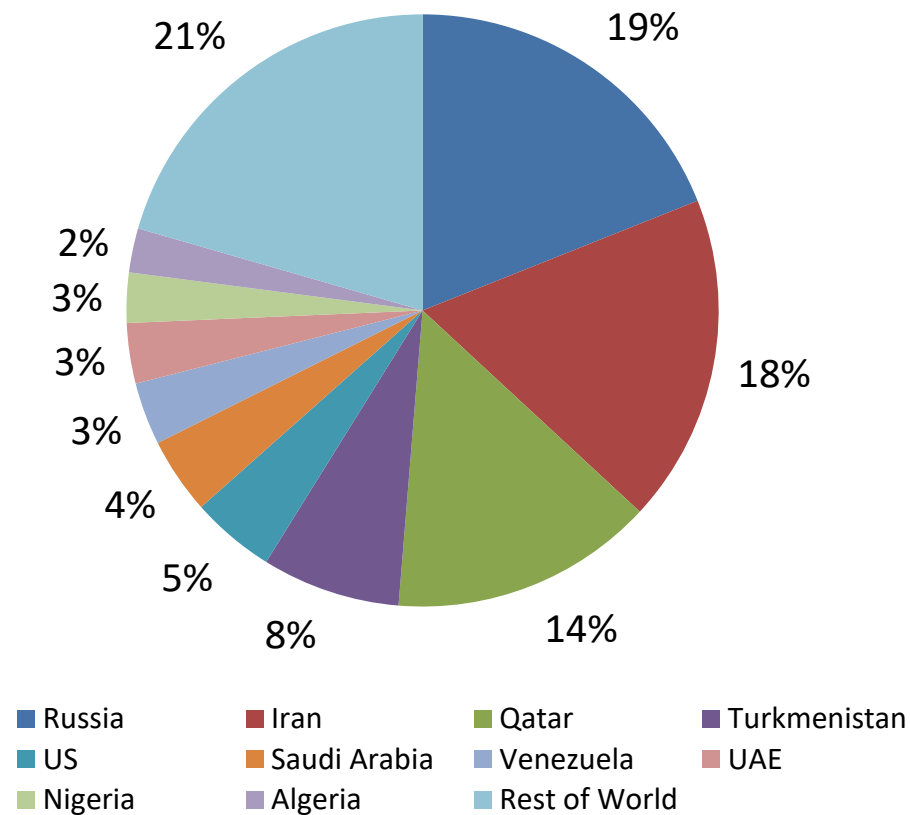


Source: Data from BP Statistical Review 2022

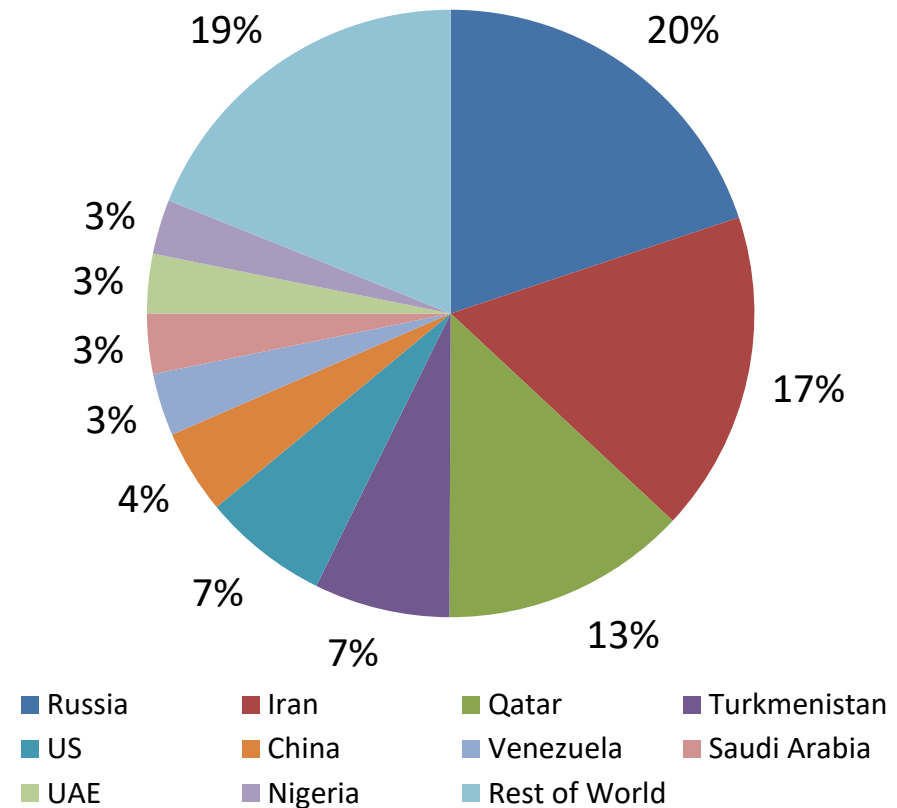


World Gas Proven Reserves 2010 - 2020

At end 2010:
180 Trillion m³



At end 2020:
188 Trillion m³

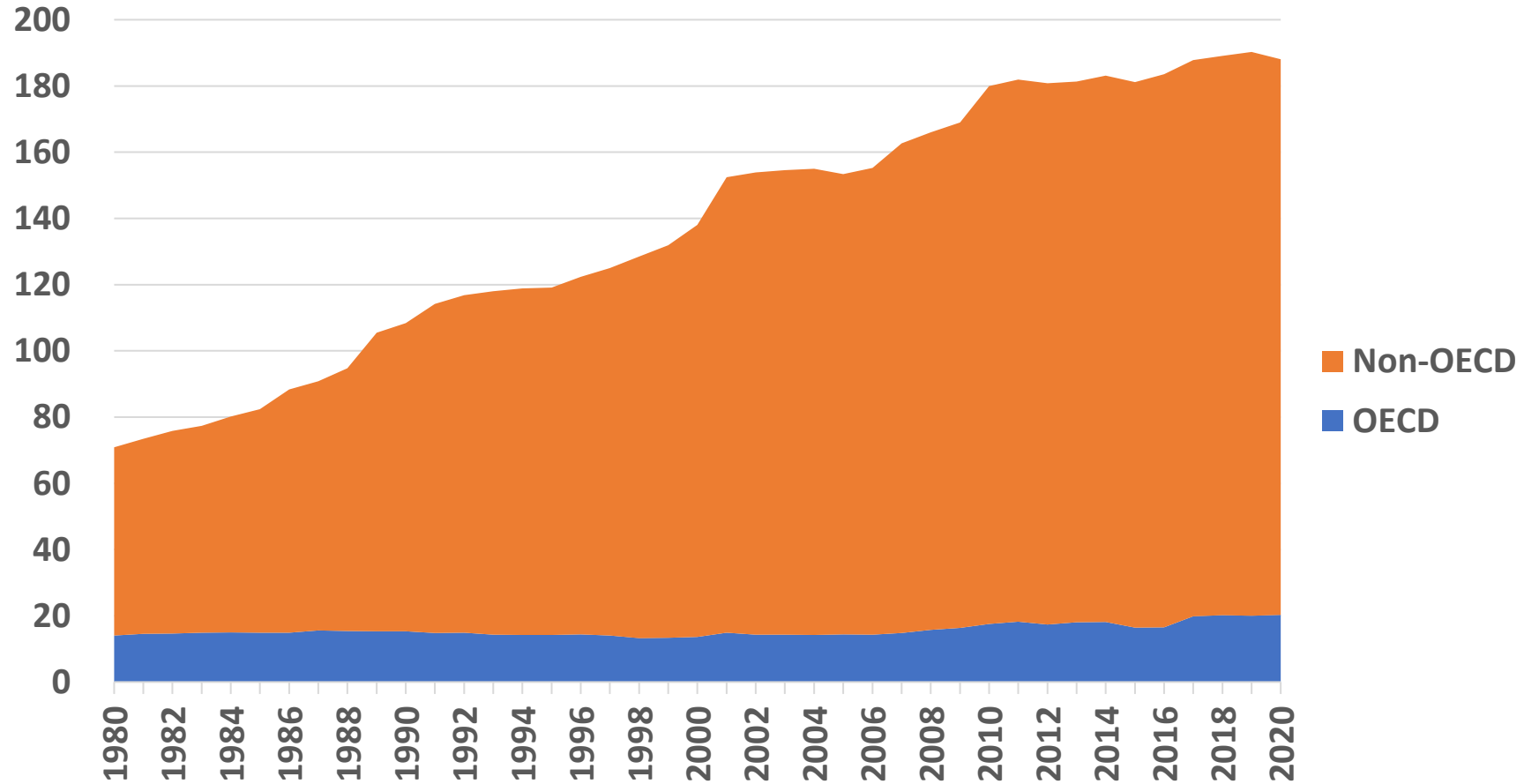


Source: Data from BP Statistical Review 2022



History of World Gas Proven Reserves 1980 - 2020

(T.m3)

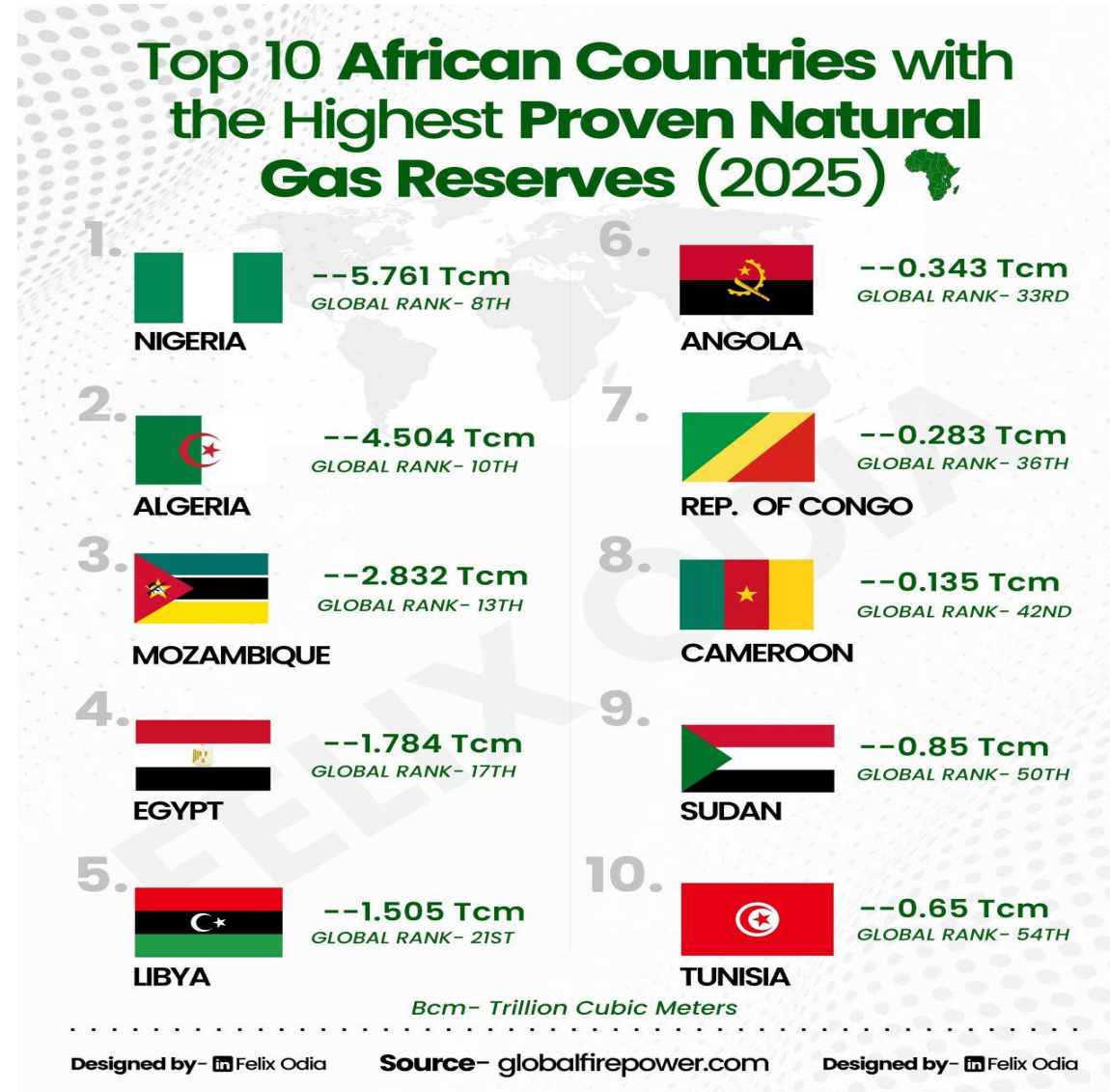


Source: Data from BP Statistical Review 2022



Africa – 10 top countries for Gas Proven Reserves

(T.m3)



3

Conventional and Unconventional Gaseous Hydrocarbons (See also Book 6)

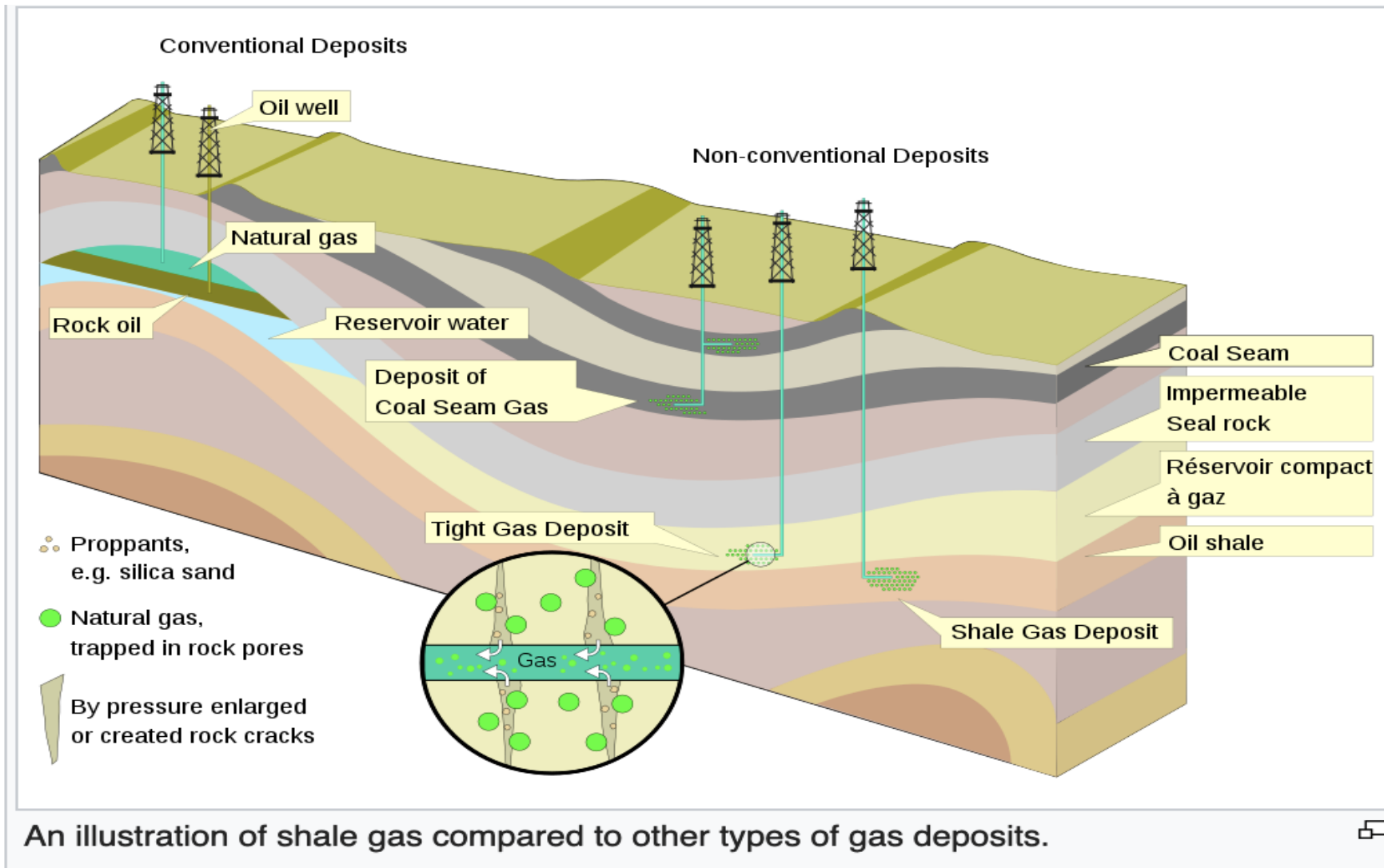


TABLE OF CONTENTS

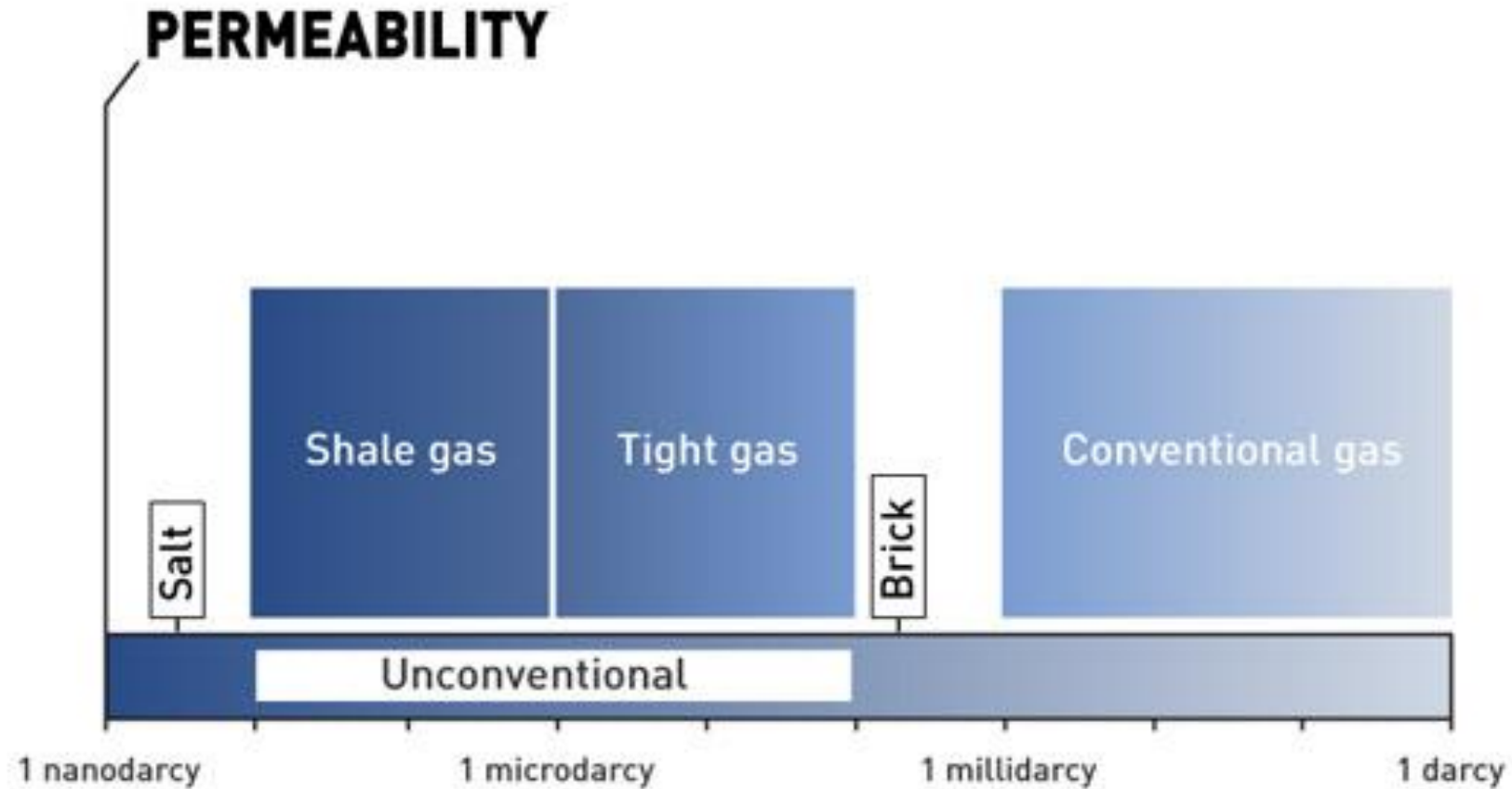
1. General considerations
2. Resources, reserves
3. Conventional and Unconventional Gaseous Hydrocarbons
4. Production, consumption: past and present
5. Production, consumption: perspectives
6. A zoom on Liquefied Natural Gas (LNG)
7. Three independant world markets
8. The gas chain components and their economics: Production & Processing
9. The gas chain components and their economics: Transportation
10. The gas chain components and their economics: Storage
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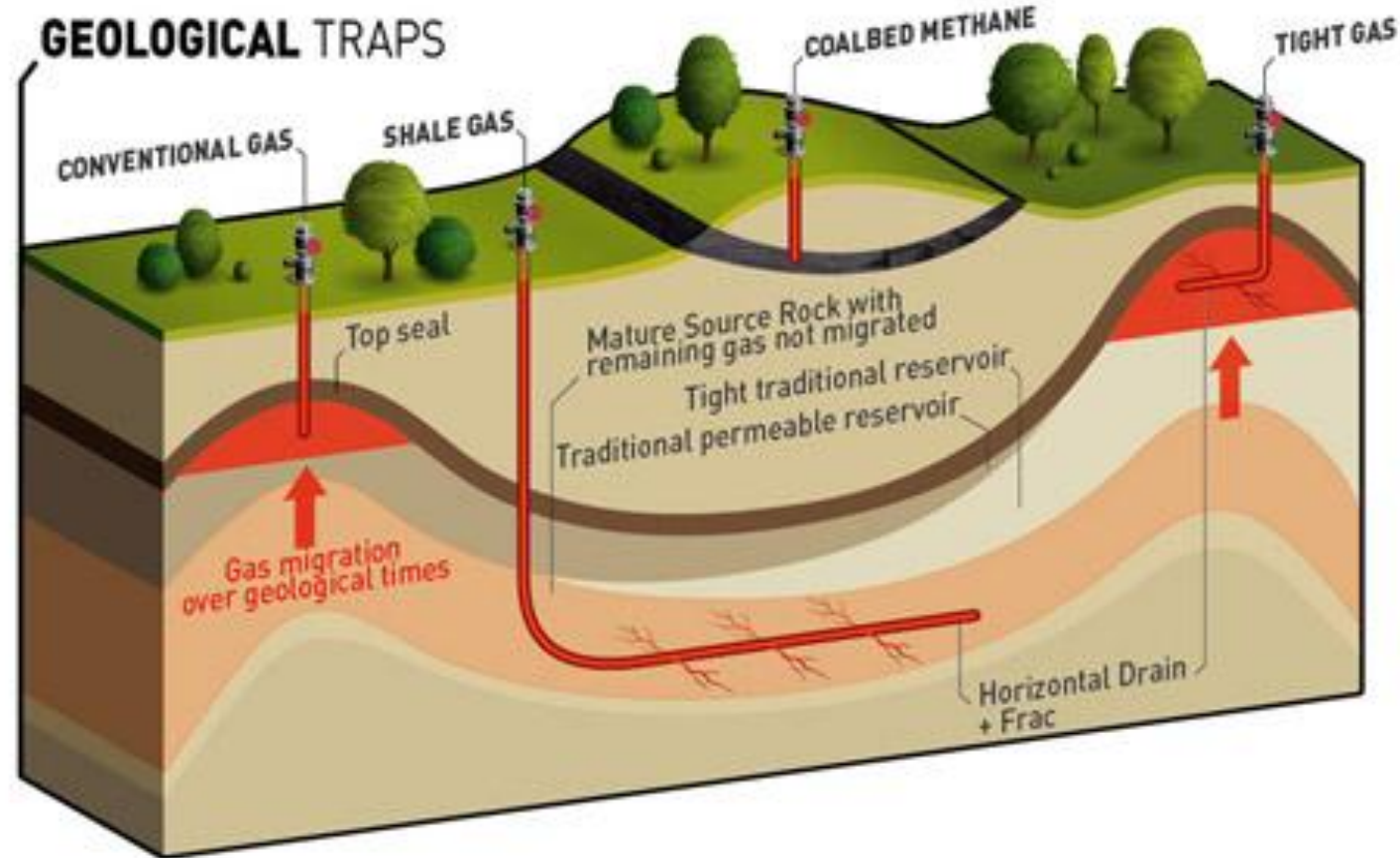
Conventional & Unconventional Hydrocarbons



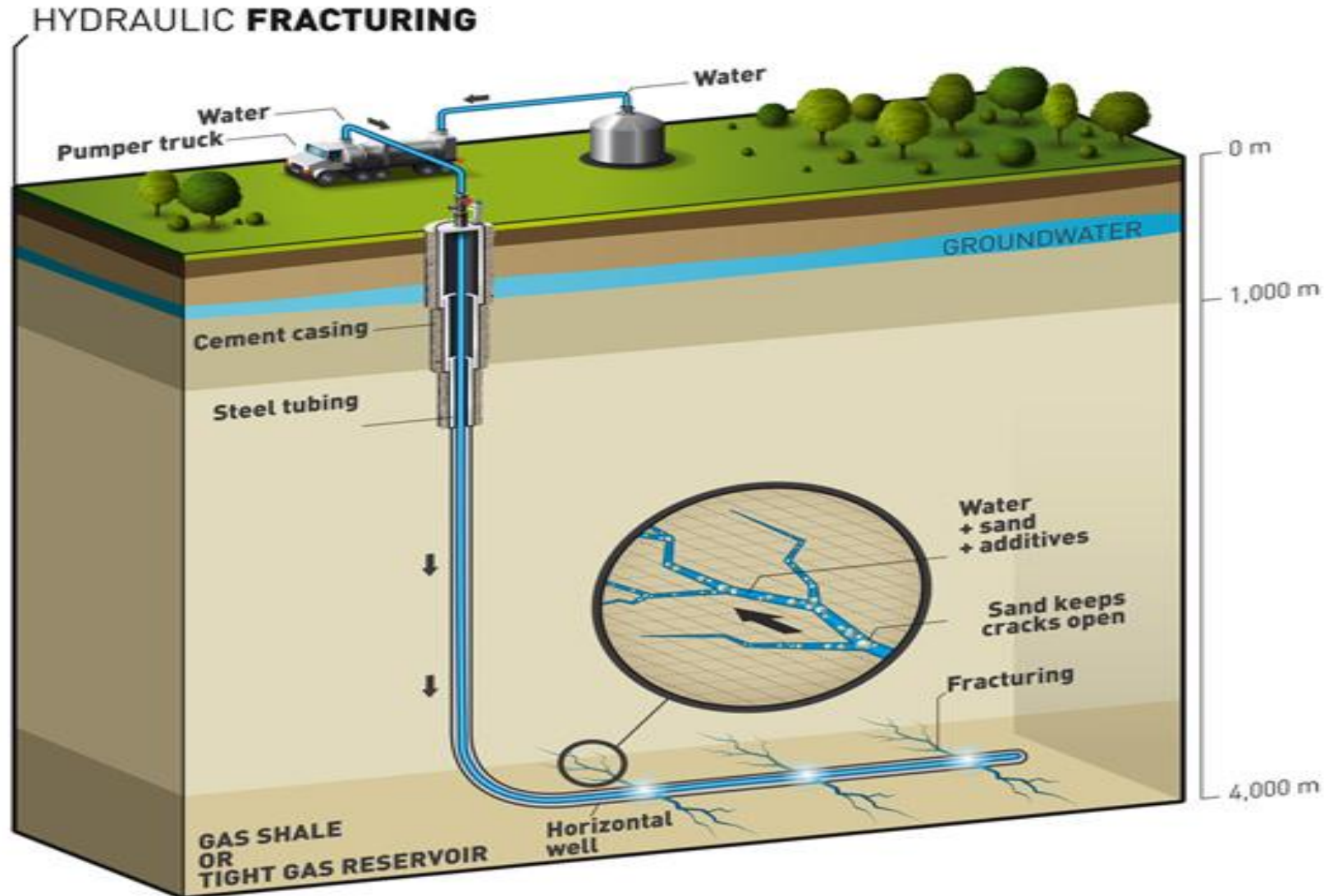
Conventional & Unconventional Gas



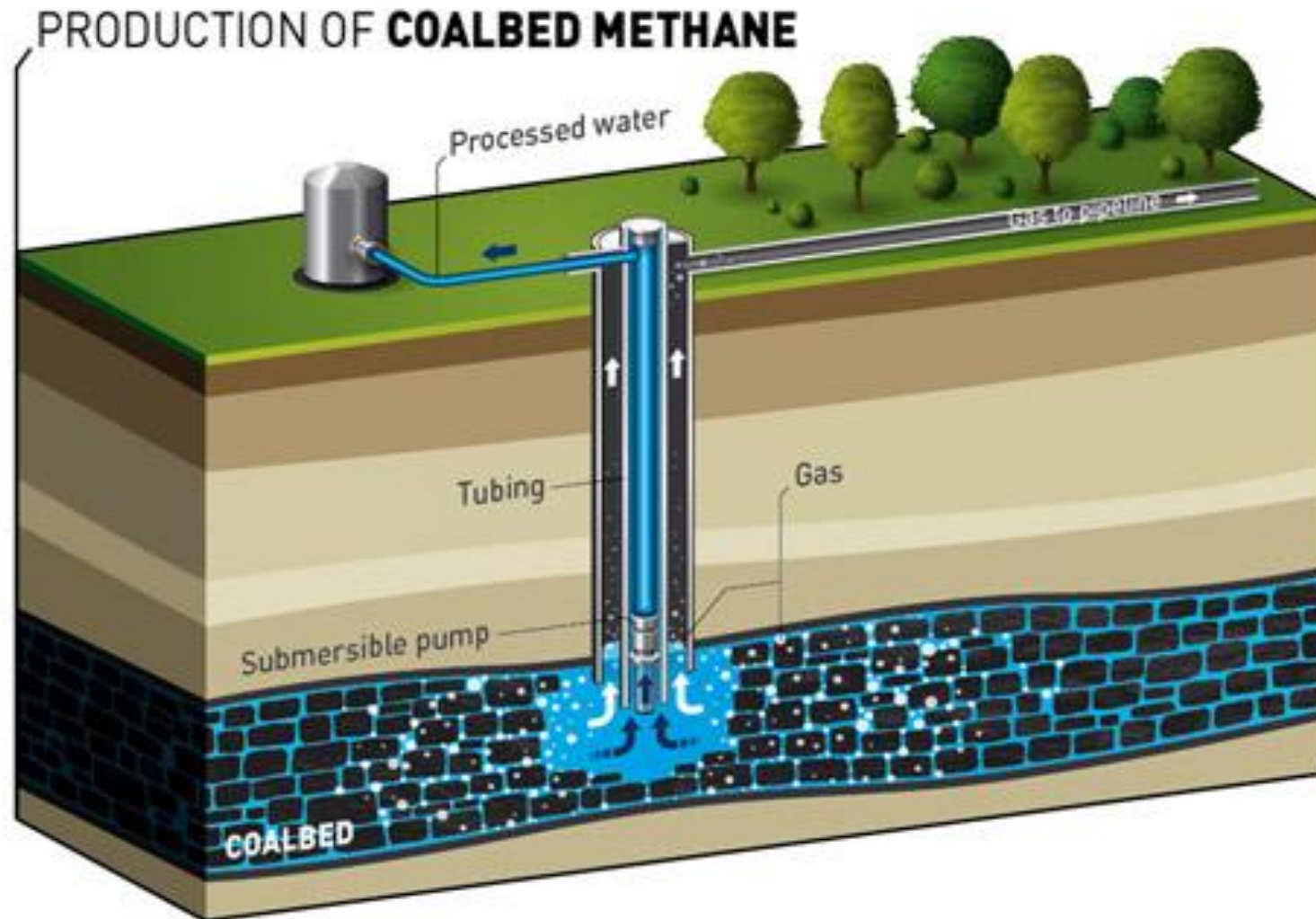
Conventional & Unconventional Gas



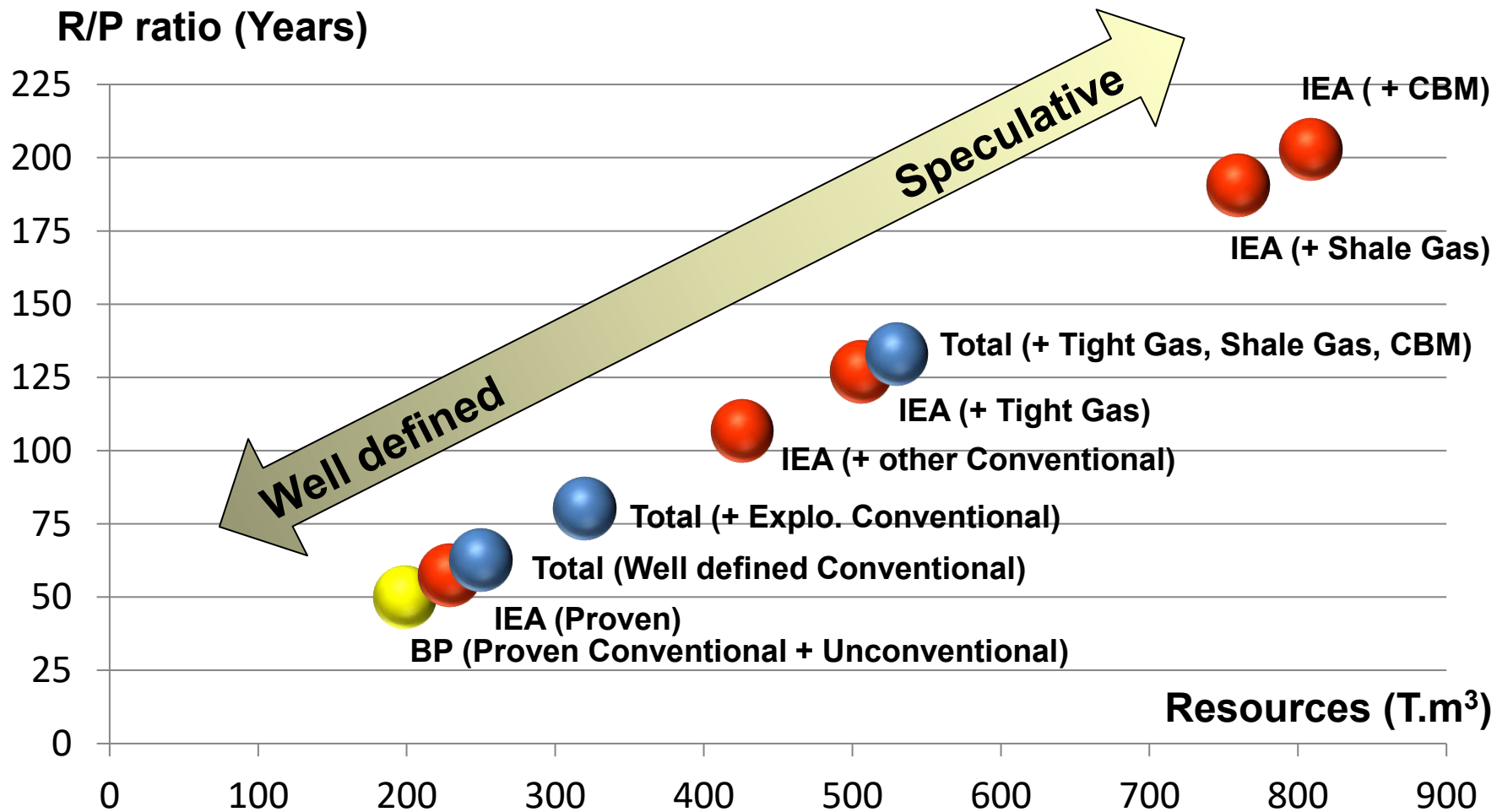
Hydraulic Fracturing



Unconventional Gas: Coalbed Methane



Reconciliation of Gas Resources Estimates at end 2019 – T.m³ & Number of Years



4

Production, consumption: past and present



TABLE OF CONTENTS

1. General considerations
2. Resources, reserves
3. Conventional and Unconventional Gaseous Hydrocarbons
4. Production, consumption: past and present
5. Production, consumption: perspectives
6. A zoom on Liquefied Natural Gas (LNG)
7. Three independant world markets
8. The gas chain components and their economics: Production & Processing
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Gas Production: from Gross to Net

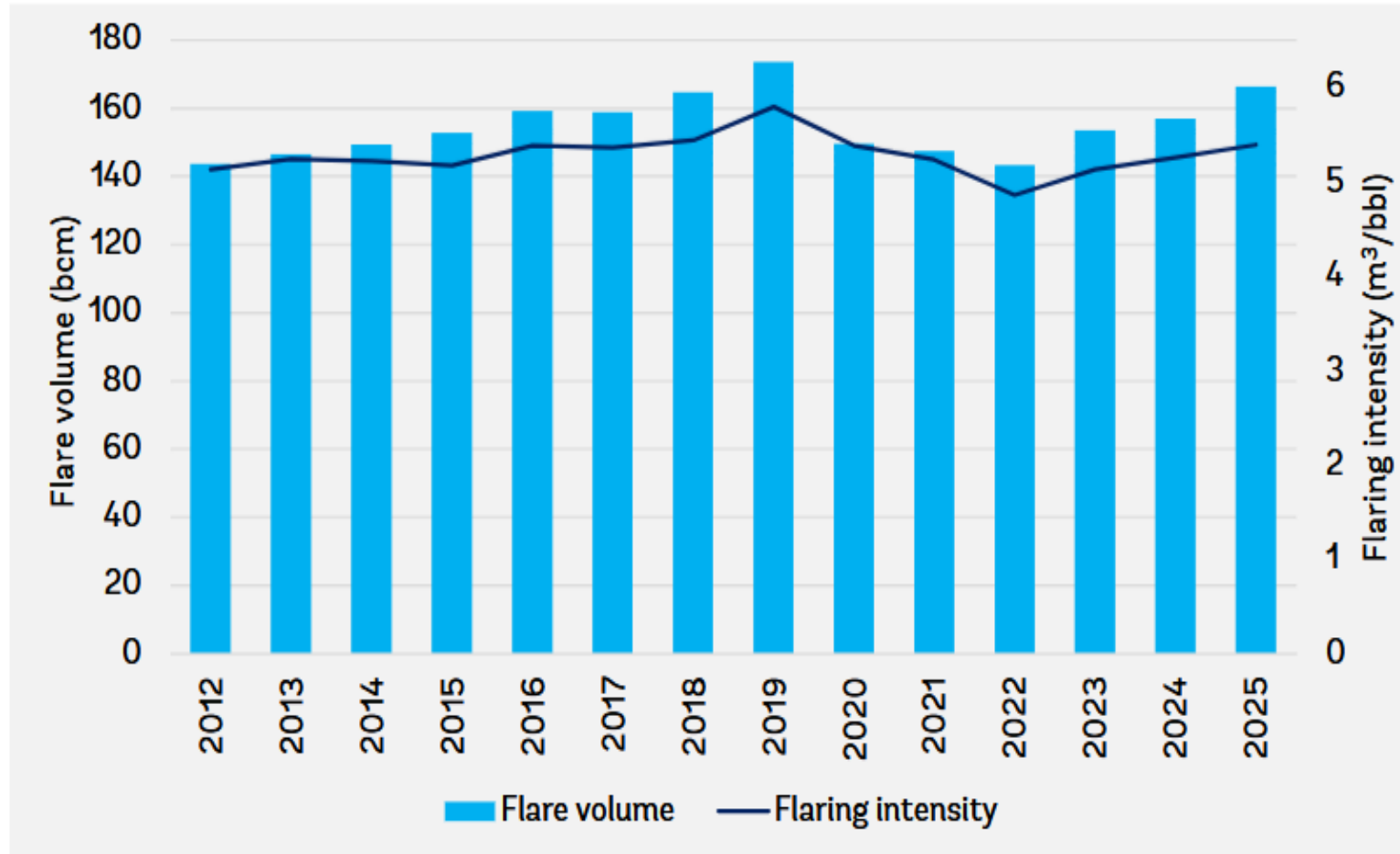
- ◆ Gross (ex-well) Production is usually not provided by statistics
- ◆ Associated Gas = about 20% of Gas Production (# 810 Bcm)
- ◆ Net (Marketed) Production = Gross Production minus
 - ◆ Reinjected gas = 9% (mostly US & Algeria)
 - ◆ Gas flaring & venting = 3% (mostly Russia, Iran, Irak)
 - ◆ Shrinkage, fuel gas, and other losses = 7%

=> Net Gas Production = 81% of Gross Gas Production



Gas Flaring – Total World: 167 G.m³ in 2025, + 16% vs 2012

Russia n°1, Iran n°2



Source: NOAA, Payne Institute and Colorado School of Mines, US Energy Information Administration (EIA), and World Bank Group.

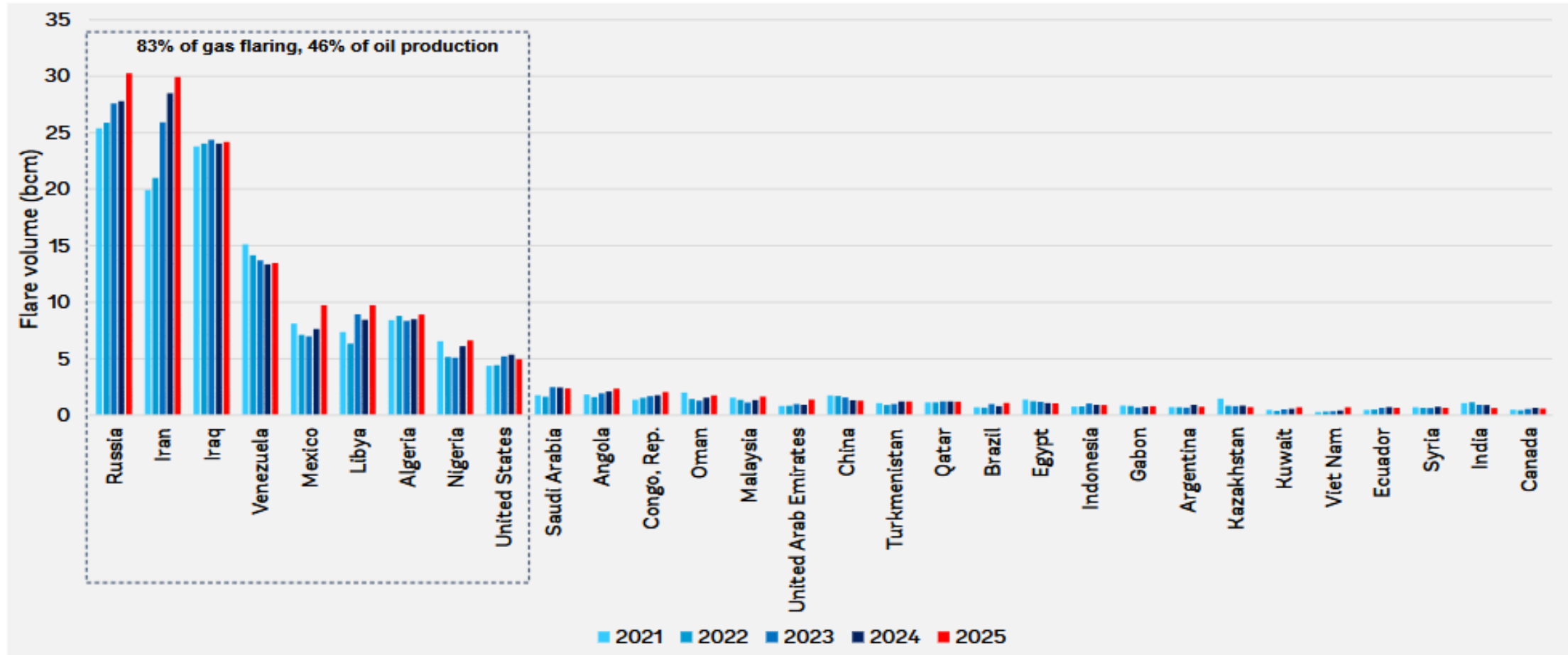


Source: Global Gas Flaring Tracker Report July 2026
Global Flaring and Methane Reductions Partnership & World Bank



Gas Flaring – Total World: 167 G.m³ in 2025, + 16% vs 2012

Russia n°1, Iran n°2



Source: NOAA, Payne Institute and Colorado School of Mines, and World Bank.

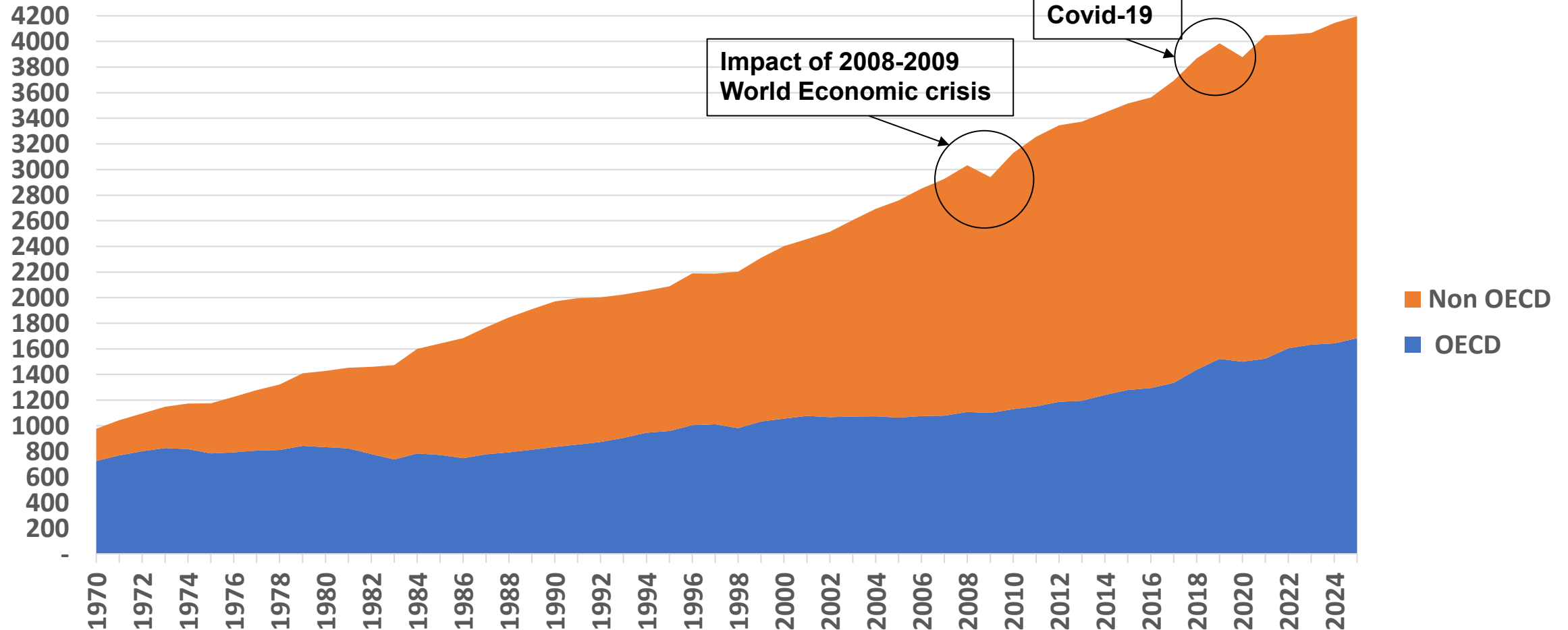
Source: Global Gas Flaring Tracker Report July 2026
Global Flaring and Methane Reductions Partnership & World Bank



History of Gas Production 1970-2025

Gas Consumption & Production will grow fast

(G.m3)



Source: Data from EI Statistical Review 2026

Excludes Natural Gas converted to liquid fuels. Includes derivatives of coal and Natural Gas consumed in GTL transformation



World Gas Production 2015 - 2025

2015

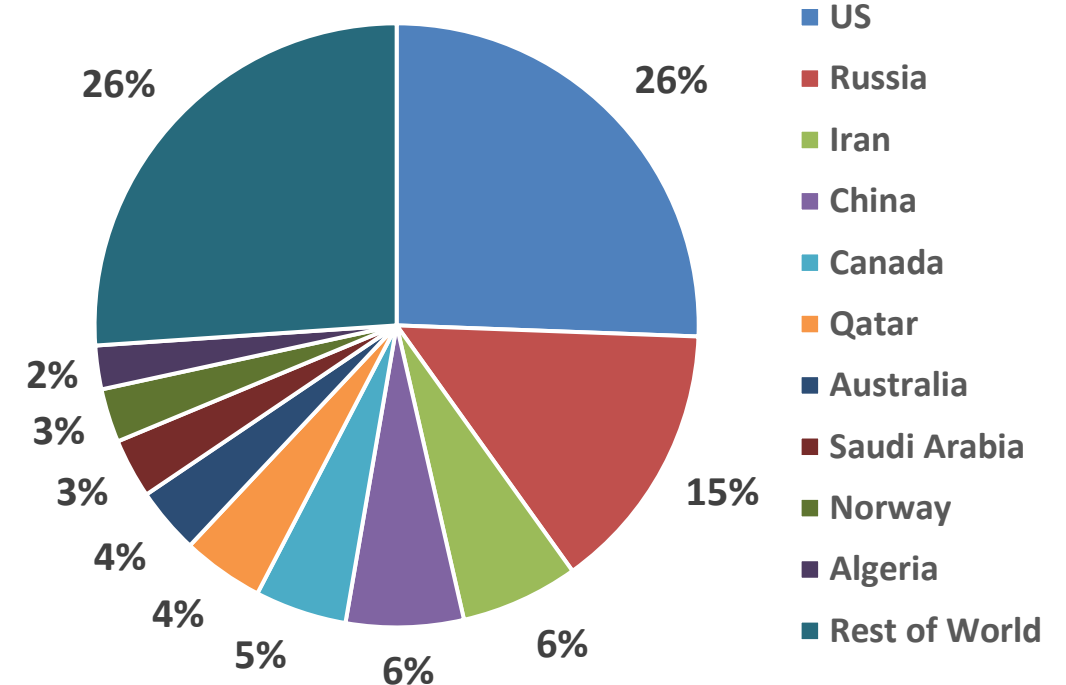
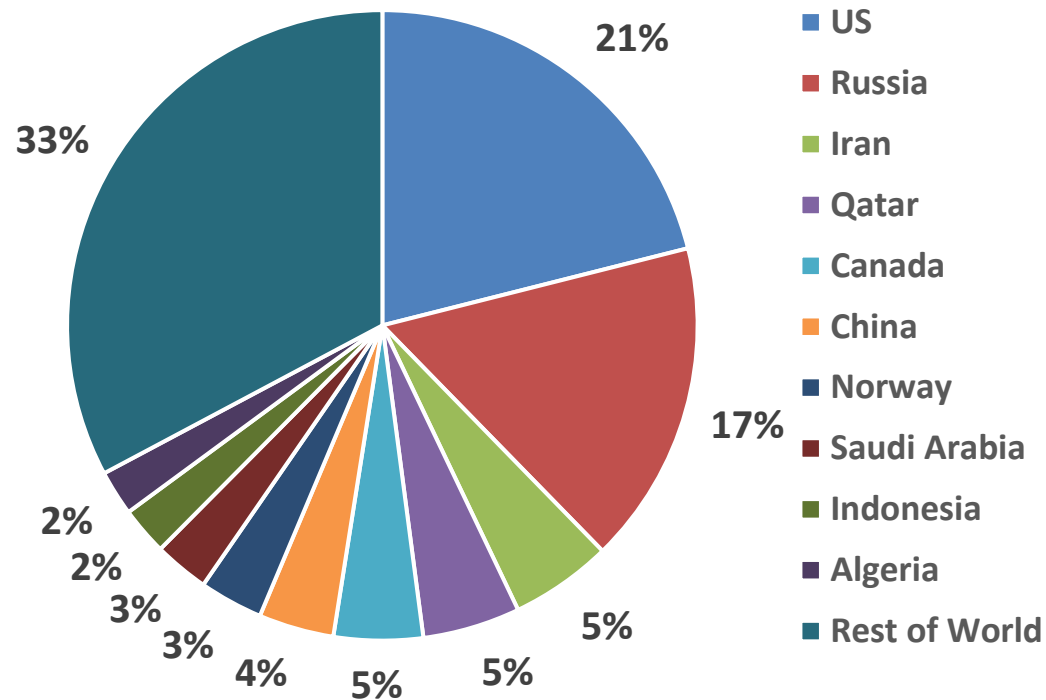
3 510 G.m3

N°1 US, N°2 Russia

2025

4 200 G.m3

N°1 US, N°2 Russia

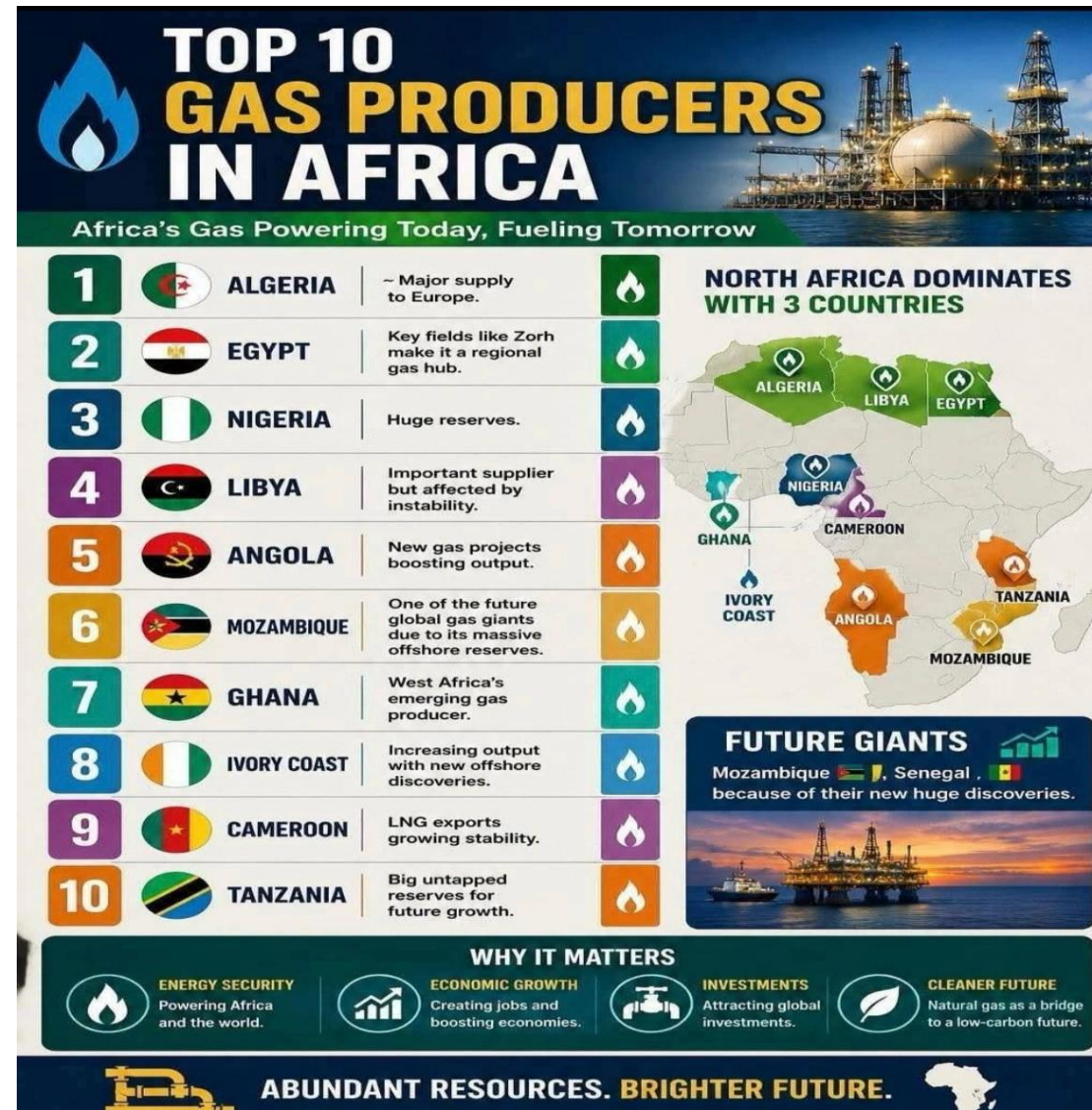


Note: Differences between consumption and production are due to stocks at storage facilities and liquefaction plants. Rounded figures

Source: Data from EI Stat. Review 2026
Excludes gas flared and recycled

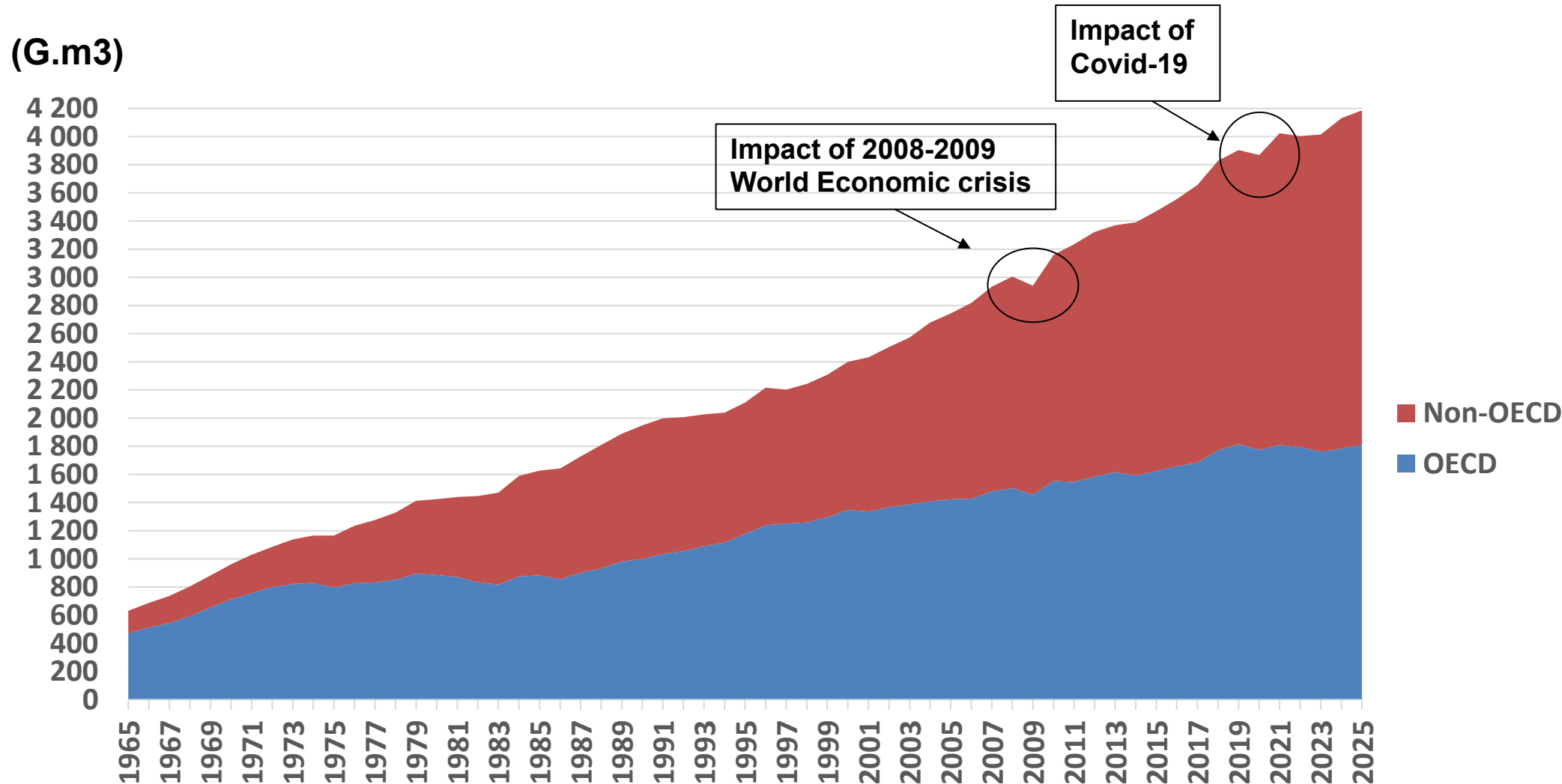


Africa – 10 top Gas Producers 2025



History of Gas Consumption 1970-2025

Gas Consumption & Production will grow fast



Source: Data from EI Statistical Review 2026

Excludes Natural Gas converted to liquid fuels. Includes derivatives of coal and Natural Gas consumed in GTL transformation

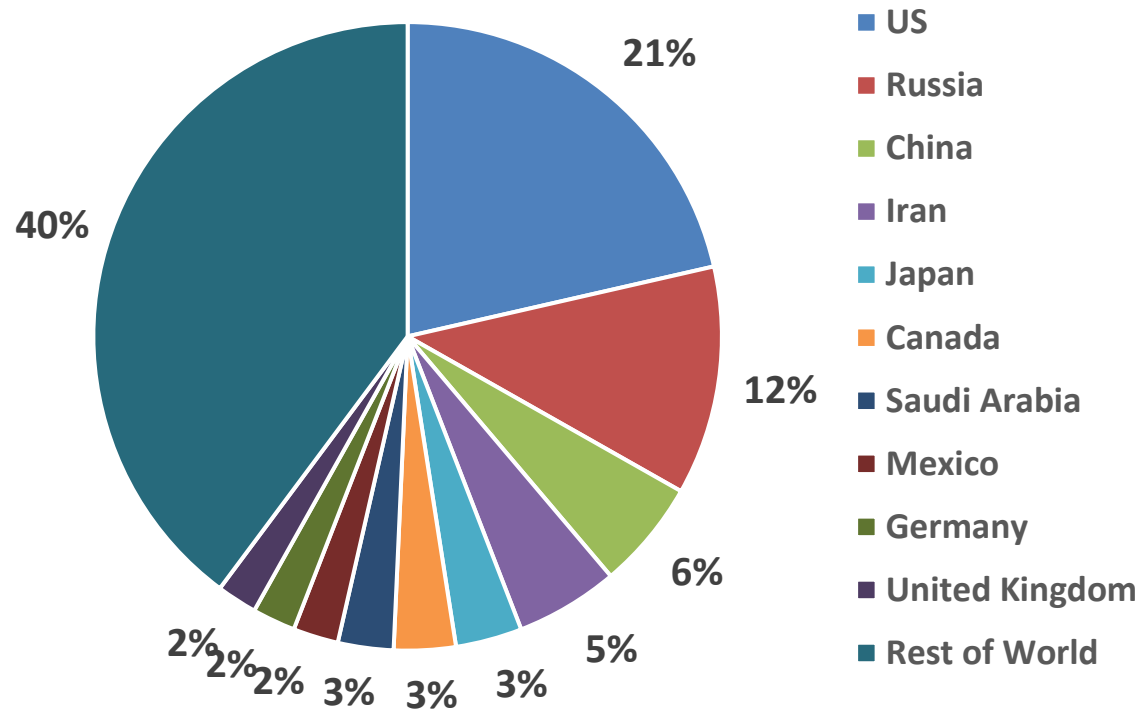


World Gas Consumption 2015 - 2025

2015

3 470 G.m3

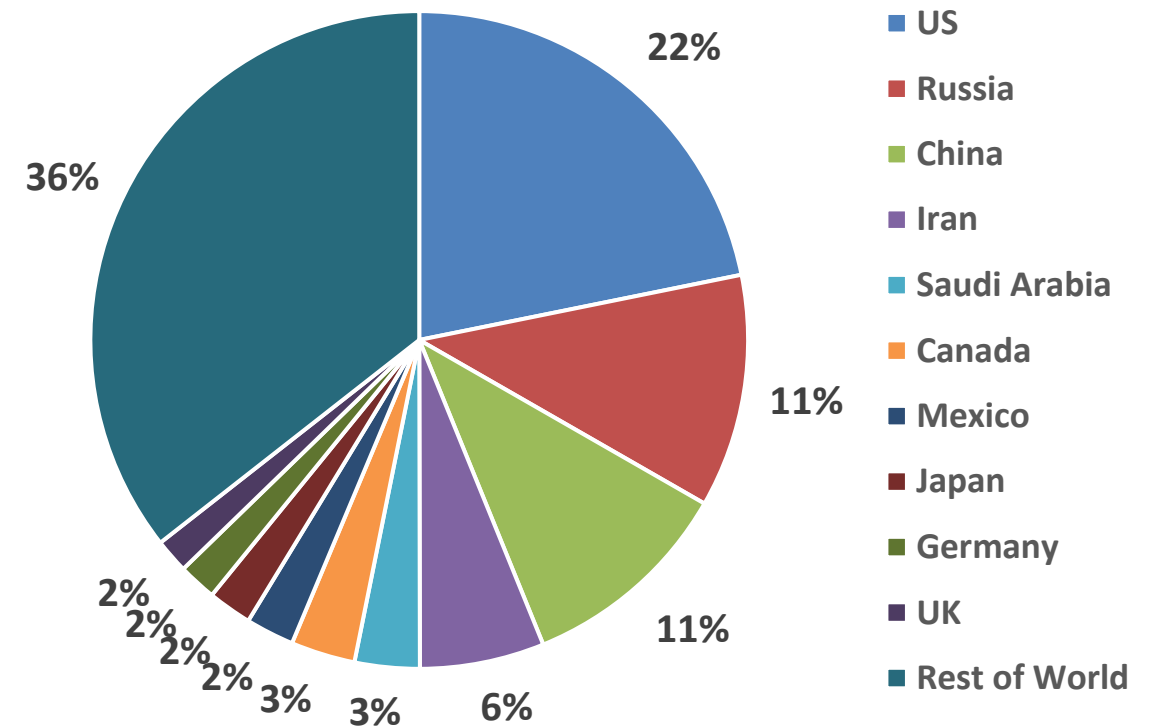
N°1 US, N°2 Russia



2025

4 190 G.m3

N°1 US, N°2 Russia

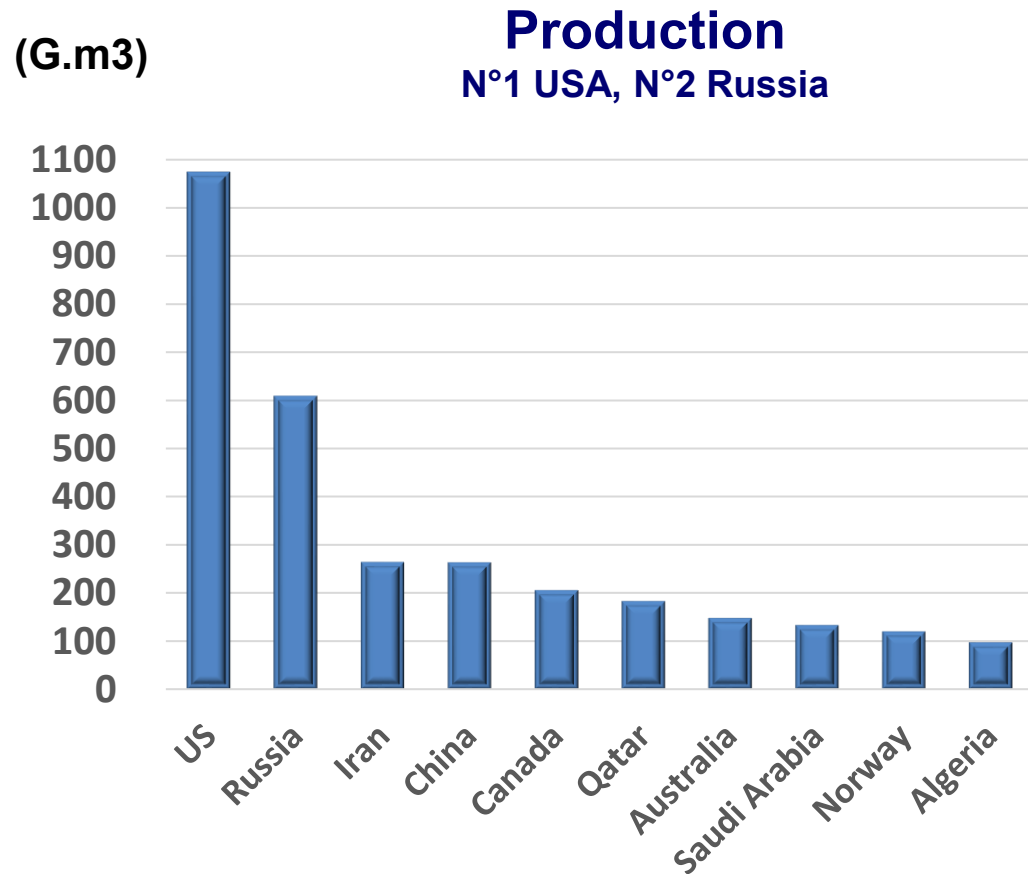


Note: Differences between consumption and production are due to stocks at storage facilities and liquefaction plants. Rounded figures

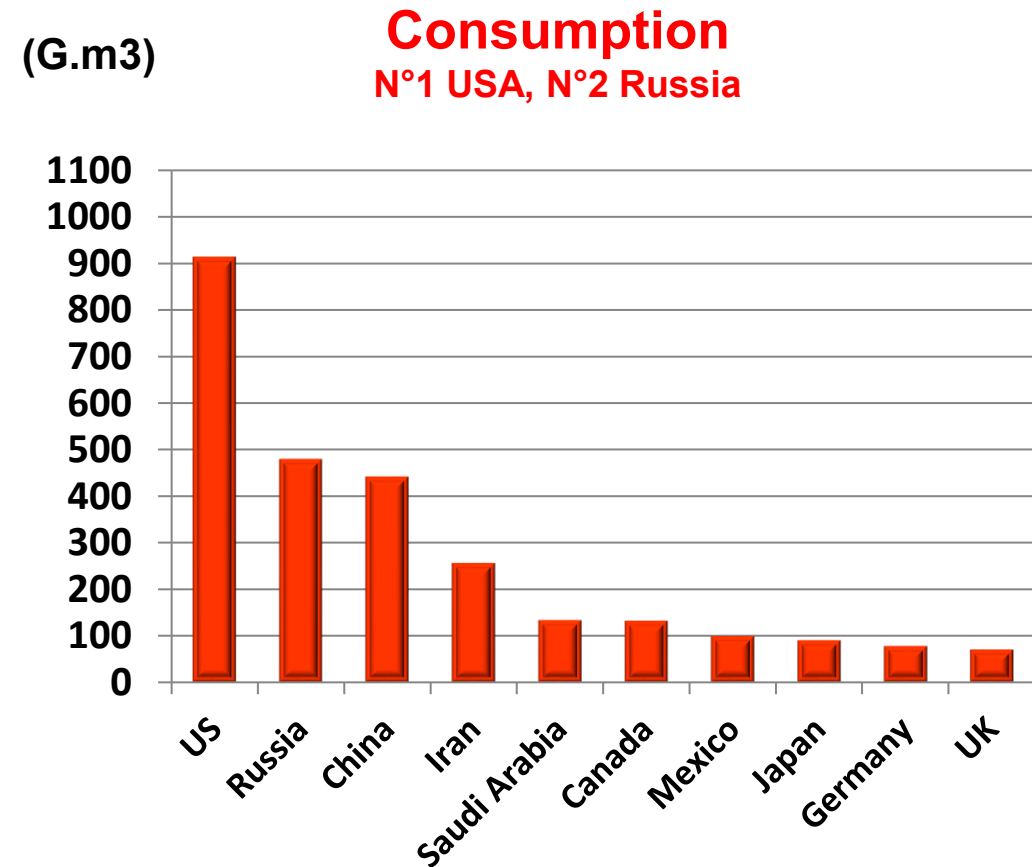
Source: Data from EI Stat. Review 2026



Main Gas Producing and Consuming Countries Year 2025



Total World # 4 200 G.m3



Total World # 4 190 G.m3

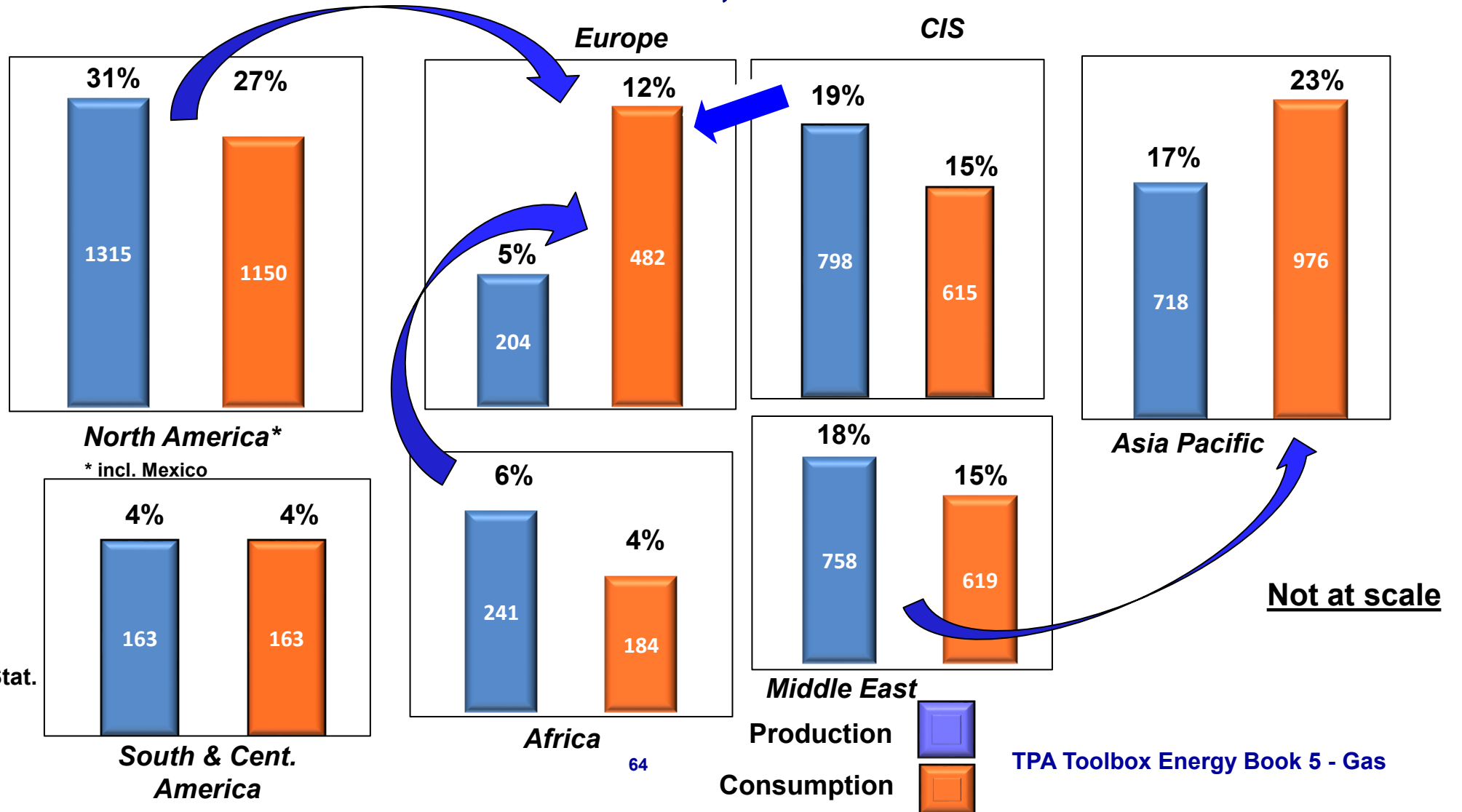
Note: Differences between consumption and production are due to stocks at storage facilities and liquefaction plants. Rounded figures

Source: Data from EI Stat. Review 2026
Rounded figures



2025 Natural Gas Supply and Demand

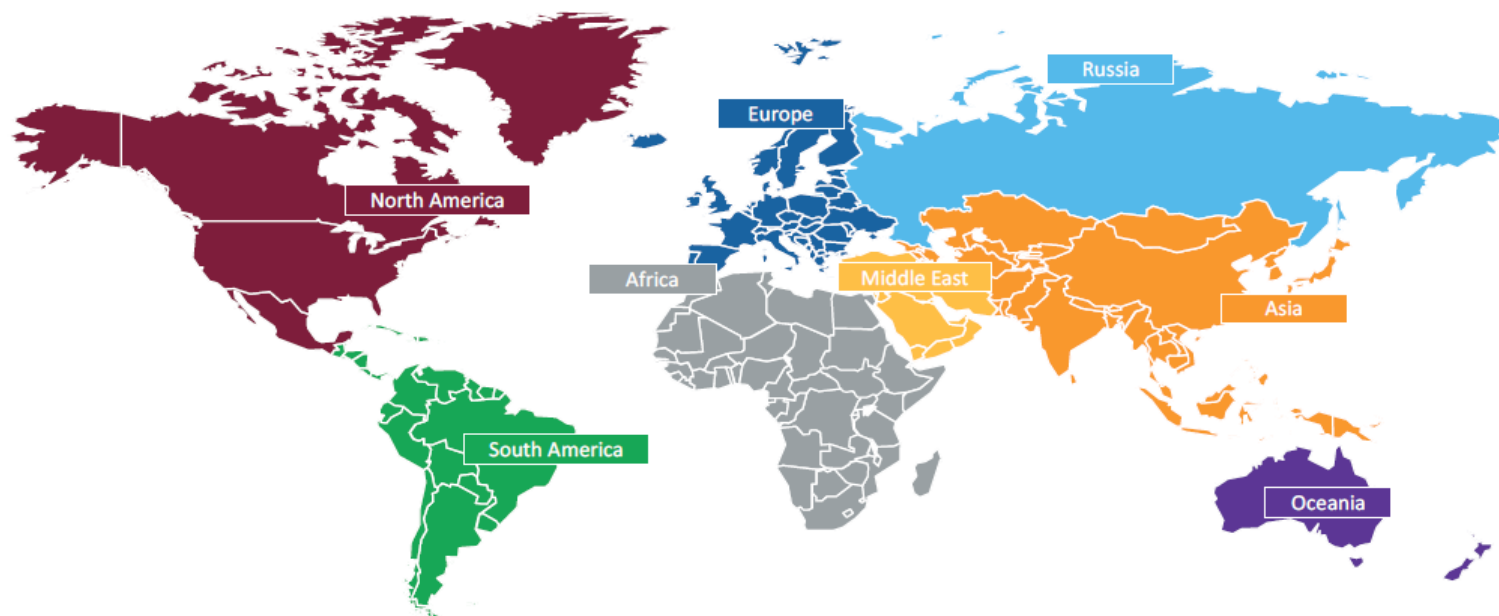
(G.m3) World Marketed Production and Consumption 2025
4 200 G.m³ = 3,6 Gtoe



Source: Data from EI Stat.
Review 2026
Not at scale



Global Gas Demand map by Regions - 2019-2025 by IGU 2025



North America		South America		Europe		Africa		Middle East		Russia		Asia		Australia	
Year	Bcm	Year	Bcm	Year	Bcm	Year	Bcm	Year	Bcm	Year	Bcm	Year	Bcm	Year	Bcm
2020	1,063	2020	144	2020	533	2020	157	2020	578	2020	423	2020	916	2020	51
2021	1,078	2021	162	2021	556	2021	167	2021	598	2021	475	2021	988	2021	51
2022	1,120	2022	152	2022	495	2022	165	2022	586	2022	452	2022	976	2022	53
2023	1,138	2023	155	2023	456	2023	171	2023	606	2023	463	2023	1,005	2023	51
2024	1,161	2024	154	2024	458	2024	168	2024	615	2024	474	2024	1,041	2024	51
2025F	1,171	2025F	157	2025F	463	2025F	174	2025F	643	2025F	476	2025F	1,057	2025F	51

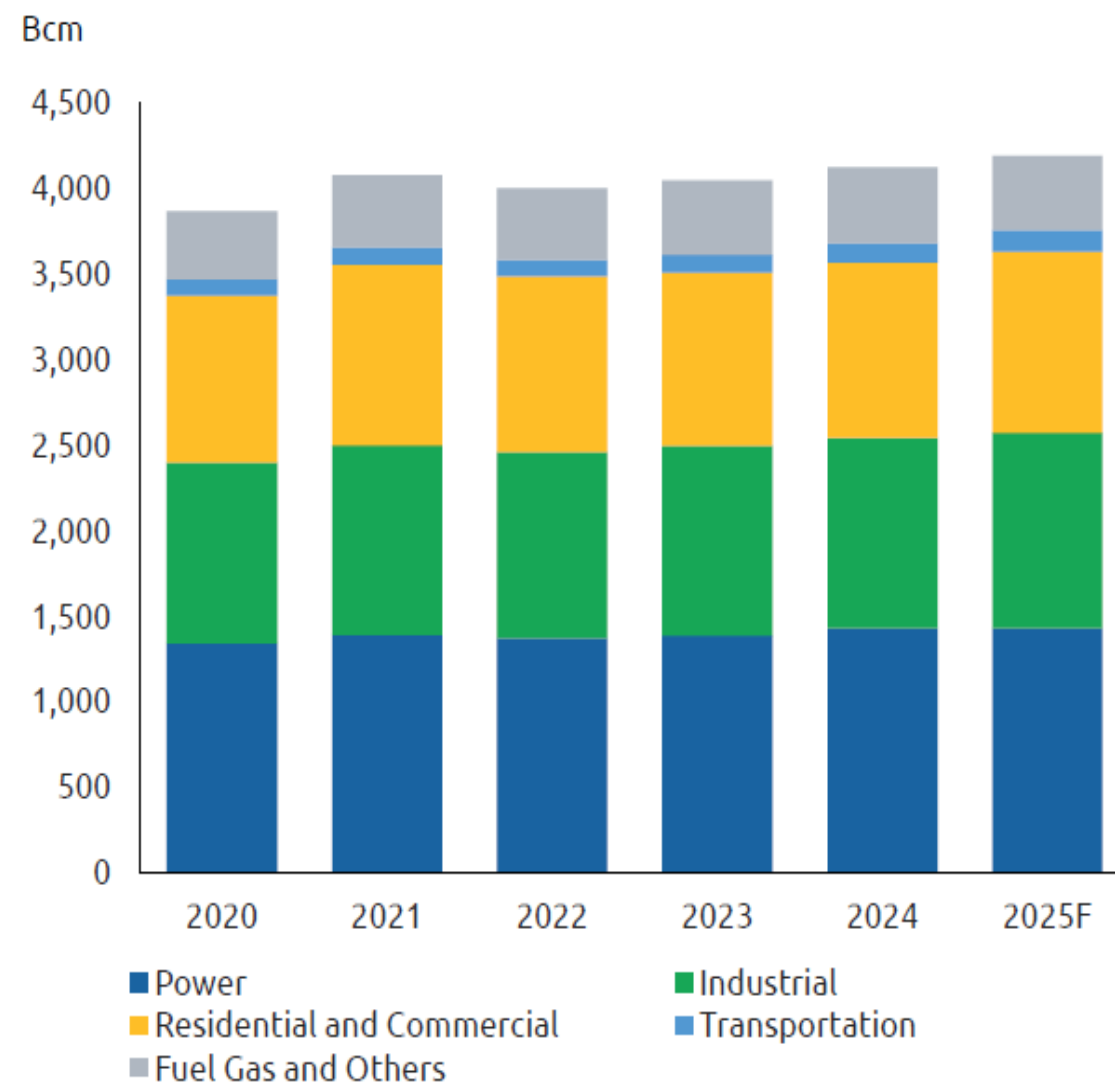
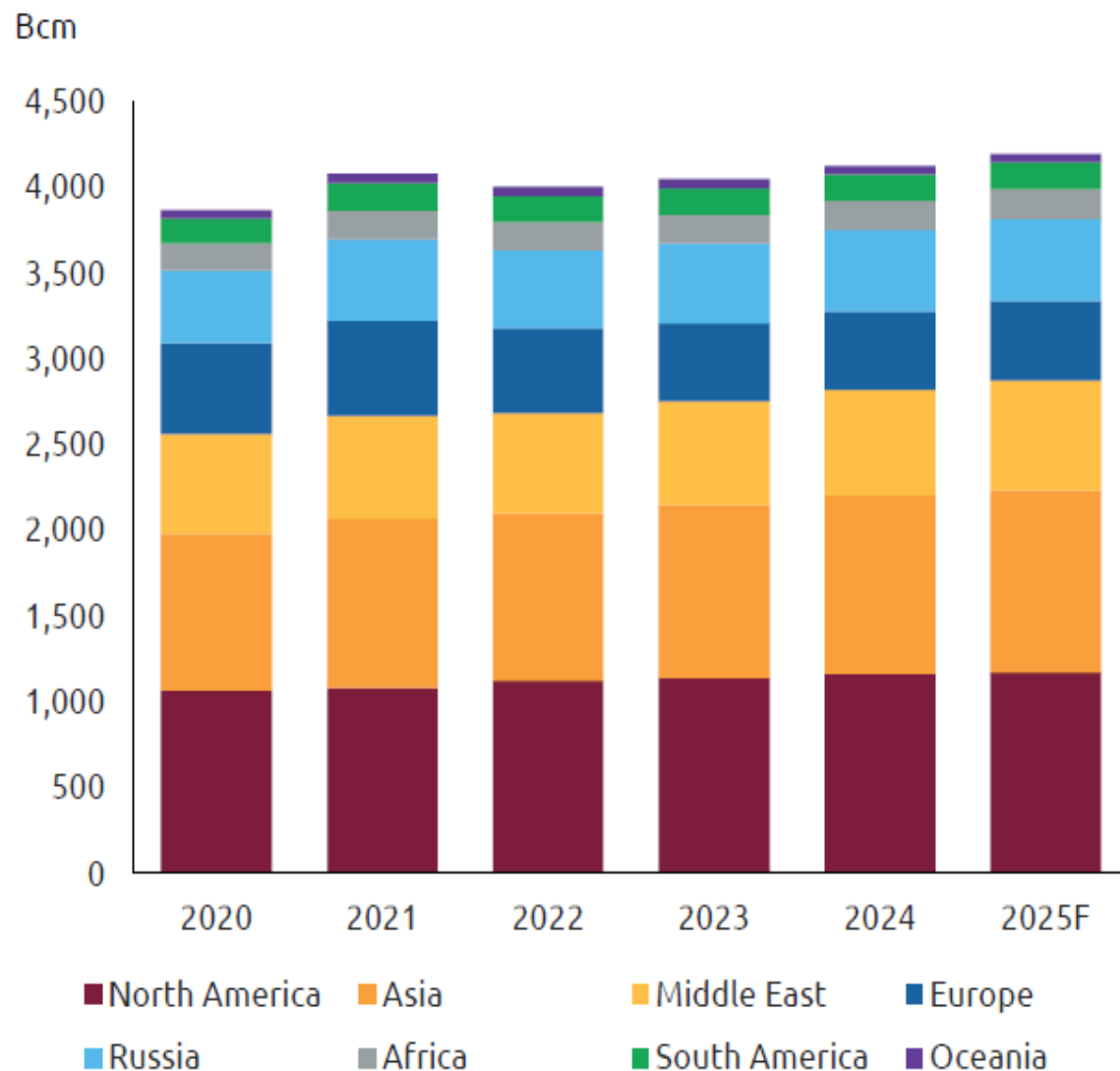
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Source: Rystad Energy

Source: International Gas Union (IGU) Global Gas Report 2025
/Rystad Energy – September 2025



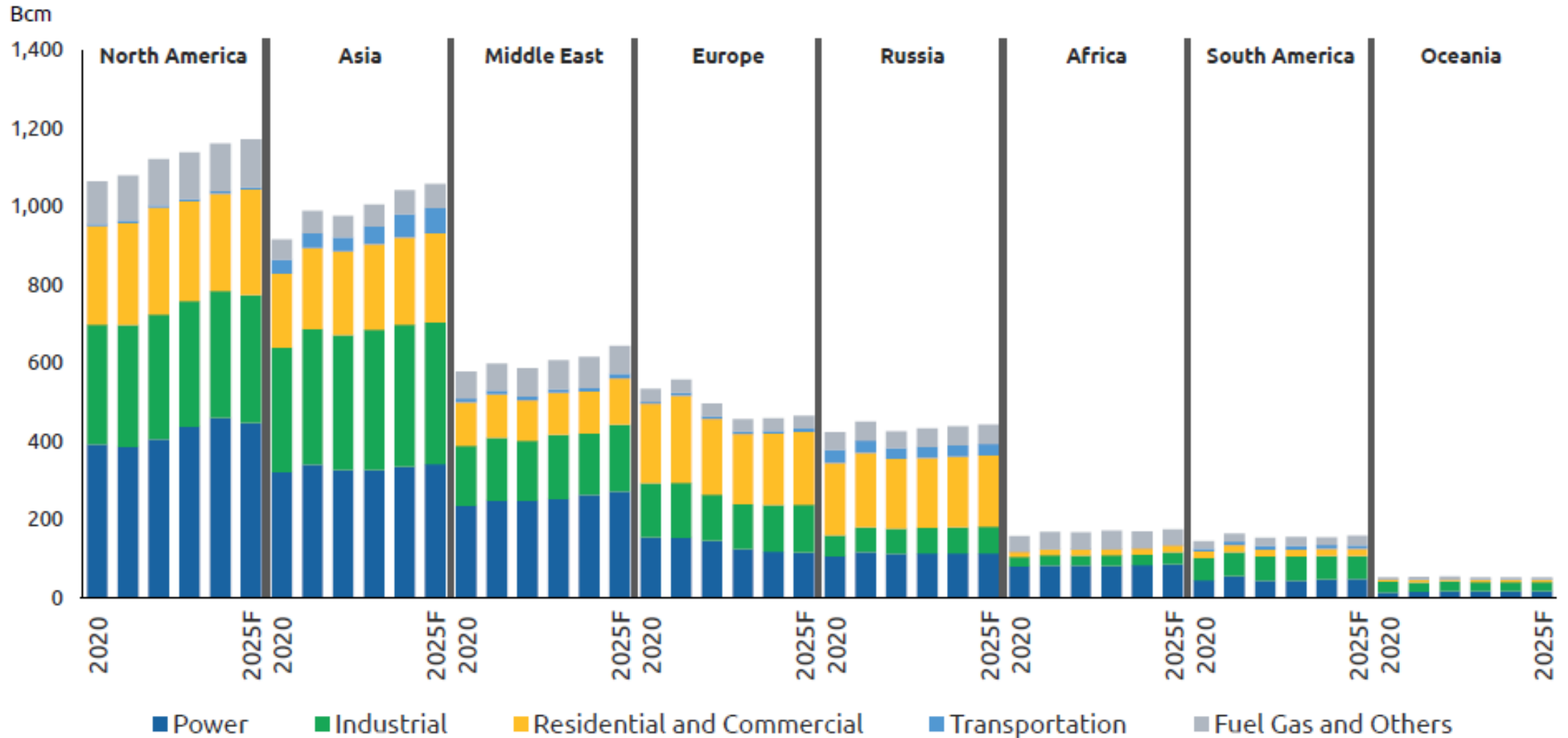
Global Gas Demand by Regions and Sectors 2020-2025 by IGU 2025



Source: International Gas Union (IGU) Global Gas Report 2025
/Rystad Energy – September 2025



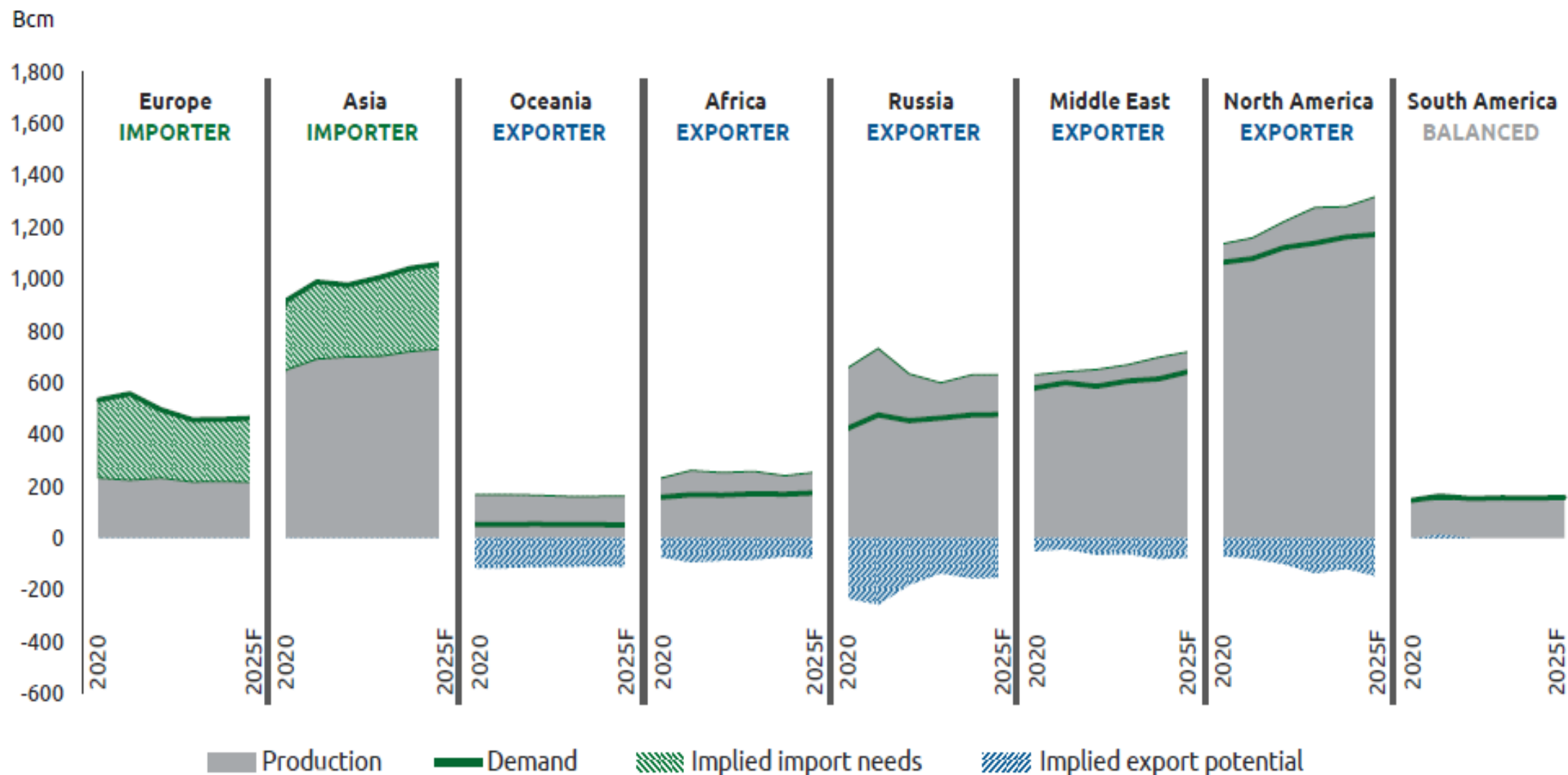
Regional Gas Demand by Sectors by IGU 2025



Source: International Gas Union (IGU) Global Gas Report 2025/
Rystad Energy – September 2025



Gas Demand, Production, Exports & Imports by Regions by IGU 2025



Source: International Gas Union (IGU) Global Gas Report 2025/
Rystad Energy – September 2025



Global Natural Gas Market 2025 vs 2024

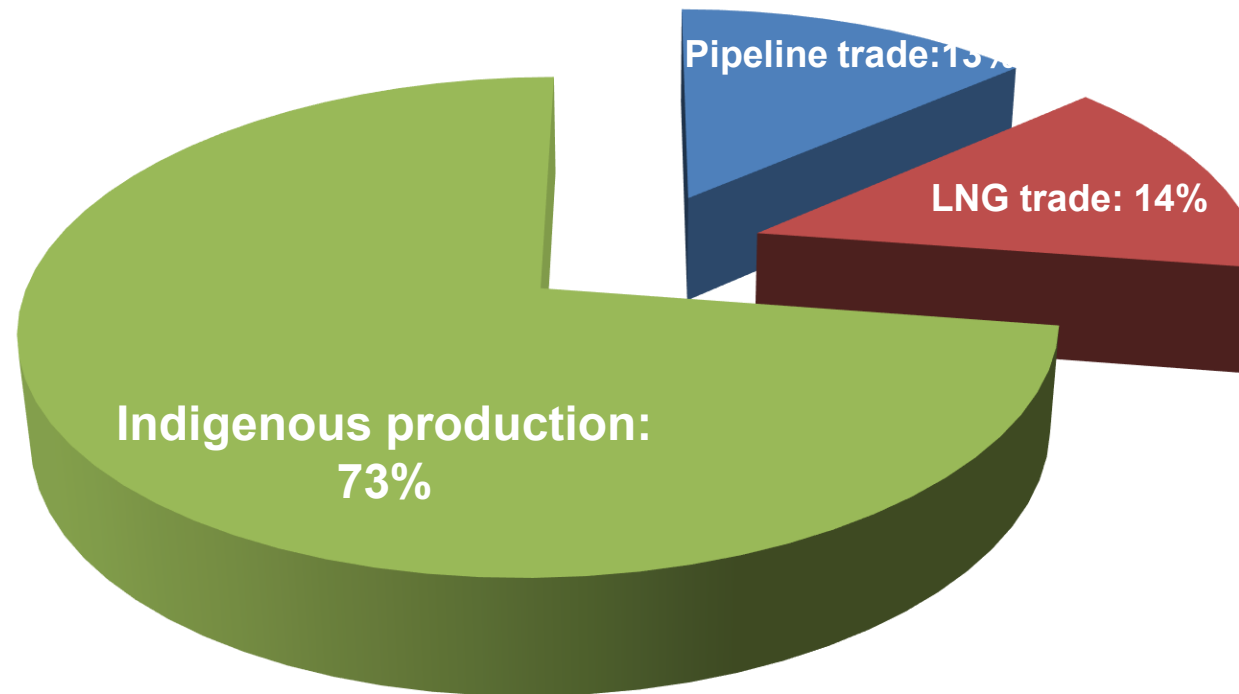
	Consumption		Production		Gross imports		Gross exports	
Regions	Bcm	% change	Bcm	% change	Bcm	% change	Bcm	% change
Asia	+ 15.9	+ 1.5%	+ 10.1	+ 1.4%	- 2.2	- 0.4%	+ 2.5	+ 1.4%
Europe	+ 5.2	+ 1.1%	- 3.4	- 1.5%	+ 23.8	+ 5.2%	+ 3.4	+ 1.6%
North America	+ 10.4	+ 0.9%	+ 40.1	+ 3.1%	+ 4.2	+ 2.3%	+ 34.8	+ 11.8%
South America	+ 3.9	+ 2.5%	+ 3.9	+ 2.6%	+ 0.1	+ 0.2%	- 4.1	- 15.4%
Africa	+ 5.7	+ 3.4%	+ 13.6	+ 5.7%	+ 7.9	+ 41.6%	+ 26.4	+ 30.3%
Middle East	+ 28.2	+ 4.6%	+ 21.3	+ 3.1%	+ 0.6	+ 0.6%	- 3.5	- 1.9%
Russia	+ 1.7	+ 0.4%	- 0.3	0.0%	- 3.6	- 47.3%	- 10.3	- 6.5%
Oceania	- 0.4	- 0.8%	+ 1.6	+ 1.0%	- 0.2	- 100.0%	- 1.4	- 1.2%
World	+ 70.6	+ 1.7%	+ 87.0	+ 2.1%	+ 30.6	+ 2.4%	+ 47.8	+ 3.8%

Source: International Gas Union (IGU) Global Gas Report 2025/Rystad Energy
September 2025



More than 70% of Gas is used in the country where it is produced...
Since 2022 (Russian attack against Ukraine), contribution of pipeline trade has decreased

World Gas Consumption in 2025 # 4 190 G.m³



2025 Gross International Gas trade is around # 1 150 G.m³
of which # 580 G.m³ of LNG (50,4%) & # 570 G.m³ by pipe (49,6%)

Note: Pipeline intra-region trade is excluded
LNG includes re-exports



Natural Gas Trade by Energy Institute (EI)



Gas – Production & Consumption by Energy Institute 2025



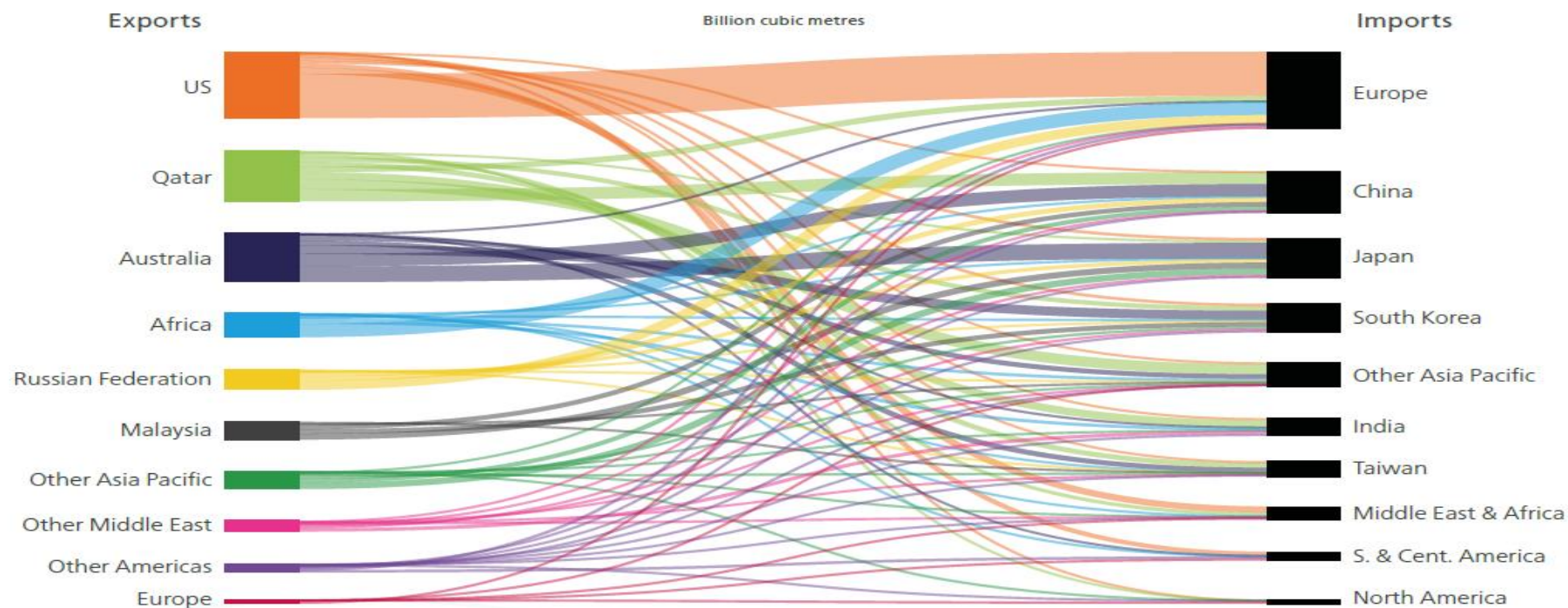
Natural gas

LNG trade expanded by 6.5% as gas consumption grew by 1.6%

Gas – Major Trade Movements 2025 - LNG



Natural gas Major trade movements 2025 – LNG



LNG trade grew significantly by 6.5% in 2025, after almost no growth between 2023 and 2024. The US was a primary driver of this large growth with exports up 27.1% on 2024 levels. The US retained its position as the largest exporter, responsible for over a quarter of global exports, followed by Qatar (19.2%) and Australia (18.1%), collectively accounting for 63% of total global LNG exports.

China decreased its LNG imports by 13.5% in 2025, and remained the largest importer of LNG with 15.7% of the

Note: regional groupings vary across trade tables and data will vary accordingly.

global share, but Japan is only narrowly behind with 15.3%. Both countries imported one-third of their LNG from Australia. The Asia-Pacific region alone was responsible for 62% of all LNG imports. After decline in 2024, European LNG imports bounced back in 2025 with a 30.6% increase. The US remained the largest supplier of European LNG, with the Russian Federation the second largest.

Source: EI Statistical Review 2026



Major LNG Trade - 2025



Natural gas Trade movements 2025 as liquefied natural gas*

		From																				
Billion cubic metres To	US	Peru	Trinidad & Tobago	Other Americas*	Norway	Other Europe*	Russian Federation	Oman	Qatar	United Arab Emirates	Algeria	Angola	Egypt	Nigeria	Other Africa	Australia	Brunei	Indonesia	Malaysia	Papua New Guinea	Other Asia Pacific*	Total Imports
Canada	^	0.2	0.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.7
Mexico	0.3	0.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1	—	—	—	0.6
US	—	—	0.2	0.1	—	^	—	—	0.1	—	—	—	—	—	—	—	—	—	—	—	^	0.4
North America	0.3	0.5	0.7	0.1	—	^	—	—	0.1	—	—	—	—	—	—	—	—	0.1	—	—	—	1.8
Argentina	0.7	—	0.6	—	—	^	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.3
Brazil	2.4	—	0.1	0.1	^	—	—	—	—	—	—	—	—	—	0.1	—	—	—	—	—	—	2.7
Chile	1.1	—	1.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.6
Other S. & Cent. America	5.3	—	2.4	1.2	—	^	—	—	—	—	—	—	—	0.9	—	^	—	—	—	—	—	9.7
S. & Cent. America	9.4	—	4.6	1.2	—	^	—	—	—	—	—	—	—	0.9	0.1	^	—	—	—	—	—	16.3
Belgium	5.3	—	0.2	—	0.2	^	5.5	—	2.5	—	—	0.2	—	0.4	0.2	—	—	—	—	—	—	14.4
France	14.3	0.8	0.1	0.1	0.8	0.1	8.6	—	—	—	3.4	0.4	—	1.8	0.4	0.1	—	—	—	—	0.2	30.9
Italy	9.4	—	0.6	—	—	0.2	0.1	—	6.7	—	2.1	—	0.1	0.3	0.5	—	—	—	—	—	—	20.2
Spain	10.1	0.6	0.2	^	0.2	—	3.8	—	0.6	—	1.9	1.9	0.1	2.4	0.5	—	—	—	—	—	^	22.3
Türkiye	8.7	—	0.4	0.1	—	—	—	0.1	—	—	4.5	0.2	0.2	0.9	1.3	—	—	—	—	—	—	16.3
United Kingdom	9.4	0.2	0.4	0.2	0.2	—	—	—	0.8	—	0.7	0.3	—	0.2	0.1	—	—	—	—	—	—	12.4
Other European Union	42.5	0.4	1.4	0.1	2.7	0.3	2.3	—	2.2	—	0.4	1.0	0.1	2.9	0.8	—	—	—	—	—	0.2	57.3
Rest of Europe	—	—	—	—	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	^	0.1
Europe	99.6	2.0	3.2	0.5	4.1	0.7	20.3	0.1	12.7	—	13.1	3.9	0.5	9.0	3.8	0.1	—	—	—	—	0.4	174.0
Egypt	11.7	—	0.3	^	0.2	0.1	—	—	—	—	—	—	—	—	0.5	—	—	—	—	—	—	12.8
Kuwait	0.2	—	—	—	—	—	—	1.4	7.1	0.1	—	0.1	—	1.3	0.1	—	—	—	—	—	—	10.3
United Arab Emirates	0.3	—	—	—	—	—	—	0.1	0.2	—	—	0.1	—	0.1	0.1	—	—	—	—	—	—	0.8
Other Middle East & Africa	1.6	—	—	—	—	^	—	—	0.2	—	—	—	—	—	0.2	—	—	—	—	—	0.2	2.2
Middle East & Africa	13.7	—	0.3	^	0.2	0.1	—	1.6	7.5	0.1	—	0.2	—	1.4	0.9	—	—	—	—	—	0.2	26.1
China	0.4	0.3	0.4	0.6	—	—	10.4	1.9	26.7	0.6	0.1	—	—	1.6	0.8	27.9	0.4	5.5	9.8	3.4	^	90.8
India	4.5	^	0.1	0.1	—	—	—	2.6	16.3	4.6	—	2.3	—	2.6	1.8	0.5	—	^	—	—	—	35.4
Japan	6.1	0.7	—	0.8	—	—	7.9	4.0	4.7	0.9	—	—	—	0.8	0.6	35.2	3.5	5.3	13.1	4.7	0.3	88.5
Malaysia	—	—	0.2	—	—	—	—	—	—	—	—	—	—	—	—	3.0	—	—	—	—	^	3.3
Pakistan	—	—	—	—	—	—	—	—	9.0	—	—	—	—	0.1	—	—	—	—	—	—	—	9.1
Singapore	0.2	0.1	—	—	—	—	—	—	3.9	—	—	—	—	^	0.8	3.2	—	0.1	0.3	—	0.5	9.1
South Korea	6.1	1.4	1.2	0.1	—	—	3.4	2.8	9.6	0.4	—	—	—	0.8	1.6	20.1	1.2	2.8	10.3	1.0	0.4	63.1
Taiwan	3.2	0.2	—	0.4	—	—	0.6	1.3	10.7	0.3	—	—	0.1	0.2	—	10.6	0.9	0.6	0.2	2.6	—	31.8
Thailand	1.8	—	—	—	—	^	—	0.9	2.9	0.1	—	0.3	—	0.7	1.7	2.9	0.3	0.3	2.1	0.2	0.2	14.3
Other Asia Pacific	1.8	—	0.1	—	—	—	0.1	0.1	6.8	—	—	0.1	—	1.8	0.8	1.3	0.2	0.5	0.7	—	0.5	15.0
Asia Pacific	24.0	2.8	1.9	1.9	—	^	22.3	13.6	90.6	6.9	0.1	2.6	0.1	8.8	8.1	104.7	6.5	15.2	36.5	11.8	1.9	360.3
Total exports	147.0	5.2	10.7	3.8	4.3	0.9	42.6	15.3	111.0	7.0	13.1	6.7	0.6	20.1	12.9	104.8	6.5	15.3	36.5	11.8	2.5	578.5

Source: Includes data from GIIGNL, S&P Global.

* Includes re-exports.

^ Less than 0.05.

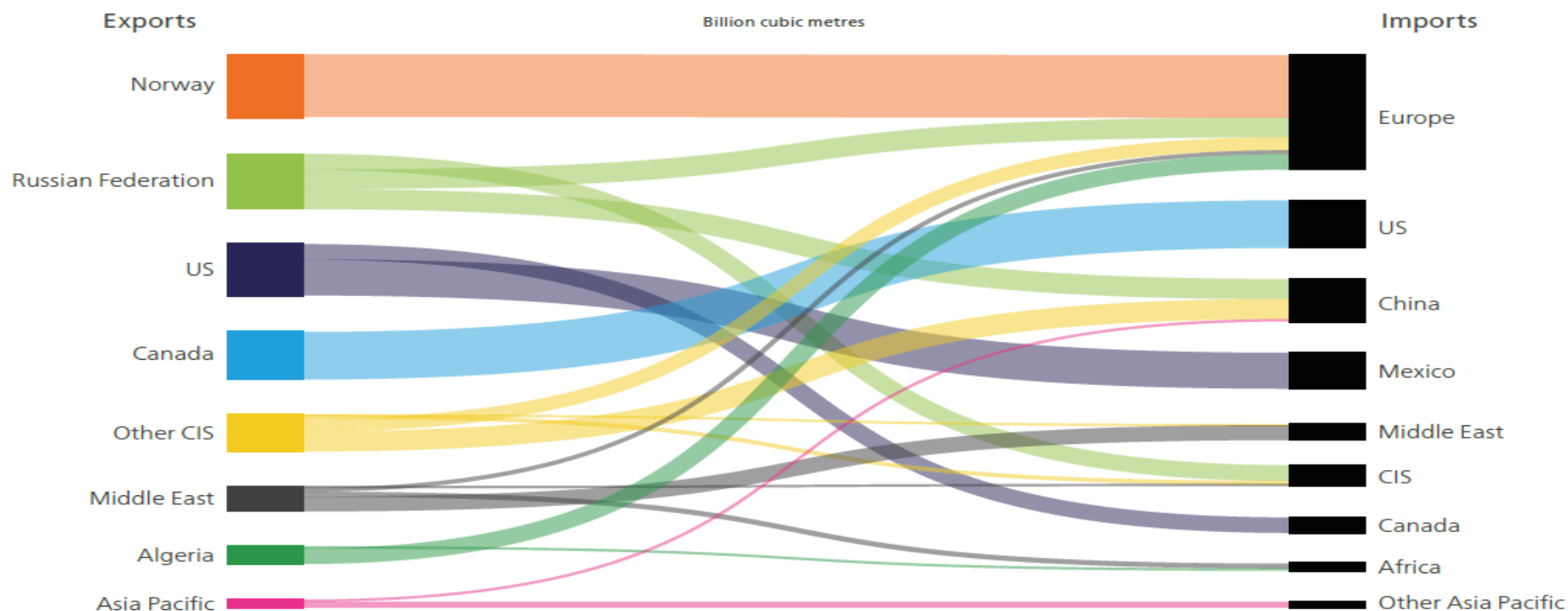
Note: As far as possible, the data above represents standard cubic metres (measured at 15°C and 1013mbar) and has been standardised using a gross calorific value (GCV) of 40MJ/m³.



Gas – Major Trade Movements 2025 - Pipeline



Natural gas Major trade movements 2025 – pipeline



Total 'inter-regional' pipeline trade decreased by 3.6% in 2025. While Europe remained the largest importer of pipeline gas, its imports declined by 14.8%, with imports from the Russian Federation declining further. Overall, the Russian Federation saw its pipeline exports decline by 8.5%.

When including trade between Norway and Europe, Europe is the largest player in global pipeline trade, responsible for 37% of global imports and 20% of exports. Norway

Note: regional groupings vary across trade tables and data will vary accordingly.

remained the largest supplier of pipeline gas to its European counterparts, supplying more than half of Europe's pipeline imports. Significant trade between the North American pipeline network continued, with the US increasing its exports by 3.8% in 2025. Canada exported 87bcm of gas entirely to the US, while the US exported 94bcm with 70% flowing to Mexico and the remaining 30% to Canada.



Major Pipe Gas Trade - 2025



Natural gas Trade movements 2025 by pipeline*

		From																				
Billion cubic metres To	Canada	Mexico	US	Bolivia	Other S. & Cent. America	Norway	Other Europe	Azerbaijan	Kazakhstan	Russian Federation	Turkmenistan	Uzbekistan	Iran	Qatar	Other Middle East	Algeria	Libya	Other Africa	Indonesia	Myanmar	Other Asia Pacific	Total Imports
Canada	–	–	28.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28.2
Mexico	–	–	66.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	66.0
US	87.2	^	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	87.2
North America	87.2	^	94.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	181.5
Argentina	–	–	–	0.1	^	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.2
Brazil	–	–	–	4.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4.3
Other S. & Cent. America	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
S. & Cent. America	–	–	–	4.4	^	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4.5
European Union	–	–	–	–	–	86.1	–	11.8	–	4.3	–	–	–	–	–	28.3	0.9	–	–	–	–	131.4
Non-EU Europe	–	–	–	–	–	28.9	–	11.6	–	31.7	0.4	–	7.4	–	–	–	–	–	–	–	–	80.0
Europe	–	–	–	–	–	115.0	–	23.4	–	36.0	0.4	–	7.4	–	–	28.3	0.9	–	–	–	–	211.4
Belarus	–	–	–	–	–	–	–	–	–	15.9	–	–	–	–	–	–	–	–	–	–	–	15.9
Kazakhstan	–	–	–	–	–	–	–	–	–	3.4	0.4	–	–	–	–	–	–	–	–	–	–	3.8
Russian Federation	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Other CIS	–	–	–	–	–	–	–	–	–	9.5	6.7	0.1	0.5	–	–	–	–	–	–	–	–	16.8
CIS	–	–	–	–	–	–	–	–	–	28.9	7.0	0.1	0.5	–	–	–	–	–	–	–	–	36.5
United Arab Emirates	–	–	–	–	–	–	–	–	–	–	–	–	–	18.1	–	–	–	–	–	–	–	18.1
Other Middle East	–	–	–	–	–	–	0.4	0.1	–	–	–	–	7.5	1.7	–	–	–	0.4	–	–	–	10.1
Middle East	–	–	–	–	–	–	0.4	0.1	–	–	–	–	7.5	19.8	–	–	–	0.4	–	–	–	28.2
South Africa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3.5	–	–	–	3.5
Other Africa	–	–	–	–	–	–	0.9	–	–	–	–	–	–	–	8.8	4.0	–	–	–	–	–	13.7
Africa	–	–	–	–	–	–	0.9	–	–	–	–	–	–	–	8.8	4.0	–	3.5	–	–	–	17.2
Australia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
China	–	–	–	–	–	–	–	–	4.9	36.7	30.3	1.5	–	–	–	–	–	–	–	4.4	–	77.8
Malaysia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Singapore	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4.1	–	2.2	6.3
Thailand	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4.2	–	4.2
Asia Pacific	–	–	–	–	–	–	–	–	4.9	36.7	30.3	1.5	–	–	–	–	–	–	4.1	8.6	2.2	88.3
Total exports	87.2	^	94.2	4.4	^	115.0	1.3	23.5	4.9	101.6	37.8	1.6	15.4	19.8	8.8	32.3	0.9	3.9	4.1	8.6	2.2	567.6

Source: Includes data from FGE NexantECA, S&P Global Energy.

* Intra-region trade is excluded. For example, trade between countries within Other Europe is excluded. Region coverage varies compared to 'inter-regional trade' table, eg Norway exports to EU, Non-EU is included above, but part of Europe in 'Inter-regional trade' table.

^ Less than 0.05.

Note: As far as possible, the data above represents standard cubic metres (measured at 15°C and 1013mbar) and has been standardised using a gross calorific value (GCV) of 40 MJ/m³.



Gas Trade & Flows has been dramatically upset as from 2022 due to the Russia – Ukraine war and its market and economic consequences, in particular in Europe

See Book 2 – Energy, Chapter 20



5

Production, consumption: perspectives



TABLE OF CONTENTS

1. General considerations
2. Resources, reserves
3. Conventional and Unconventional Gaseous Hydrocarbons
4. Production, consumption: past and present
5. Production, consumption: perspectives
6. A zoom on Liquefied Natural Gas (LNG)
7. Three independant world markets
8. The gas chain components and their economics: Production & Processing
9. The gas chain components and their economics: Transportation
10. The gas chain components and their economics: Storage
11. Technology and innovation
12. Competing fuels and Gas prices
13. Evolution of national gas markets towards liberalization & globalization
14. Example of challenging gas projects: Shtokman & Yamal

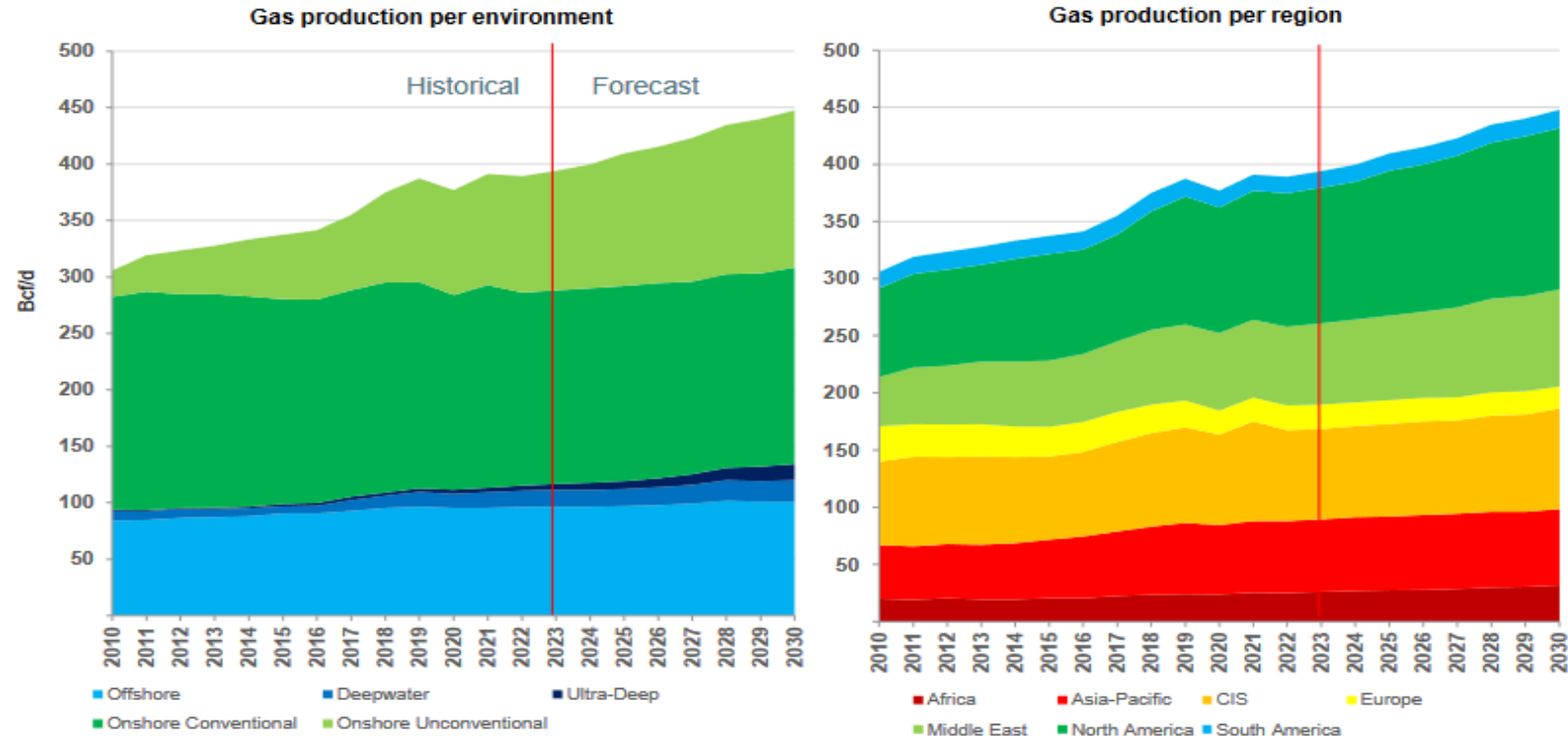


Gas – Perspectives by TotalEnergies

See Book 2 - Energy



Gas Production perspectives 2010 - 2030



Main growth drivers and expected difference in production between 2023 and 2030 (Bscf/d)

United States - Haynesville - Shale gas		Saudi Arabia - Jafurah, Marjan complex	+2.4	Israel - Leviathan	+0.8
United States - Utica - Shale gas		Iran - Rub Al Khalim Zagros foldbelt and Aghar	+2.3	Iraq - Bina Bawi	+0.7
United States - Marcellus - Shale gas		China - Anyue, Sichuan basin, Sulige	+2.0	United Arab Emirates - Offshore Hail & Ghasha	+0.7
United States - Mid-continent - Shale gas	+17.2	Malaysia Lang Lebah, SK316, Rosmari/Marjoram	+1.9	Trinidad and Tobago - Calypso	+0.7
Qatar - NFE, NFS, NFW	+7.6	Australia - Scarborough, Browse	+1.9	Cyprus - Aphrodite	+0.7
Russian Federation- Utenneye, North Yamal, others	+5.8	Mozambique - Golfinho-Atum Train 1 & Train 2	+1.8	Tanzania B1 & B4	+0.7
Canada - Shale gas	+4.5	Turkey - Sakarya	+1.3	Indonesia - Ganal PSC	+0.6
Turkmenistan - South Iolotan, others	+3.7	Papua New Guinea - Elk-Antelope	+0.8	Algeria - Ain Tsila	+0.6
United States Permian - Associated gas production	+14.5				

Source: TotalEnergies E&P Data Book 2023



Gas – Perspectives by BP

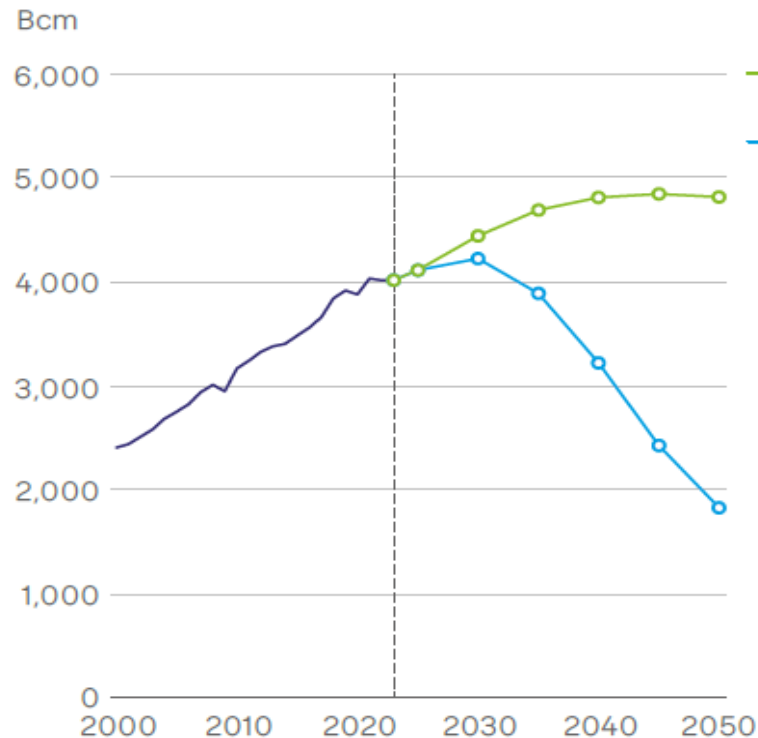


Natural Gas Demand Evolution

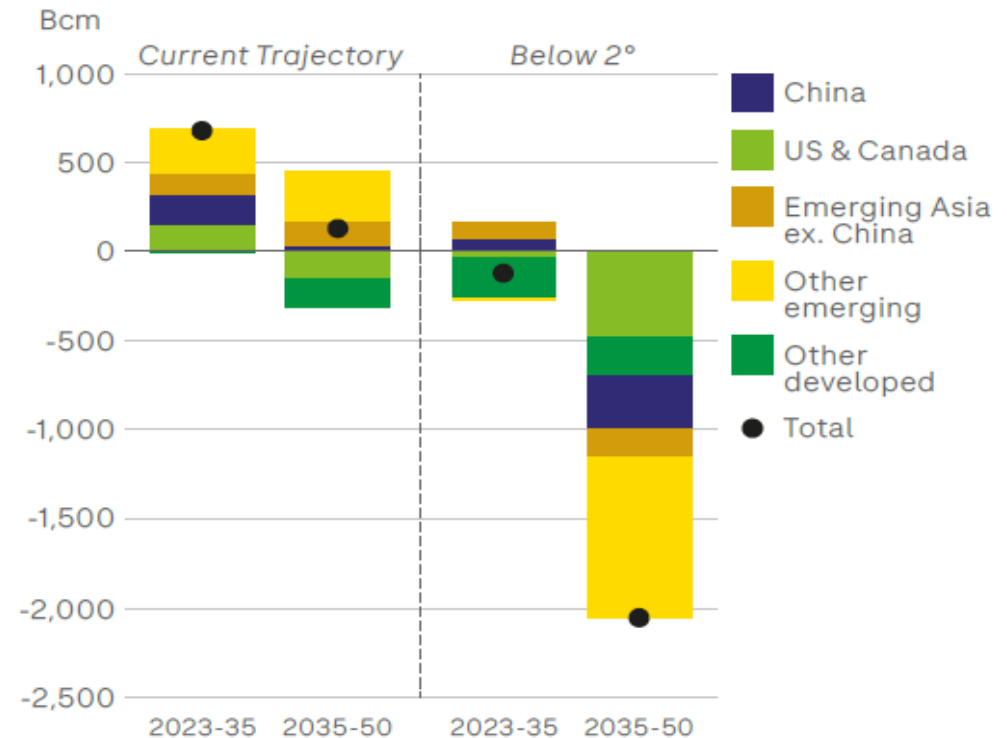
A vision by BP 2025

The outlook for gas demand depends on the speed of the energy transition

Natural gas demand



Change in natural gas demand by region



Source: BP Energy Outlook 2025

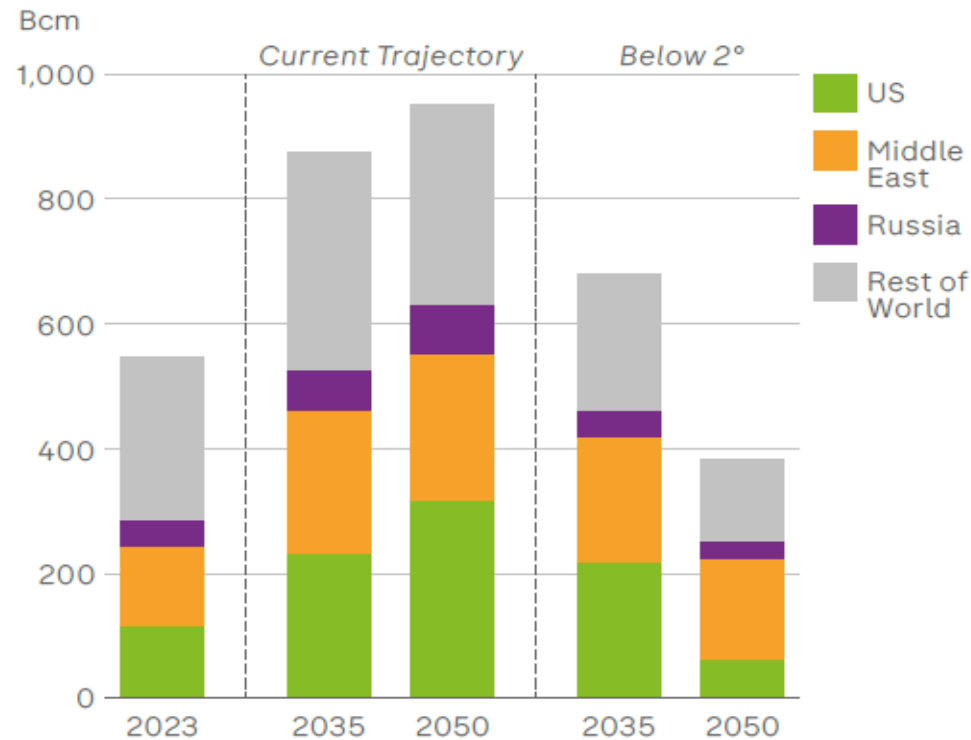


LNG Demand Evolution

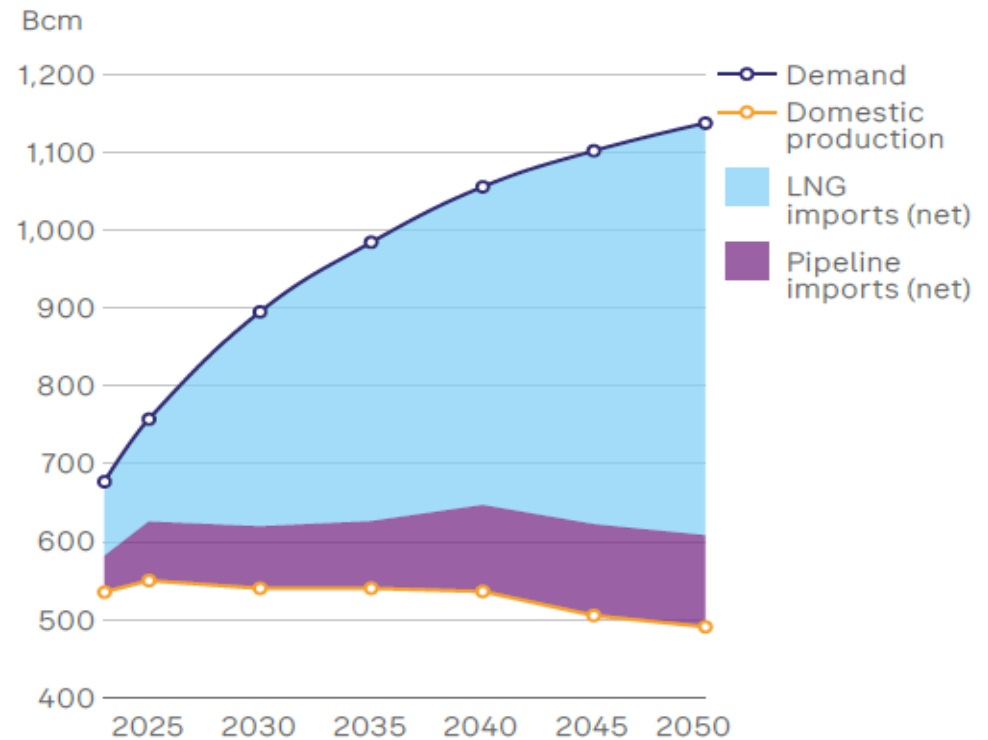
A vision by BP 2025

LNG trade is underpinned by gas demand in emerging Asia

LNG exports by region



Natural gas demand and supply in emerging Asian economies in Current Trajectory



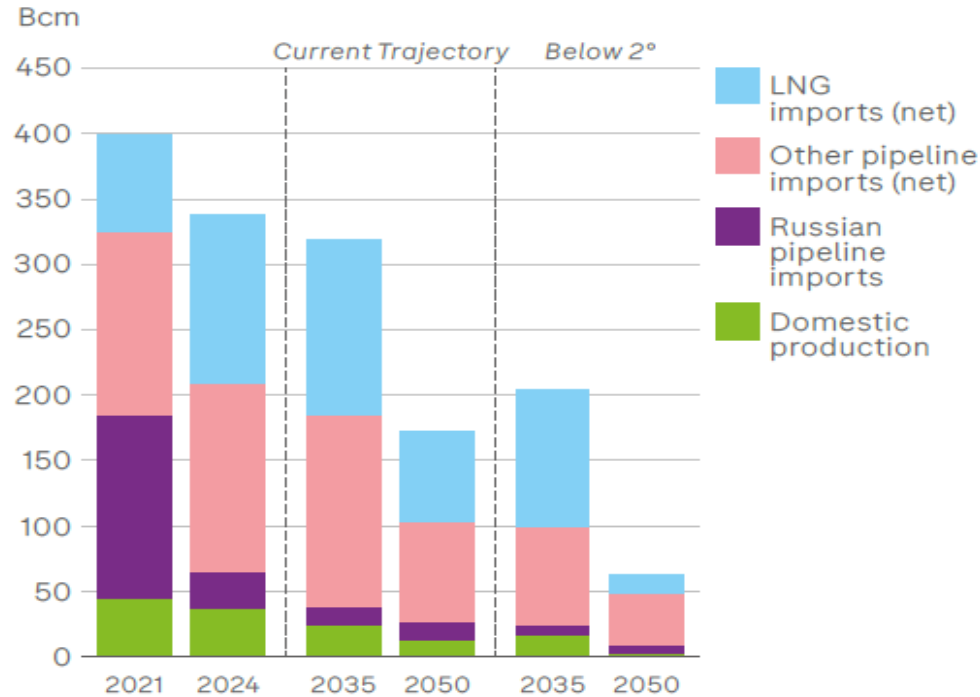
Source: BP Energy Outlook 2025

LNG Demand Evolution

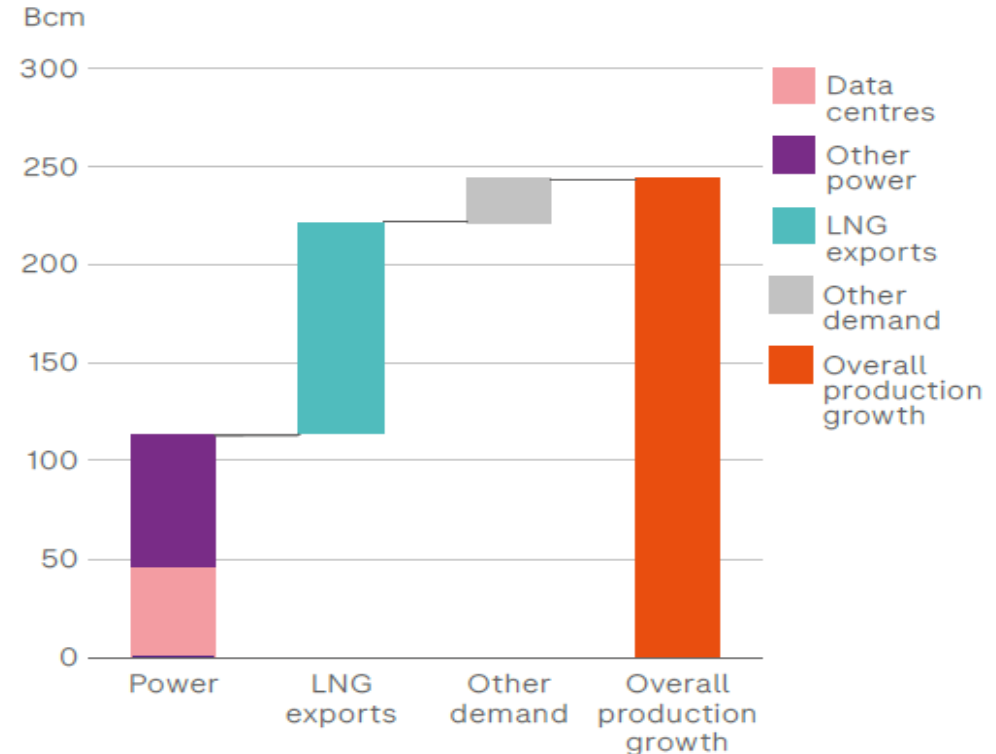
A vision by BP 2025

Natural gas markets are impacted by both geopolitical factors and new sources of demand

EU natural gas demand by source



Sectoral contributions to US natural gas production growth* (2024-2035)



Source: BP Energy Outlook 2025



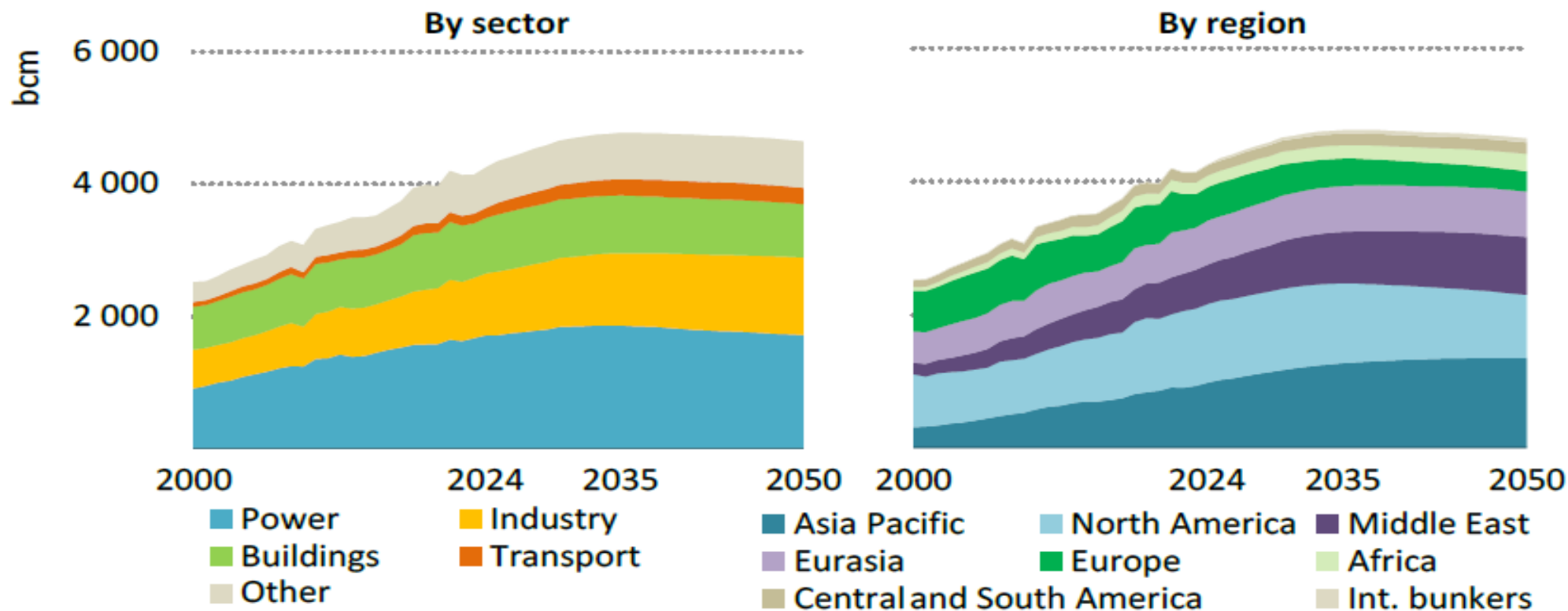
Gas – Perspectives by IEA



**Global Gas Production and Demand
Perspectives
In 2050: 4 400 G.m³ in STEPS Scenario**



World Natural Gas Demand by IEA 2025 STEPS



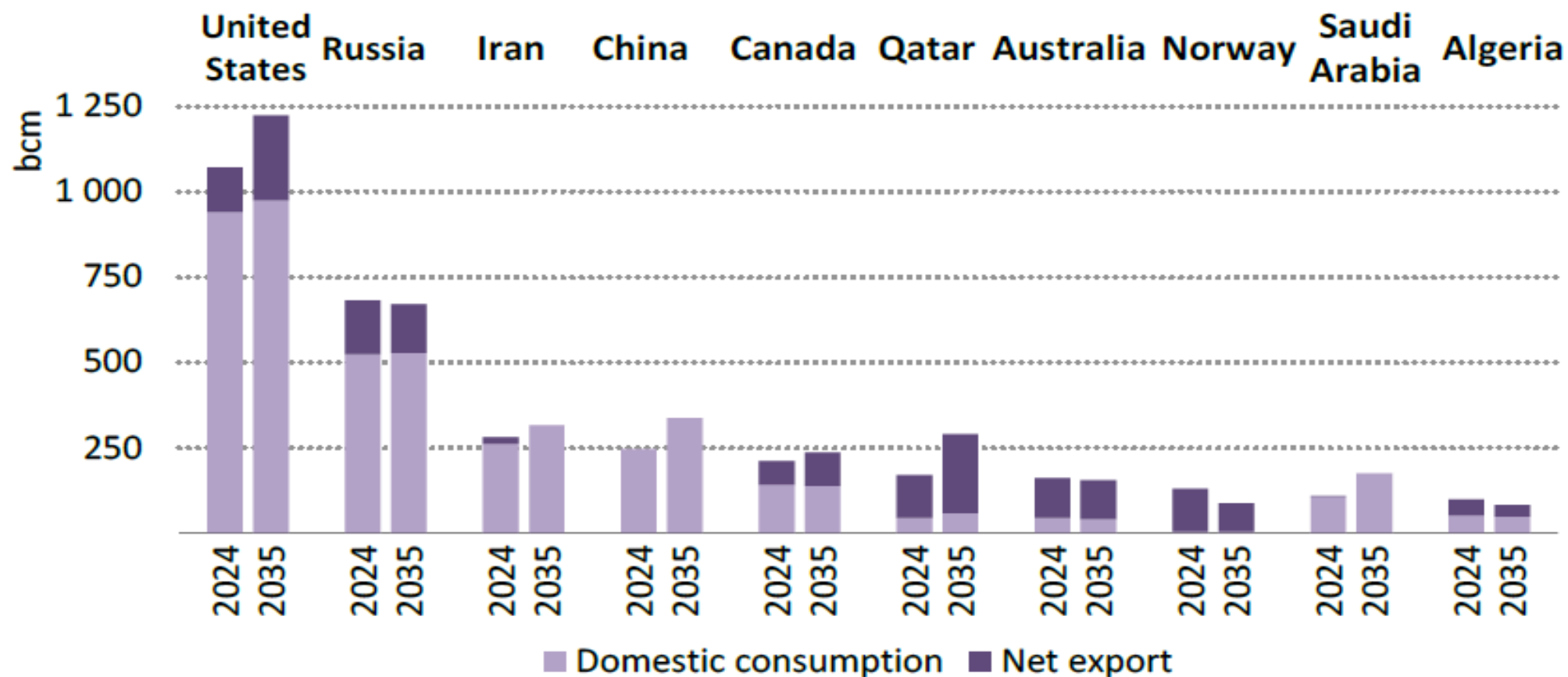
IEA. CC BY 4.0.

Natural gas demand growth levels off in the mid-2030s, with reductions in North America and Europe more than offsetting increases in Asia Pacific and Middle East

Note: bcm = billion cubic metres; Int. bunkers = international bunkers.



World Natural Gas Production by Countries - IEA 2025 STEPS



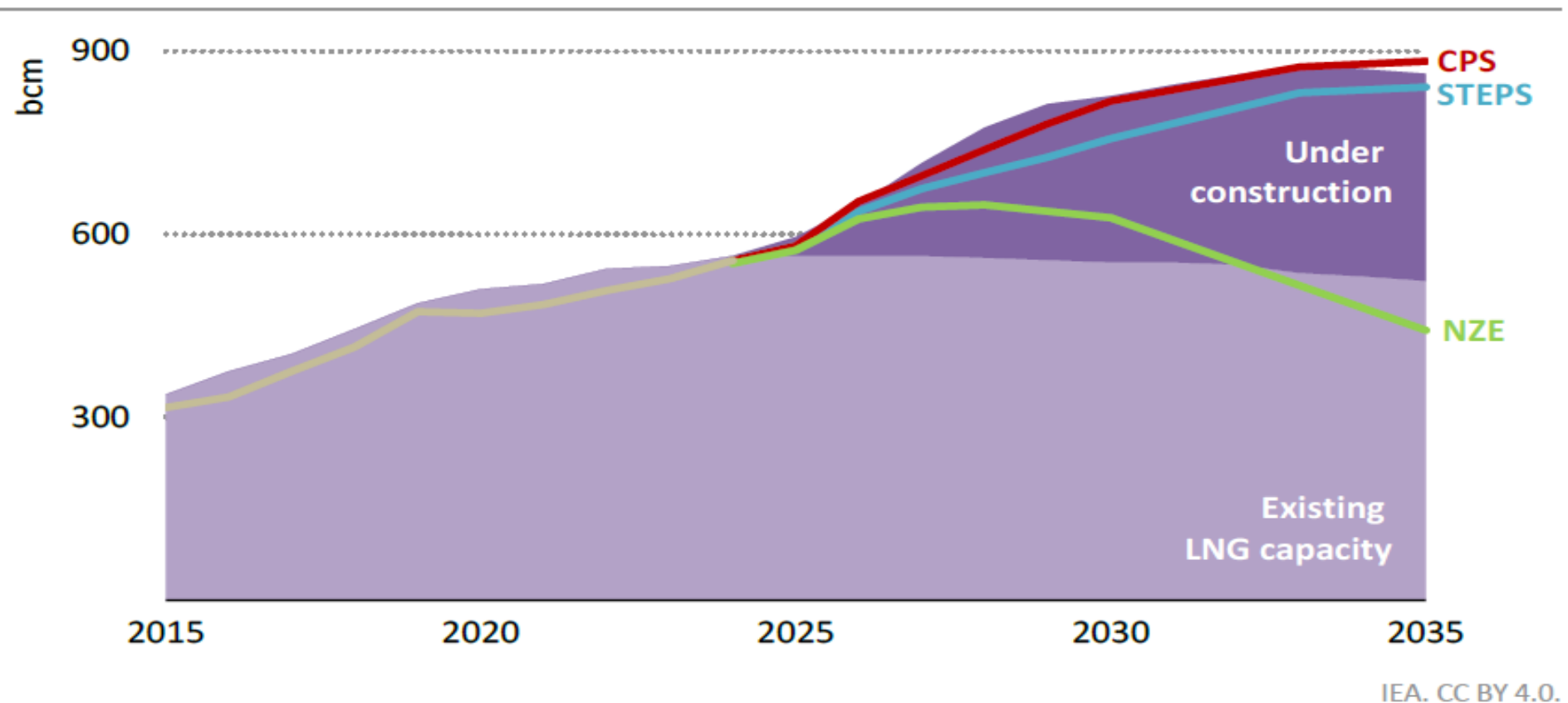
IEA. CC BY 4.0.

*The Middle East and United States drive growth in global gas supply to 2035,
and they add around 250 bcm to their combined export capacity*

Source: IEA WEO 2025



LNG Export Capacities - IEA 2025 Scenarios



The large upcoming wave of additional LNG export capacity is fully absorbed in the CPS but results in well-supplied global gas markets in the STEPS through to 2035

Note: CPS = Current Policies Scenario; STEPS = Stated Policies Scenario; NZE = Net Zero Emissions by 2050 Scenario.



Natural Gas Production - IEA 2025 Scenarios (G.m³)

	2010	2023	2024	Current Policies		Stated Policies	
				2035	2050	2035	2050
World	3 293	4 222	4 282	5 044	5 596	4 770	4 645
Conventional gas	2 792	2 912	2 955	3 350	3 782	3 162	3 136
Tight gas	268	316	319	383	294	373	220
Shale gas	155	895	897	1 201	1 414	1 130	1 194
Coalbed methane	77	84	93	85	81	81	70
North America	815	1 322	1 324	1 563	1 588	1 489	1 301
Central and South America	163	158	159	183	223	171	177
Europe	341	240	247	216	166	198	150
European Union	148	39	37	41	32	36	29
Africa	210	252	240	272	389	259	281
Middle East	464	707	717	1 092	1 393	1 012	1 166
Eurasia	814	837	877	933	997	894	894
Asia Pacific	487	705	717	785	840	748	676
Southeast Asia	215	204	209	185	202	176	140



Natural Gas Demand - IEA 2025 Scenarios (G.m³)

	2010	2023	2024	Current Policies		Stated Policies	
				2035	2050	2035	2050
World	3 317	4 138	4 254	5 044	5 596	4 770	4 645
North America	838	1 158	1 179	1 253	1 192	1 198	950
United States	678	925	942	1 022	943	975	733
Central and South America	151	154	157	188	222	177	177
Brazil	29	30	32	38	51	33	31
Europe	697	504	507	477	426	411	304
European Union	446	328	329	296	244	256	166
Africa	107	174	172	214	323	199	260
Middle East	370	582	596	837	1 077	773	870
Eurasia	578	633	660	693	713	690	684
Russia	467	503	526	529	507	529	490
Asia Pacific	575	931	982	1 330	1 565	1 274	1 345
China	110	397	428	632	724	584	606
India	64	68	75	137	209	139	187
Japan	95	90	91	97	93	87	67
Southeast Asia	149	176	184	238	285	244	272



Gas – Perspectives by OPEC



Natural Gas Demand by Regions by OPEC 2026

Natural gas demand by region, 2025–2050

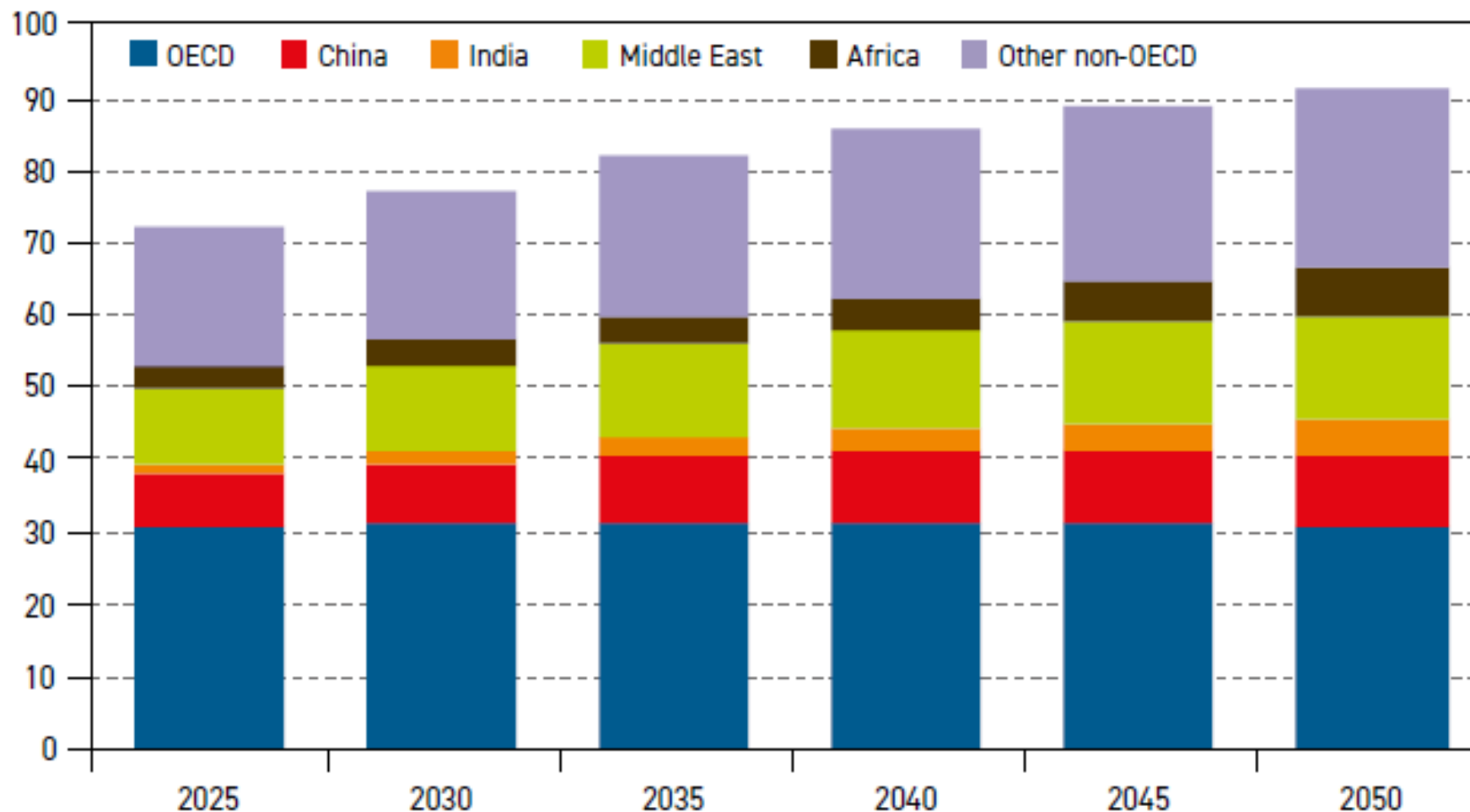
	Levels <i>mboe/d</i>						Growth <i>mboe/d</i>	Growth <i>% p.a.</i>	Share <i>%</i>	
	2025	2030	2035	2040	2045	2050	2025–2050	2025–2050	2025	2050
OECD Americas	19.9	20.3	20.6	20.8	20.8	20.5	0.5	0.1	27.7	22.4
OECD Europe	7.3	7.2	7.0	6.9	6.7	6.4	–0.8	–0.5	10.1	7.1
OECD Asia-Pacific	3.7	3.7	3.7	3.8	3.8	3.8	0.1	0.1	5.1	4.2
OECD	30.9	31.2	31.4	31.4	31.2	30.7	–0.2	0.0	43.0	33.6
China	7.2	8.4	9.2	9.6	9.8	9.9	2.7	1.3	10.0	10.8
India	1.3	1.8	2.3	3.1	4.0	5.2	3.8	5.6	1.8	5.7
Other Asia	4.9	5.8	6.7	7.4	7.9	8.1	3.2	2.0	6.9	8.9
Latin America	2.5	3.0	3.5	4.0	4.6	5.1	2.7	3.0	3.4	5.6
Middle East	10.3	11.7	12.8	13.5	14.1	14.4	4.0	1.3	14.4	15.7
Africa	3.0	3.5	4.1	4.8	5.6	6.5	3.6	3.2	4.1	7.1
Russia	8.7	8.4	8.1	7.9	7.6	7.4	–1.3	–0.6	12.0	8.1
Other Eurasia	2.8	3.0	3.3	3.5	3.6	3.6	0.8	1.0	4.0	4.0
Other Europe	0.3	0.3	0.4	0.4	0.4	0.4	0.1	1.2	0.4	0.5
Non-OECD	41.0	45.9	50.6	54.2	57.6	60.6	19.5	1.6	57.0	66.4
World	72.0	77.1	81.9	85.7	88.9	91.3	19.3	1.0	100	100

Source: OPEC WOO 2026



Natural Gas Demand by Regions by OPEC 2026

Natural gas demand by region, 2025-2050, mboe/d



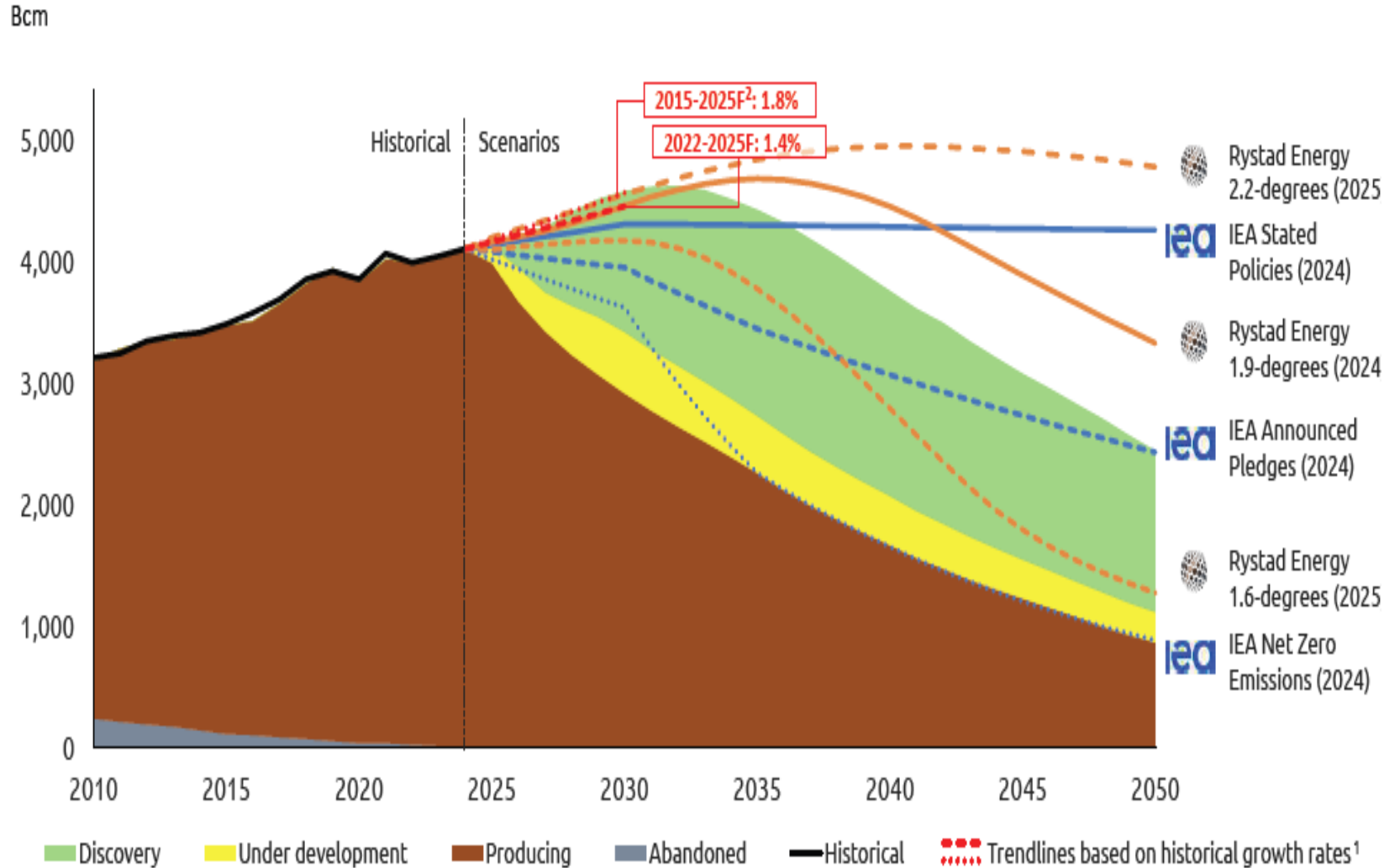
Source: OPEC WOO 2026



Gas – Perspectives by IGU



Global Natural Gas Demand/Supply Scenarios by IGU 2025



Notes:

1) This analysis considers two trendlines based on historical growth rates: the 2022-2025F trendline and the 2015-2025F trendline. Each trendline uses a consistent annual growth rate towards 2030, which is calculated as the average of the annual growth rates of the historical years considered, respectively 1.4% and 1.8%.

2) The 2015-2025F trendline excludes Covid-19 impacted years 2020 and 2021 from the average growth rate calculation to adjust for the unusually low and high growth rates observed in the respective years.

- a) 'Abandoned' denotes all abandoned fields which have stopped producing or where production was suspended by owners.
- b) 'Producing' includes all the assets that are currently producing. Also, refinery gains are included.
- c) 'Under development' denotes assets for which development has been approved by companies & government, but production has not yet started.
- d) 'Discovery' includes assets where discoveries have been made but are not yet in a phase of further development (appraisal, field evaluation)

Source: International Gas Union (IGU) Global Gas Report 2024
/Rystad Energy



6

A zoom on Liquefied Natural Gas (LNG)



TABLE OF CONTENTS

1. General considerations
2. Resources, reserves
3. Conventional and Unconventional Gaseous Hydrocarbons
4. Production, consumption: past and present
5. Production, consumption: perspectives
6. A zoom on Liquefied Natural Gas (LNG)
7. Three independant world markets
8. The gas chain components and their economics: Production & Processing
9. The gas chain components and their economics: Transportation
10. The gas chain components and their economics: Storage
11. Technology and innovation
12. Competing fuels and Gas prices
13. Evolution of national gas markets towards liberalization & globalization
14. Example of challenging gas projects: Shtokman & Yamal



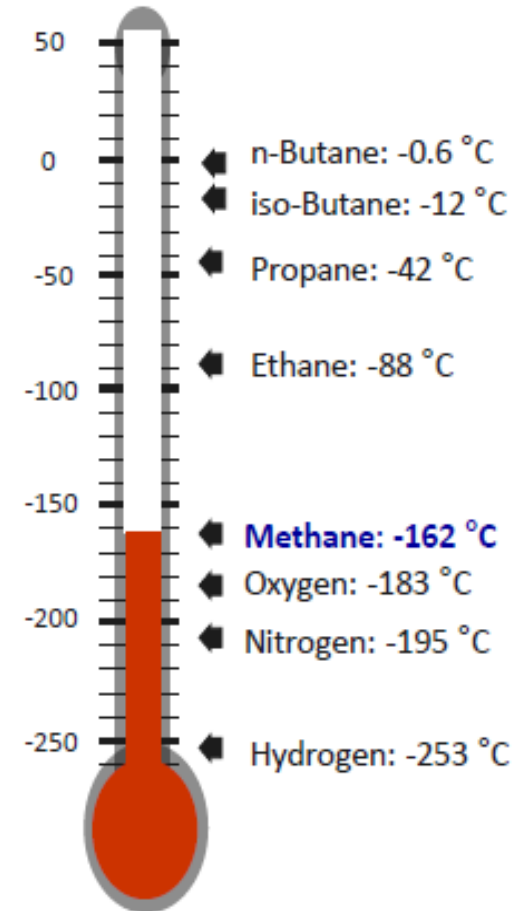
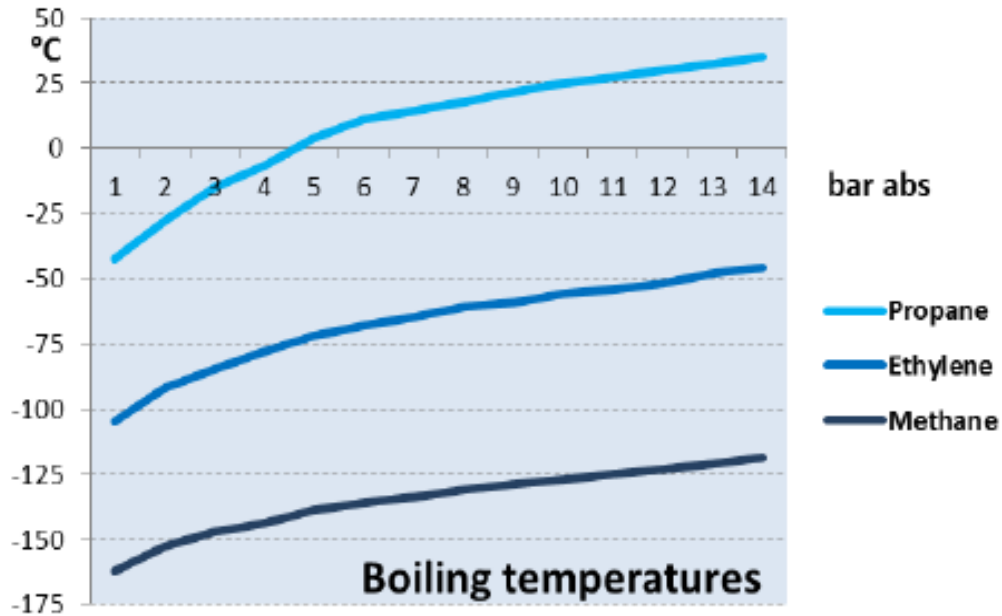
LNG Business



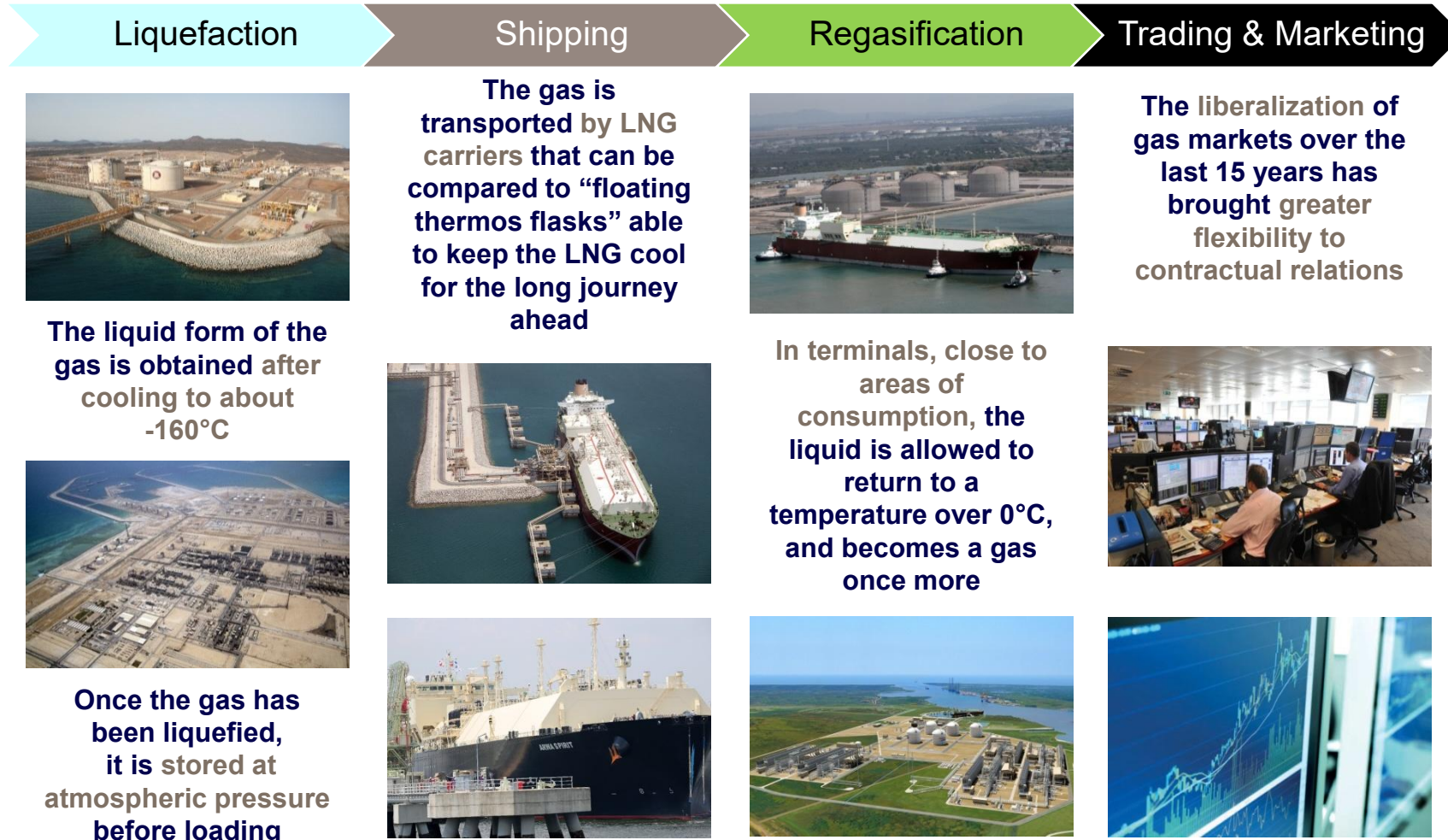
Prelude FLNG. Courtesy Photographic Services, Shell International Limited



LNG Properties: Boiling Temperature



Along the LNG Value Chain



LNG: Advantages and Challenges

ADVANTAGES

Reserves located far away from the main consumption areas are now being developed and produced

An alternative to the costly development of pipelines

Gas can be transported over long distances at a reasonable cost

Greater flexibility owing to the possibility of redirecting cargo in transit

A market that was originally region-focused is now open globally

Good returns with long plateau projects

CHALLENGES

Lengthy studies: currently, it takes at least ten years from the point when studies begin to delivery of the first cargo of LNG

Know-how: many interdependent, complementary skills are required to manage all the risks associated with projects of this size

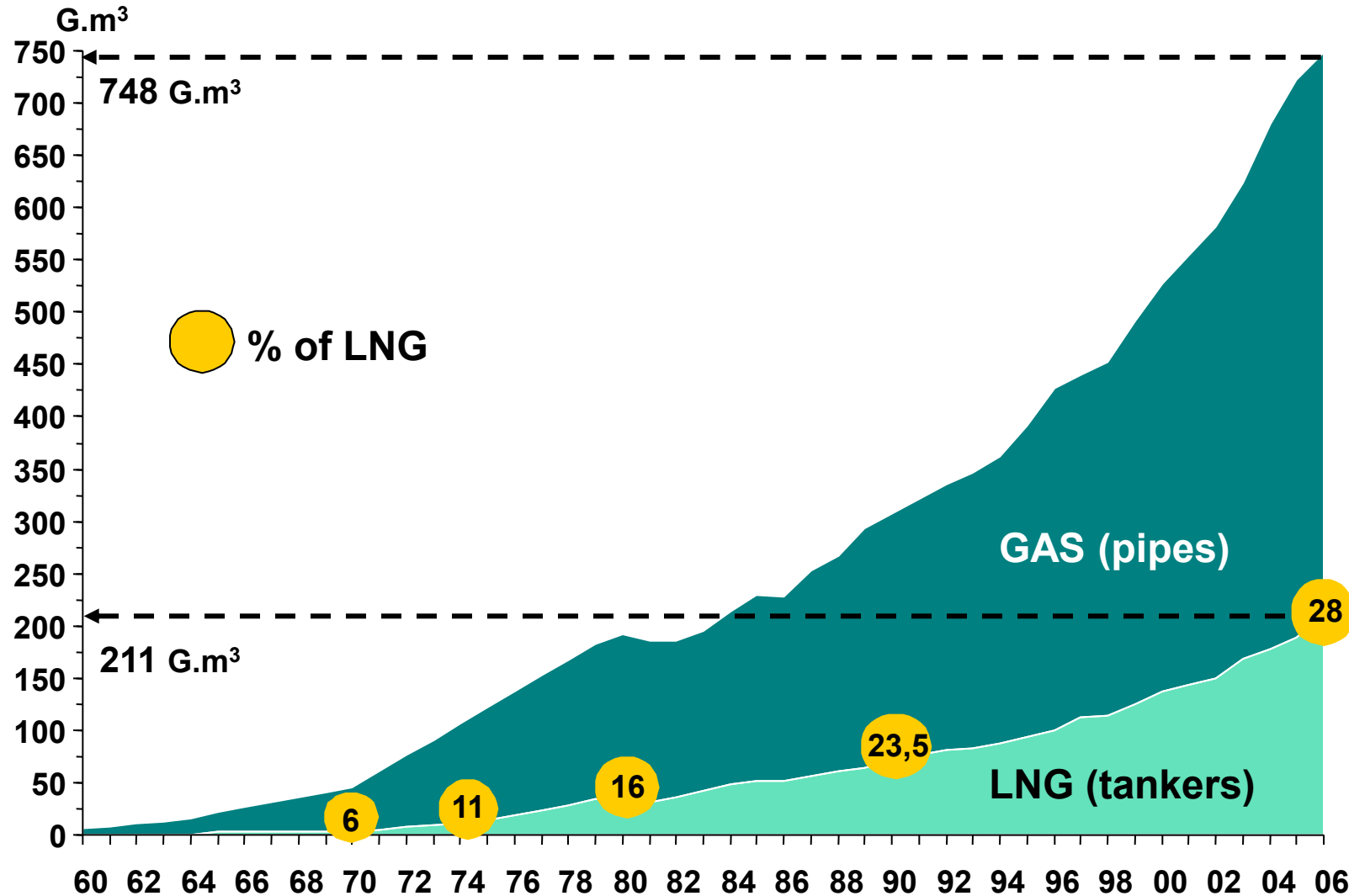
More and more deals are “hub indexed”, which shows the dynamism of the market



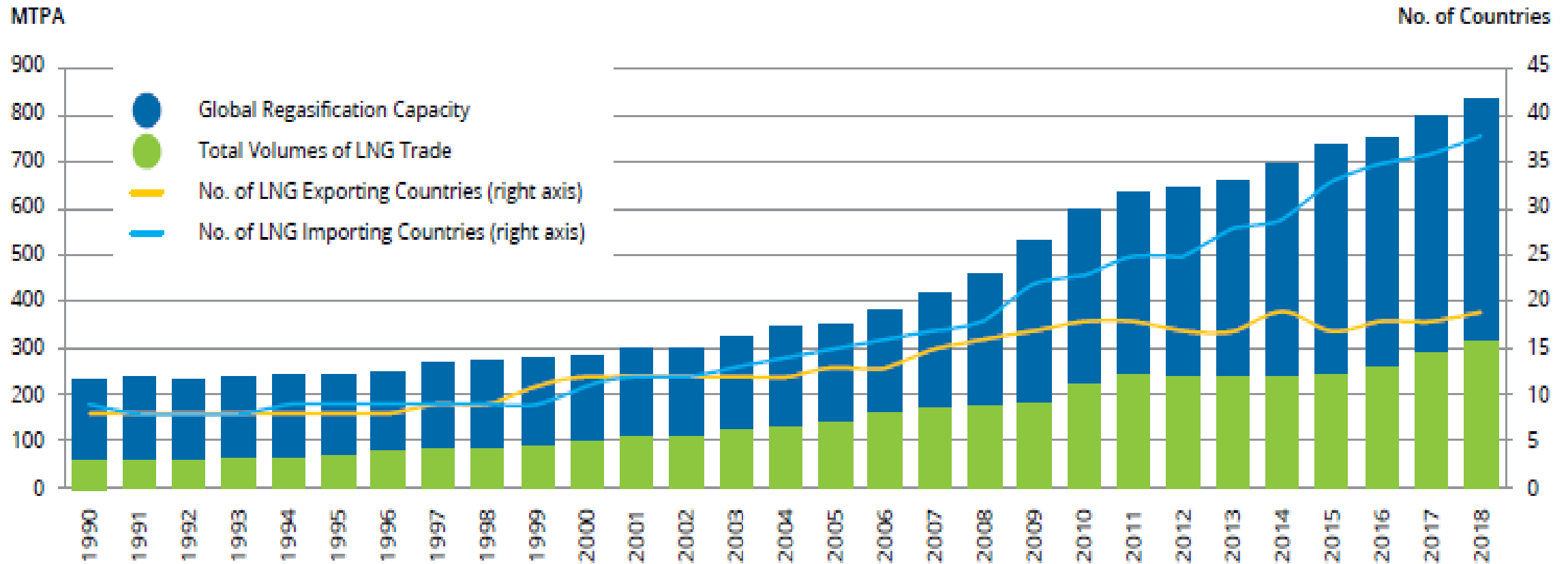
LNG Trade – History & Current Situation



Reminder: History of evolution of Natural Gas international trade 1960 - 2006



Reminder - LNG Trade Volumes 1990 - 2018

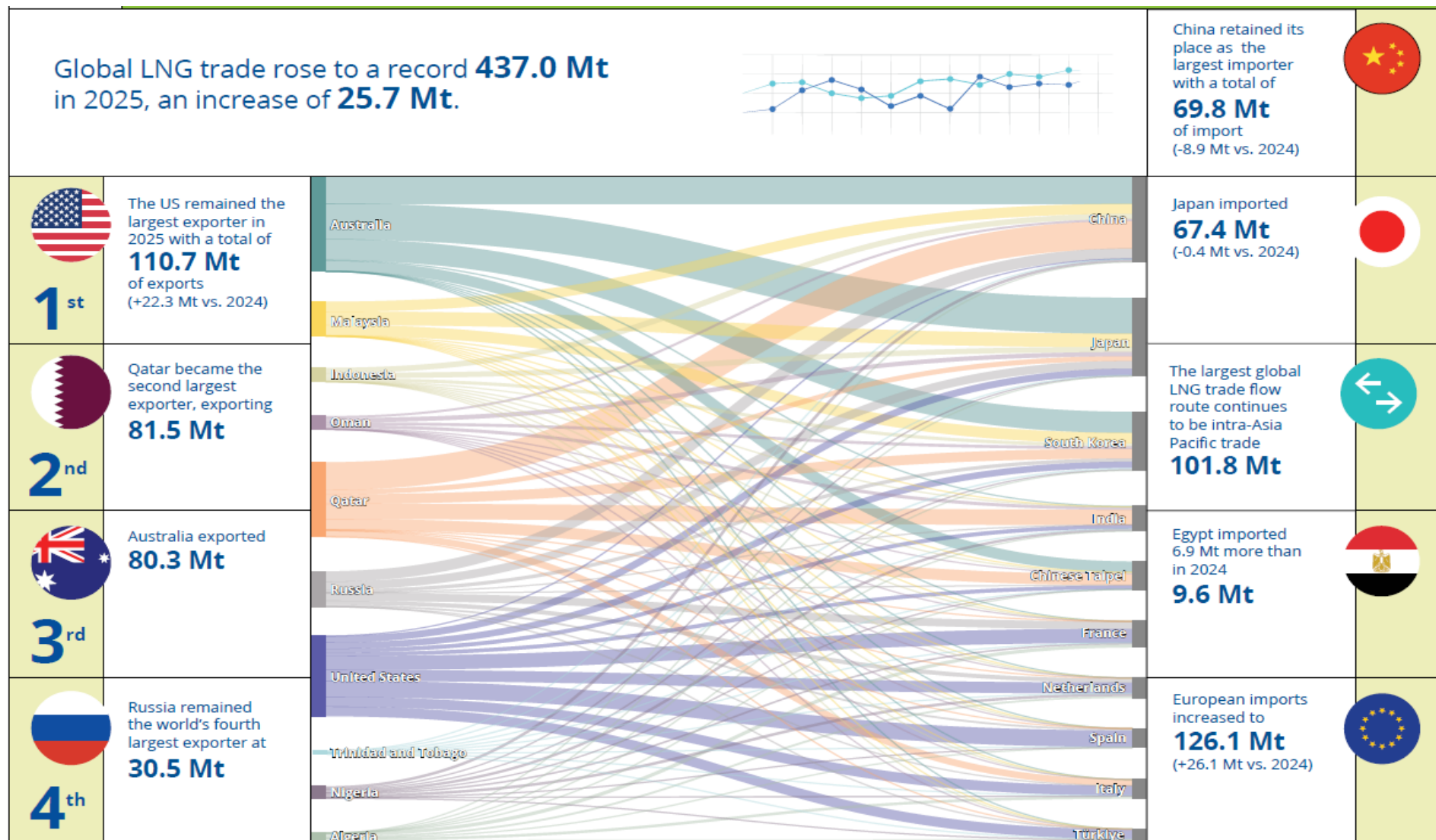


Source: IHS Markit, IEA, IGU

Source: International Gas Union (IGU) 2019



Global LNG Trade 2025



Source: Rystad Energy

The diagram only represents trade flows between the top 10 exporters and top 10 importers.



LNG Trade between Regions – 2025 (437 Mt) vs 2024 (411 Mt)

Table 3.1: LNG trade between regions, 2025 vs 2024 (Mt)

		Asia Pacific Exports	Middle East Exports	North America Exports	Africa Exports	Russia Exports	Latin America Exports	Europe Exports	Grand Total
Asia Pacific Imports	2024	96.8	32.2	19.2	6.7	7.9	2.3	-	165.0
	2025	101.8	32.5	15.9	7.0	8.8	3.3	-	169.2
Europe Imports	2024	-	10.6	46.3	18.2	16.9	4.3	4.8	101.1
	2025	0.1	9.1	74.1	22.4	14.0	4.0	3.1	126.7
Asia Imports	2024	41.8	46.0	10.3	10.0	8.5	1.0	-	117.6
	2025	36.8	49.8	5.1	7.7	7.7	0.7	-	107.8
Latin America Imports	2024	-	-	8.7	0.8	-	3.3	-	12.9
	2025	-	0.1	7.2	0.7	-	3.1	0.02	11.1
Middle East Imports	2024	0.04	5.4	1.7	1.6	0.2	0.1	-	9.1
	2025	-	6.6	1.4	1.5	-	-	0.03	9.4
North America Imports	2024	0.3	-	0.3	0.3	-	2.0	0.2	3.2
	2025	0.1	-	1.3	0.2	-	1.4	-	3.1
Africa Imports	2024	-	-	2.0	0.3	-	0.1	-	2.4
	2025	-	-	8.9	0.4	-	0.2	0.2	9.7
Russia Imports	2024	-	-	-	-	0.1	-	-	0.1
	2025	-	-	-	-	-	-	-	-
Total	2024	138.9	94.2	88.6	38.0	33.5	12.9	5.0	411.2
	2025	138.8	98.0	113.9	39.8	30.5	12.7	3.3	437.0

Source: Rystad Energy

Note that interregional trade does not account for re-exports.



LNG Trade between Regions 2025 - 437 Mt

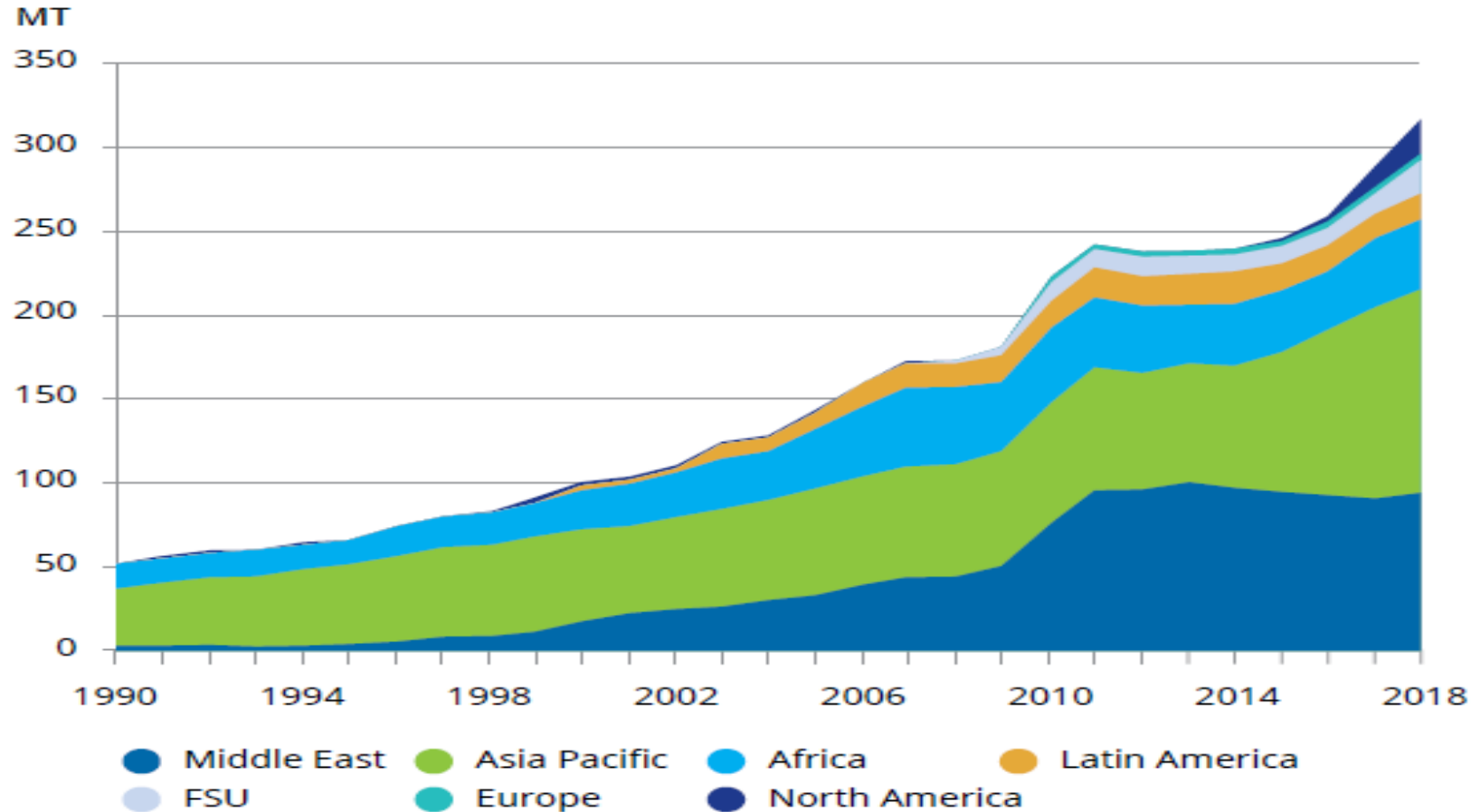


Source: Rystad Energy

LNG Exports



Reminder: LNG Exports and Market Share by Countries Evolution 1990 - 2018

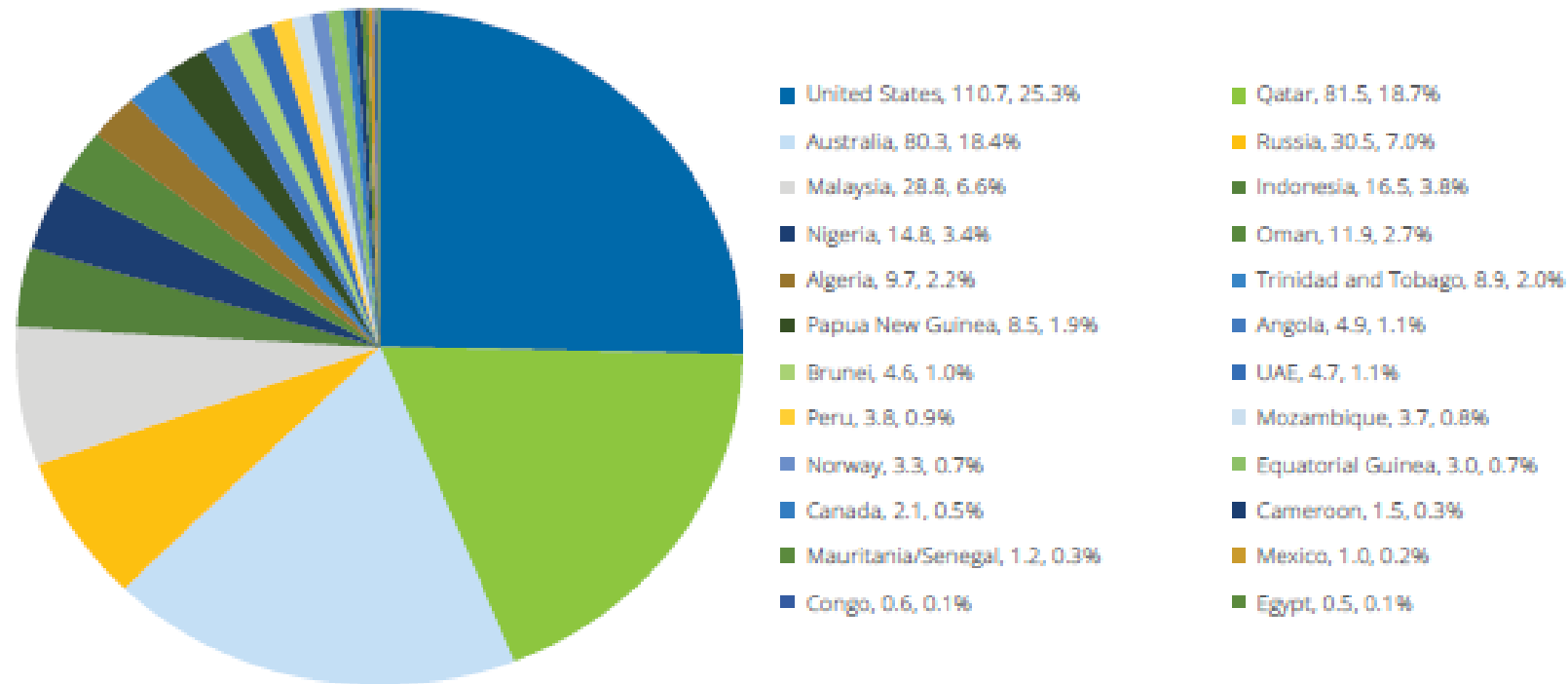


Note: FSU = Former Soviet Union
Sources: IHS Markit, IGU



LNG Exports and Market Share by Countries

Year 2025 = 437 Mt (+ 6,3% vs 2024) - US n°1

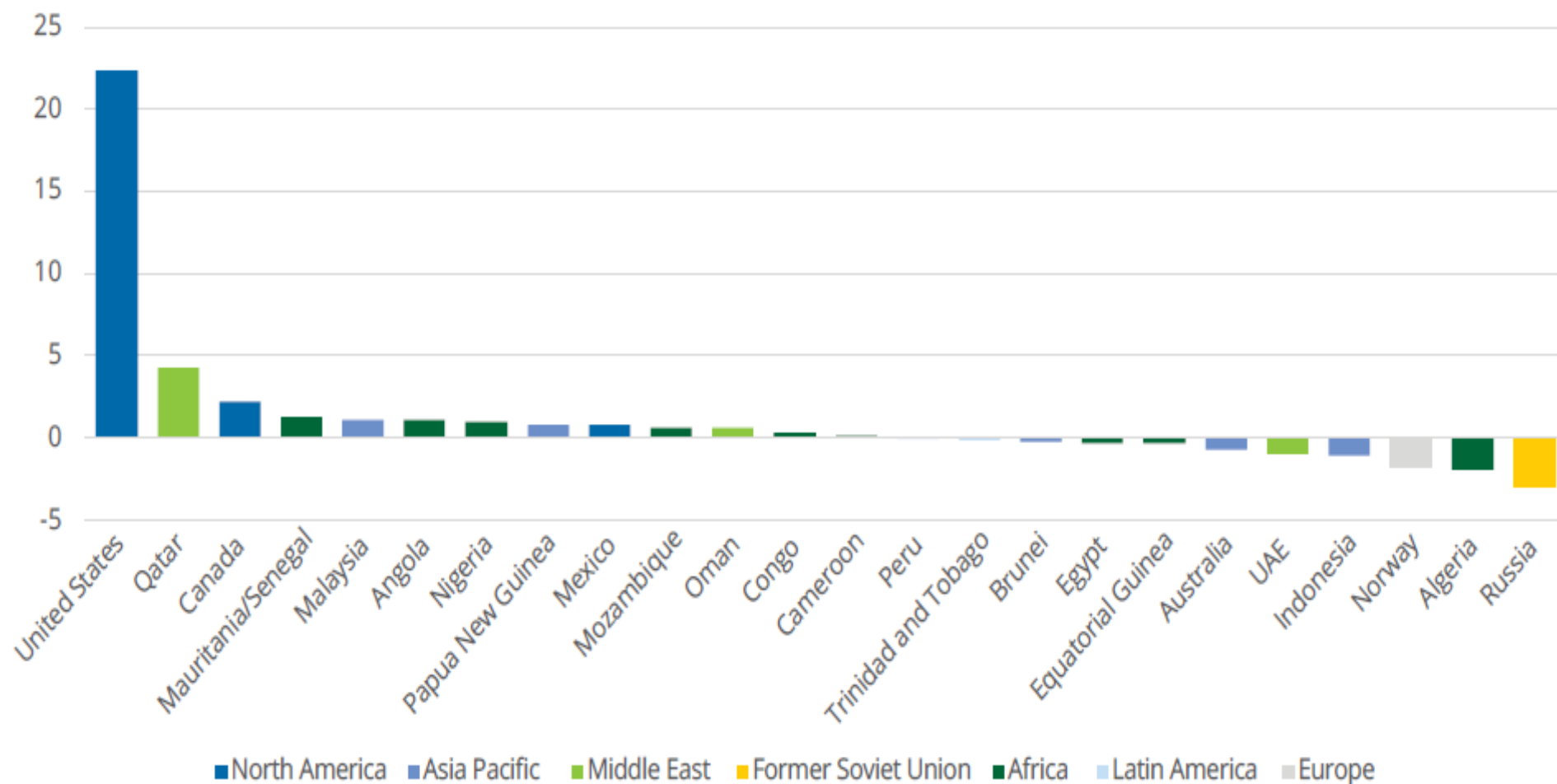


Source: Rystad Energy

The US significantly widened its lead as the world's largest LNG exporter in 2025, at a total of 110.74 Mt, equal to 25% of global LNG output and up 22.3 Mt from the previous year. The increase points to a major expansion in available export capacity and improved utilisation, with the US alone accounting for the vast majority of global growth in 2025. This also lifted North America's share of global LNG trade materially and reshaped interregional flows, especially towards Europe.



Incremental LNG Exports by Countries 2025 vs 2024 (Mt)



Source: Rystad Energy

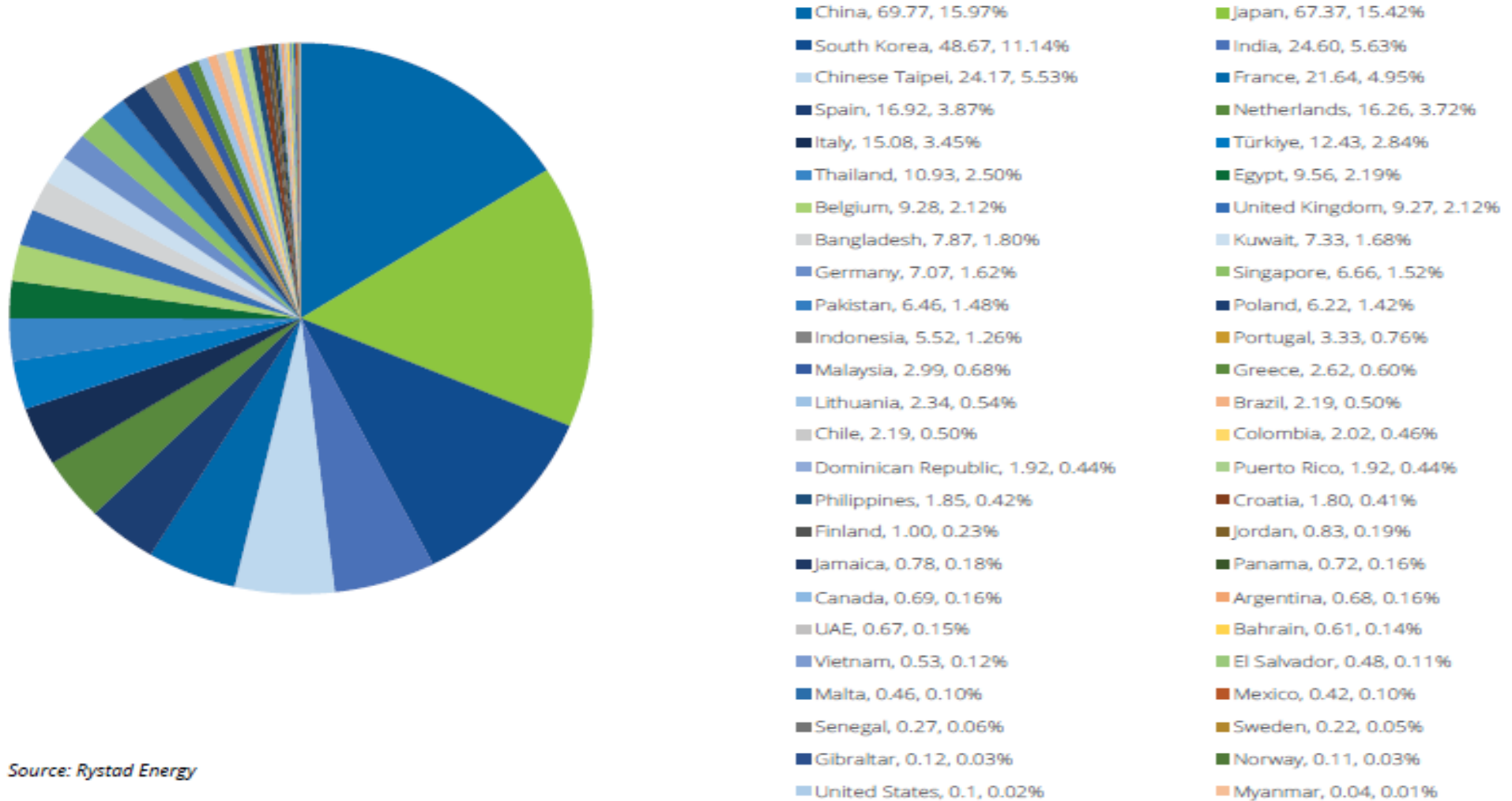


LNG Imports



LNG Imports and Market Share by Countries

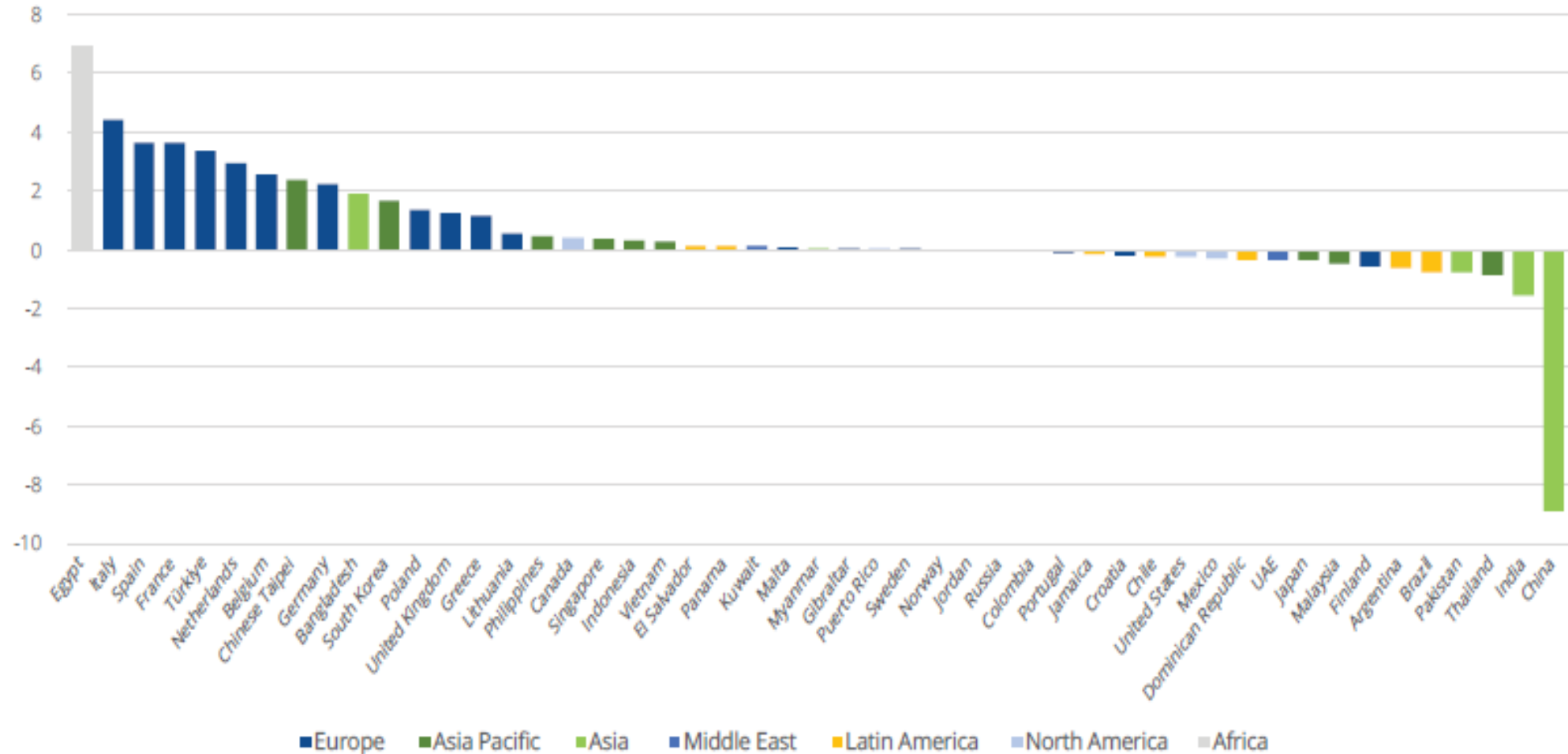
Year 2025 = 437 Mt – China n°1



Source: Rystad Energy



Incremental LNG Imports by Countries 2025 vs 2024 (Mt)



Source: Rystad Energy



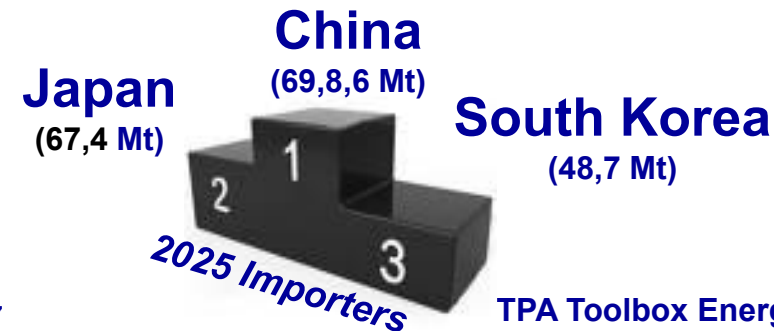
LNG BUSINESS: MORE AND MORE PLAYERS & ACTIVITY

2005: 143 Mt
13 exporters
15 importers
59 flows

2025: 437 Mt
24 exporters
50 importers
6870 voyages



Source: Rystad Energy



- In 2019, US replaced Malaysia as n°3 LNG exporter
- In 2020, Australia replaced Qatar as n°1 LNG exporter
- In 2021, US increased by 52% their exports
- In 2021, China replaced Japan as n°1 LNG importer
- In 2022, US replaced Qatar as n°2 LNG exporter
- In 2022, Japan replaced China as n°1 LNG importer
- In 2022, France became the 4th LNG importer
- In 2023, US replaced Australia as n°1 LNG exporter
- In 2023, China replaced Japan as n°1 LNG importer. France n°5 LNG importer

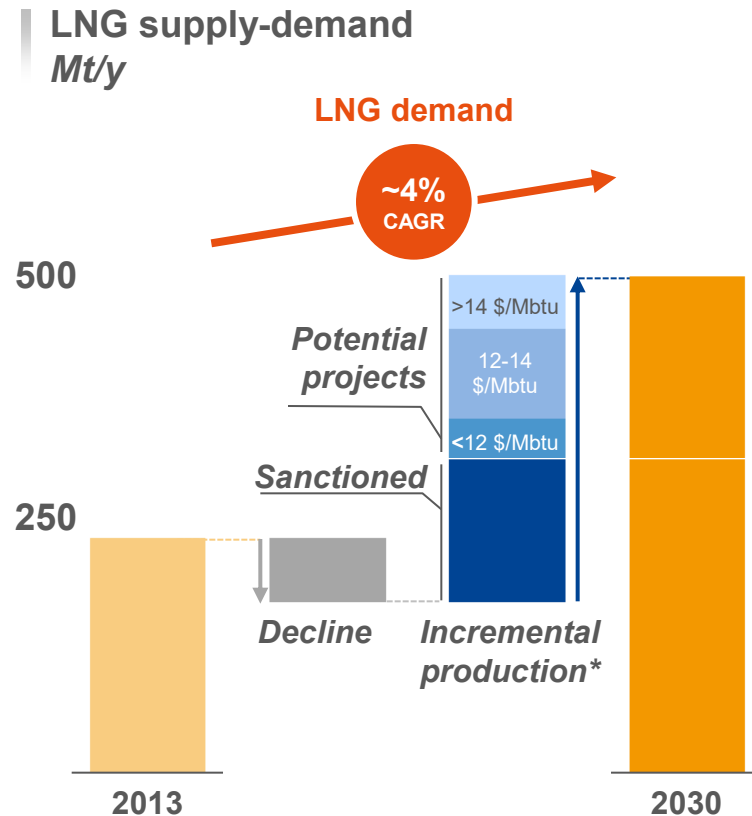


LNG Business – TotalEnergies position & strategy

See Book 2 – Chapter 7



Reminder: Robust LNG fundamentals – TotalEnergies vision 2015



- ◆ **Demand to double by 2030**
most of new supply not yet sanctioned
- ◆ **New projects require adequate LNG prices**
 - New LNG countries
 - US export economics
- ◆ **Total well positioned**
 - Projects already sanctioned with favorable price formula
 - Low breakeven projects
 - Integrated along the entire LNG chain with strong trading position

High LNG prices required to encourage investment

* Break even at IRR 15% nominal
Source: Total 2015

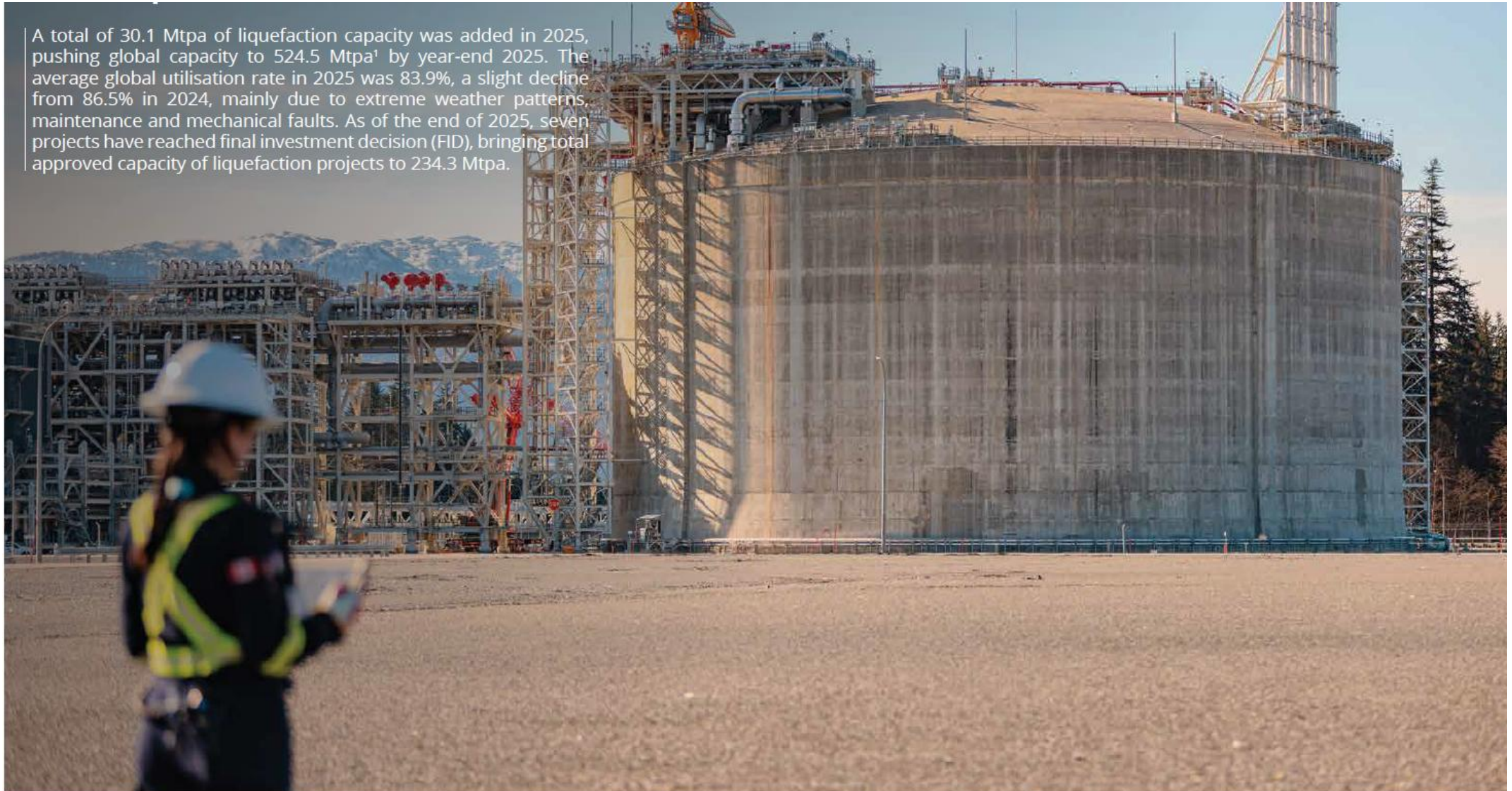


LNG Facilities in the World



Liquefaction Plants

A total of 30.1 Mtpa of liquefaction capacity was added in 2025, pushing global capacity to 524.5 Mtpa¹ by year-end 2025. The average global utilisation rate in 2025 was 83.9%, a slight decline from 86.5% in 2024, mainly due to extreme weather patterns, maintenance and mechanical faults. As of the end of 2025, seven projects have reached final investment decision (FID), bringing total approved capacity of liquefaction projects to 234.3 Mtpa.



Courtesy LNG Canada



Liquefaction Plants – Total Capacity 2025 = 525 Mtpa

Global liquefaction capacity reached **524.5 Mtpa** in 2025.

Capacity Additions for 2025



30.1 Mtpa
of liquefaction capacity brought online



6.1%
year-on-year growth vs 2024



United States
116.9 Mtpa
Market with the highest liquefaction capacity



Australia
85.1 Mtpa



Qatar
77.1 Mtpa

Pre-FID



1,105.4 Mtpa
of liquefaction capacity currently in pre-FID stage

384.4 Mtpa
from the US

227.3 Mtpa
from Canada



170.4 Mtpa
from Russia

45.5 Mtpa
from Australia



FIDs and Under Construction



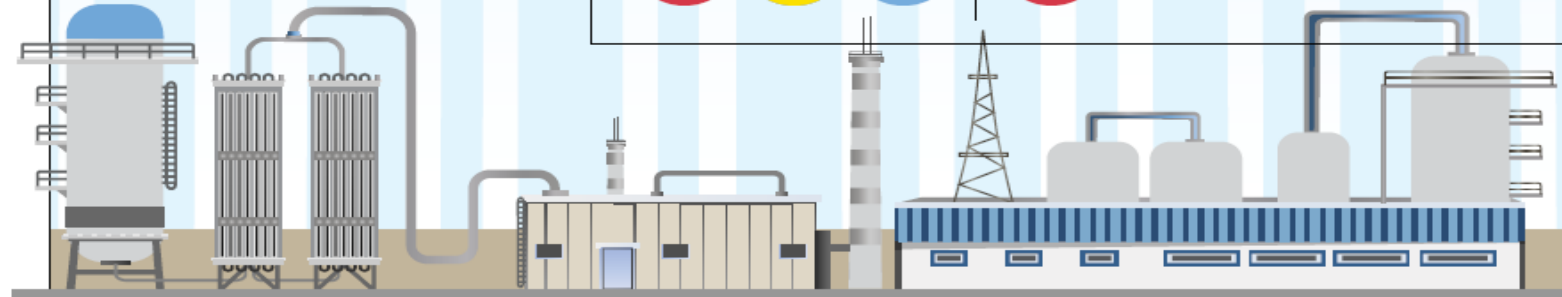
68.4 Mtpa
FID in 2025



234.3 Mtpa
of liquefaction capacity under construction or approved for development as of Dec 2025

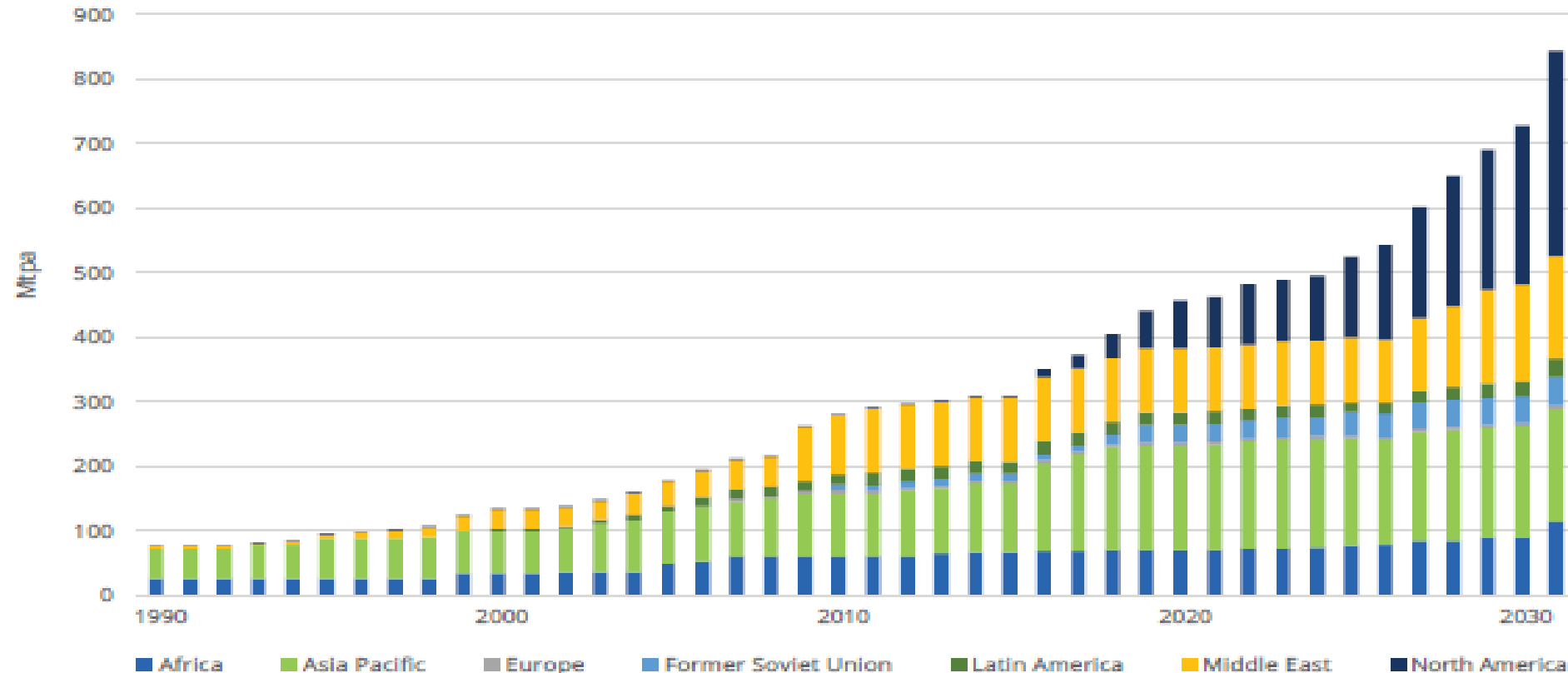


112 Mtpa
across 6 LNG projects



World LNG Liquefaction Capacity evolution by Regions 1990 – 2030

Important Growth expected (Impact of Ukraine/Russia war)

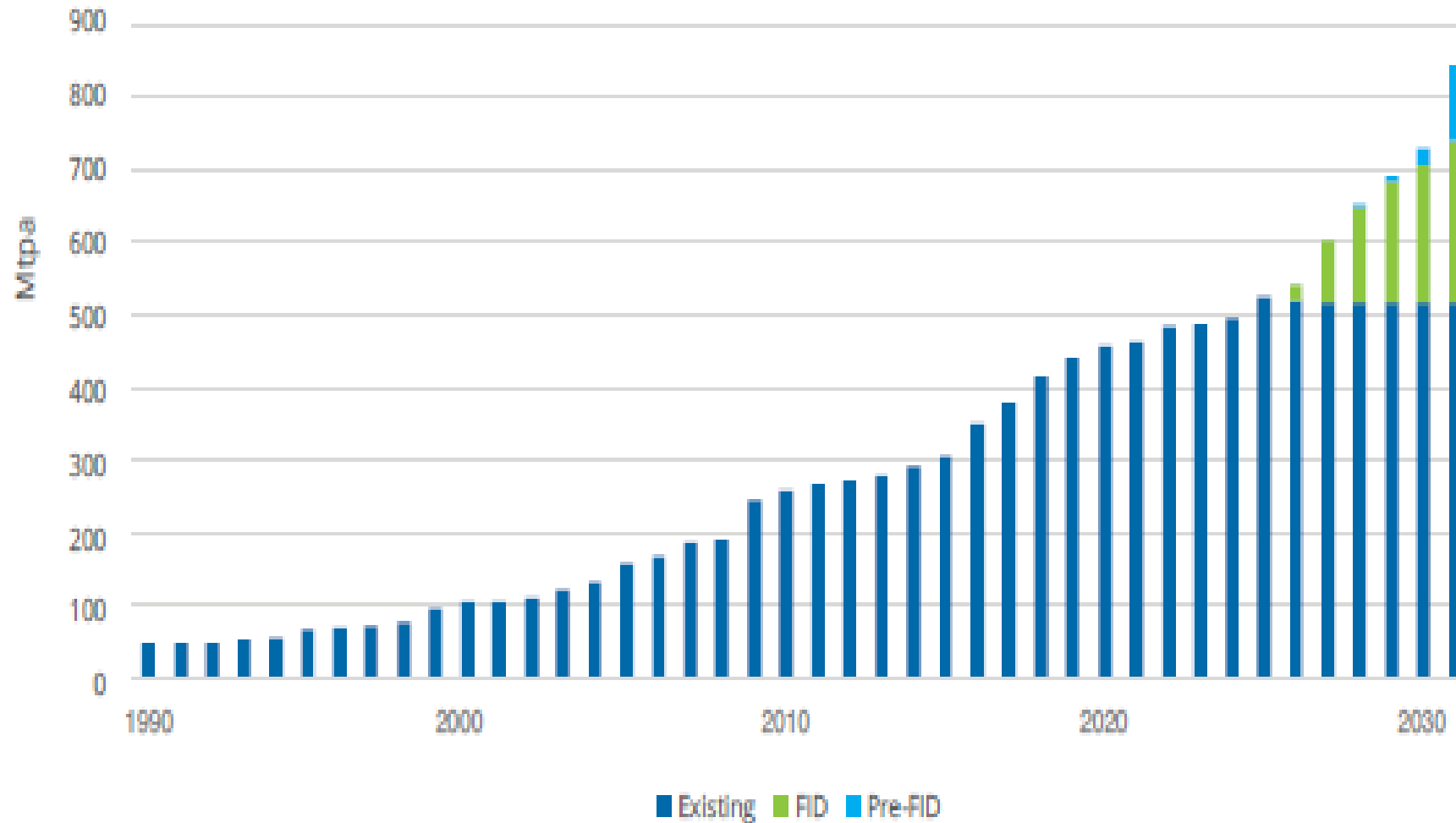


Source: Rystad Energy

The liquefaction capacity brought online globally in 2025 includes the addition of Plaquemines LNG T9-T36 (15.1 Mtpa, assuming startup of the eight trains in the first four blocks in 2024 for simplicity) and Corpus Christi Stage 3 (6.0 Mtpa) in the United States (US), LNG Canada (7.0 Mtpa) on the North American West Coast, Tortue/Ahmeyim FLNG phase 1 (2.5 Mtpa) in Africa while Arctic LNG 2 also added 6.6 Mtpa of capacity.



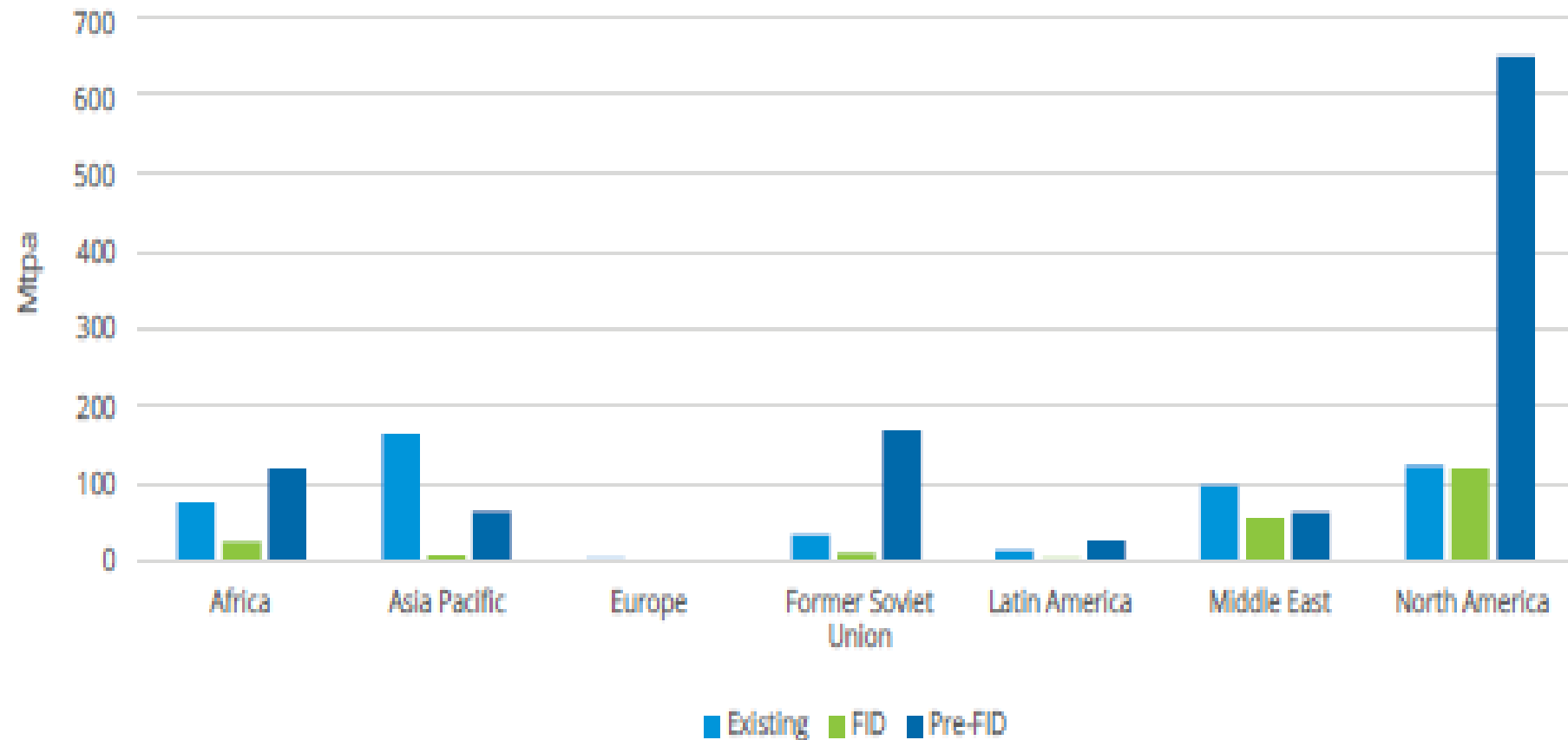
World LNG Liquefaction Capacity evolution 1990 – 2030 (Existing + FID + Pre-FID)



Source: Rystad Energy



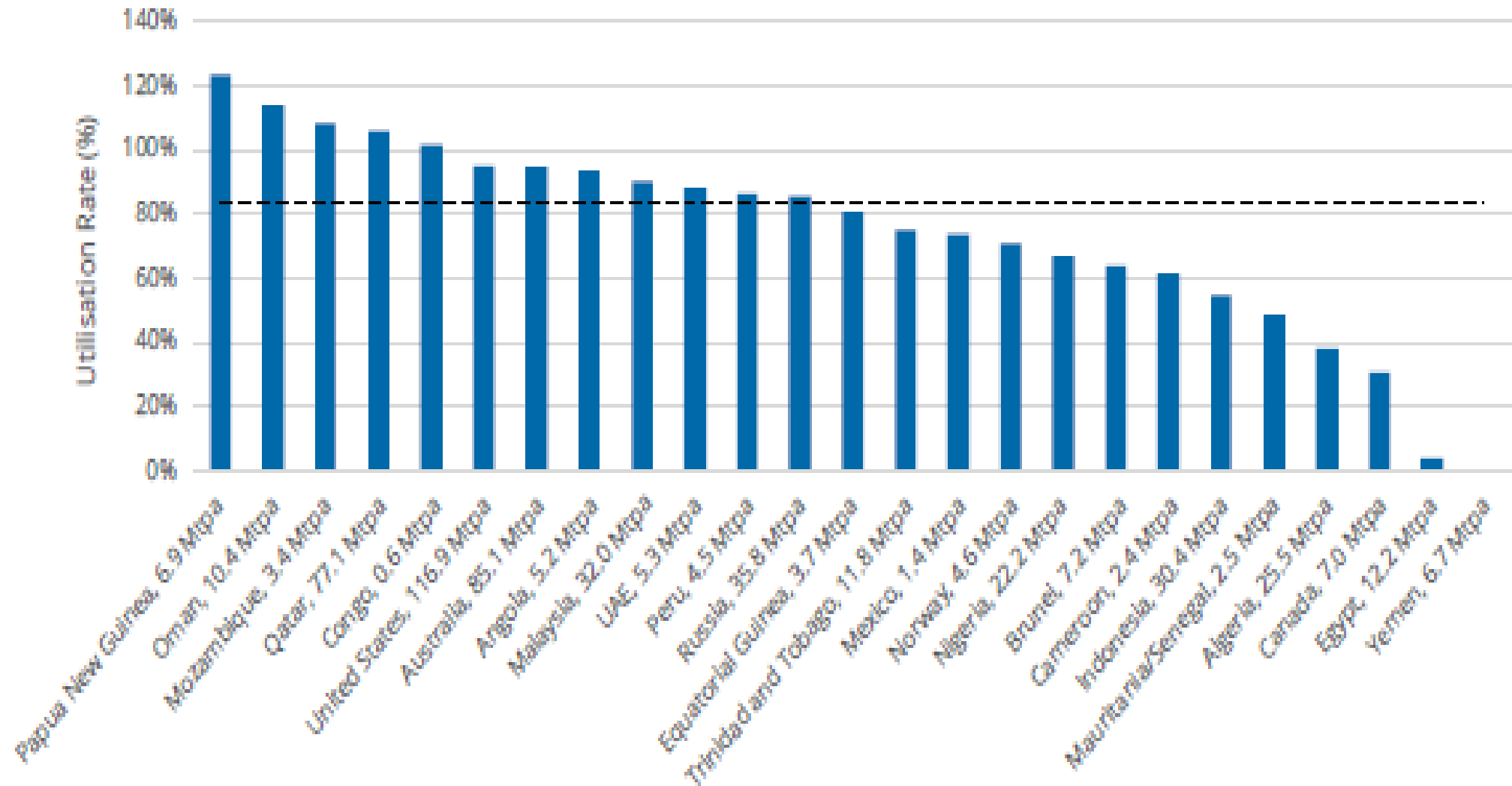
Global Liquefaction Capacity by Region & Status End 2025 – High number of new potential Projects



Source: Rystad Energy



Global Liquefaction Capacity Utilisation in the World - 2025



Source: Rystad Energy



Existing operational & FID LNG plants in the world expected to commission by 2030 at End 2025



Note:
Numbers in parentheses behind project names refer to Appendix 1: Table of Global Liquefaction Plants and Appendix 2: Table of Global Liquefaction Plants Approved or Under Construction
Source: Rystad Energy



Qatargas Liquefaction Plant



The Yamal Project – Russia

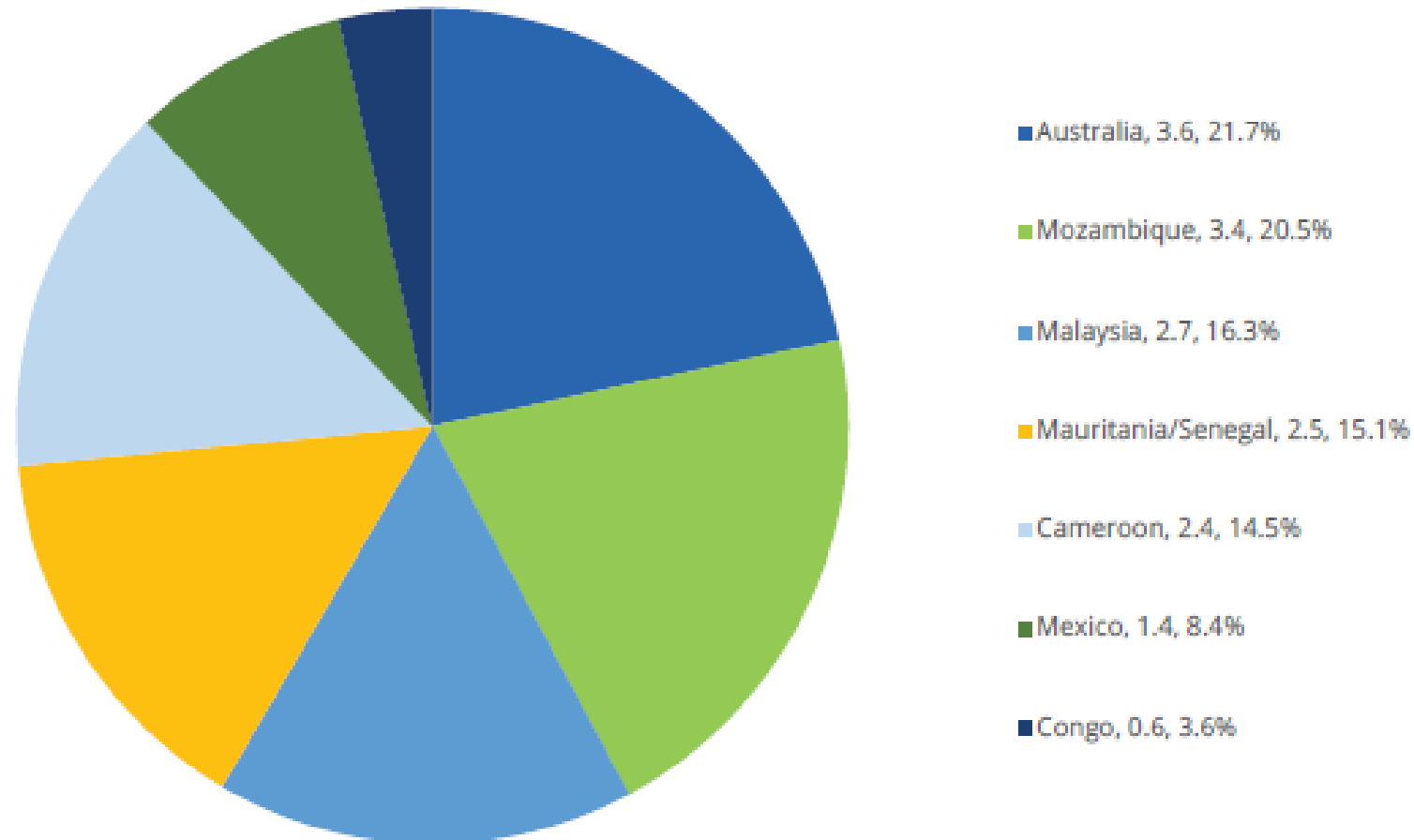
Project Joint-Venture structure has been reshaped following Russia-Ukraine war



Floating LNG (FLNG)



Global operational FLNG Projects Capacity End 2025 (16,6 Mtpa operational at End 2025)

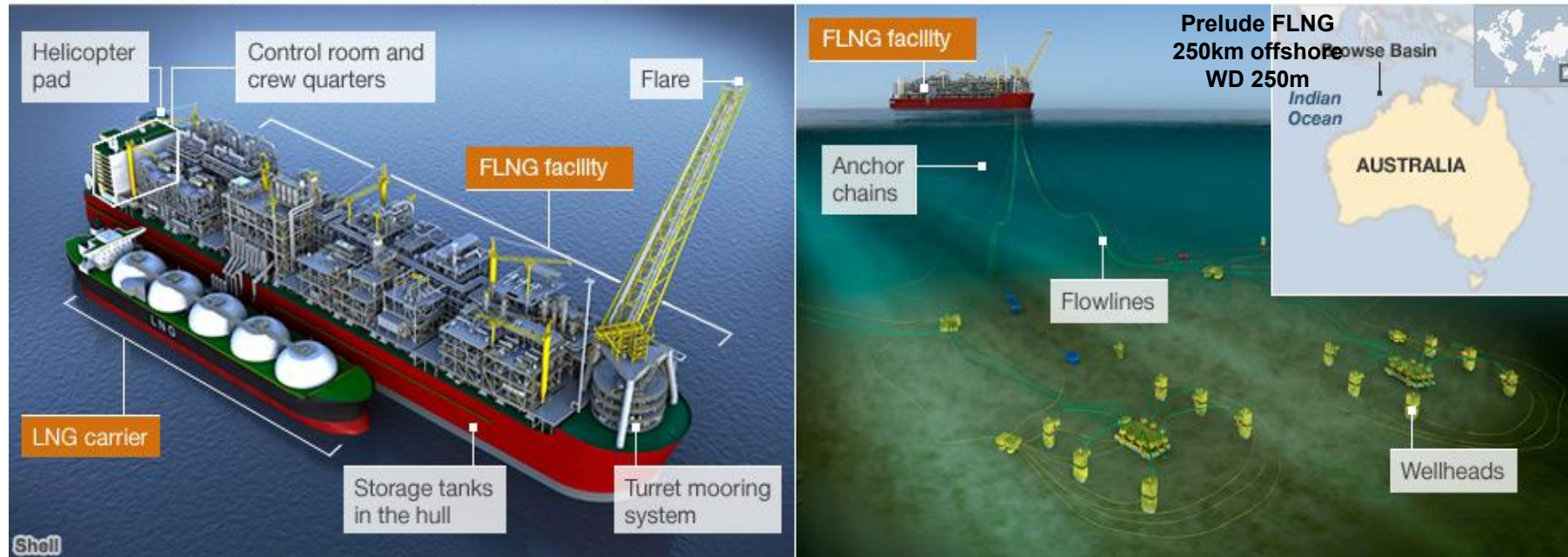


Source: Rystad Energy



SHELL Prelude FLNG (Floating LNG) - Australia

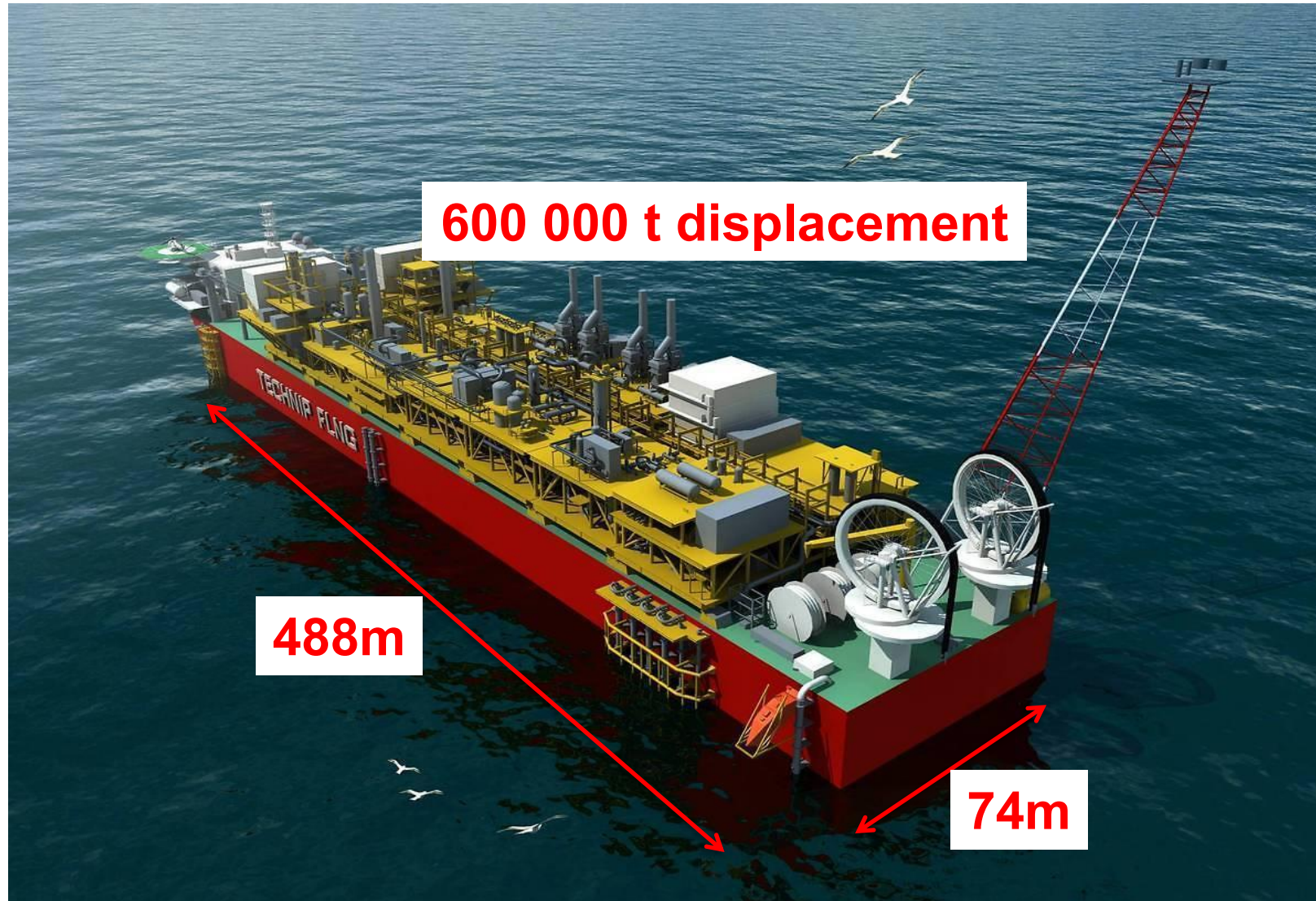
Shell's Floating Liquefied Natural Gas (FLNG) Project



- ◆ 3TCF +120 m bbl condensate reservoir
- ◆ First FLNG under construction (FID May 2011 , on site 2016-17)
- ◆ Size 488mx75m - 600,000 tons of steel
- ◆ Production : 3,6 Mtpa of LNG+1,6 Mtpa of Condensate+0,6 Mtpa of LPG



Floating LNG – Shell Prelude project



The Coral-Sul FLNG to operate at the Coral South project Offshore Mozambique



LNG Receiving Terminals

62.9 Mtpa of receiving capacity
was added in 2025.

13

new terminals
in 2025

7

expansion projects at
existing terminals



China commissioned 4 new onshore terminals and
expanded 1 existing LNG regasification plant

5

new floating terminals:
**Egypt (2), Jordan (1),
Italy (1), Senegal (1)**



8

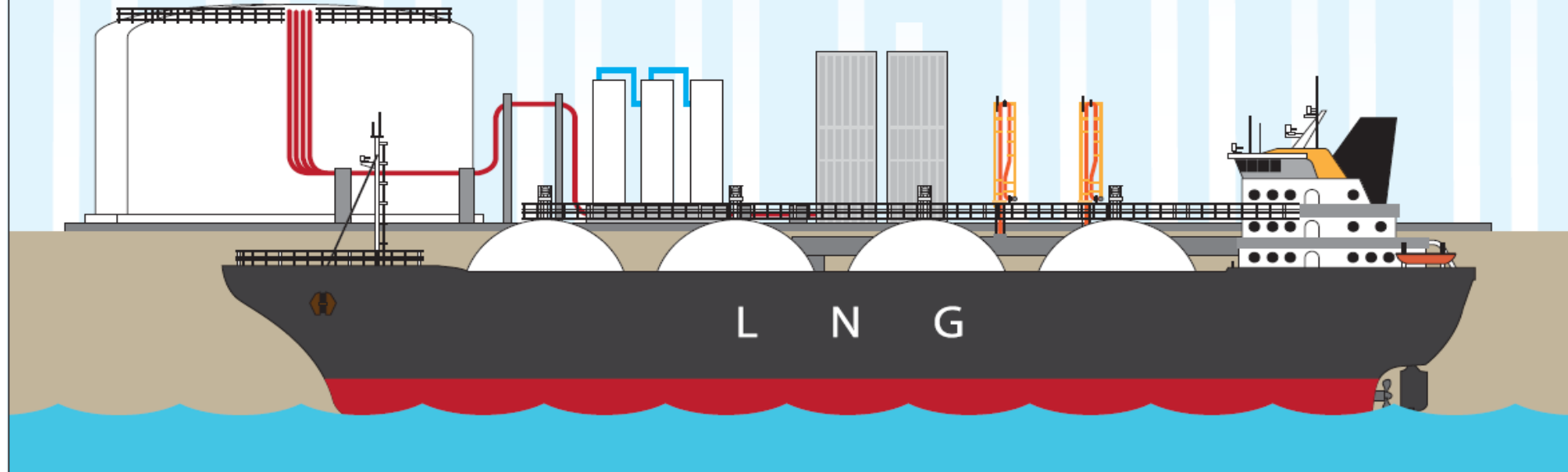
new markets are building
their first LNG import terminals

12

floating and offshore projects
had reached FID

229.3 Mtpa

of new regasification capacity
under construction



LNG Receiving Terminals

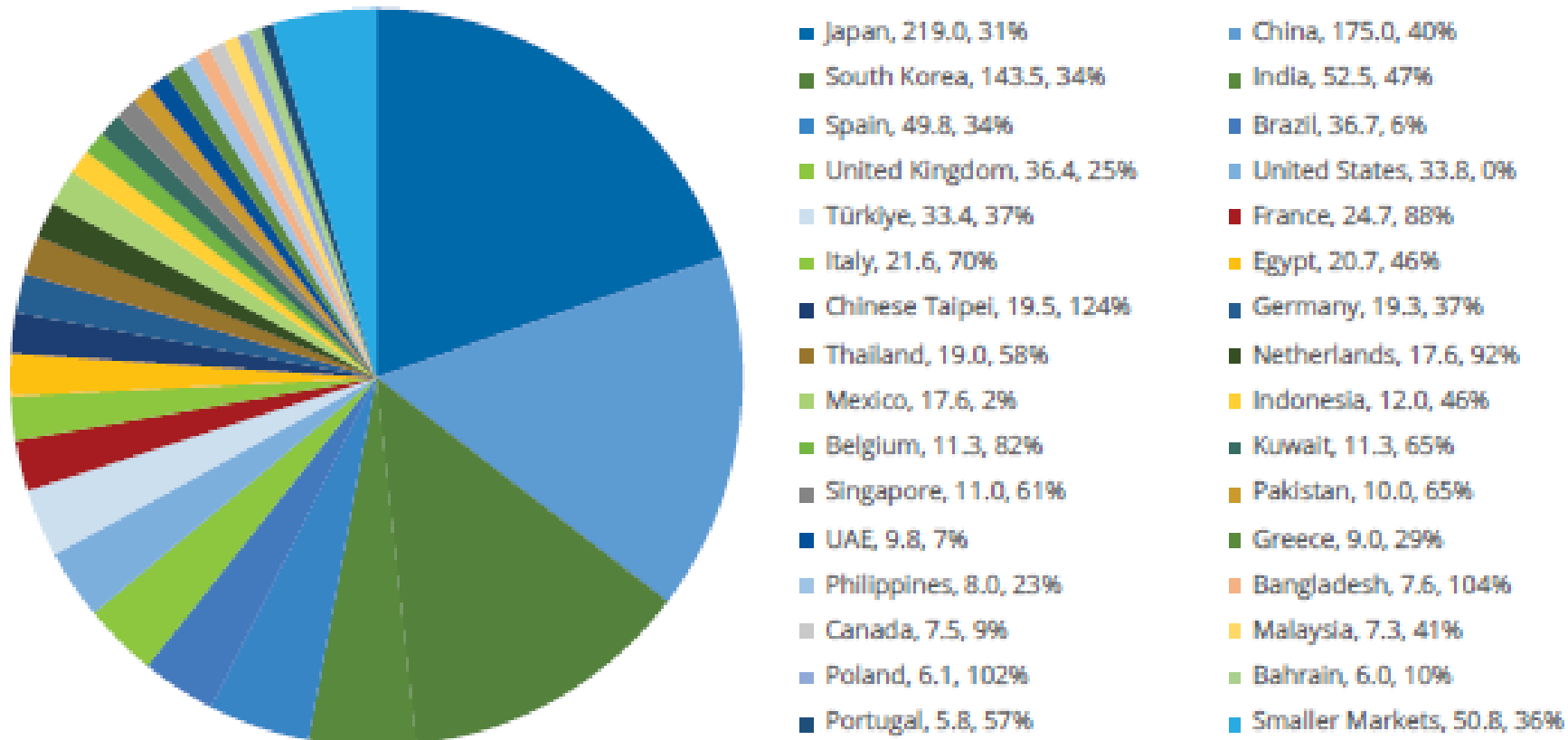
As of the end of 2025, global regasification capacity stood at 1,113.5 Mtpa across 50 markets. During the year, 62.9 Mtpa of new capacity was added, driven by the start-up of eight new onshore import terminals, five new floating terminals, and seven expansion projects at existing facilities. Among the largest projects commissioned in 2025 were three floating-based projects, including Ain Sokhna (Sonkar) FSRU (Energos Power) and Ain Sokhna (Sumed) FSRU (Energos Eskimò) in Egypt, and Aqaba FSRU (Energos Force) in Jordan, each with a regasification capacity of 5.7 Mtpa.



Lithuania's KN, first LNG import facility in Klaipeda



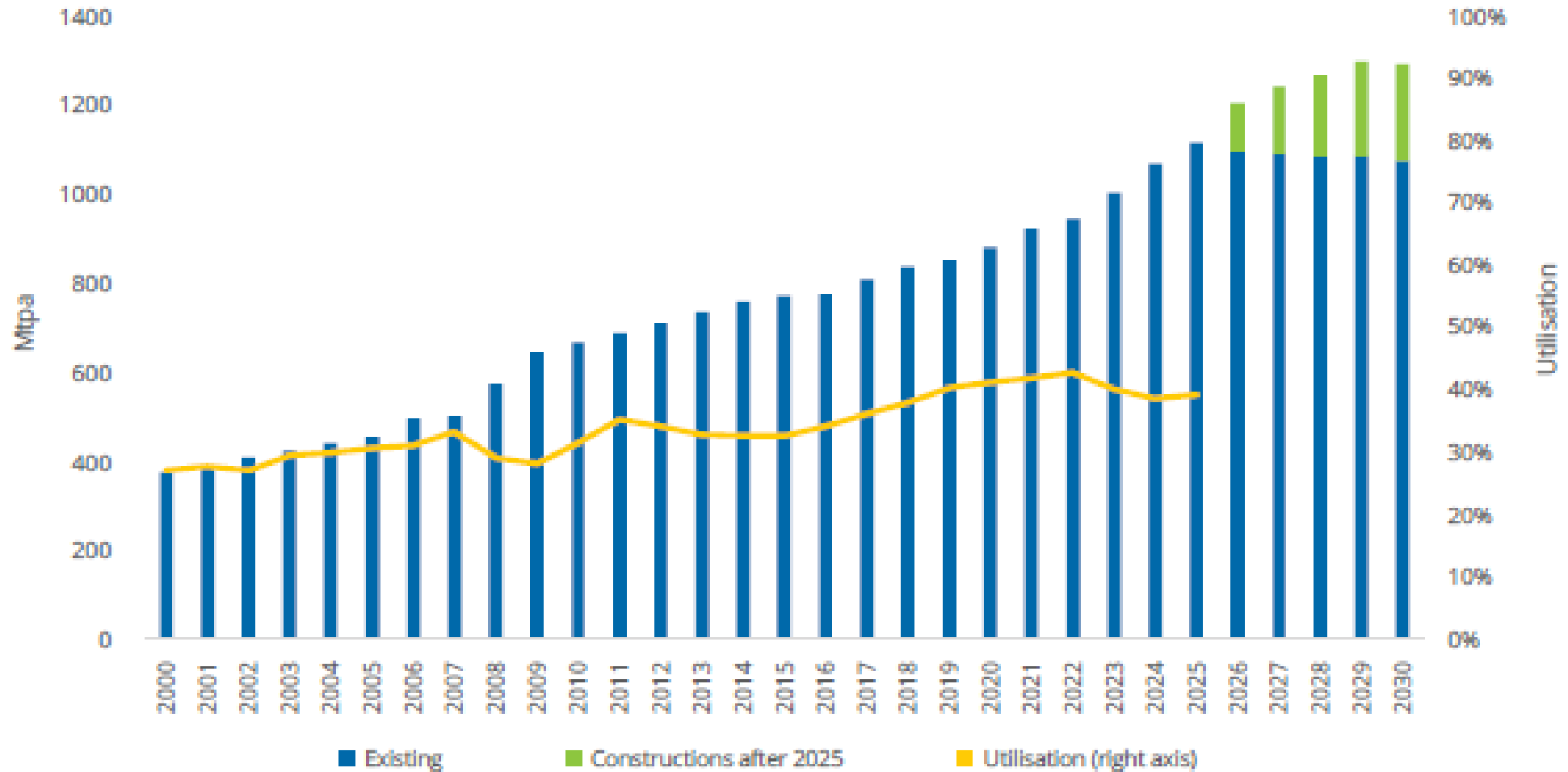
Global Regasification Nominal Capacity and Utilisation Rate in the World as of End 2025 – 1115 Mtpa



Source: Rystad Energy



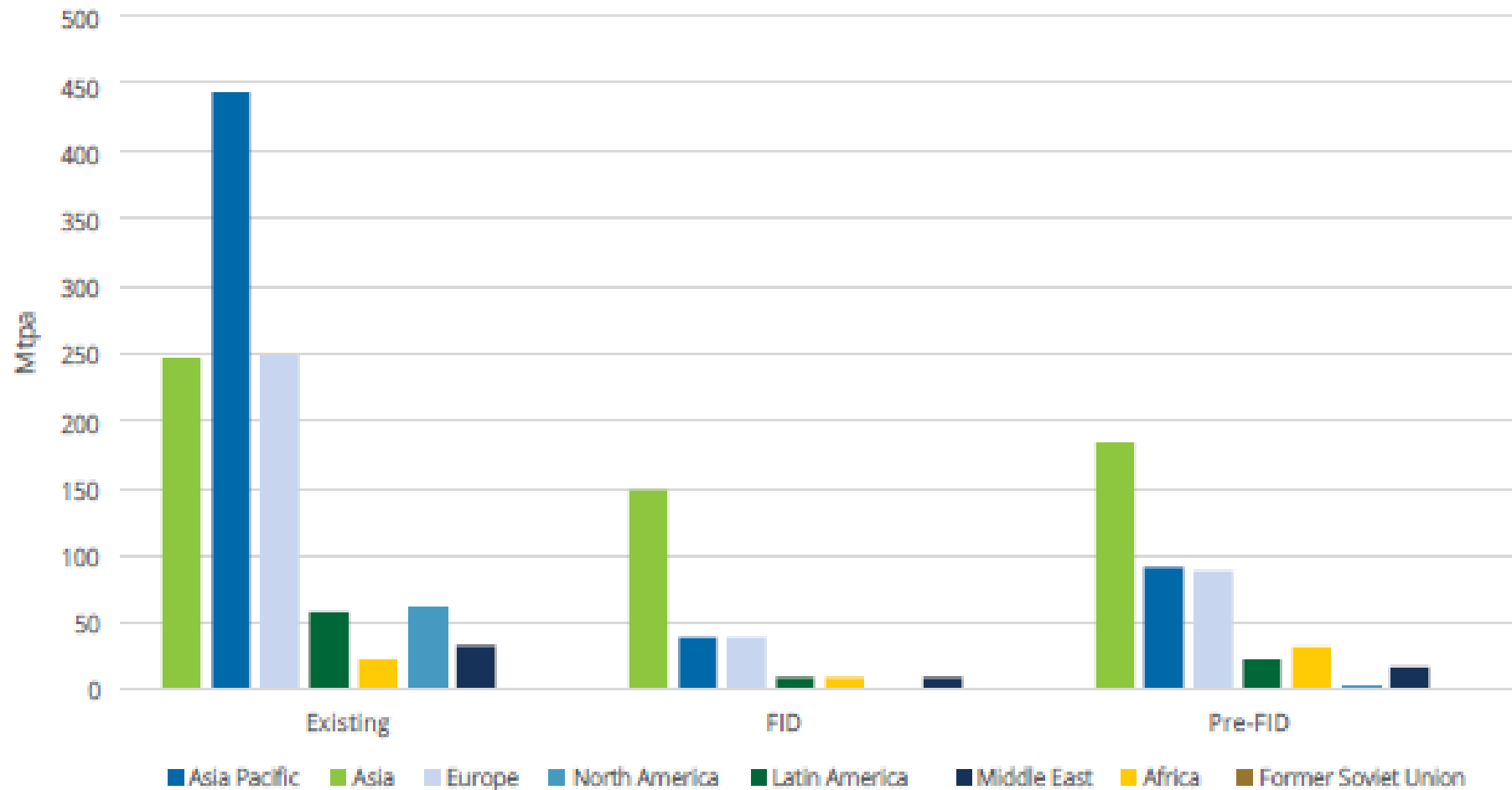
Evolution of Global Regasification Capacity in the World 2000 - 2030



Source: Rystad Energy



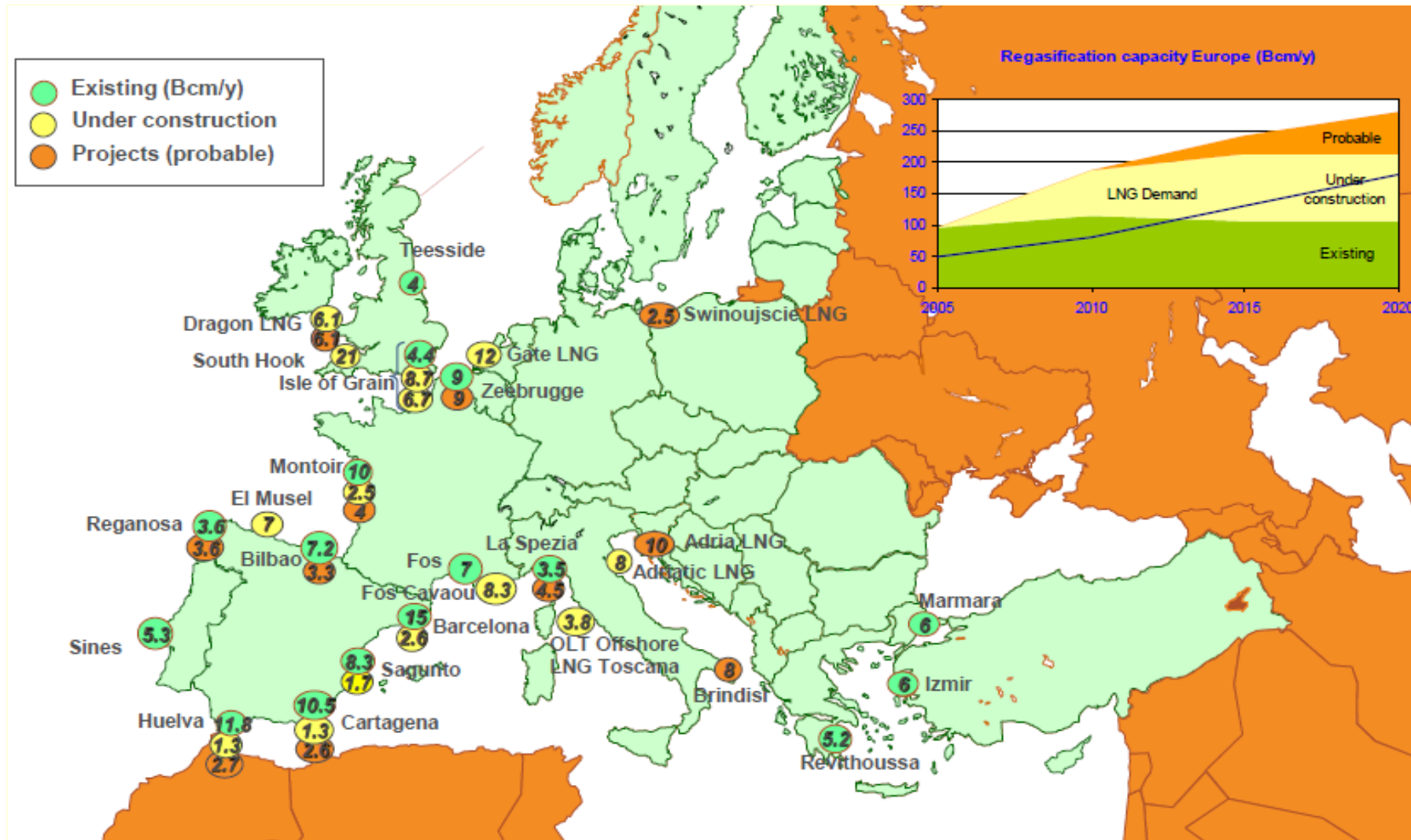
Global Regasification Capacity by status & Regions - End 2025



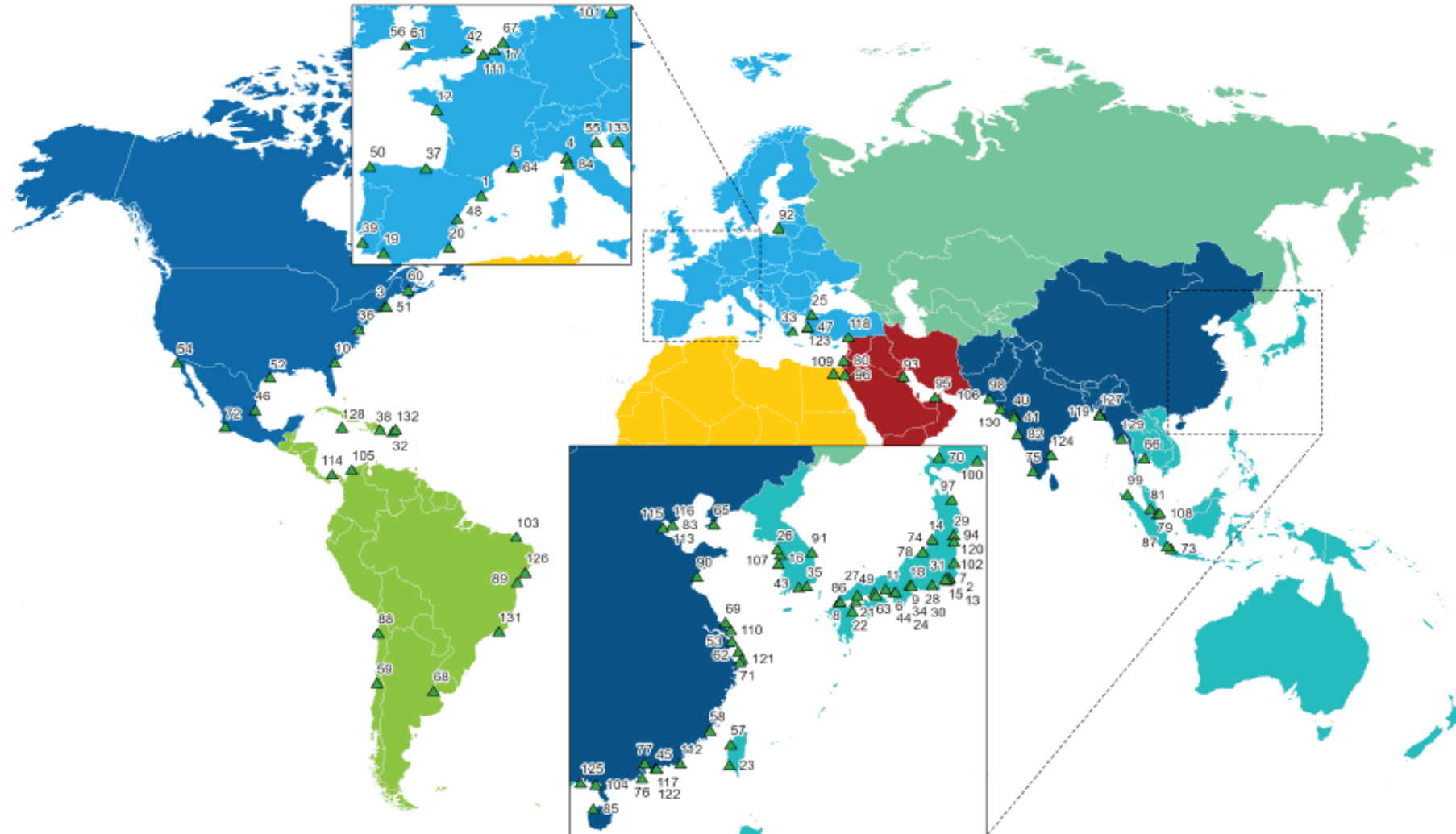
Source: Rystad Energy



Reminder: Europe LNG Receiving Terminals Situation & Vision 2016



Existing LNG Receiving Terminals – End 2020



*Note: Terminal Numbers Correspond to Appendix 5: Table of Global LNG Receiving Terminals.
Source: Rystad Energy*

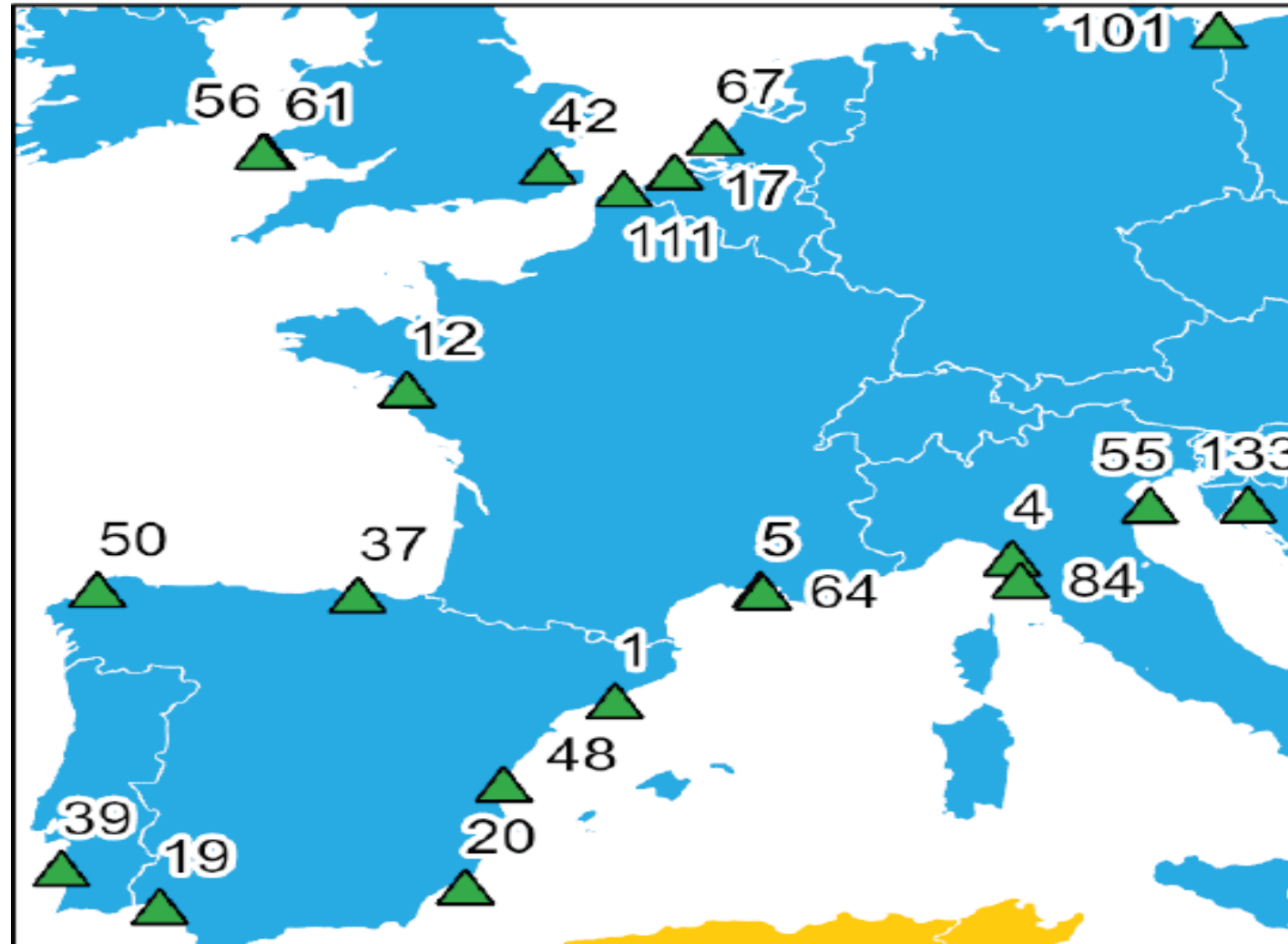
Source: IGU 2021 World LNG Report/Rystad

142

TPA Toolbox Energy Book 5 - Gas

Existing LNG Receiving Terminals – End 2020

Zoom on Europe



Source: IGU 2021 World LNG Report/Rystad

Regasification Terminal Montoir-de-Bretagne - France

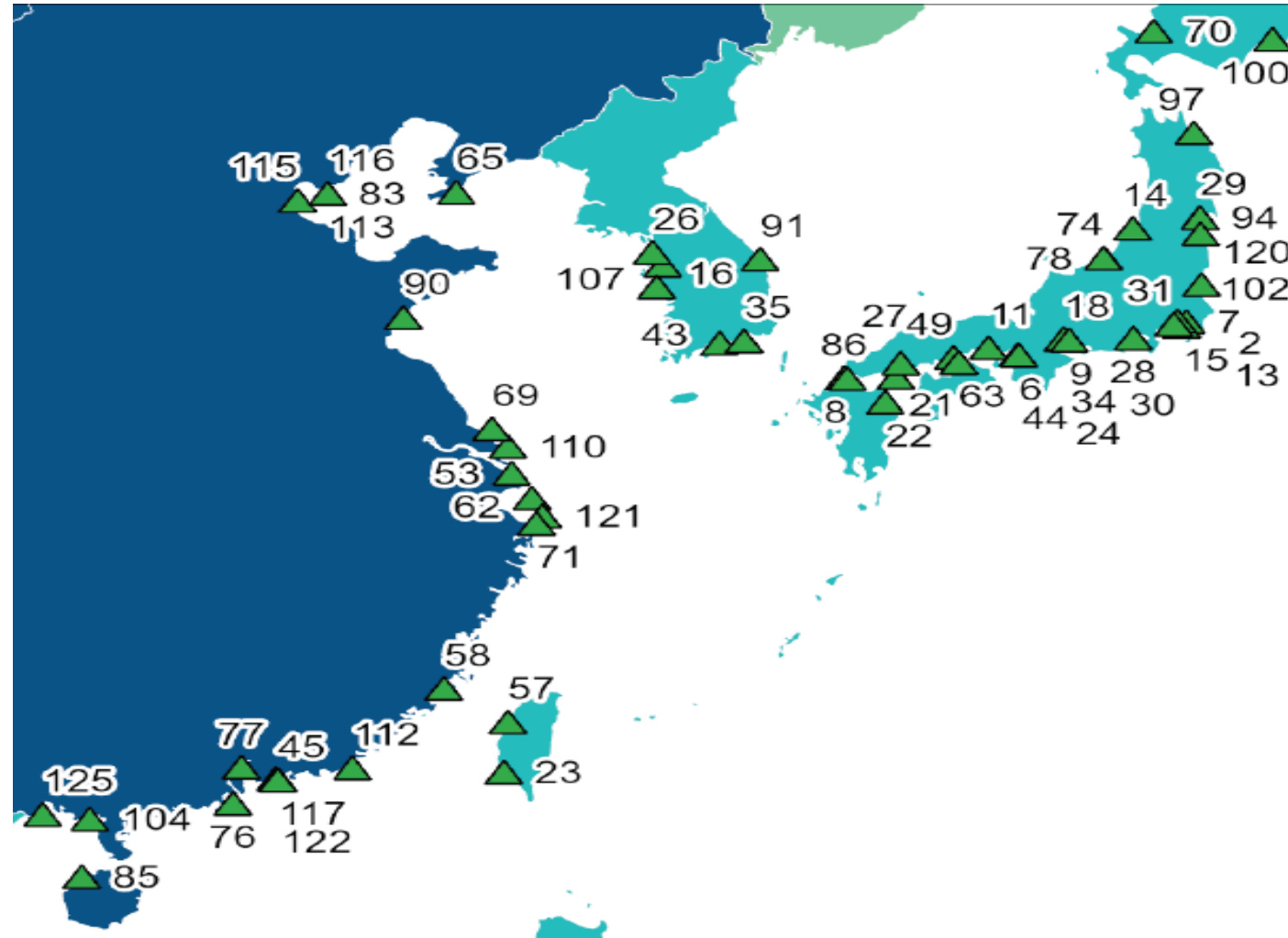


Regasification Terminal - Fos sur Mer - France



Existing LNG Receiving Terminals – End 2020

A Zoom on Asia



Source: IGU 2021 World LNG Report/Rystad

146

TPA Toolbox Energy Book 5 - Gas

Floating Storage Regasification Units (FSRU)

A new Tool for Diversification of Supply

Figure 26: FSRU illustration



FSRUs are ships used for LNG storage and regasification directly, with the regasification equipment installed on the vessel. Compared to conventional onshore regasification terminals, FSRUs offer more flexibility, with the option to be deployed anywhere along the shore. FSRUs are deployed off the coast of the markets they serve, instead of on land, making it the preferred option for land-scarce regions and areas with poor accessibility. Capital expenditure and construction time for FSRUs are almost half of that of an onshore terminal, however, operating costs are usually higher.



Floating Regas Terminals

Fonctionnement d'un FSRU

1 ... ⑤ Étapes du processus
par ordre chronologique

② SPHÈRE
DE STOCKAGE GNL

⑤ MANIFOLD* D'EXPORT
déchargement du gaz
haute pression
(de l'autre côté de l'unité)

④ TRAINS DE REGAZÉIFICATION
transformation du GNL
à -160°C en gaz
haute pression

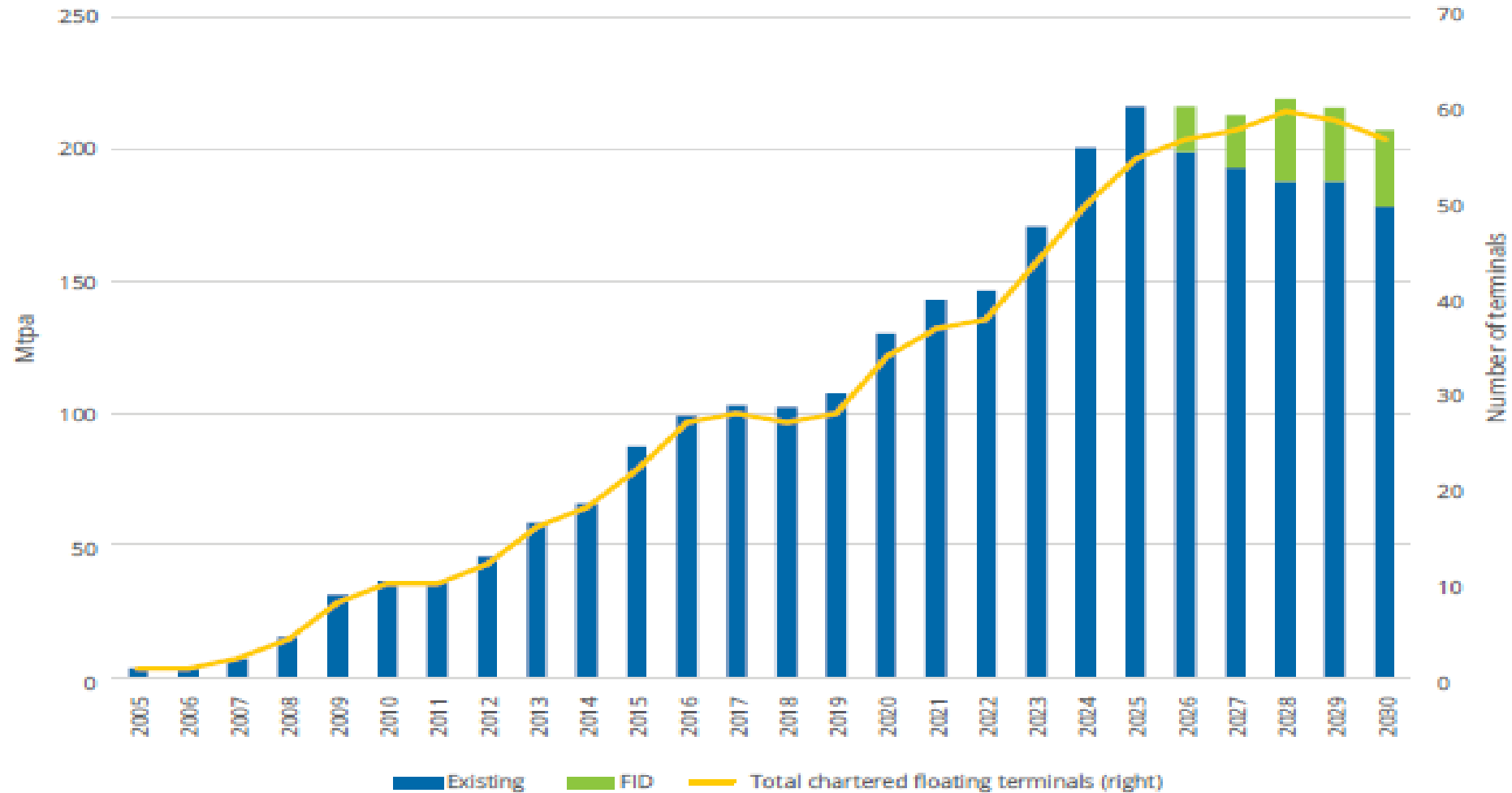
① TUYAUX FLEXIBLES
CRYOGÉNIQUES
chargement du GNL
depuis un méthanier
(d'un côté de l'unité)

③ POMPES D'EAU DE MER
pompage d'eau de mer
vers les trains de regazéification
pour réchauffer le GNL
et le ramener à un état gazeux

**Ensemble de conduits et vannes destinés à acheminer le gaz.*



Floating Regas Capacity 2005 - 2030



Source: Rystad Energy

Source: IGU - World LNG Report July 2026



The Exmar FRSU S188 recently arrived at the Port of Rotterdam – June 2022



Floating Regasification Terminals in Brazil



New FSRU in Europe

EUROPE: 27 existing LNG Terminals (Onshore & FSRU)

GERMANY:

No existing LNG Terminals, 5 FSRU units scheduled:

- **First one started operations in Willemssen in Dec. 2022**
- **Second one under commissioning in Lubmin, production in Feb. 2023**

FRANCE: 4 onshore LNG Terminals

- **Fos Cavaou**
- **Fos Tonkin**
- **Montoir de Bretagne**
- **Dunkerque**

and 1 FSRU « Cape Ann » to be installed in Le Havre in Summer 2023

Other ones to come in Europe



LUBMIN FSRU in Germany: Provided by TotalEnergies (shuttle LNG tanker between outside FSU and FSRU inside the port)



The 10,000-cbm Coral Furcata (built 2011) makes its first call on the FSRU with a transhipped cargo in Lubmin. Photo: Frank Borrmann

Germany's Lubmin FSRU fires up with small-scale LNG deliveries

Regasification vessel Neptune readies to receive first test cargo with second shuttle shipment set to load outside port

30 December 2022 23:48 GMT UPDATED 2 January 2023 7:41 GMT



LNG Shipping

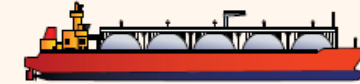
The global LNG fleet grew by **8.4% year-on-year** in 2025.

6,870
trade voyages, a change of
-2.8% year-on-year

804 / **79**
active vessels / new vessels¹

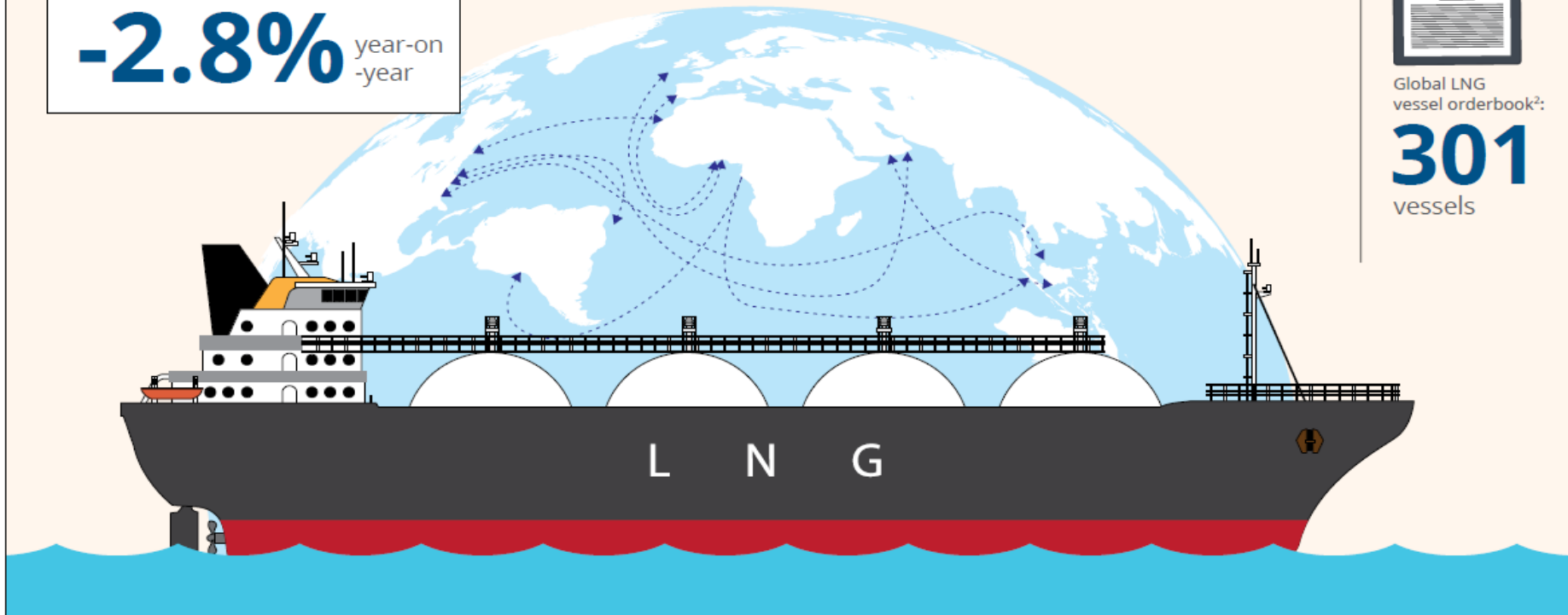


Including
49 / **11**
FSRUs / FSUs¹



Global LNG vessel orderbook²:

301
vessels



¹ During 2025
² Under construction vessels



LNG Shipping

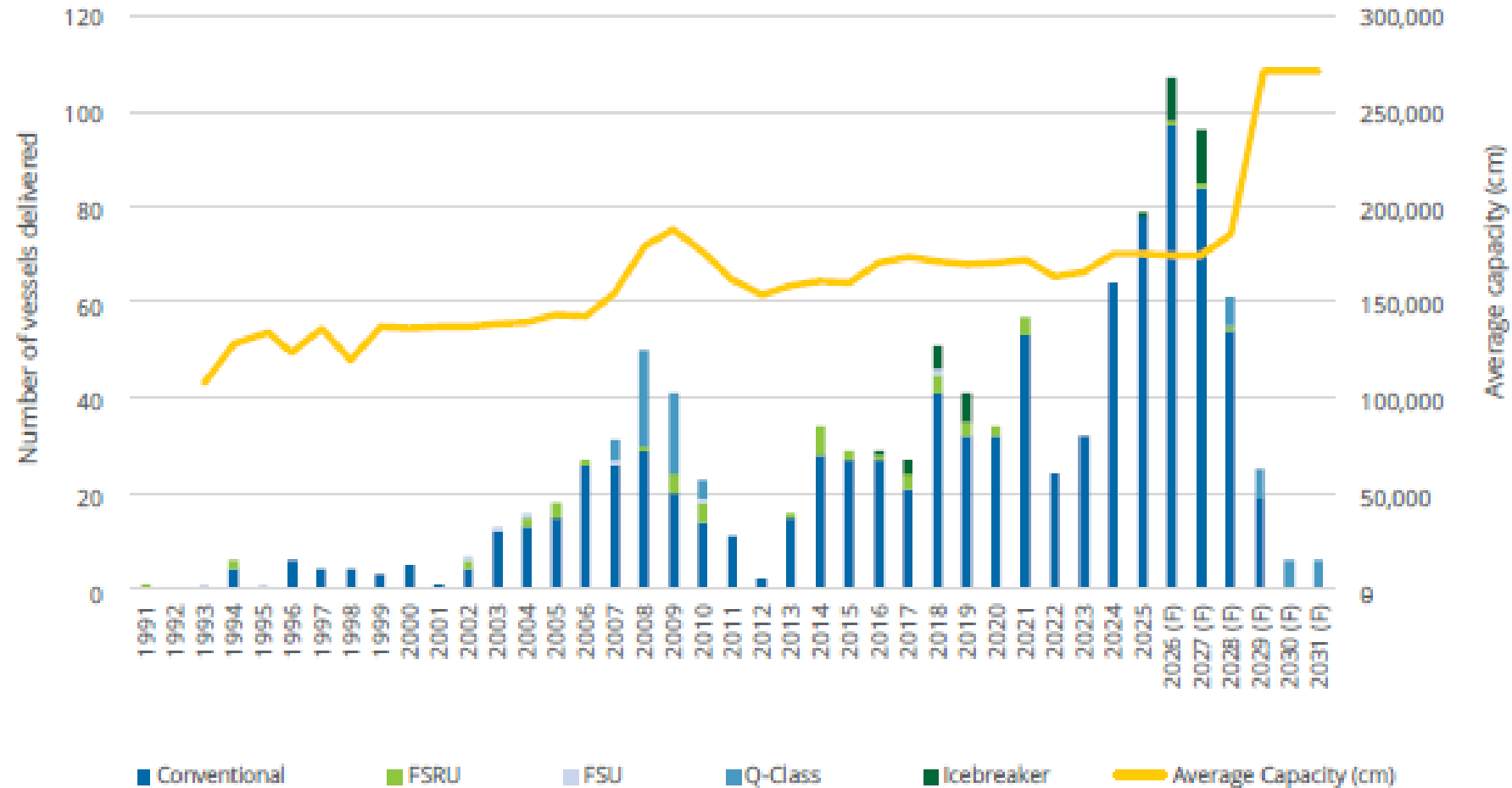
In 2025, the global LNG vessel fleet grew to 804 active vessels³, including 49 operational FSRUs and 11 FSUs, following the delivery of 79 vessels throughout the year. This represents an 8.4% increase in the operational fleet from 2024. However, the number of LNG voyages decreased by 2.8%. This rapid expansion of active LNG carriers relative to trade growth kept the market oversupplied. Newer vessels represent a step-increase in efficiency, emissions performance and project economics over the older fleet that will be retired in coming years due to commercial and regulatory pressures.



Courtesy SK Shipping



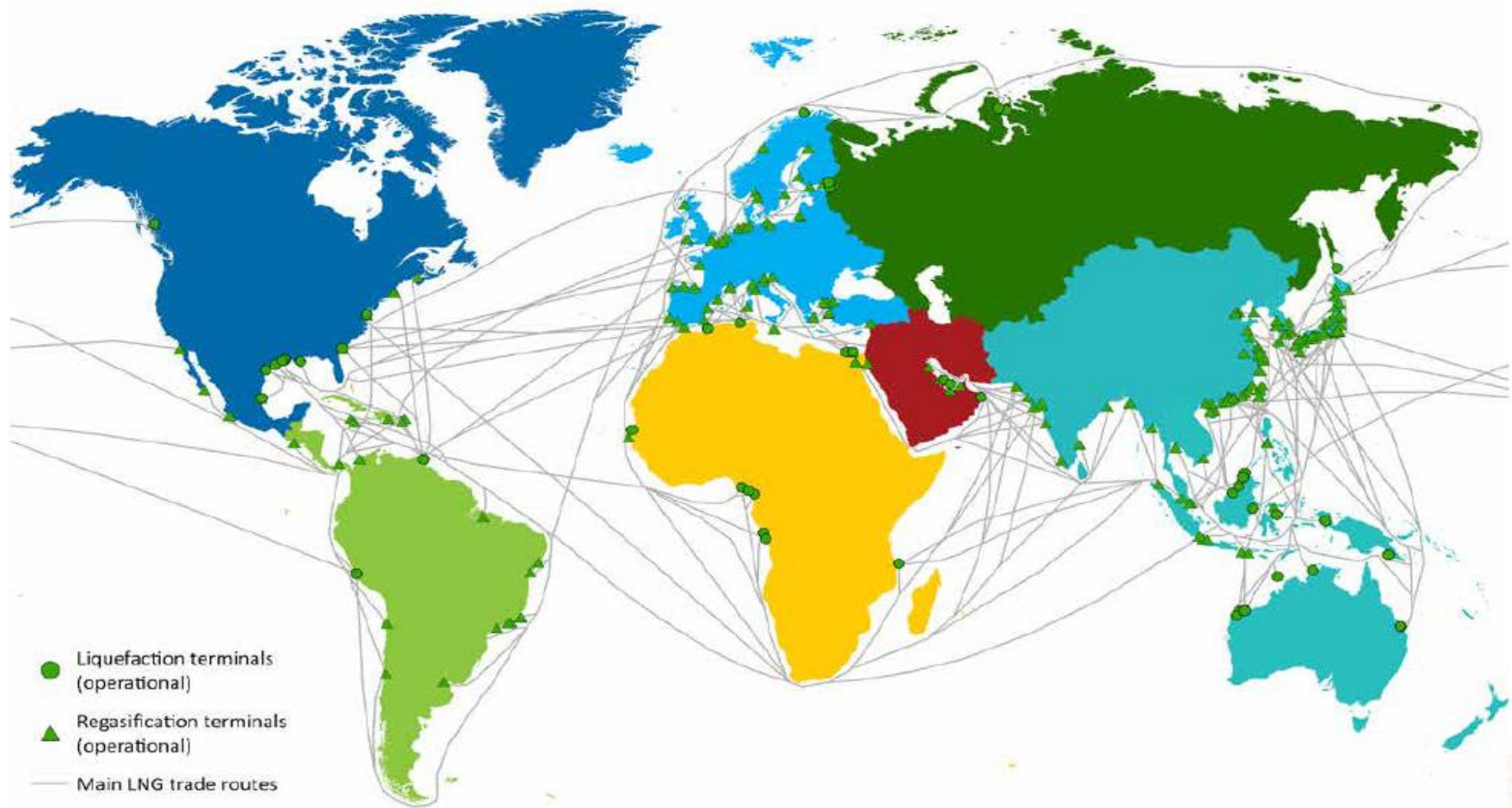
LNG Fleet and average capacity



Source: Rystad Energy



Major LNG Shipping Routes 2025



Source: Rystad Energy



TotalEnergies LNG Projects – Some examples



Liquefaction Plant: Bontang, Indonesia



The Yemen LNG Complex

(Under Force Majeure since several years)



The Yemen LNG liquefaction complex in which Total is the main shareholder. Construction of the site mobilized 10,000 people.



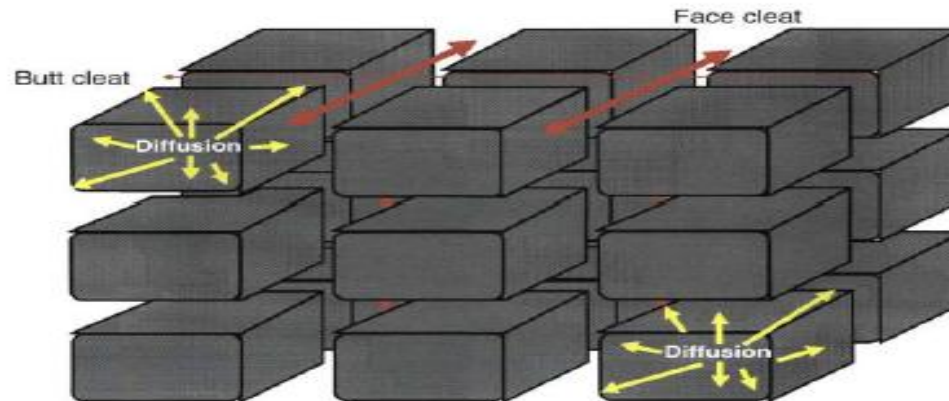
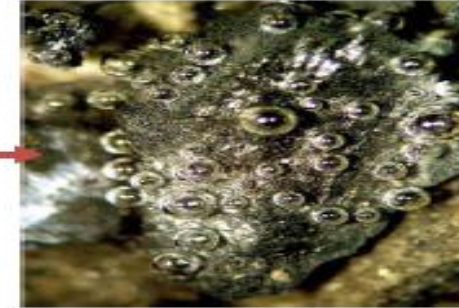
Gladstone LNG Project From CBM to LNG



Gladstone LNG: From CBM to LNG (1)

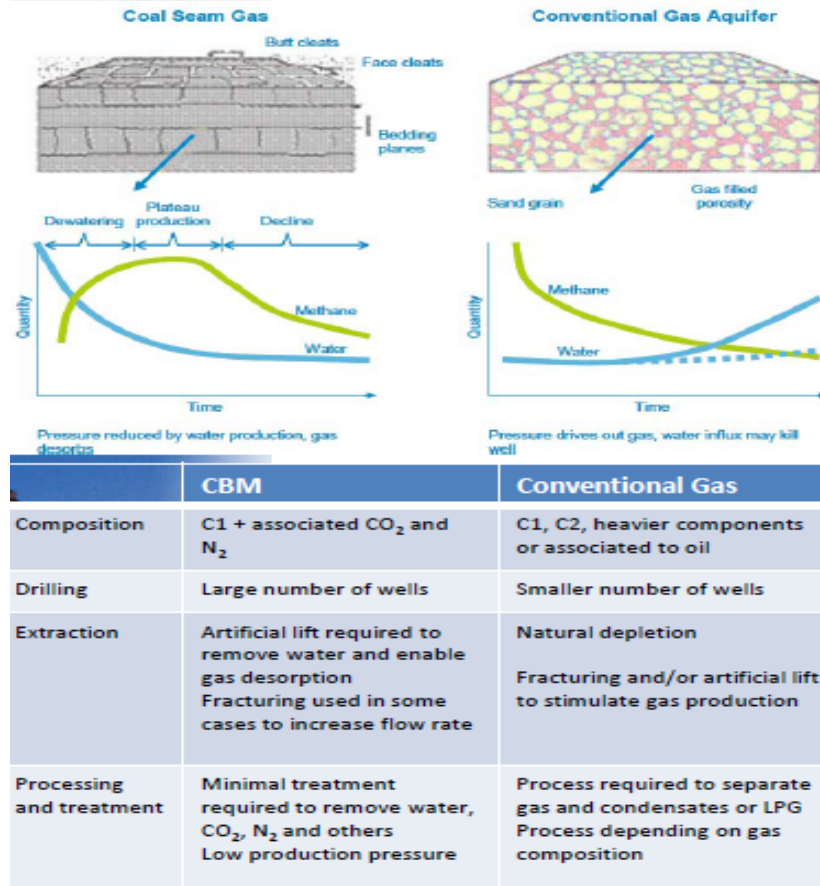
CBM - fundamentals

- Non conventional trapping of the gas: adsorption
 - The gas is fixed on organic matter (by water pressure) in a semi liquid state (→ storage capacity significantly higher than in porous matrix)
- Principles controlling production from reservoir: desorption
 - In order to produce natural gas, the pressure on the coal needs to be released. This usually occurs by removing water that may be present in coal seam
 - With the reduction of the pressure on formation, CH₄ desorbs from the coal and travel through the microporous matrix
 - Cleats provide pathways for water and then methane to travel to the wellbore



Gladstone LNG: From CBM to LNG (2)

CBM production + LNG develop. specificities



- CBM development specificities
 - Huge development area requiring excellent relationship with the local people
 - Number of wells and continuous drilling during producing life
 - Gas peak production reached several years after wells start-up
 - Large volumes of produced water, requiring desalting prior disposal
 - Very low production pressure (from 0.5 to 4 bar)
 - Difficult production performance prediction
- CBM production + LNG specificities
 - Ramp-up
 - Need to anticipate well production (dewatering) to have sufficient production capacity at start up
 - Need to define use of gas during and after dewatering (no flaring)
 - Progressive ramp up not possible => interest for underground gas storage
 - Gas supply chain (from WH to LNG = LNG f' supply with low productivity wells)
 - Low Gross Calorific Value (35 MJ/Nm³)

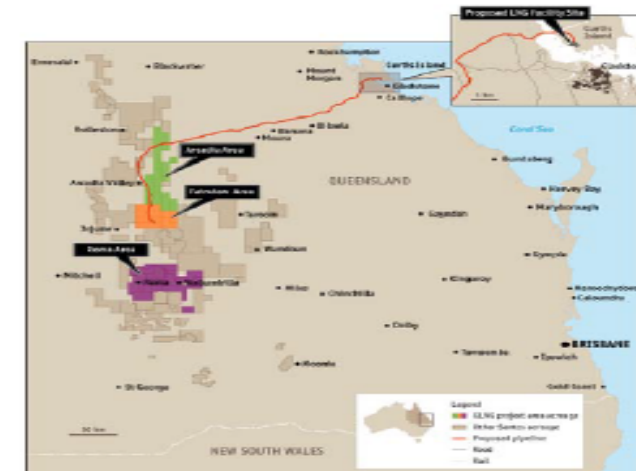


Gladstone LNG: From CBM to LNG (3)

GLNG development main characteristics

- GLNG is an integrated development to valorize CBM gas

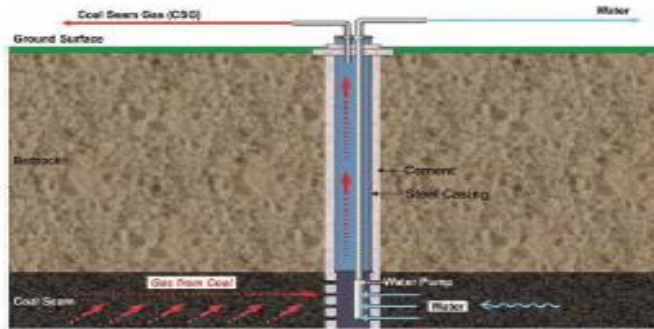
- ▮ Production from 4 fields (Fairview, Roma, Arcadia & Scotia) with continuous drilling during life of project (30 years)
- ▮ Pipeline 420 km long – 42 inches from fields to Gladstone
- ▮ GNL plant with 2 trains (2 x 3.6 mtpa) based on Cascade optimized process. 1st cargo planned in 2015.
- ▮ Environmental approval granted from Queensland and federal governments (Q4-2010)
- ▮ 3 main EPC contracts: upstream surface facilities (Fluor), gas transportation pipeline (Saipem) and LNG plant (Bechtel)
- ▮ Partnership: Santos (operator) 30 % - Total 27.5 % - Petronas 27.5 % - Kogas 15 %



Gladstone LNG: From CBM to LNG (4)

Wells

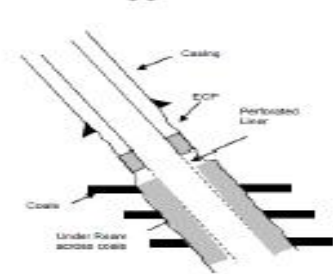
- Drilling from well pads
 - Vertical or deviated wells
 - Depth: 800-1200 m TVD
 - Duration: 4 to 12 days
- 0.8 M\$ < well cost < 1.5 M\$
- Average EUR = 1.4 bcf
- 200 to 300 wells per year – 5 rigs in operation



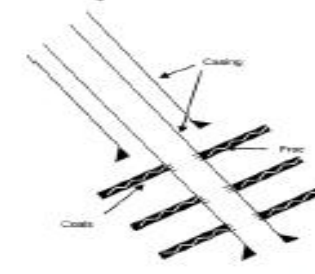
Example of well section



Typical Bottom hole completion



Cavitation, w/ slotted liner



Cased hole w/ hydraulic frac

Drilling concepts
Vertical or deviated wells
Drilling fluid : mud or air



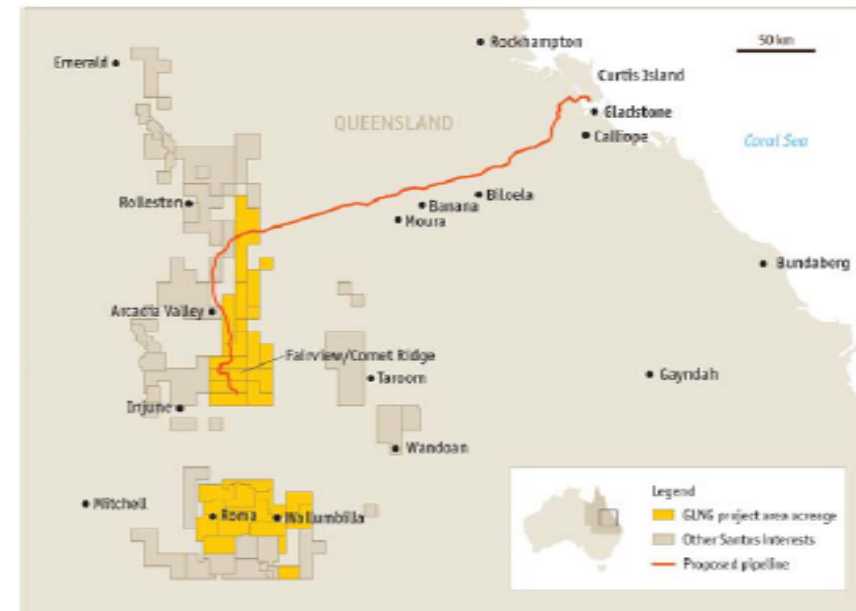
TOTAL



Gladstone LNG: From CBM to LNG (5)

Gas Transportation Pipeline definition

Design element	Specification
Length	420 km
Diameter	42"
Wall thickness	14,1 to 19,7 mm
Coating	2 layers FBE coating + epoxy
Design capacity	700 to 2100 mscfd
Operating pressure	100 bar
Design life	40 years
Pipe depth	0,75 m < x < 2 m
Others	Launcher & receiver traps 1 x 5.5 km marine crossing 100 landholders



Pipeline route



Gladstone LNG: From CBM to LNG (6)

Plant localisation

- Gladstone : 5th worldwide harbor for coal export
 - 70Mt in 2010 of which 60 Mt of coal
 - 20% of Australian export
- LNG plant location: Curtis Island
 - Overall size: circa 190 ha
 - Criteria's selection:
 - Shipping access
 - Geotechnical suitability
 - Environmental suitability
 - Proximity to infrastructure

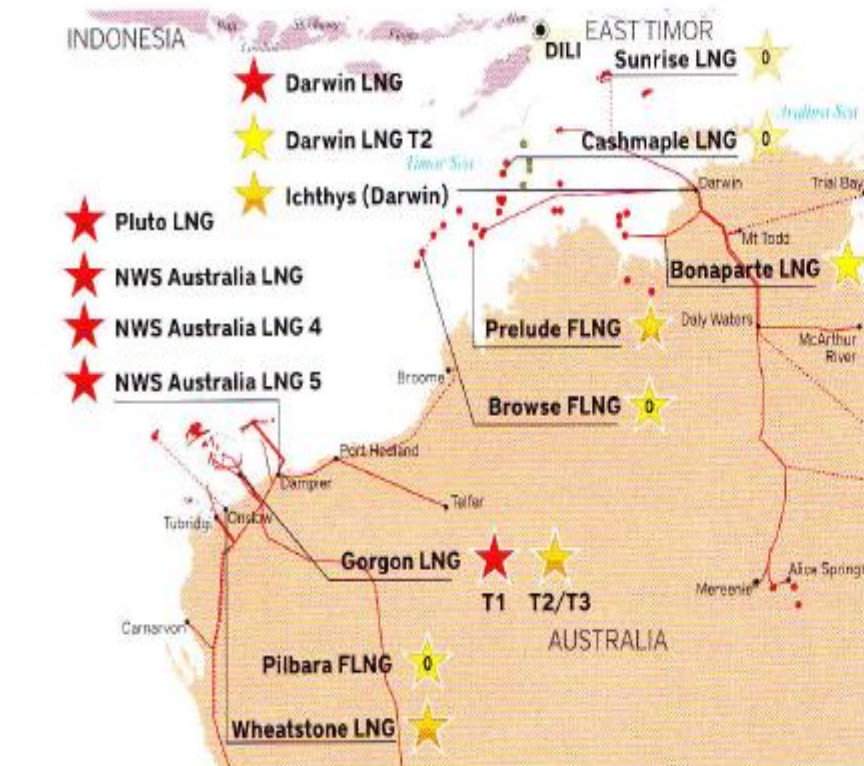


Design element	Specification
Liquefaction process	CoP optimized Cascade system
Capacity	2 x 3.91 Mtpa design 2 x 3.60 Mtpa FOB
Loading facilities	Material offloading facility Product loading facility: 324 m marine jetty
Pipeline / plant interface pressure	65 bar
Site ambient temperature	27°C
Pre-process	Limited
Design life	20 years
LNG storage capacity	2 x 140 000 m ³



Australia is becoming an important player LNG Projects in Australia

West Australian LNG Source: Petroleum Economist's World LNG Factbook 2016 edition



East Australian LNG Source: Petroleum Economist's World LNG Factbook 2016 edition



MARSA LNG - Oman



MARSA LNG



To be updated



OMAN
SOHAR area



CAPEX
~1.6 G\$
TTE share
80%

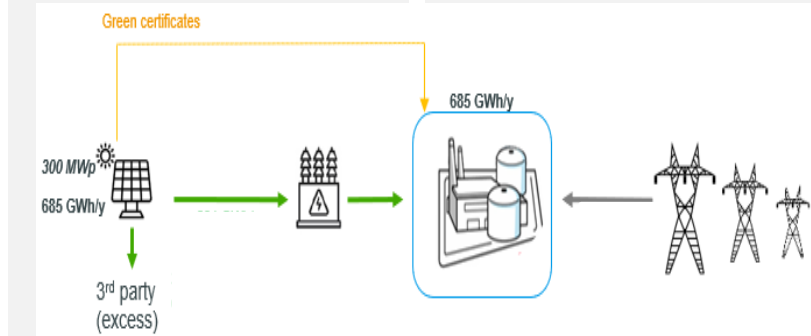
FID 04/2024

Execution Ongoing

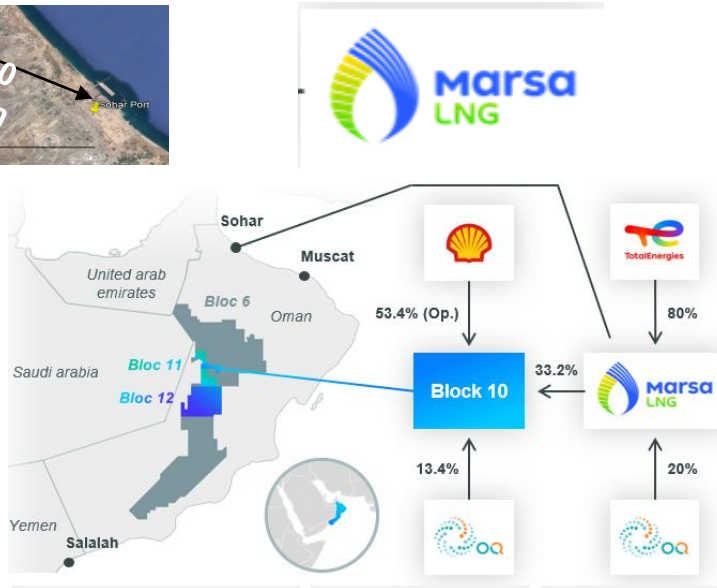
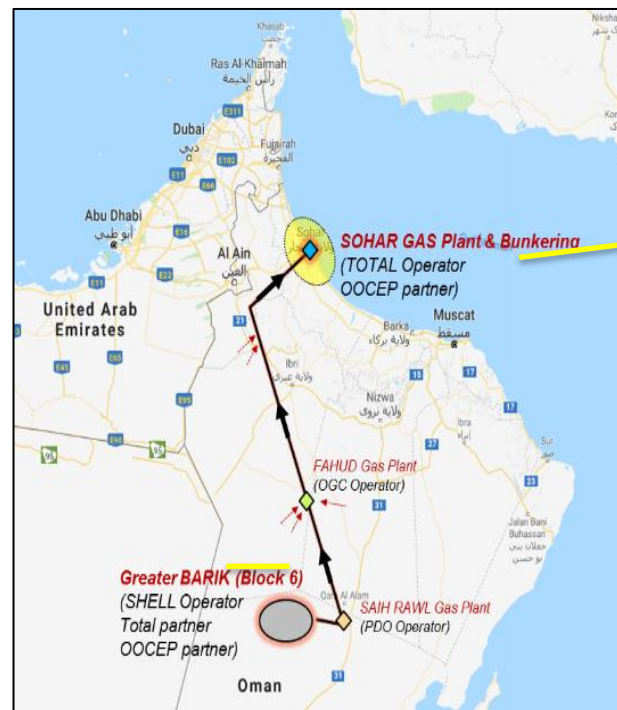
RFSU Q1/2028

1 Train of 1MTPA
(2nd train in option)
1 LNG tank -165000m3
1 jetty for LNGC and
bunkering vessels
Elec driven compressors

Associated Solar Plant
300MWp ~30 km



First LNG Plant operated by Total Energies
Best-in-class Total Energies' LNG asset for GHG Footprint



RIO GRANDE LNG - USA



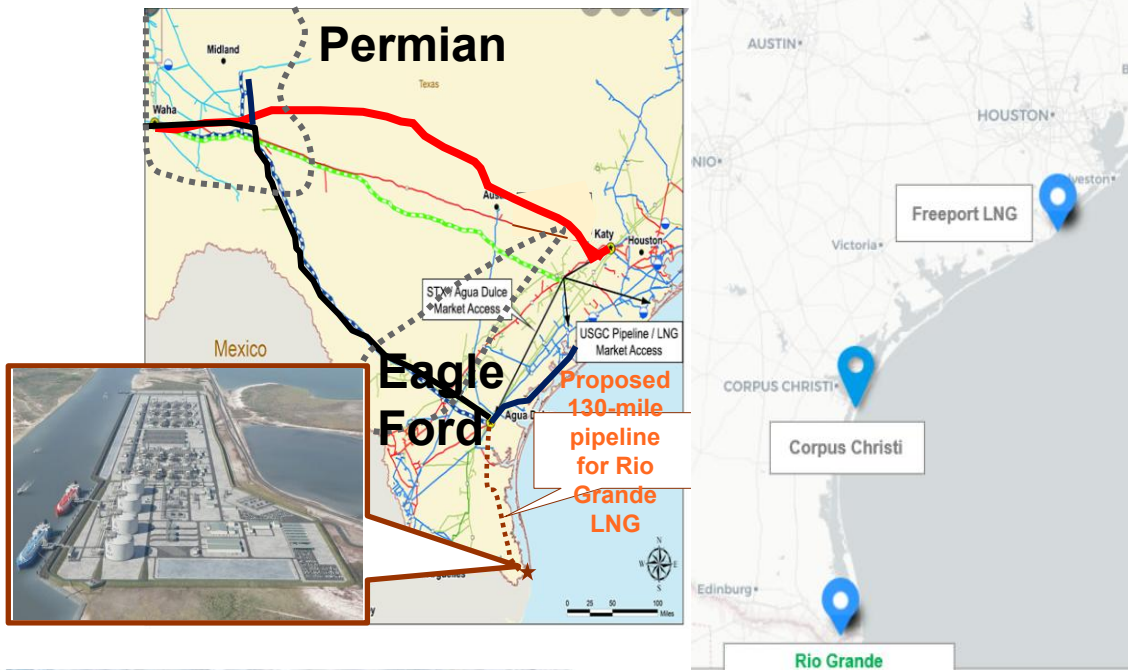


Figure 5: Early development of the Bechtel / ND Pioneer Office Complex (July 2023)



RIO GRANDE LNG



USA
Brownsville , TEXAS



RGLNG

CAPEX
18,4 B\$
TTE share
16,7%

RGLNG

3 liquefaction Trains
Total capacity 17,5 MTPA
2 LNG Tanks
2 jetties

RGLNG

Intensity
26 kgCO2e/boe (scope 1 + scope 2)

TTE Offtakes
5.4 Mtpa SPA

To be updated

RGLNG

FID 07/2023
Execution Ongoing
RFSU 25/11/2025
COD
(Commercial Operating Date)
T1: dec 2027
T2: July 2028
T3: Feb 2029



Major LNG development in USA context



The Yamal Project – Russia

Project Joint-Venture structure has been reshaped following Russia-Ukraine war



7

Three independant world markets for Natural Gas



TABLE OF CONTENTS

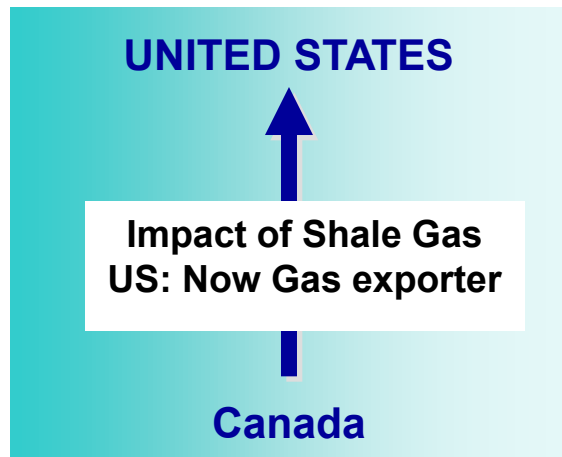
1. General considerations
2. Resources, reserves
3. Conventional and Unconventional Gaseous Hydrocarbons
4. Production, consumption: past and present
5. Production, consumption: perspectives
6. A zoom on Liquefied Natural Gas (LNG)
7. Three independant world markets
8. The gas chain components and their economics: Production & Processing
9. The gas chain components and their economics: Transportation
10. The gas chain components and their economics: Storage
11. Technology and innovation
12. Competing fuels and Gas prices
13. Evolution of national gas markets towards liberalization & globalization
14. Example of challenging gas projects: Shtokman & Yamal



Regional natural Gas markets

- ◆ Natural gas is condemned to rigid, expensive infrastructures, which limit trade over very long distances
- ◆ No world gas market but various national and regional gas markets
- ◆ Three Main Regional Gas Markets with Marginal Links

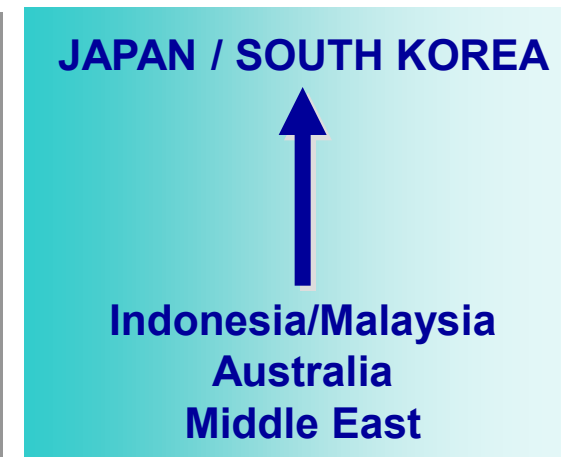
NORTH AMERICA



EUROPE



EAST ASIA



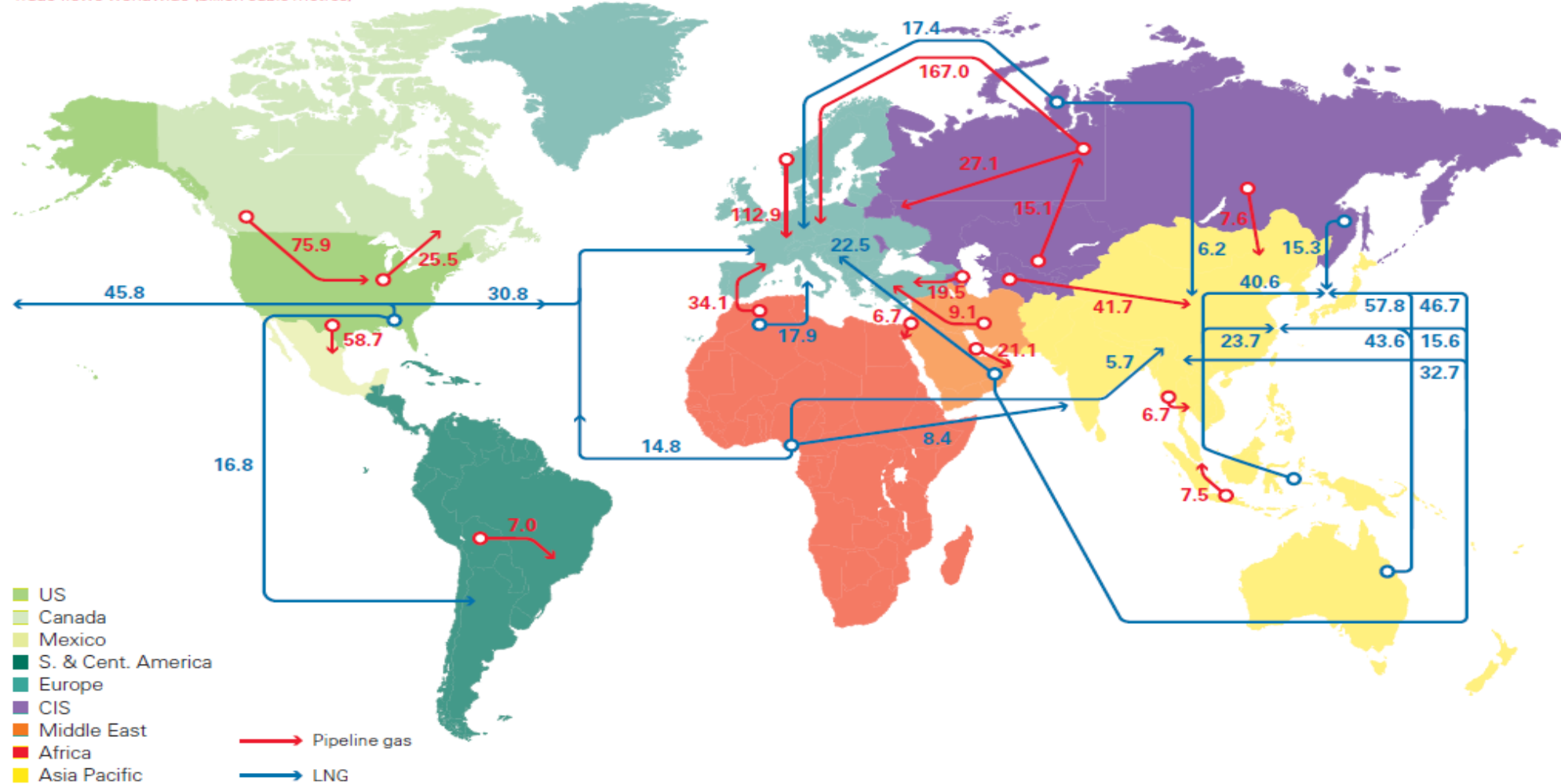
**With this world market structure,
Gas is in Competition with Regional Energy References.
No Mutual Price Adjustment and thus No International Gas Price Marker**



Reminder - Gas – Major Trade Movements Year 2021

Major trade movements 2021

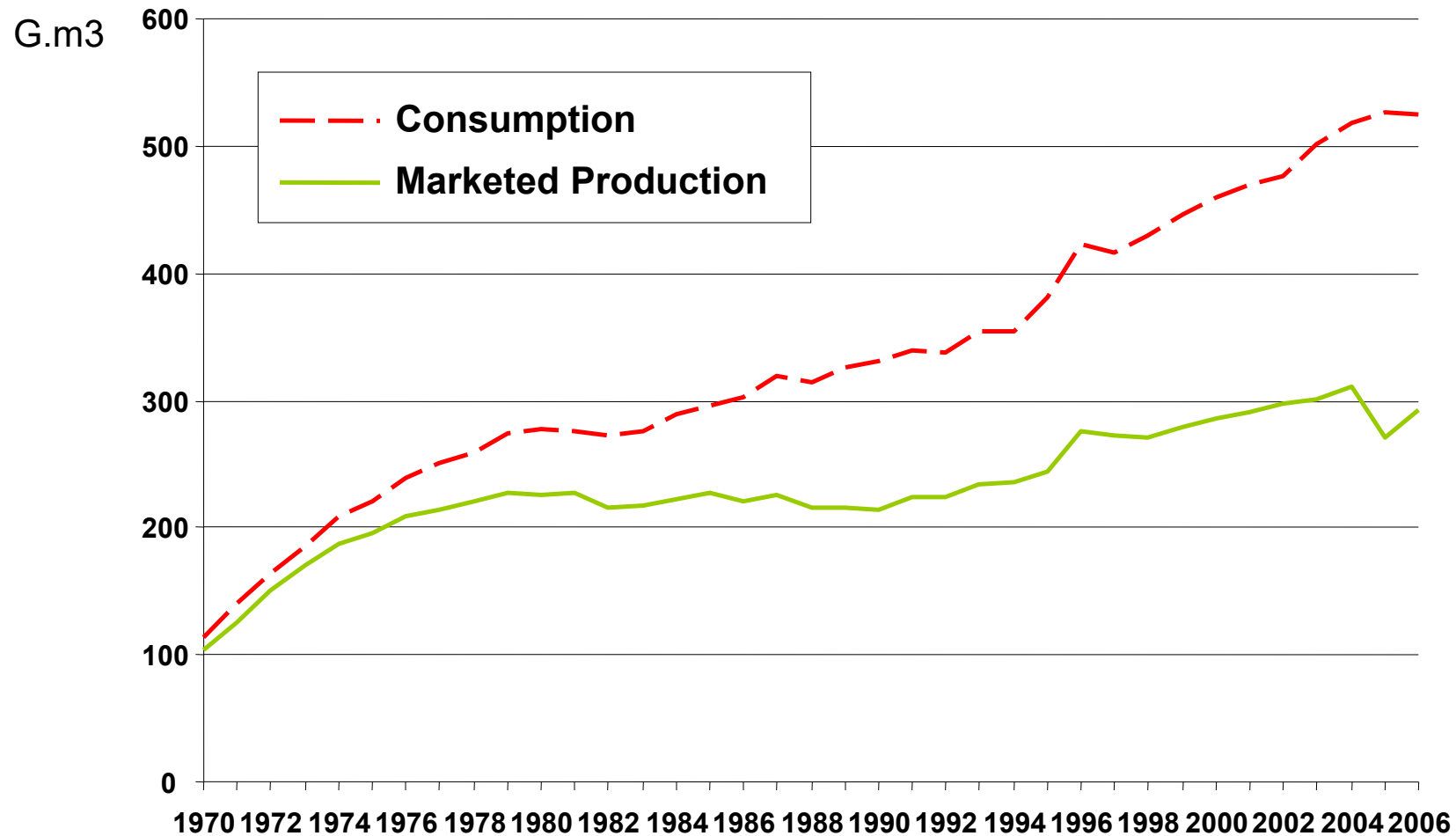
Trade flows worldwide (billion cubic metres)



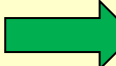
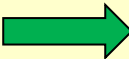
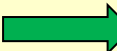
The European Market



Natural gas supply gap in Europe Evolution 1970 - 2006



Gas market evolution in Europe 2007-2025

- ❑ Natural Gas consumption in Europe declined from # 600 G.m3 some years ago to # 480 G.m3 in 2025 as a consequence of the World economical environment evolution and the russian attack on Ukraine.
- ❑ Emergence of renewable energies (intermittent)  New gas power plants built as « back-up » by energy companies.
- ❑ Combination of renewable energies new capacities and shale gas development in the US 
Additional export of coal in Europe  Over-capacity of gas power plants in Europe.
- ❑ But due to GHG emissions constraints, Natural Gas is going to progressively replace coal on the medium-long term.
- ❑ LNG is taking a more important share (Technology improvement, Flexibility,...)
- ❑ Covid 19 had a negative impact on World Gas Consumption in 2020.
- ❑ The Russia – Ukraine war has considerable consequences on Europe Supply/Demand balance, with russian blockages of North Stream 1 & 2 Gas Flows. Increase of US LNG imports to Europe.



**Gas Trade & Flows has been dramatically upset in 2022 and 2023 due to the Russia – Ukraine war and its market and economic consequences, in particular in Europe
See also Book 2 - Energy**



Gas Pipelines from Russia to Europe

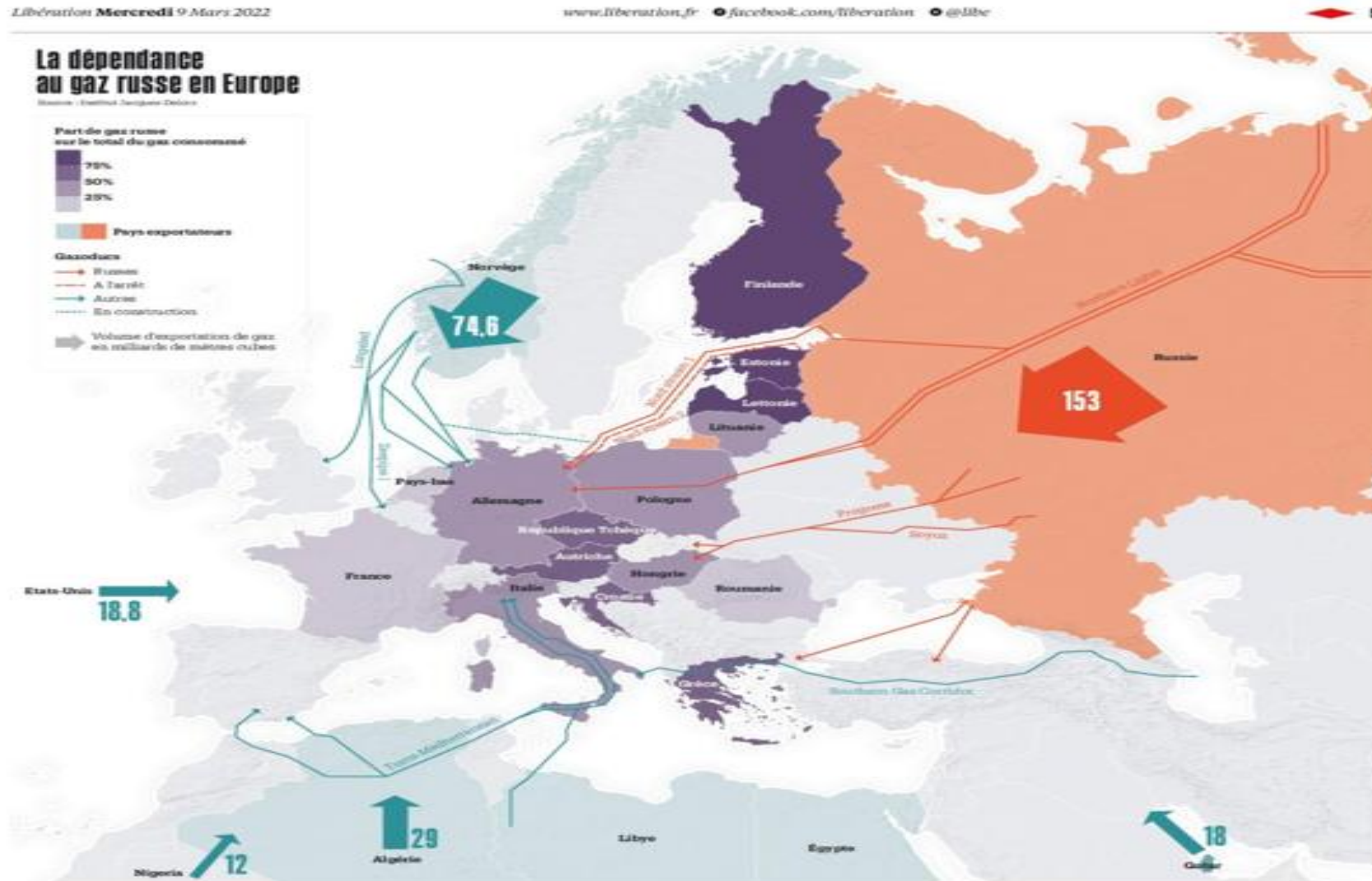


Note: End 2014, Russia decided to abandon the South Stream project (Gazprom 50%, ENI 20%, EDF 15%, Wintershall 15%, 63 Gm³/year, 16 G€)

North Stream 2: new project to double capacity. Partners: Gazprom, Engie, Shell, OMV, BASF, Eon

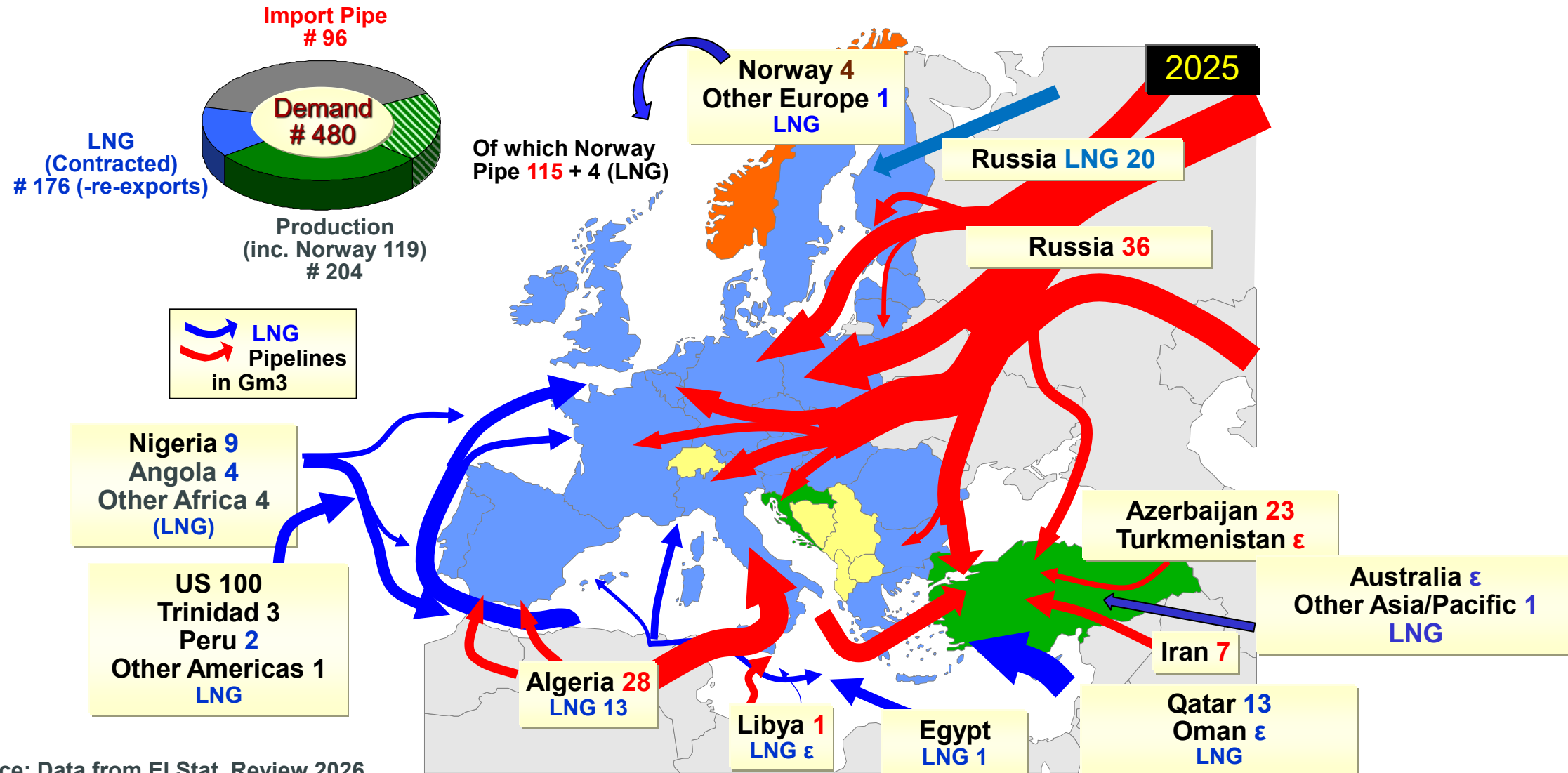


Gas Pipelines from Russia to Europe



Europe Gas Supply & Demand in 2025 (G.m3)

Russian pipe exports to Europe: 152 G.m3 in 2021 down to 36 G.m³ in 2025 (4 G.m3 to UE)



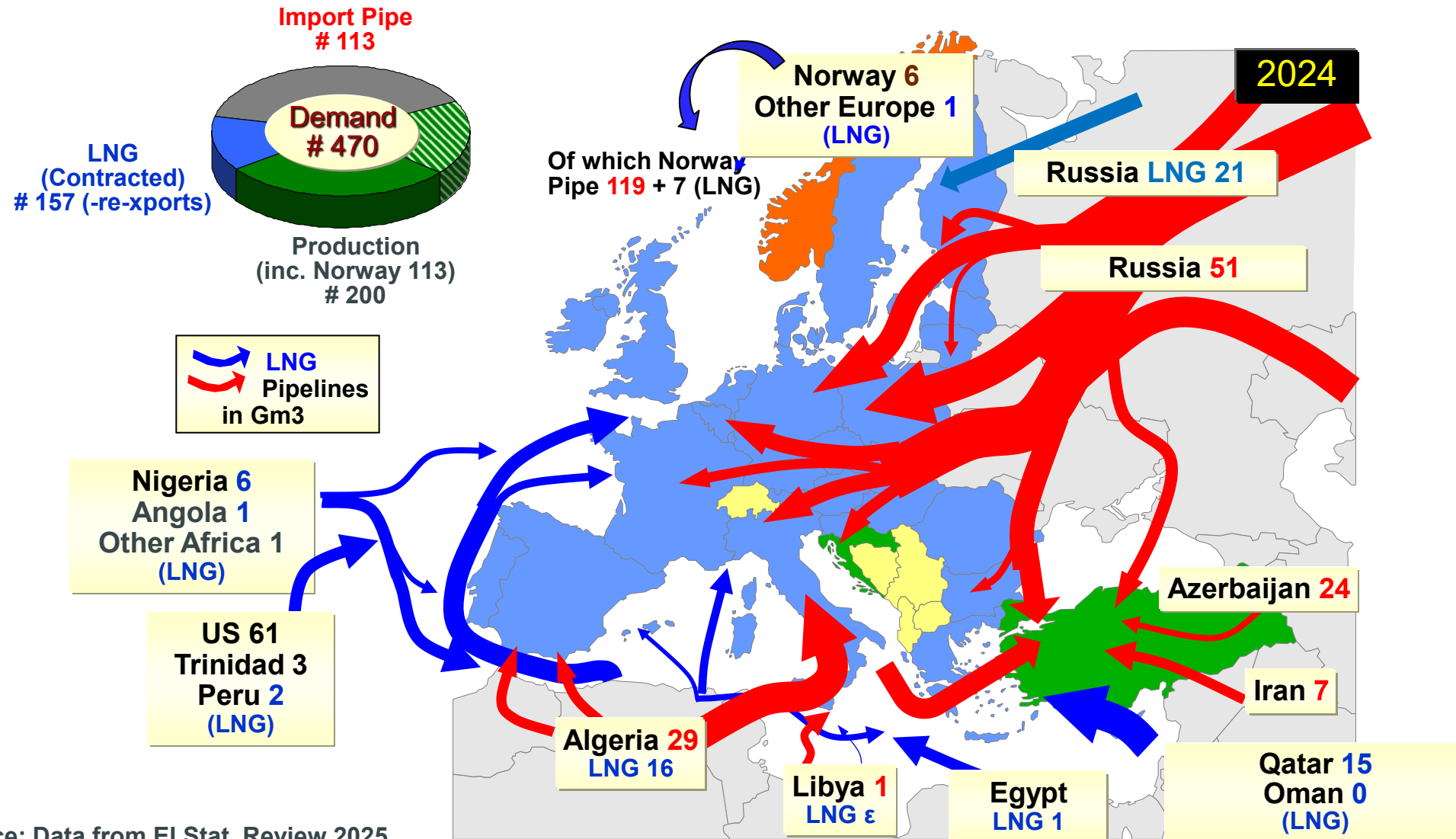
Source: Data from EI Stat. Review 2026

All countries in Europe including Turkey. EU: European Union

Arrows not at scale

Europe Gas Supply & Demand in 2024 (G.m3)

Russian pipe exports to Europe: 152 G.m3 in 2021 down to 51 G.m³ in 2024 (27 G.m3 to EU)



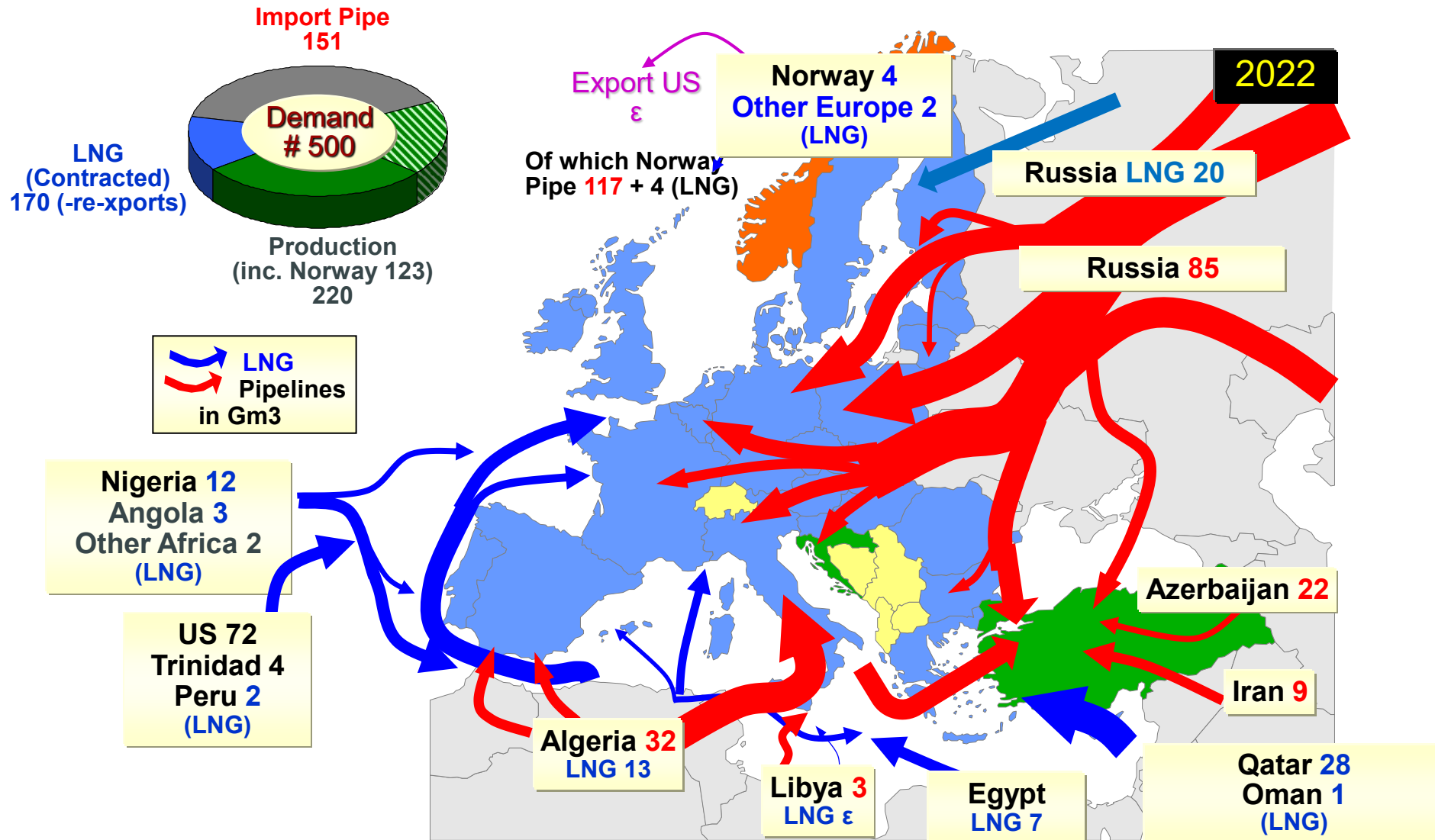
Source: Data from EI Stat. Review 2025

All countries in Europe including Turkey. EU: European Union

Arrows not at scale

Europe Gas Supply & Demand in 2022 (G.m3)

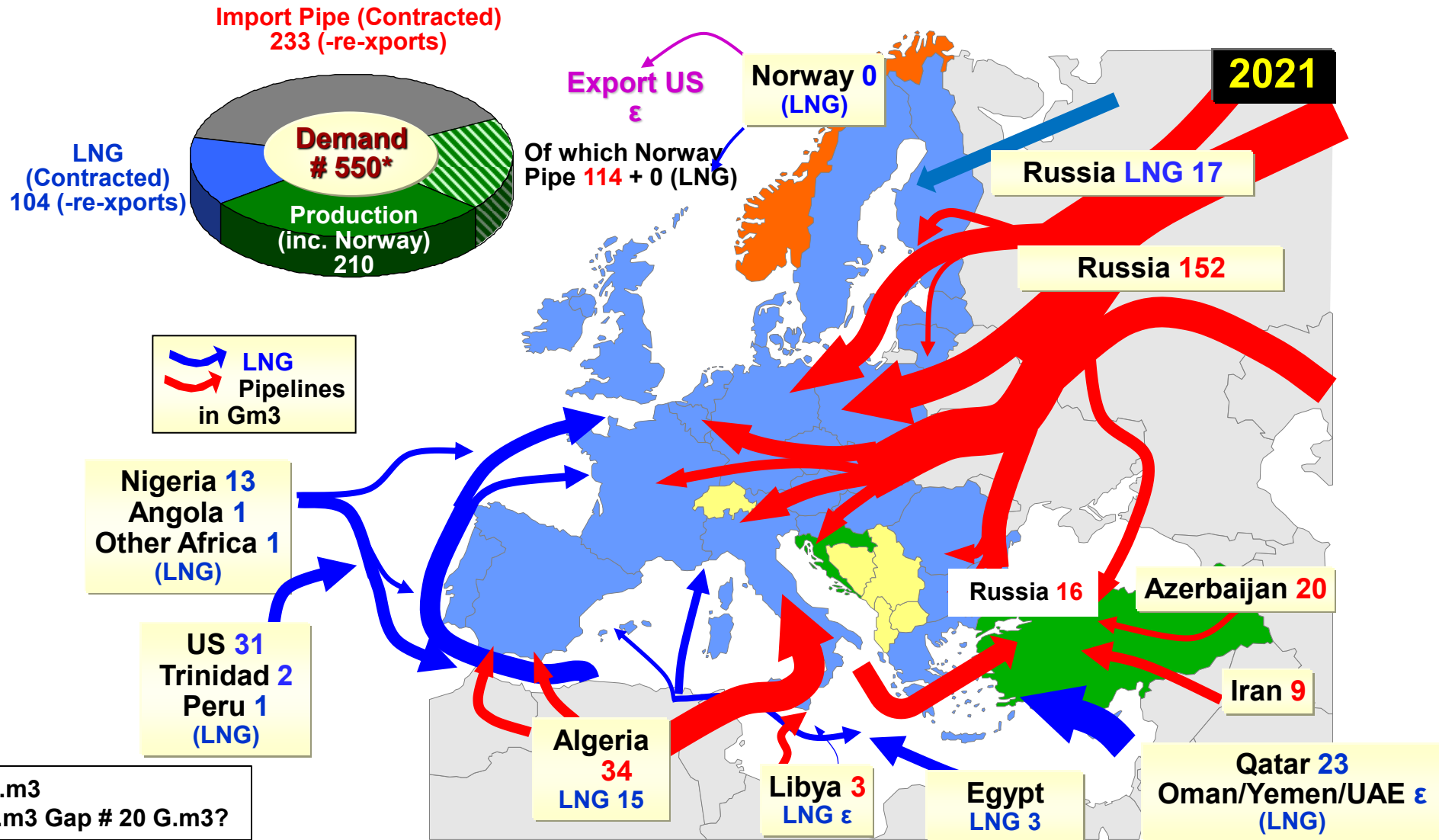
Russian exports: 152 G.m3 down to 85 G.m3 in 2022 vs 2021



Source: Data from EI Stat. Review 2023
All countries in Europe including Turkey



Europe Gas Supply & Demand in 2021 (G.m3)

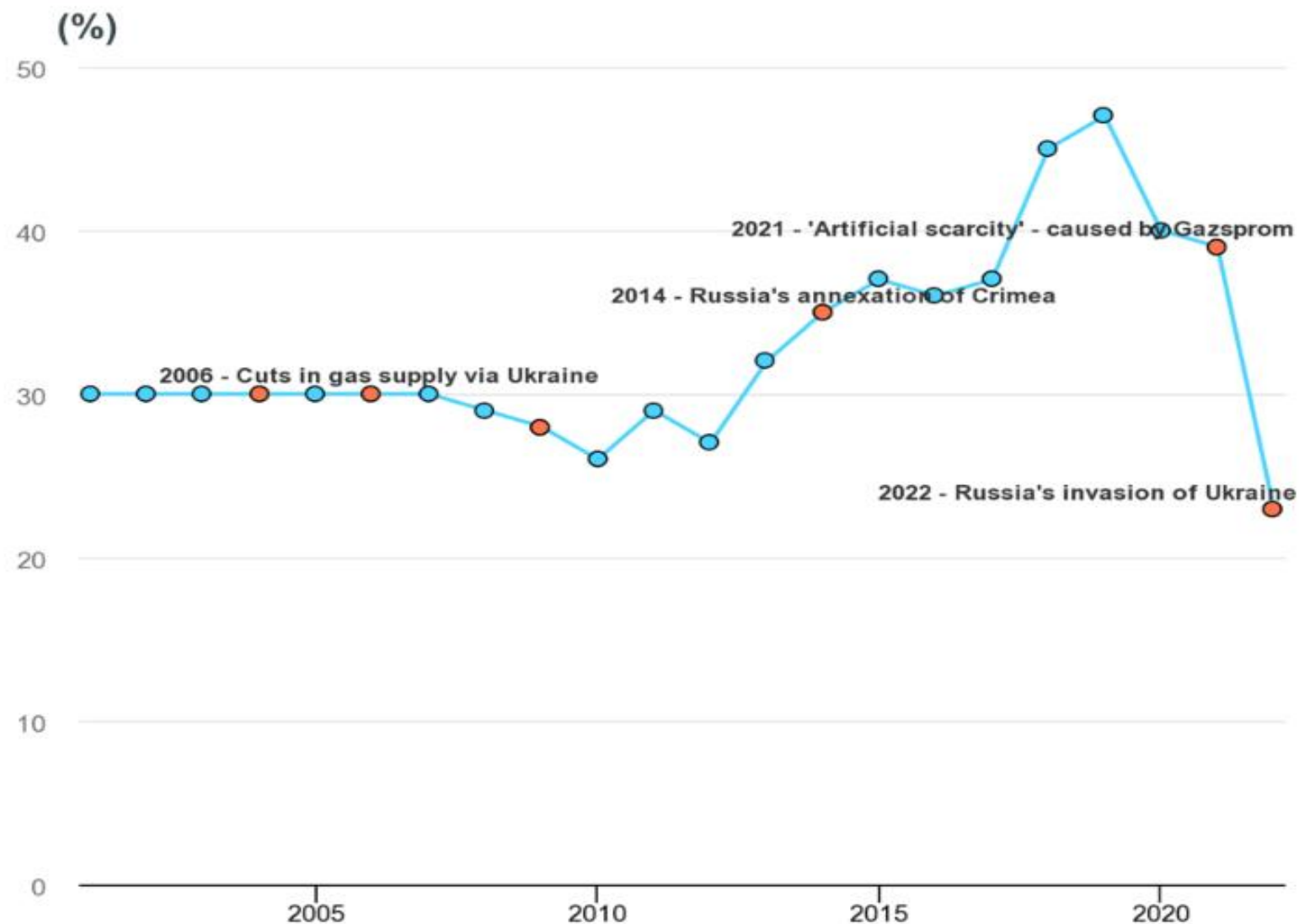


- IGU: 550 G.m3
- BP : 570 G.m3 Gap # 20 G.m3?

Source: Data from BP Stat. Review 2022
All countries in Europe including Turkey

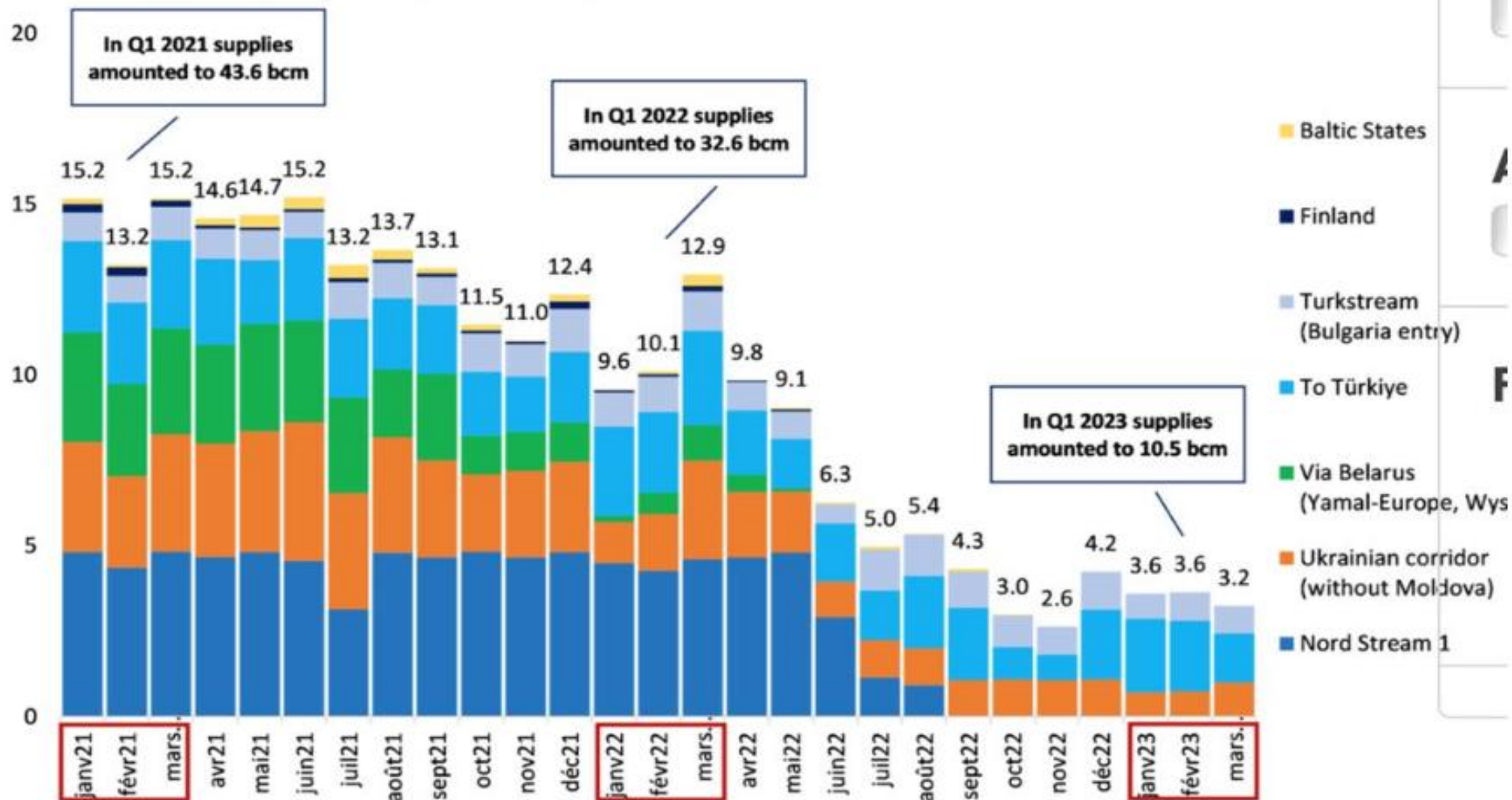


Share of EU Gas Demand met by Russian Supply 2001 - 2022



Russian Pipeline Exports to Europe 2011 - 2023

Russian monthly pipeline exports to Europe (with Baltic states) 2021-Q1 2023, bcm



Sources: EPDK, ENTSOG, Eurostat data for Turkey imports of Russian gas in March 2023

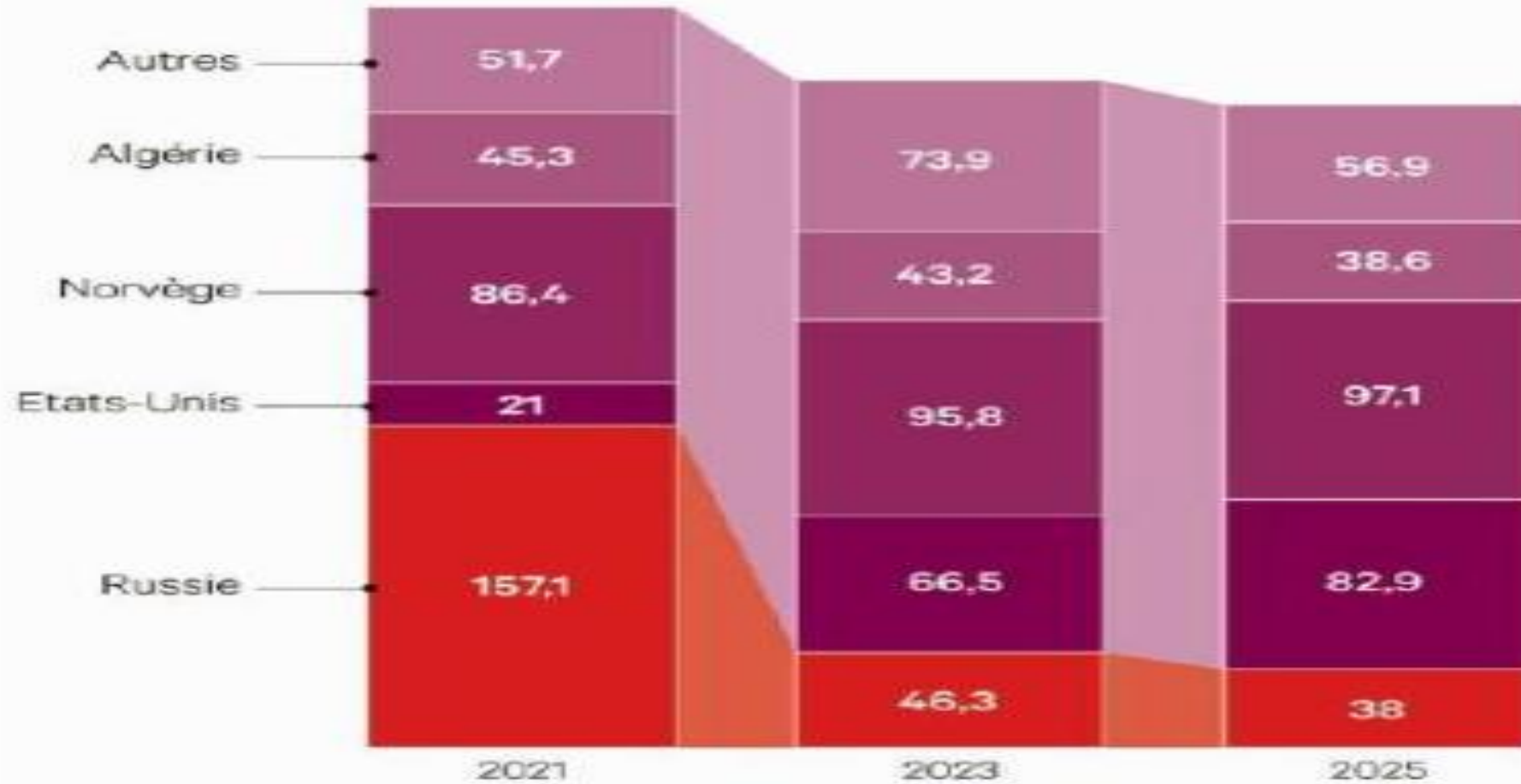
Supply volumes via Ukraine are net of flows to Moldova (calculations based on ENTSOG interconnection points)



EU Gas Supply Evolution 2021 - 2025

La Norvège et les Etats-Unis ont remplacé la Russie dans l'approvisionnement en gaz de l'UE...

En milliards de mètres cubes (gazoducs et GNL)

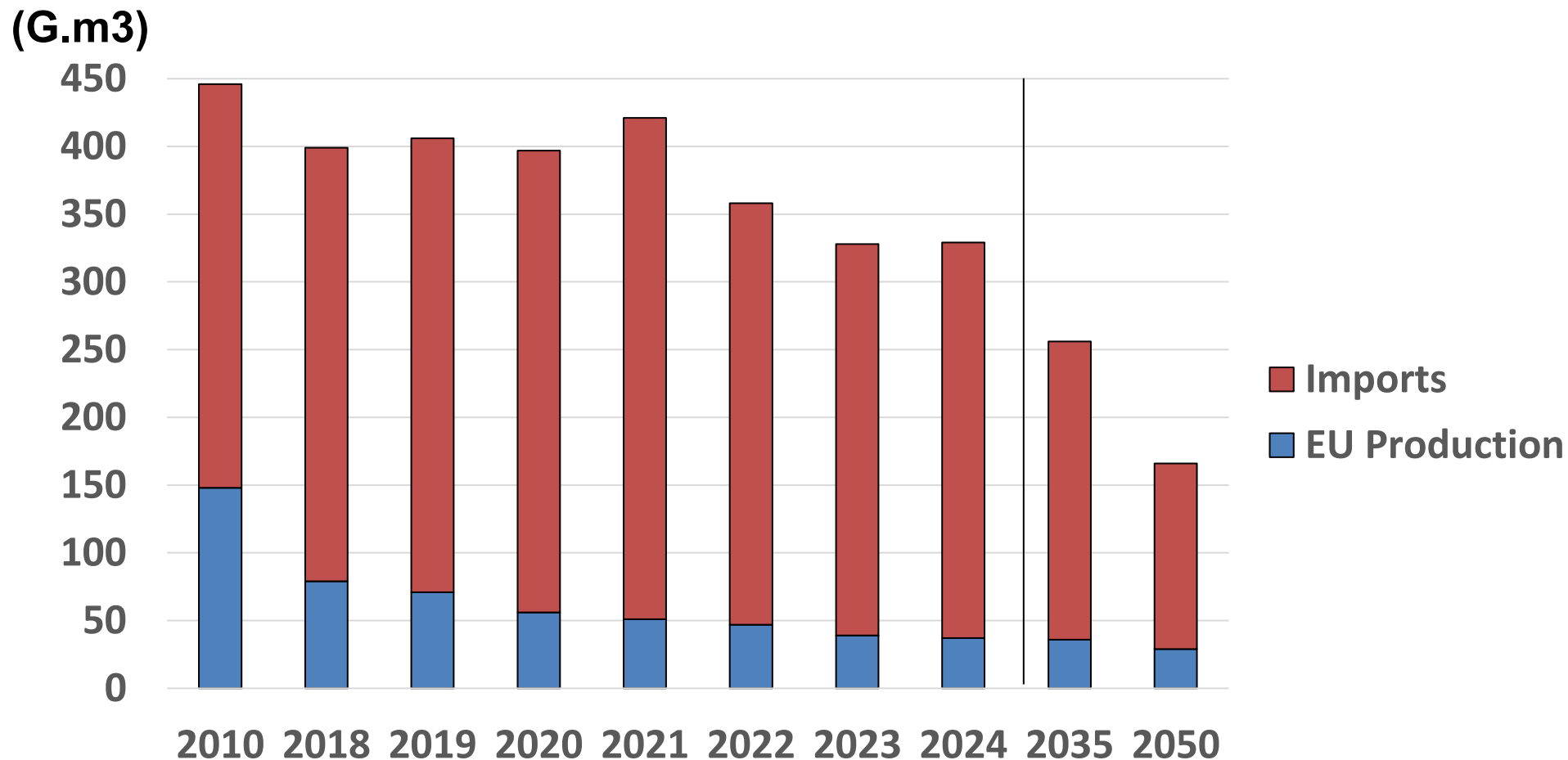


European LNG Import Terminals **announced** since the Russia-Ukraine conflict



* The locations of the two Italian FSRUs are indicative, as the actual locations are still being discussed

Gas Supply and Demand European Union IEA 2025 – STEPS Scenario

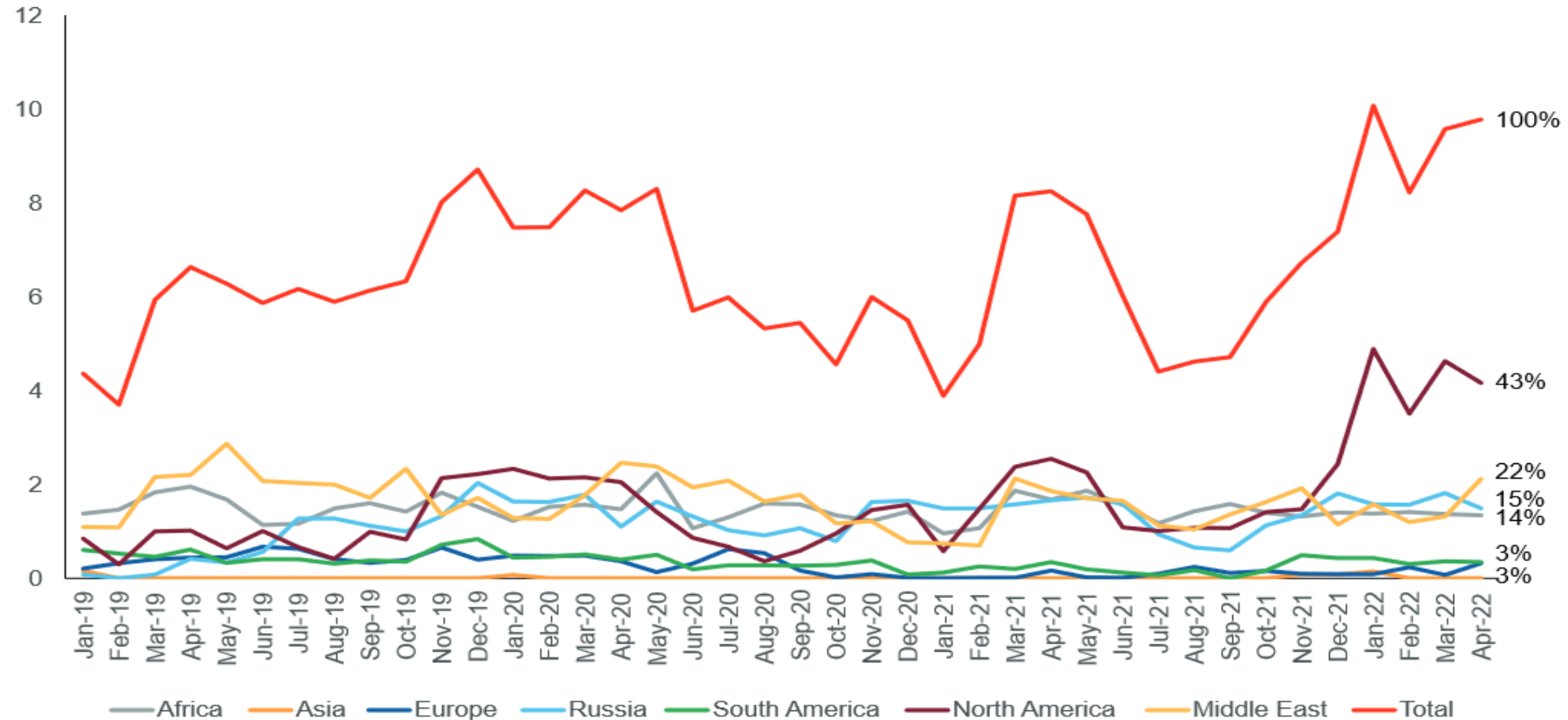


Note: EU = 27 countries, without Norway. Data from IEA WEO 2025



Europe LNG Import Volumes

Million tonnes



Source: Rystad Energy

Source: IGU Gas Report 2022



Snovhit LNG Terminal



The Arctic Lady, the first LNG tanker under a long-term charter by Total (© Eliv Leren, Statoil).



EU Energy Supply challenge for the future

How to replace # 150 G.m³ of russian Gas (situation 2022) for the supply of EU?

- **By reducing Gas Consumption**
- **By increasing the access to new LNG supply
(Current World Production today : 580 G.m³)**
- **By increasing Gas storage capacities**

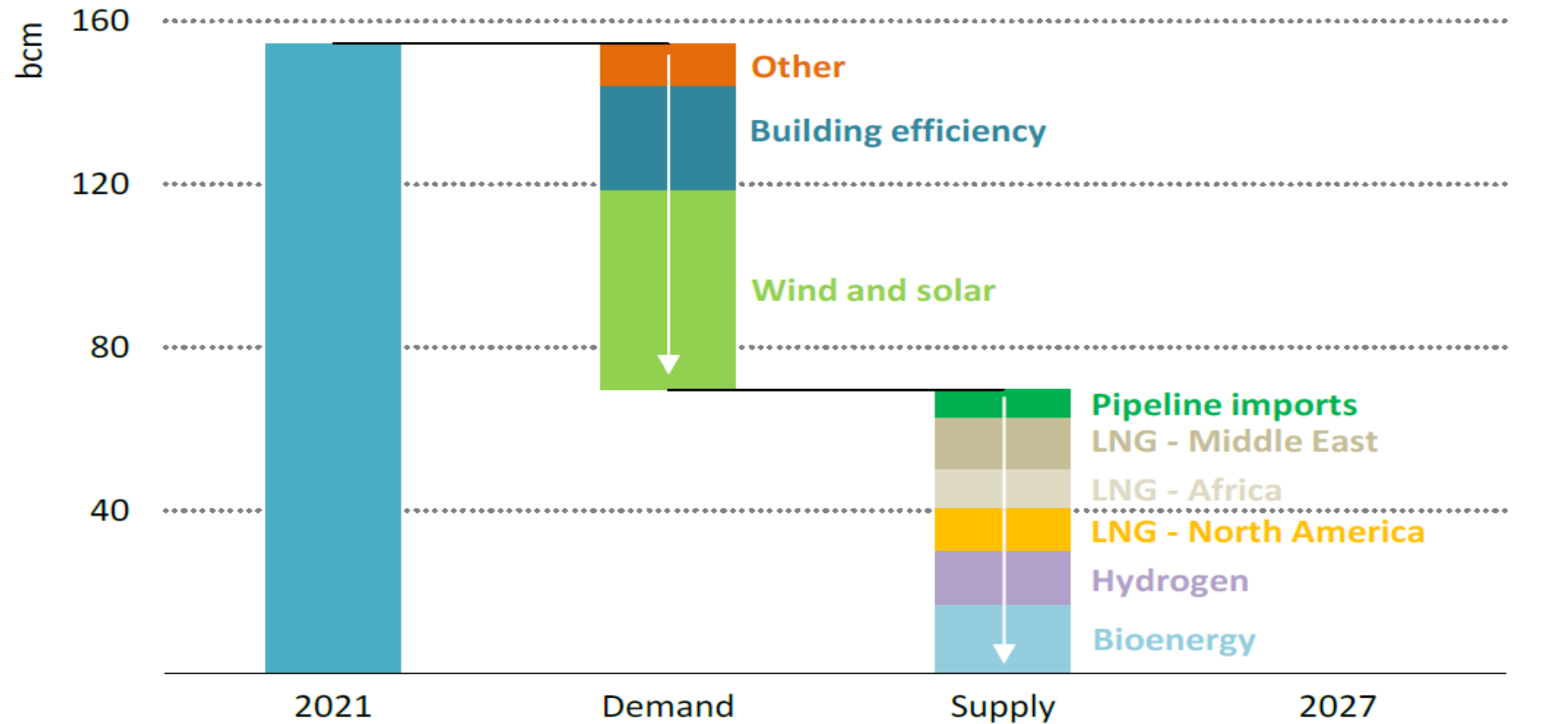


Where will future Gas come from?

Some scenarios in relation with the Russia-Ukraine conflict



EU: Drivers for reduced Natural Gas dependancy from Russia



IEA. CC BY 4.0.

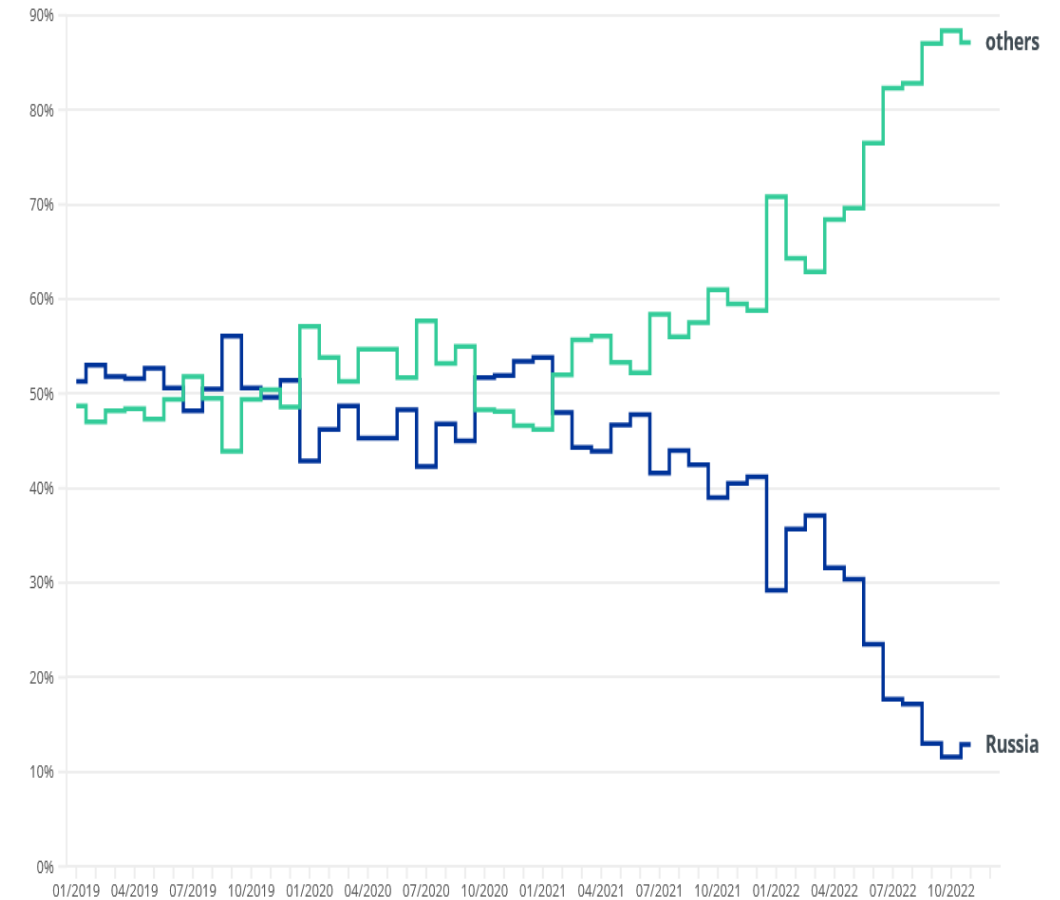
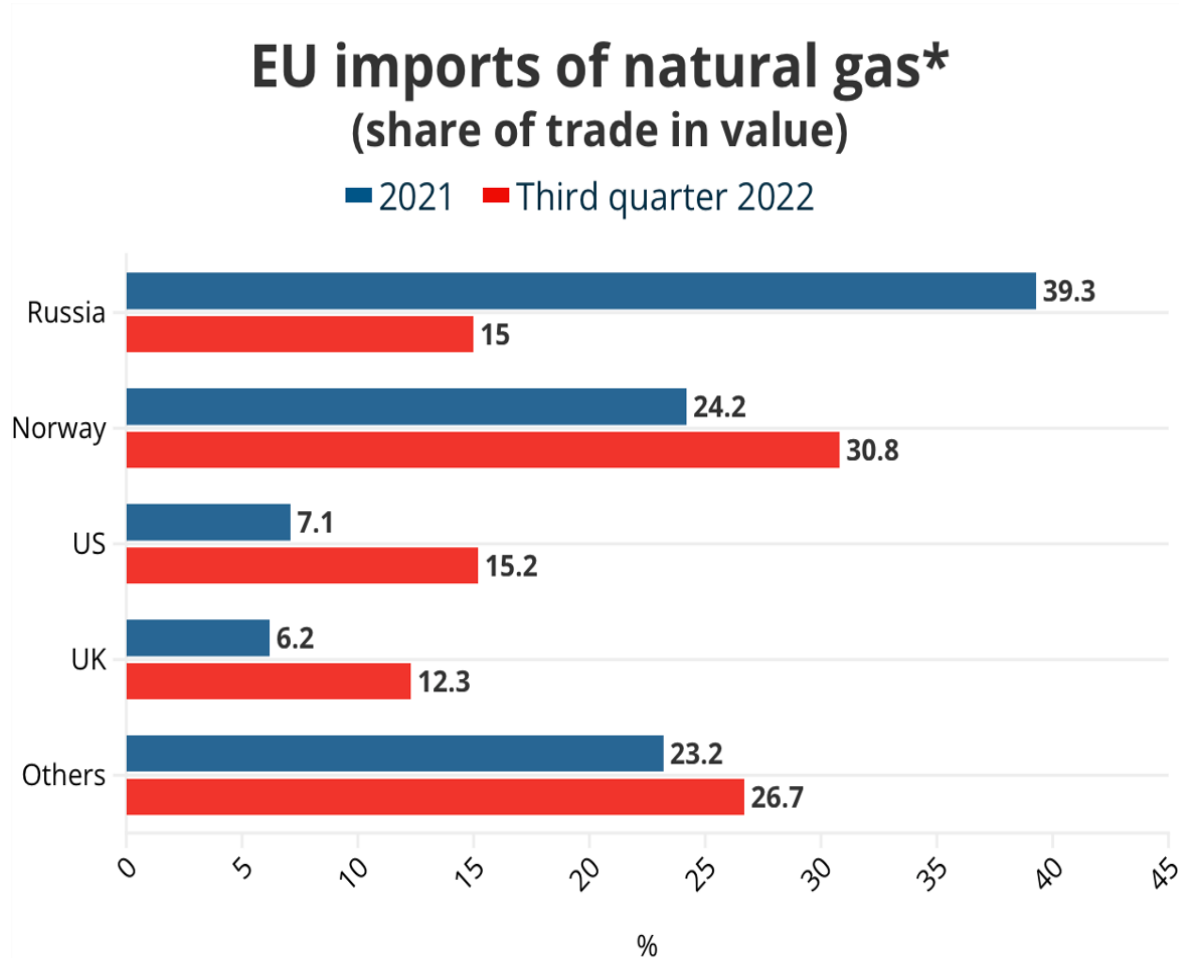
*A mix of supply- and demand-side measures are required
for the European Union to reduce reliance on Russian gas to zero before 2030*

Source: IEA WEO 2022



Share of EU's Gas Imports by source

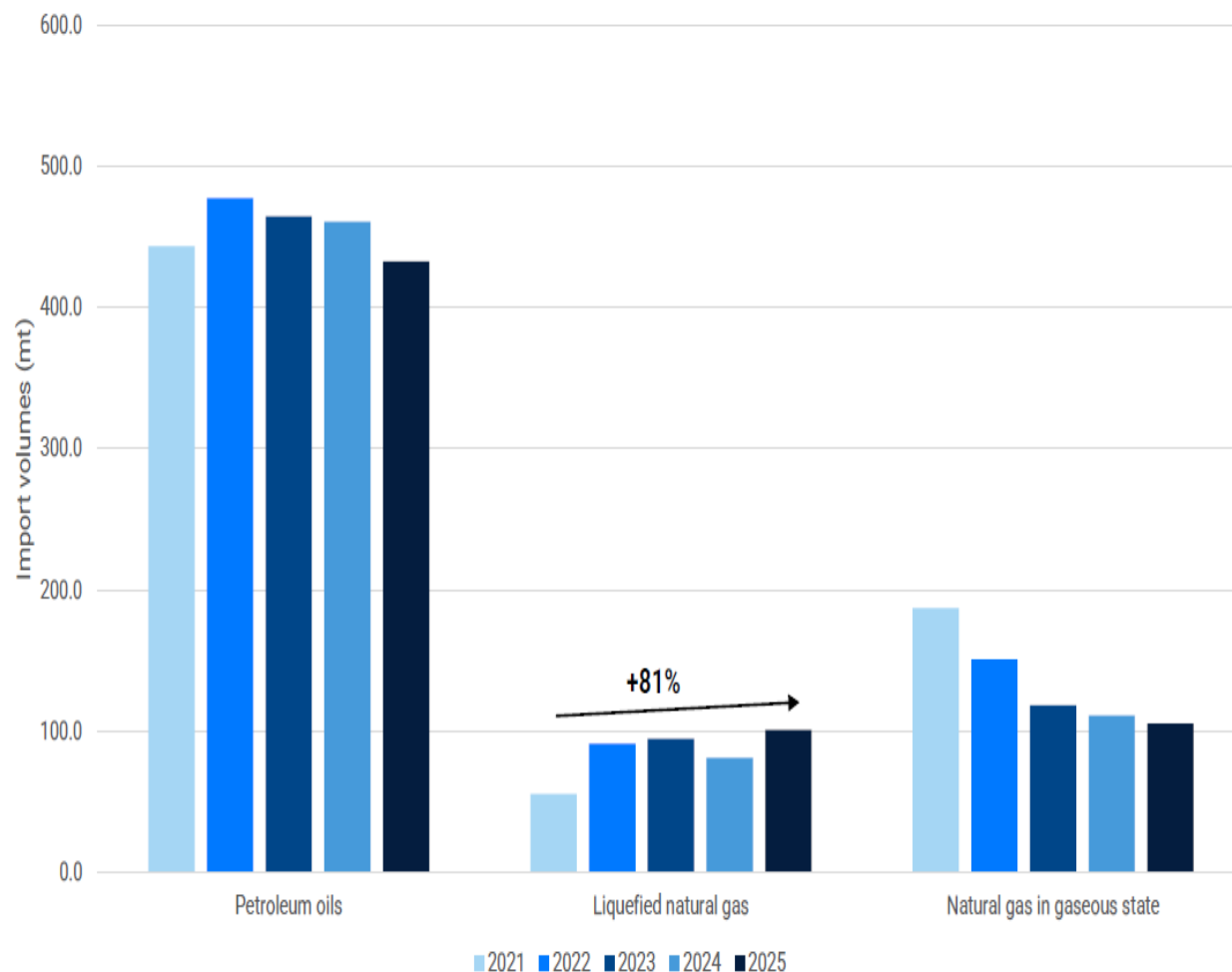
A drastic decrease of Russian Gas Imports from mid 2021 & 2022



Source: European Commission

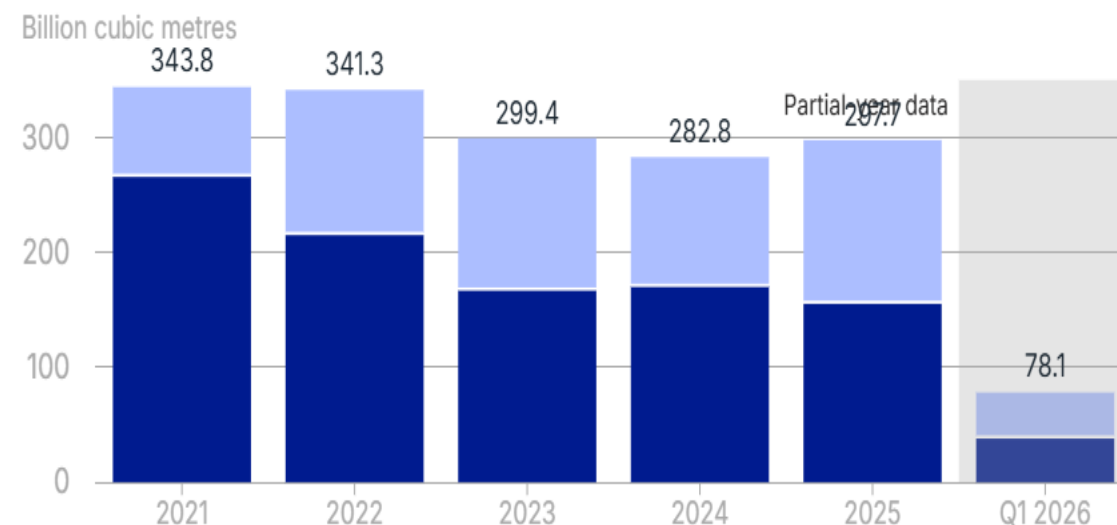
Evolution of EU's Gas Imports by source

A drastic decrease of pipe Gas Imports from 2021 to 2025



EU pipeline gas imports fell 9% in 2025
EU gas imports*

Gas pipeline LNG



Source: EU Joint Research Centre's security of gas supply dashboard, IEEFA's European LNG Tracker, Kpler. • *Import data could include volumes sent to neighbouring non-EU countries.

REPower EU – A plan to reduce russian gas dependency (1)

1/ Diversify gas supply

- additional import of 50 Bcm of LNG from Qatar, the US, Egypt and West Africa
- new pipelines sources from Azerbaïdjan, Algeria and Norway for 10 Bcm
- large scale development of bio methane 35 Bcm in 2030
- H2 accelerator initiative to replace 50 Bcm by 2030

2/ Reduce fossil fuel use faster by boosting energy savings

- reinforce the current targets of the Fit to 55
- european gas demand reduction by 15% by next spring
- lowering the temperature of its thermostat by 1°C saves 10 Bcm of gas imports

3/ Massive developments of renewable energies

- increase the 2030 renewable energies target from 40 to 45% raising generation capacity from 511 GW today to 1236 GW



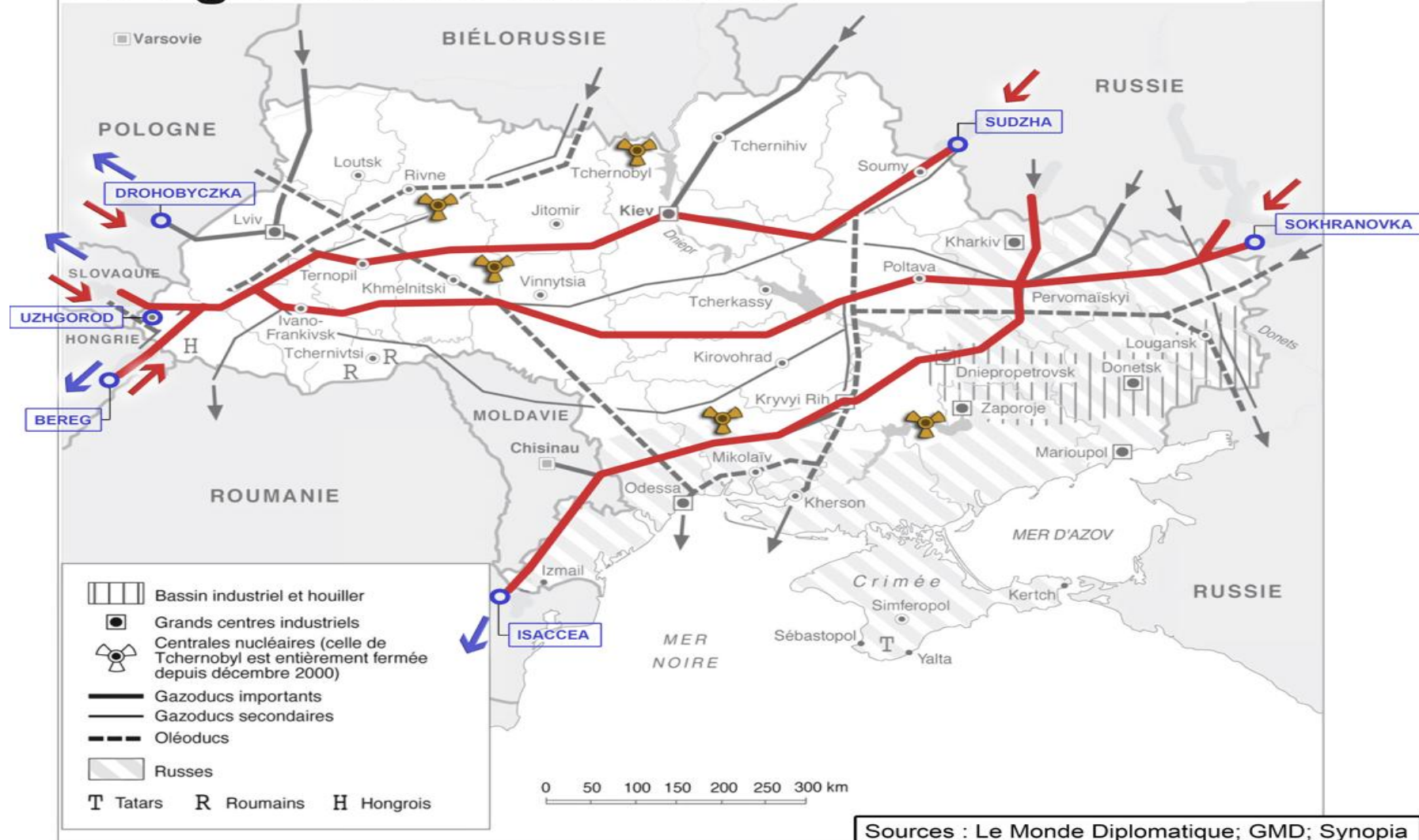
REPower EU – A plan to reduce russian gas dependency (2)

- The EU plan will mobilize close to 300 B€
- All Members States should have access at least three gas resources
- The filling of gas stocks in the EU must start right now to reach a minimum level of 80% of their capacity for next winter



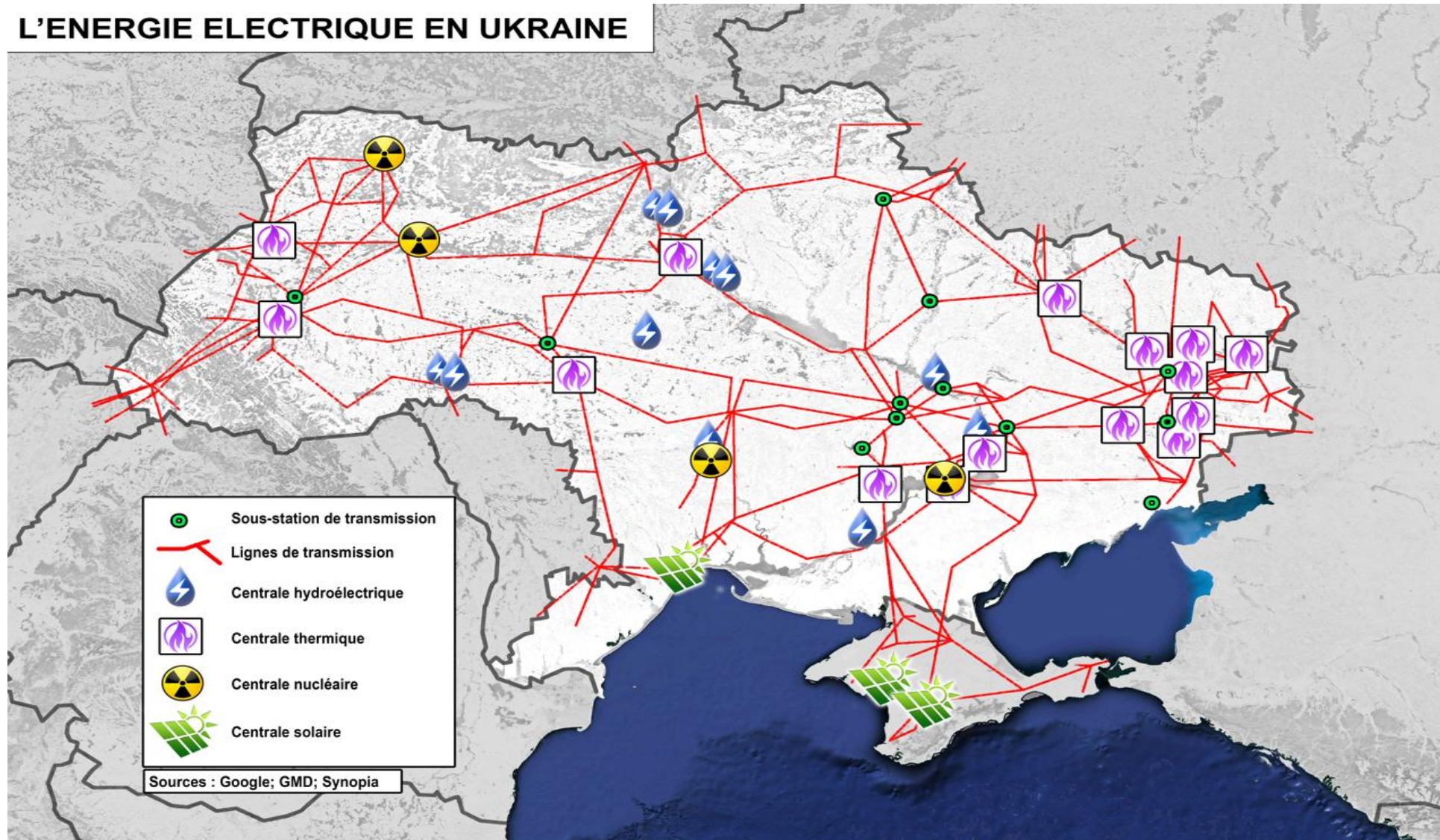
Specific situation in Ukraine

Les gazoducs ukrainiens



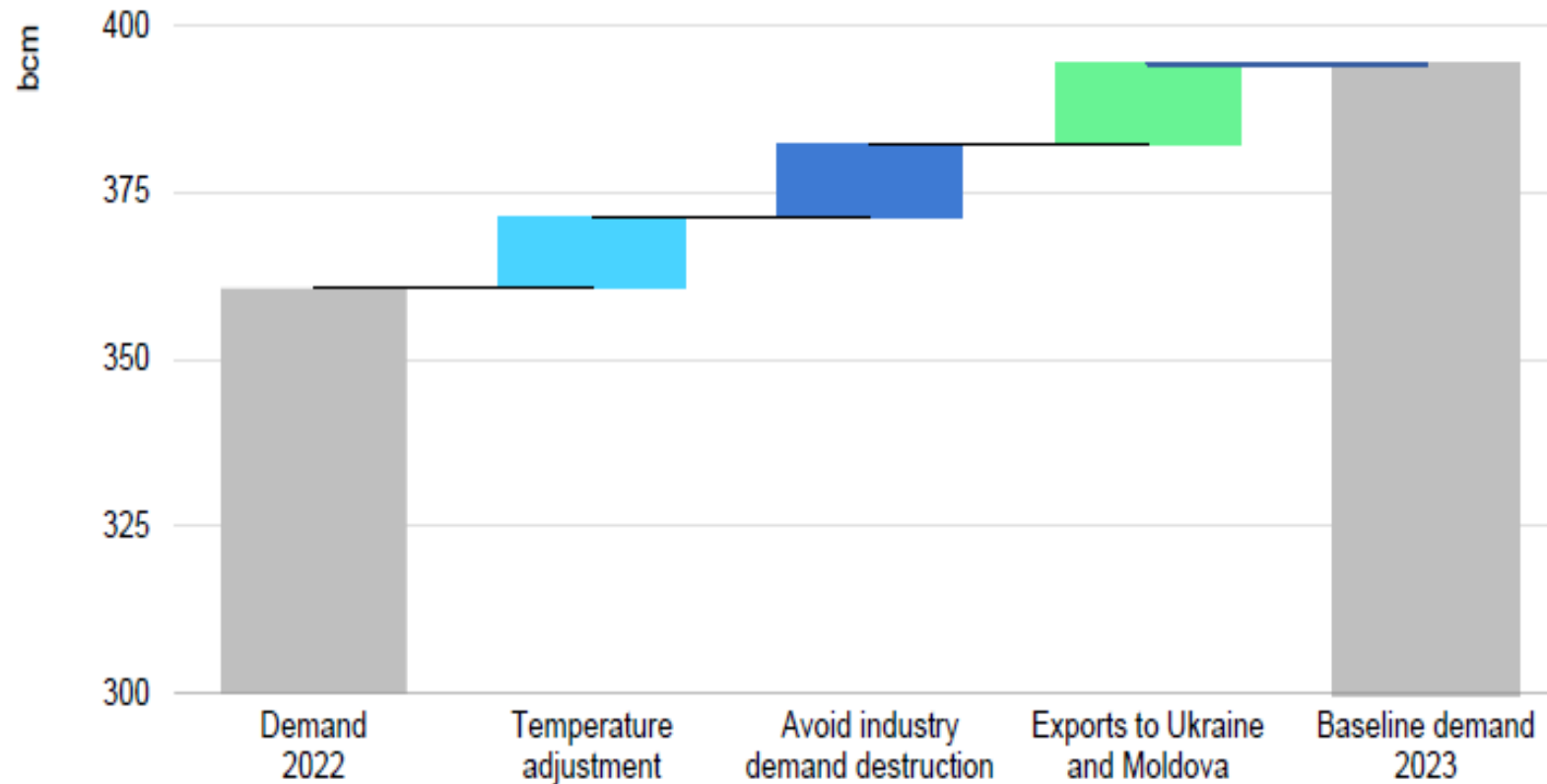
Specific situation in Ukraine

L'ENERGIE ELECTRIQUE EN UKRAINE



EU – Increased Demand anticipated in 2023 vs 2022

Additional levels of EU gas demand in 2023 above demand in 2022



IEA. CC BY 4.0.

Source: IEA Report December 2022 – How to avoid Gas shortages
in the European Union in 2023

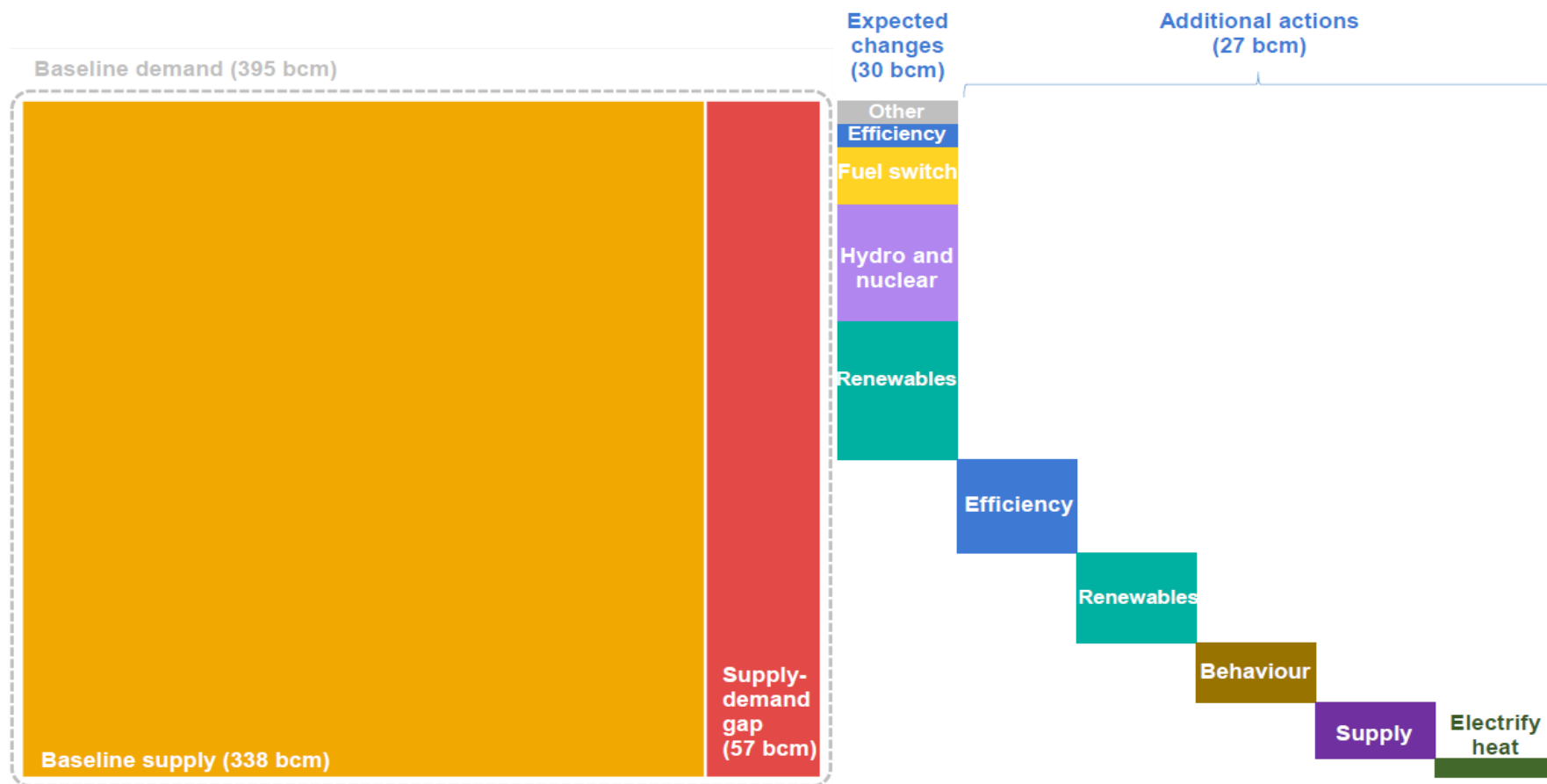
204

TPA Toolbox Energy Book 5 - Gas



EU – A Supply-Demand gap in 2023?

Expected changes and additional actions to close the supply-demand gap in the European Union in 2023



IEA. CC BY 4.0.

Note: Other = heat pumps and biomethane.

Source: IEA Report December 2022 – How to avoid Gas shortages
in the European Union in 2023

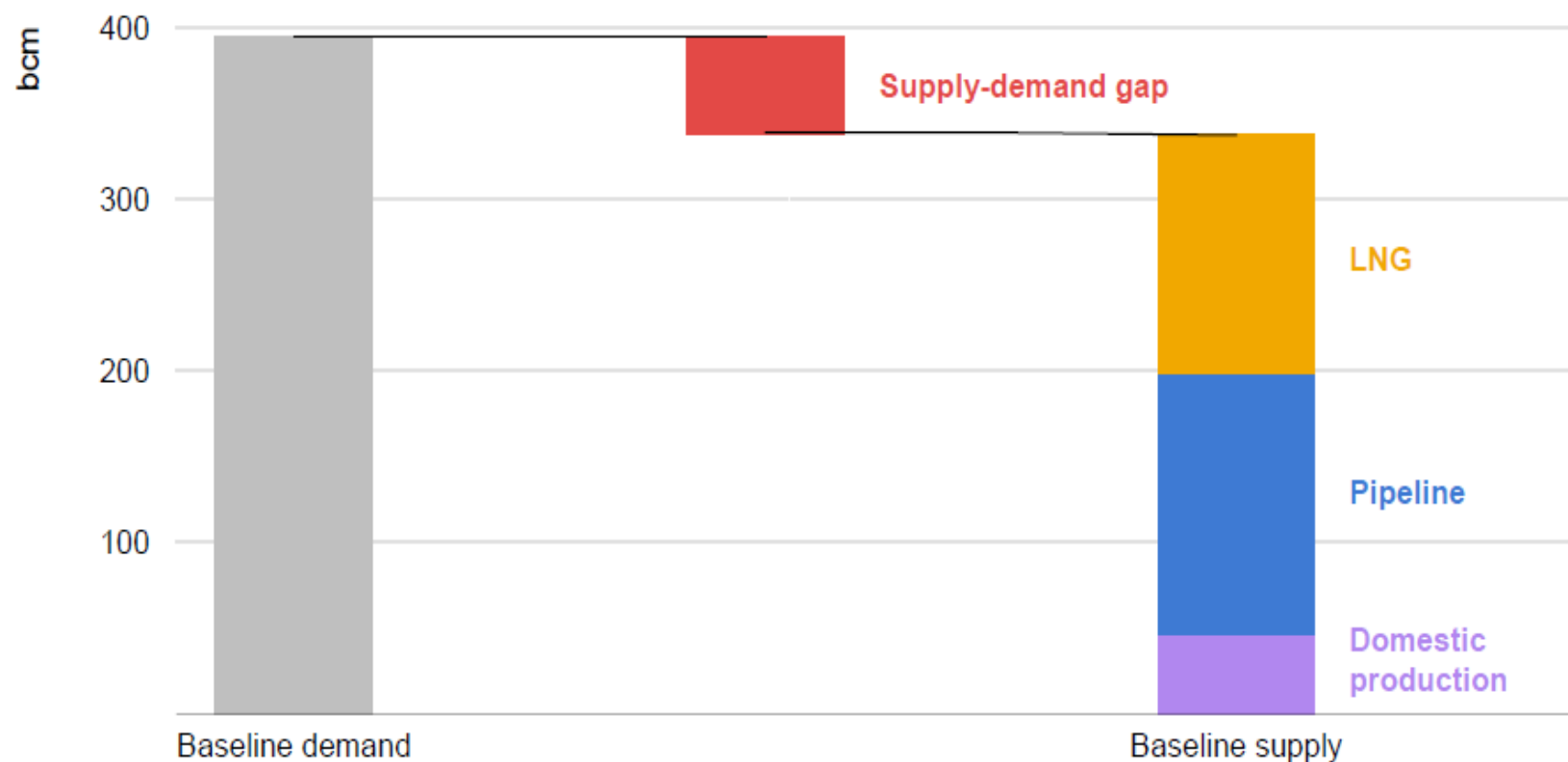
205

TPA Toolbox Energy Book 5 - Gas



EU – A Supply-Demand gap in 2023?

Assessment of the natural gas balance of the European Union in case of total cut-off of Russian flows and limited LNG availability, in 2023



IEA. CC BY 4.0.

Note: Baseline demand includes ensuring supply to Ukraine and Moldova. See Annex for assumptions.

Source: IEA Report December 2022 – How to avoid Gas shortages
in the European Union in 2023

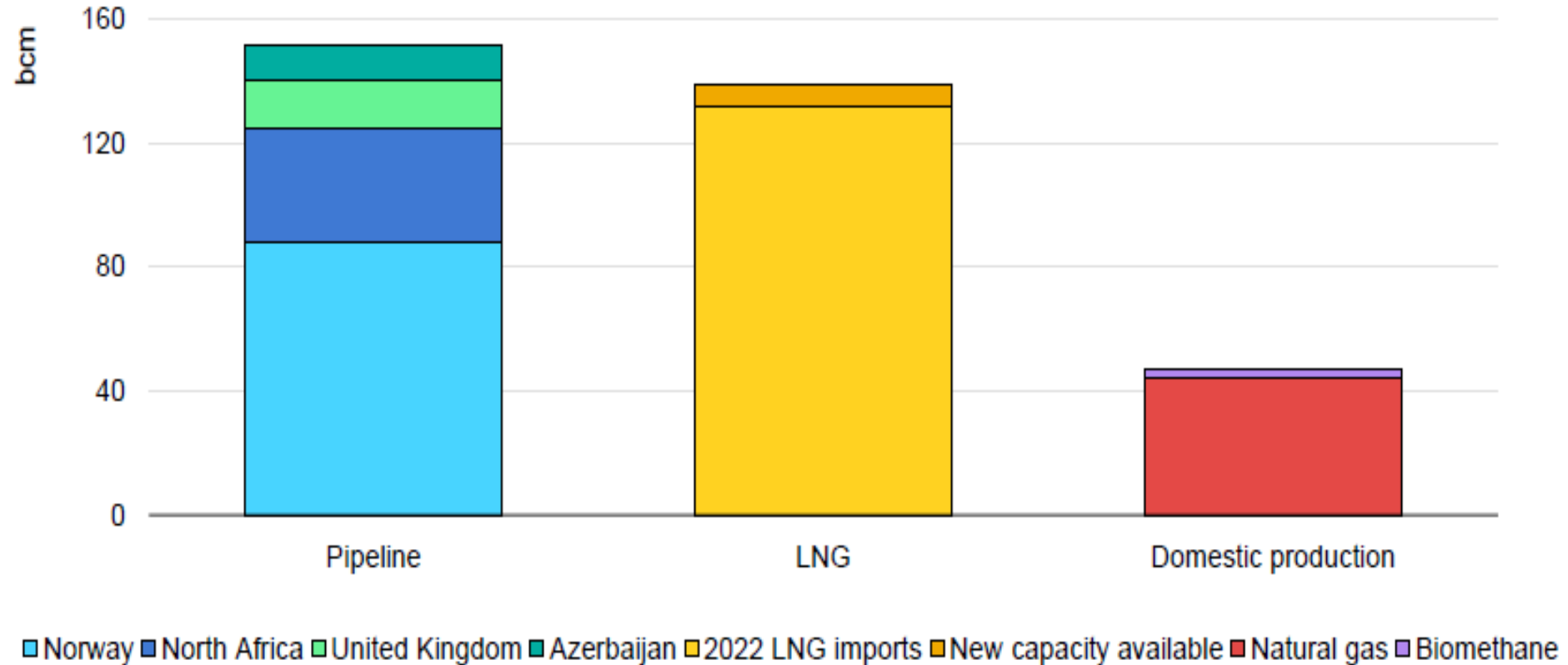
206

TPA Toolbox Energy Book 5 - Gas



EU – Assumptions for Gas Supply in 2023

Baseline level of gas supply available to the European Union in 2023



IEA. CC BY 4.0.

Source: IEA Report December 2022 – How to avoid Gas shortages
in the European Union in 2023

207

TPA Toolbox Energy Book 5 - Gas



Azeri Gas to Europe (Trans Anatolian NAtural Gas Pipeline)

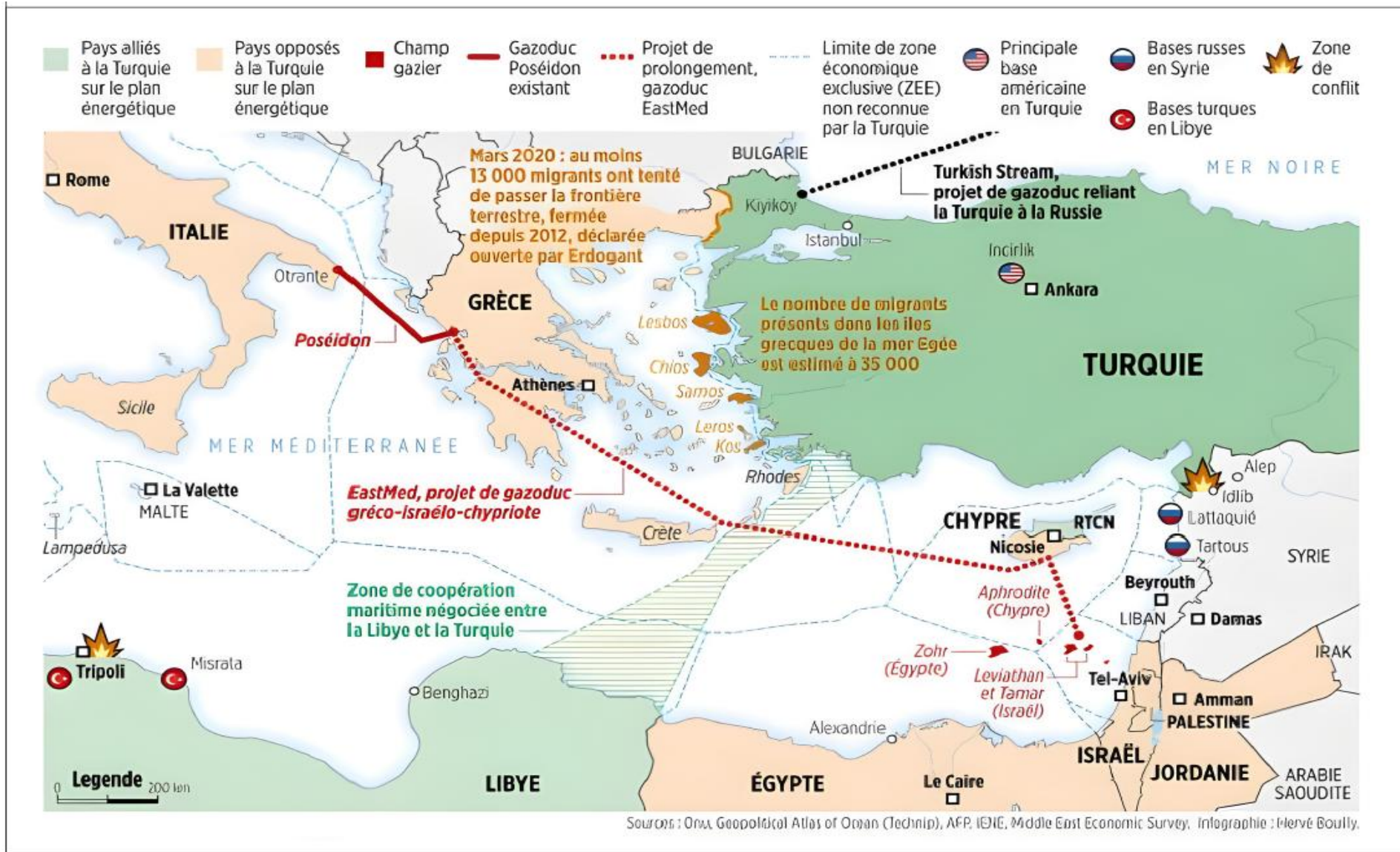


Source: Agence d'Information d'Etat d'Azerbaïdjan

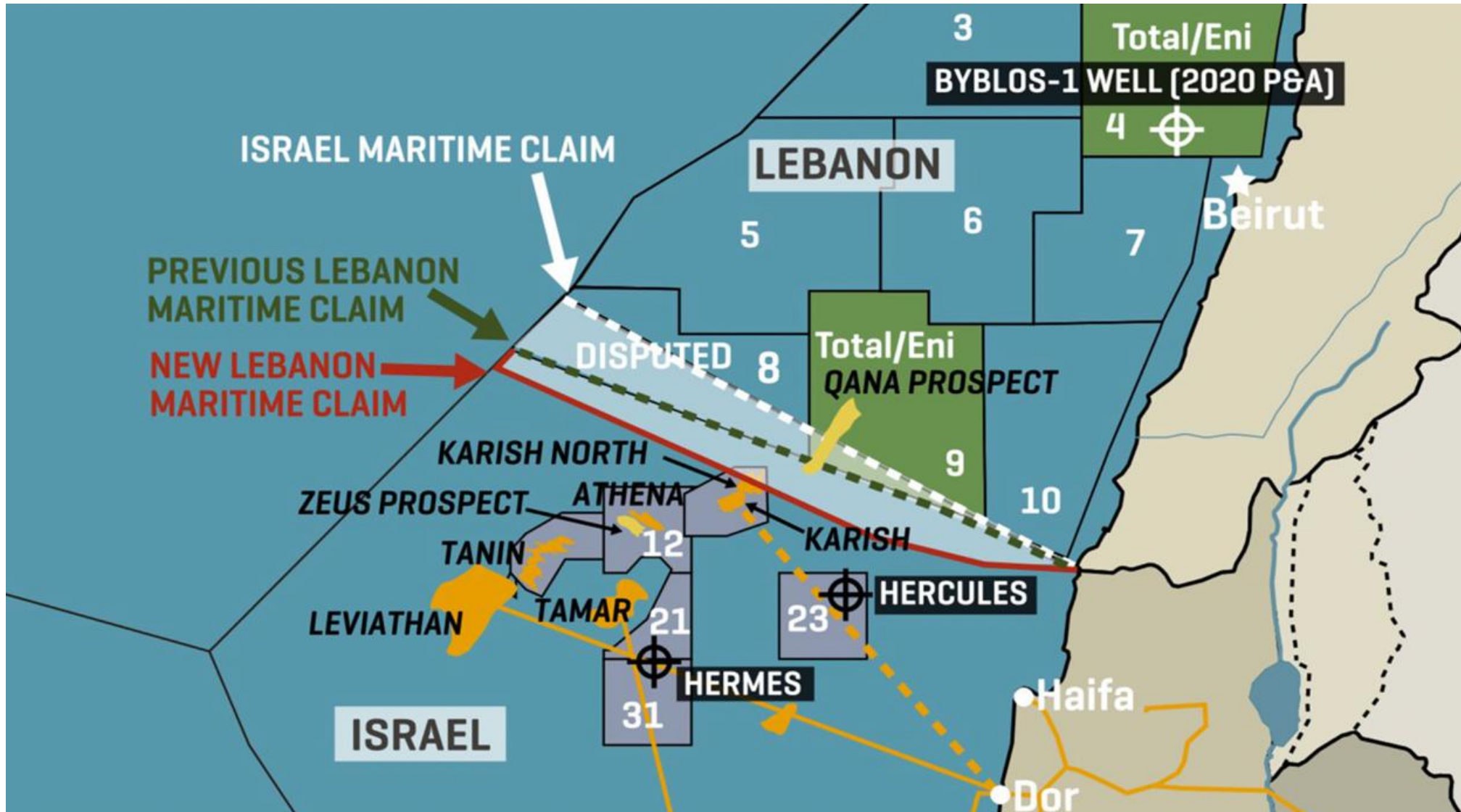
208

TPA Toolbox Energy Book 5 - Gas

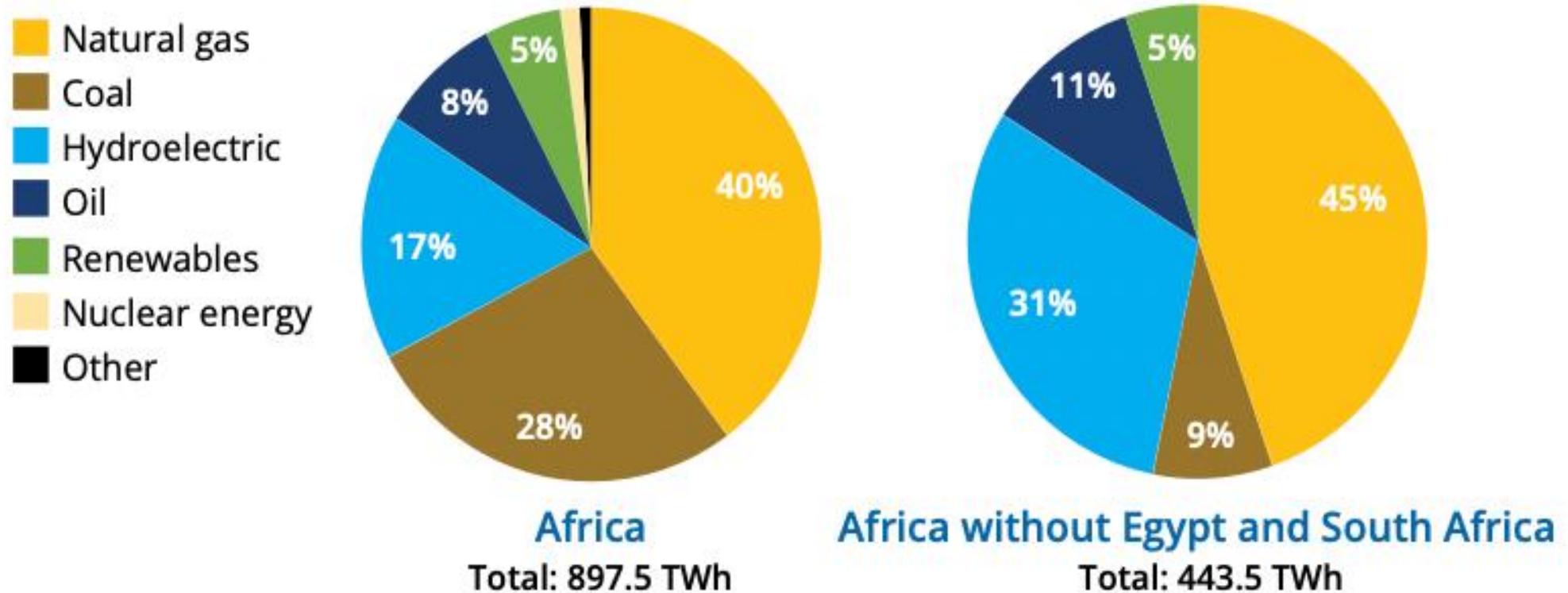
EastMedGaz in the mediterranean geopolitics



Israel & Lebanon key Gas Infrastructure



African Energy Mix 2021



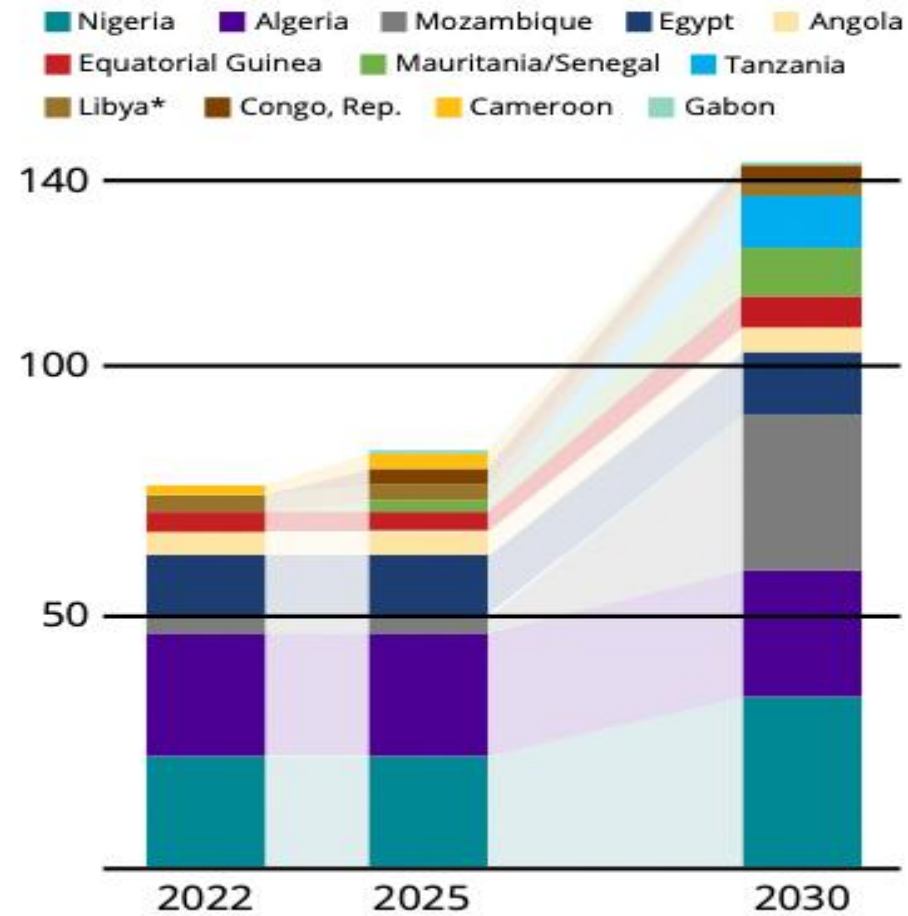
Source: bp Statistical Review of World Energy, 2022

⁵ Africa Energy Outlook 2022, IEA

⁶ "Utility evolution in Africa to reshape global electricity demand", 17 March 2022, Wood Mackenzie



African LNG Exports



Best-case scenario projections based on approved and pre-FID projects.

* Libyan capacity is unoperational

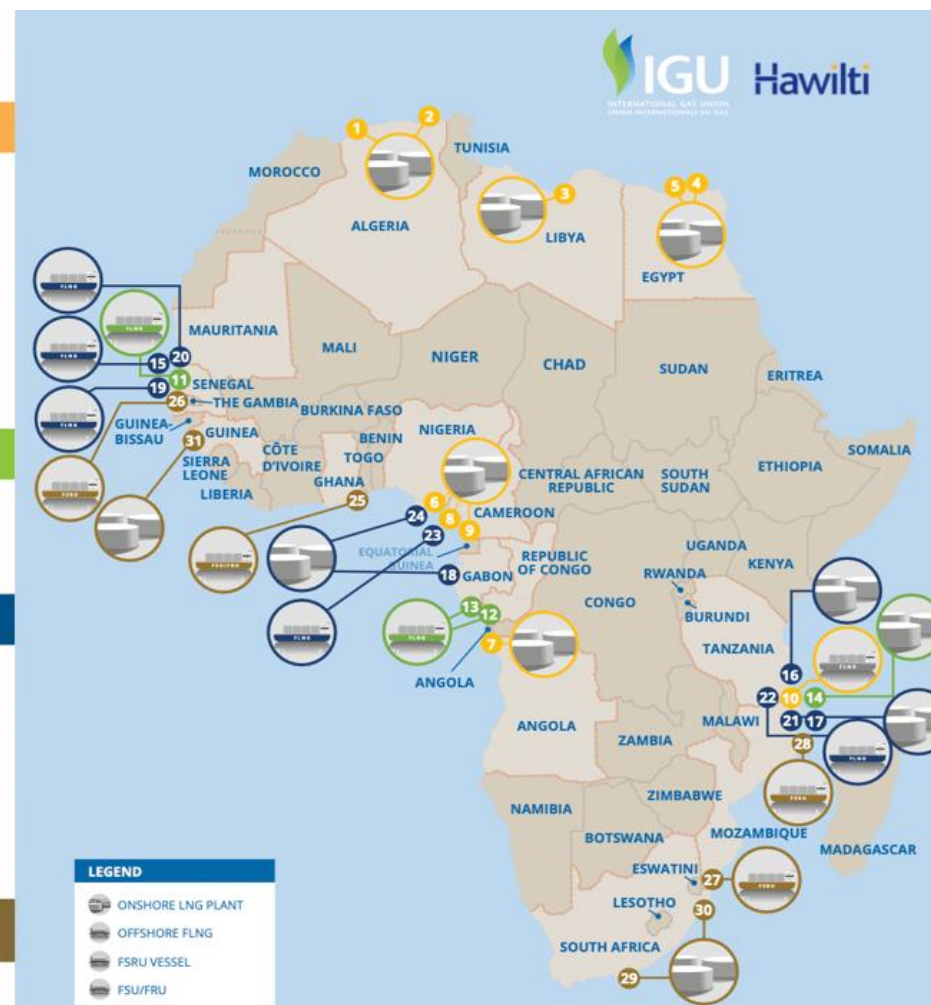
Source: IGU, Hawiliti Research



Africa's LNG infrastructure

Figure 32: Africa's LNG Infrastructure

Existing LNG Export Infrastructure	Type	Capacity	Owner/Operator	Commissioning
1 Arzew/Bethioua LNG (GLI-2-3Z)	Onshore	20.8 mtpa	Sonatrach	1977-2014
2 Skikda LNG (GLIK)	Onshore	4.5 mtpa	Sonatrach	2013
3 Marsa El Brega LNG	Onshore	3.2 mtpa	LNOC	1970
4 Damietta	Onshore	5 mtpa	Segas LNG	2005
5 Idku LNG	Onshore	7.2 mtpa	Egyptian LNG	2005
6 Bonny LNG	Onshore	22.5 mtpa	Nigeria LNG	1999-2007 under expansion
7 Soyo LNG	Onshore	5.2 mtpa	Angola LNG	2013
8 EG LNG	Onshore	3.7 mtpa	EG LNG	2007
9 Hilli Episeyo	FLNG	2.4 mtpa	Golar LNG	2018
10 Coral South	FLNG	3.4 mtpa	Eni	2022
Under-Construction LNG Export Infrastructure	Type	Capacity	Owner/Operator	Commissioning
11 GTA	FLNG	2.5 mtpa	bp	2023
12 Marine XII (Tango)	FLNG	0.6 mtpa	Eni	2023
13 Marine XII	FLNG	2.4 mtpa	Eni	2025
14 Mozambique LNG	Onshore	12.88 mtpa	TotalEnergies	2026
Planned LNG Export Infrastructure	Type	Capacity	Owner/Operator	Commissioning
15 GTA Ph.2	FLNG	2.5 mtpa	bp	2025/2026
16 Tanzania LNG	Onshore	15 mtpa	Equinor, Shell	2030
17 Rovuma LNG	Onshore	15.2 mtpa	ExxonMobil, Eni	TBA
18 Cap Lopez	Onshore	0.6 mtpa	Perenco	2026
19 Yakaar-Teranga	Possible FLNG	4.5 mtpa	bp	2026
20 BirAllah-Orca	Possible FLNG	TBA	bp	FID 2025
21 Mozambique LNG	Onshore	30 mtpa	TotalEnergies	2026
22 Coral 2	FLNG	TBA	Eni	TBA
23 Fortuna	FLNG	TBA	TBA	TBA
24 Padah	Onshore	3.4 mtpa	Padah LNG	2025
Planned LNG Import & Regasification Infrastructure	Type	Capacity	Owner/Operator	Commissioning
25 Tema LNG	FSU/FRU	1.7 mtpa	Helios Inv. Partners	2022
26 KARMOL LNGT Powership Africa FSRU	FSRU	84 MMscf/d	KARMOL	2022
27 Matola LNG	FSRU	TBA	TotalEnergies, Gigajoule	2025
28 KARMOL (ex. LNG Vesta)	FSRU	TBA	KARMOL	TBA
29 Coega LNG	Onshore	TBA	TBD	TBA
30 Richards Bay LNG	Onshore	TBA	Transnet SOC	TBA
31 Kamsar LNG	Onshore	TBA	West Africa LNG Group, Inc. (WALNG)	TBA

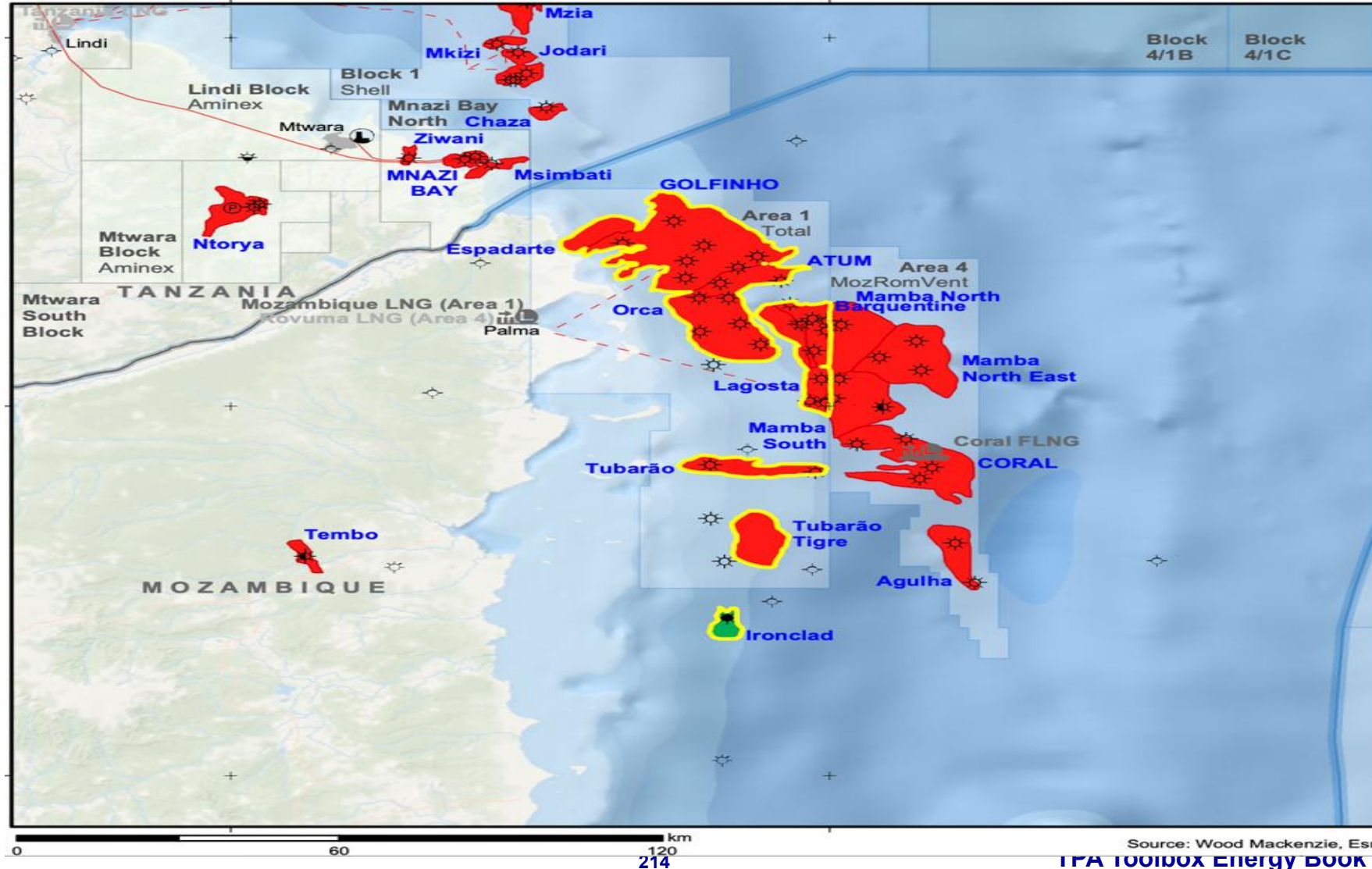


Source: World LNG Report 2022, IGU; Hawilti Research

Disclaimer: The boundaries, colors, denominations, and other information shown on any map in this work do not imply any judgment on the part of Hawilti Ltd nor the International Gas Union concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

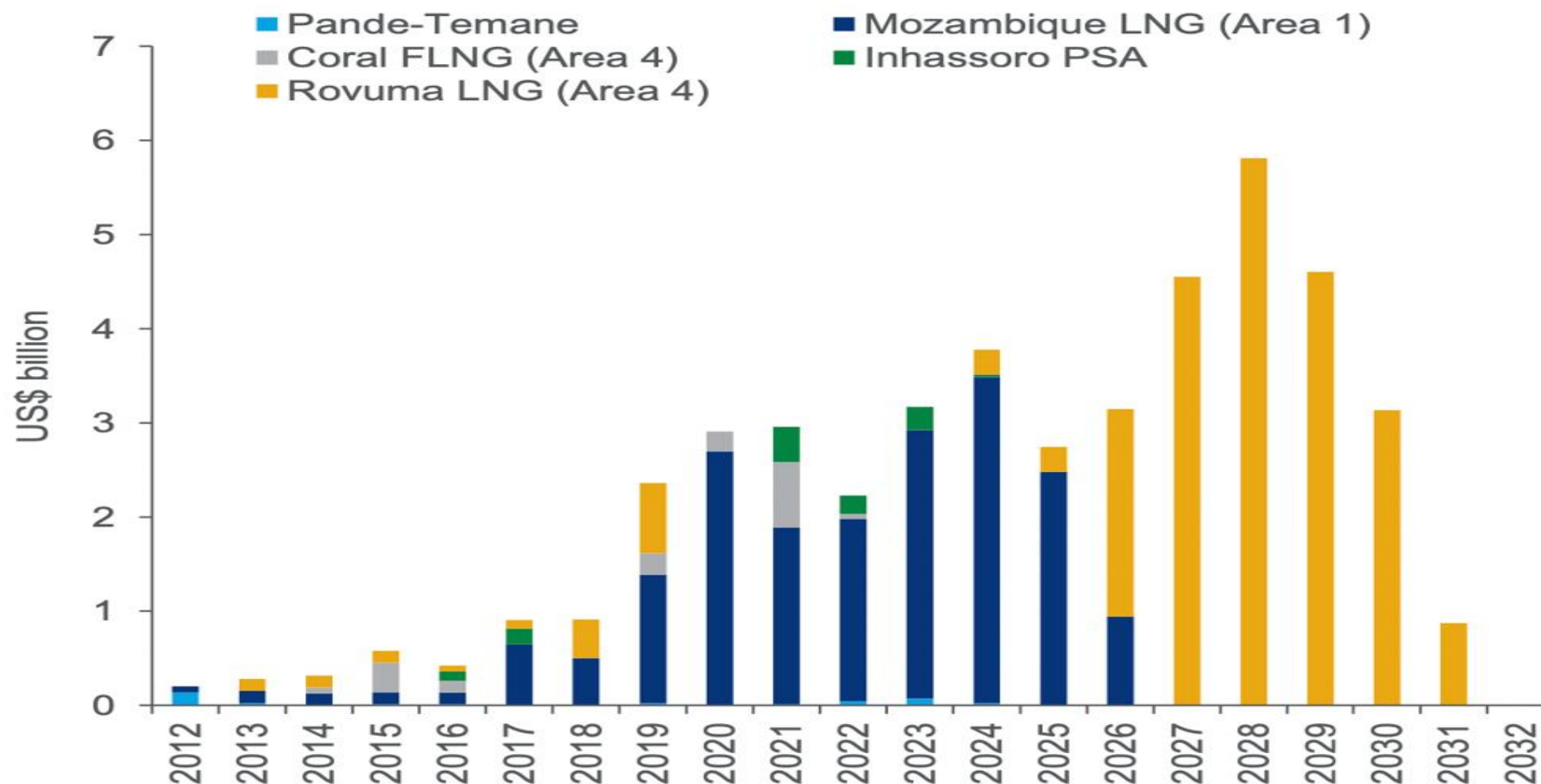


Potential Gaz Fields development in Tanzania/Mozambique



Capex by LNG projects in Mozambique

Capex by project



Source: Wood Mackenzie Lens



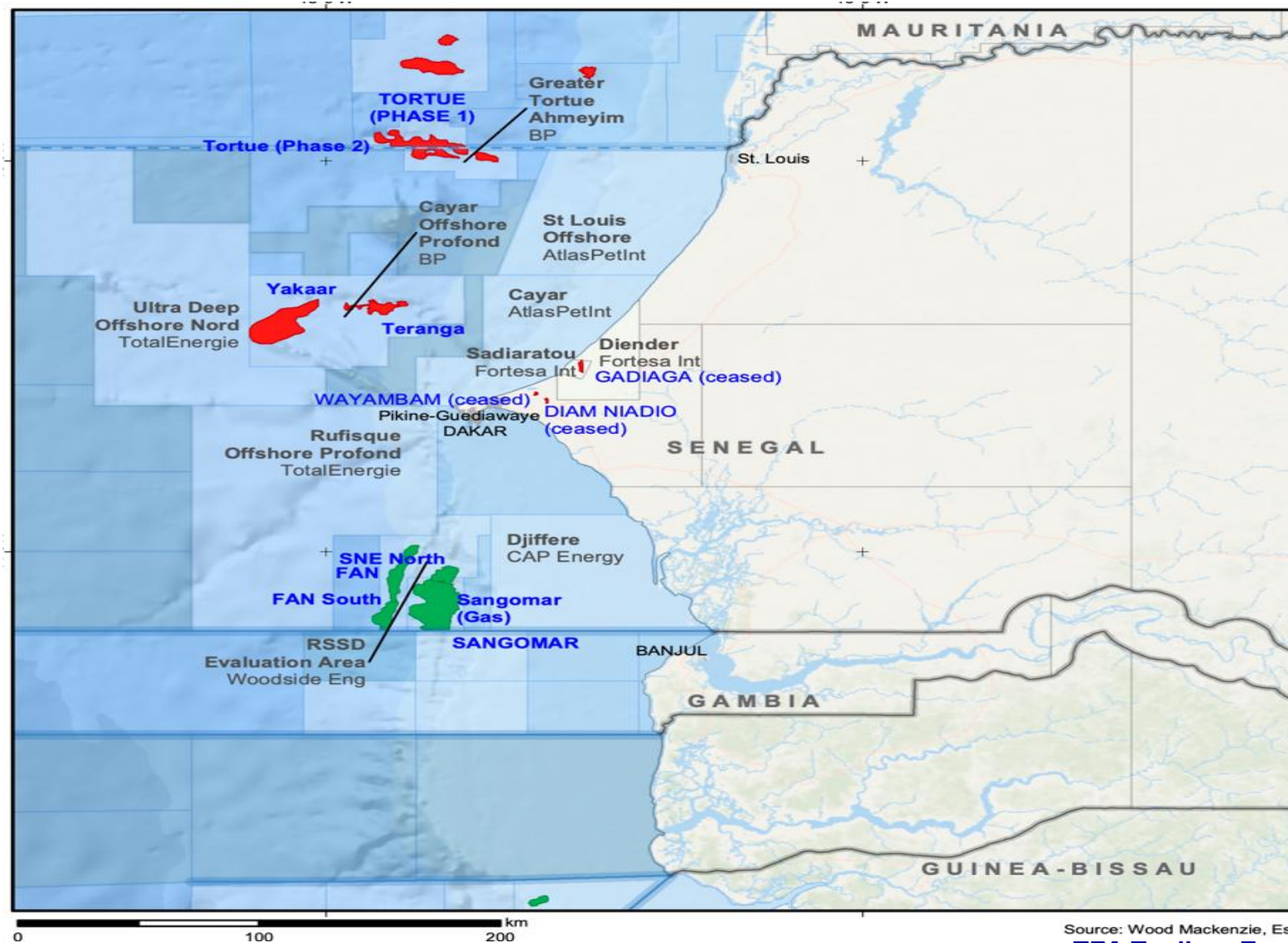
FLNG Mozambique Coral Sul



The Coral Sul FLNG offshore
Mozambique exported its
first cargo in 2022.
Picture: Eni



Potential Gas Fields Development in Senegal/Mauritania



Source: Wood Mackenzie, Esri



The North American Market (See Book 6 – Unconventional Hydrocarbons)



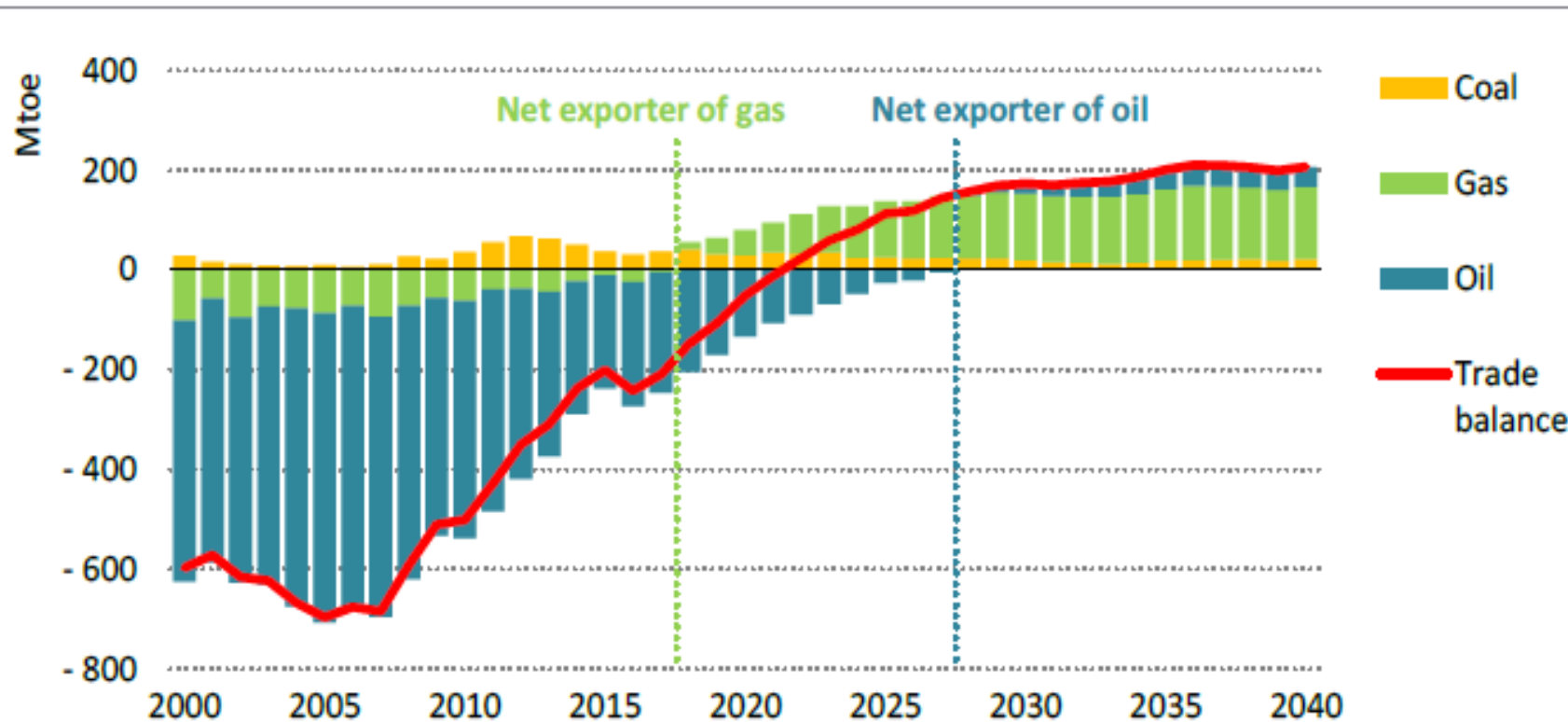
North America

- ◆ Mature markets, mature infrastructures.
- ◆ The Gas transport and Gas market competition are ruled.
- ◆ A liquid and deep market.
- ◆ The Gas demand is elastic.
- ◆ Coal is a competitive energy for power generation, despite the negative consequences of CO2 emissions.
- ◆ The conventional Gas production decreases, while uncertainties over the unconventional reserves remain due to the sensitivity to the price. Economics are the keys.
- ◆ A growing business: the Gas Shales exploitation, high contribution to production increase, environmental concerns. USA has become a gas exporter. US Gas exports through LNG have considerably increased due to the Ukraine/Russia war.



Reminder: US are going to become Net Exporter of HC

A IEA 2017 Vision

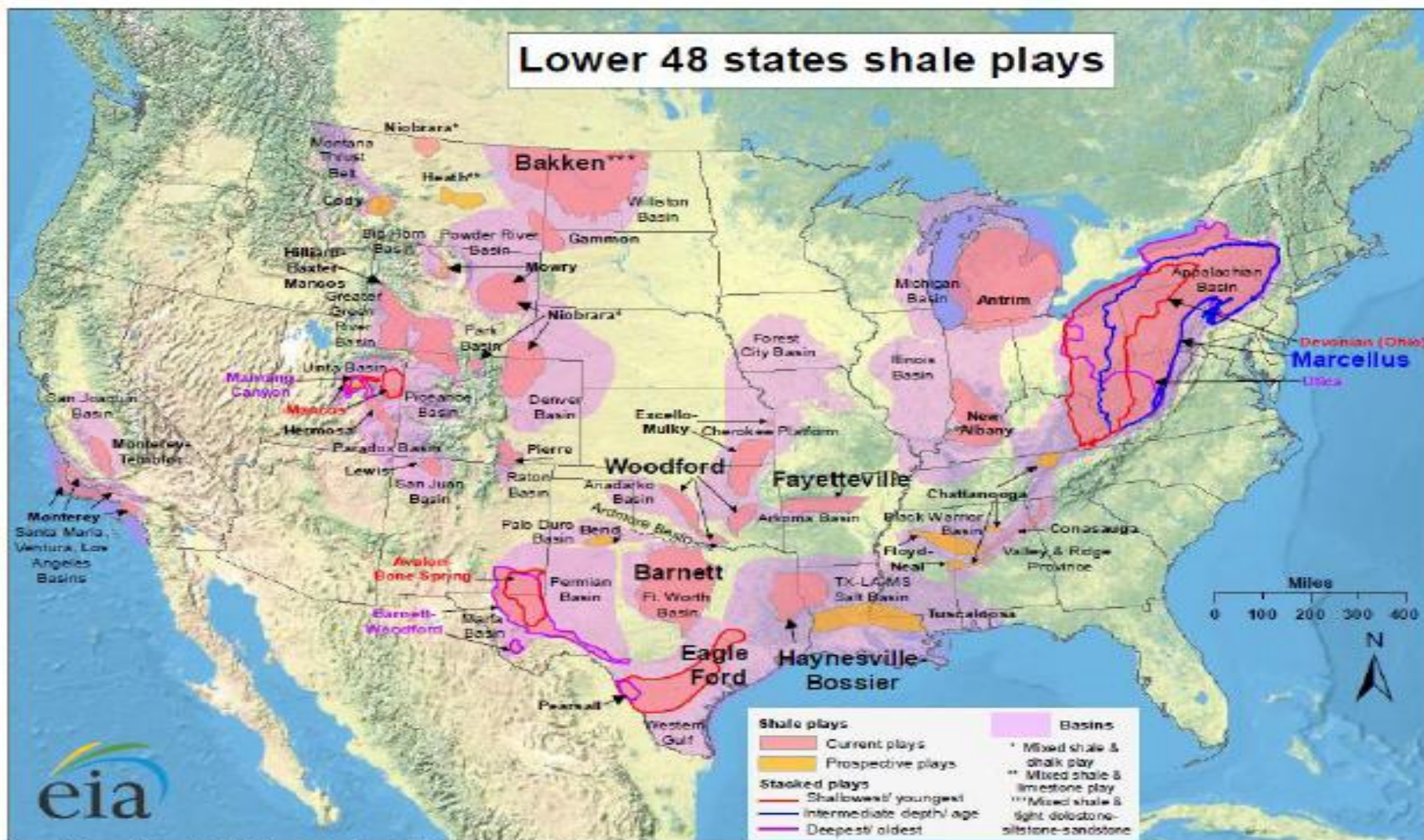


The United States is switching already to become a net gas exporter, and is projected to become a net oil exporter in the late 2020s

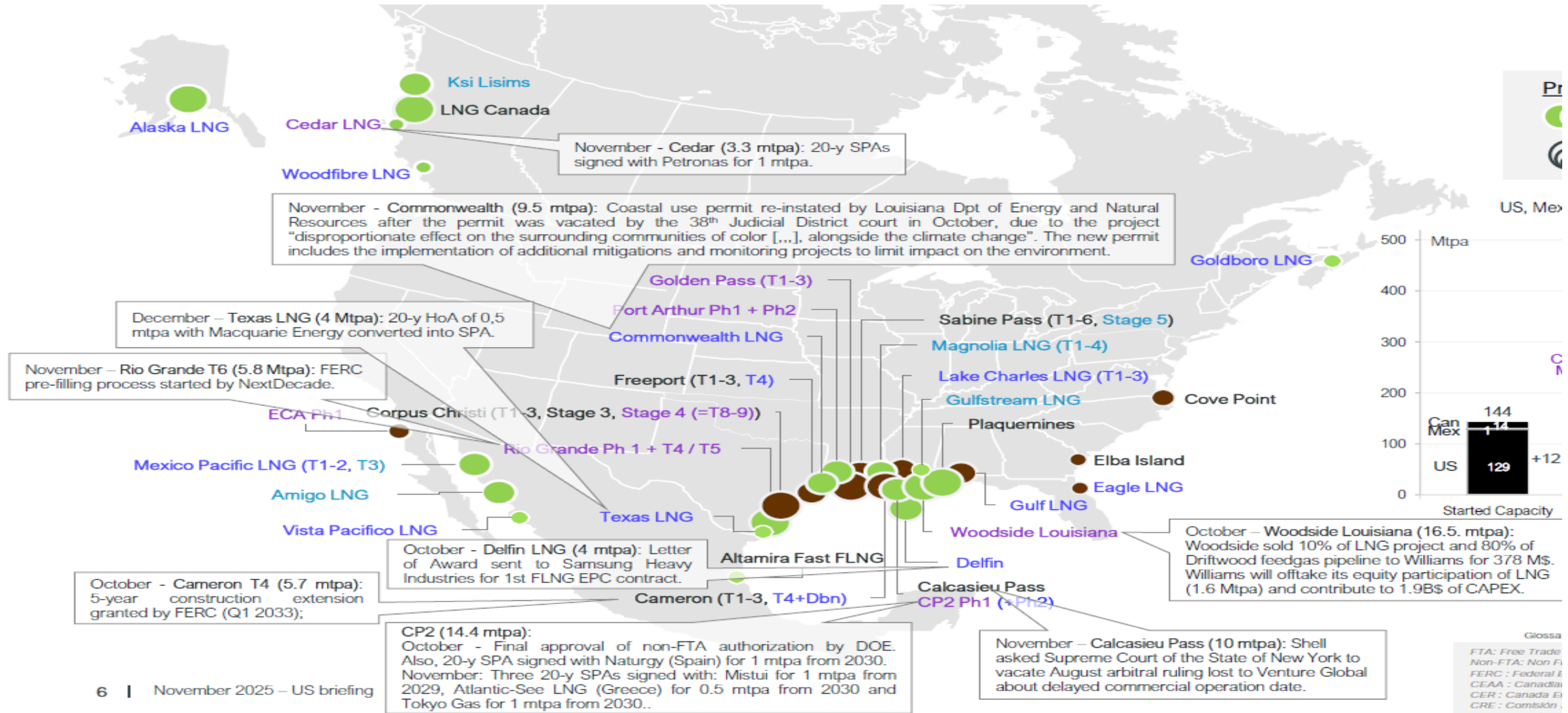
Source: IEA WEO 2017



New plays to potentially impact supply-demand balance



North America LNG Projects - 2026



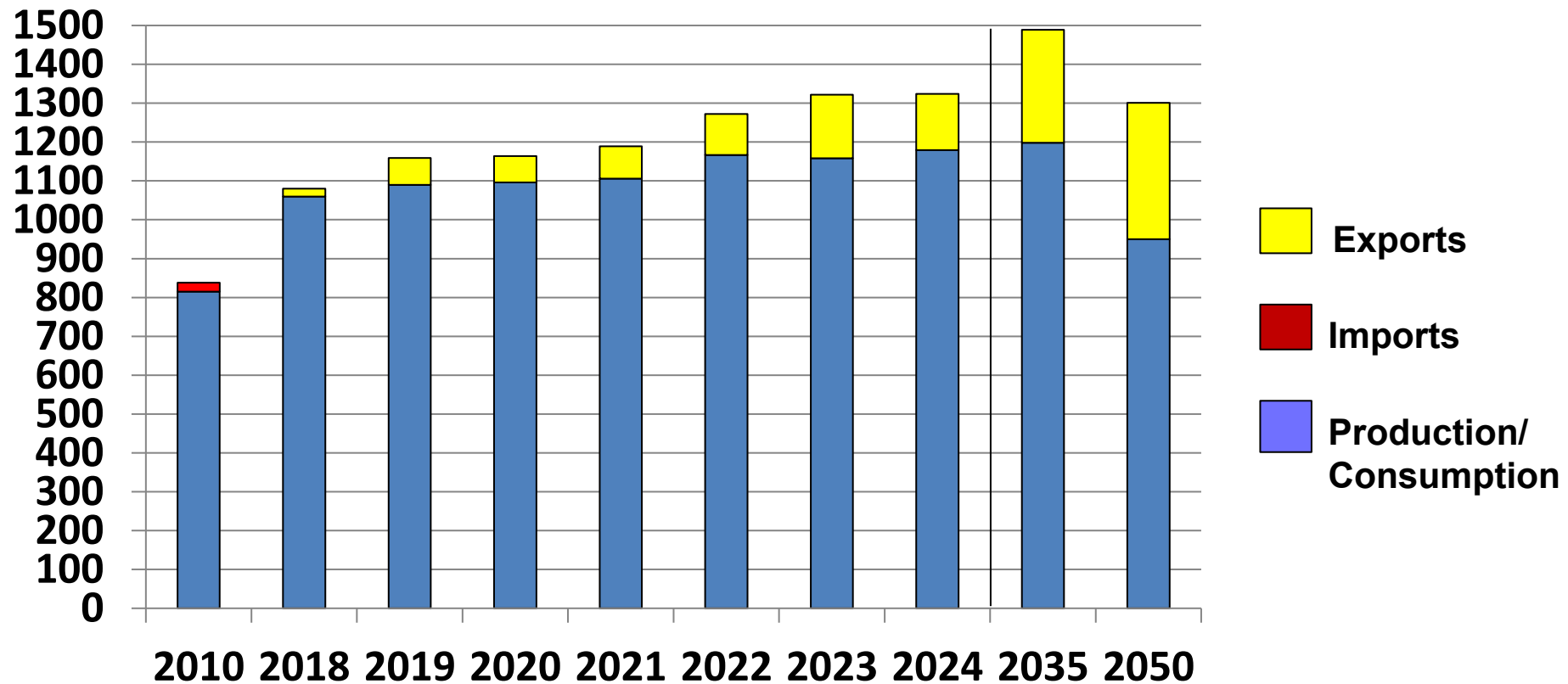
6 | November 2025 – US briefing



Gas Supply and Demand North Americas*

IEA 2025 STEPS Scenario

(G.m³)



Shale Gas production changes the picture: US has become a gas exporter

* US, Canada, Mexico

Data from IEA WEO 2025



Sabine Pass – United States

From LNG Import to LNG Export

2008: start up of the Sabine Pass LNG **regasification** terminal built by Cheniere Energy (operator)

- 40 Bcm/y of total regasification capacity
- 10 Bcm/y of regasification capacity subscribed by Total for 20 years from 2009

2012: Sabine Pass received the authorization to export LNG from four **liquefaction** trains and, in 2015, from a fifth train, which involves converting the regasification plants into liquefaction plants.

- 6 liquefaction trains with a capacity of 4.5 Mt/y each
- T1-T4: under construction, start-up from 2015
- T5: FID in 2015, T6: pre FID, start-up from 2018
- Agreement with Kogas for the purchase of 0.7 Mtpa of LNG from Sabine Pass for a duration of 20 years (T3)
- Agreement with Cheniere covering exports of 2 Mtpa of LNG from Sabine Pass for 20 years (T5)



START-UP OF PRODUCTION IN THE FOURTH QUARTER OF 2015

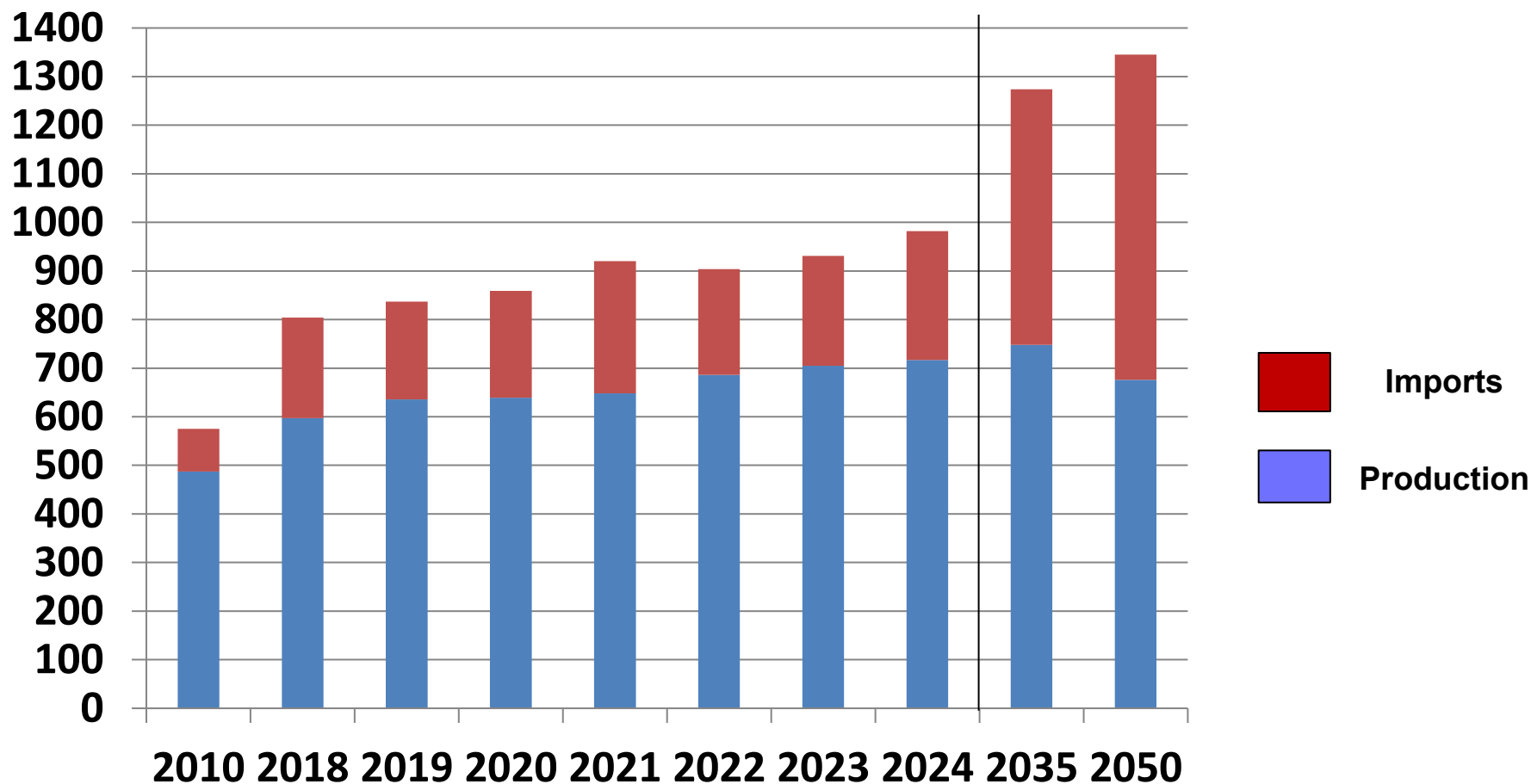


The Pacific Asia Market



Gas Supply and Demand Asia Pacific IEA 2025 STEPS Scenario

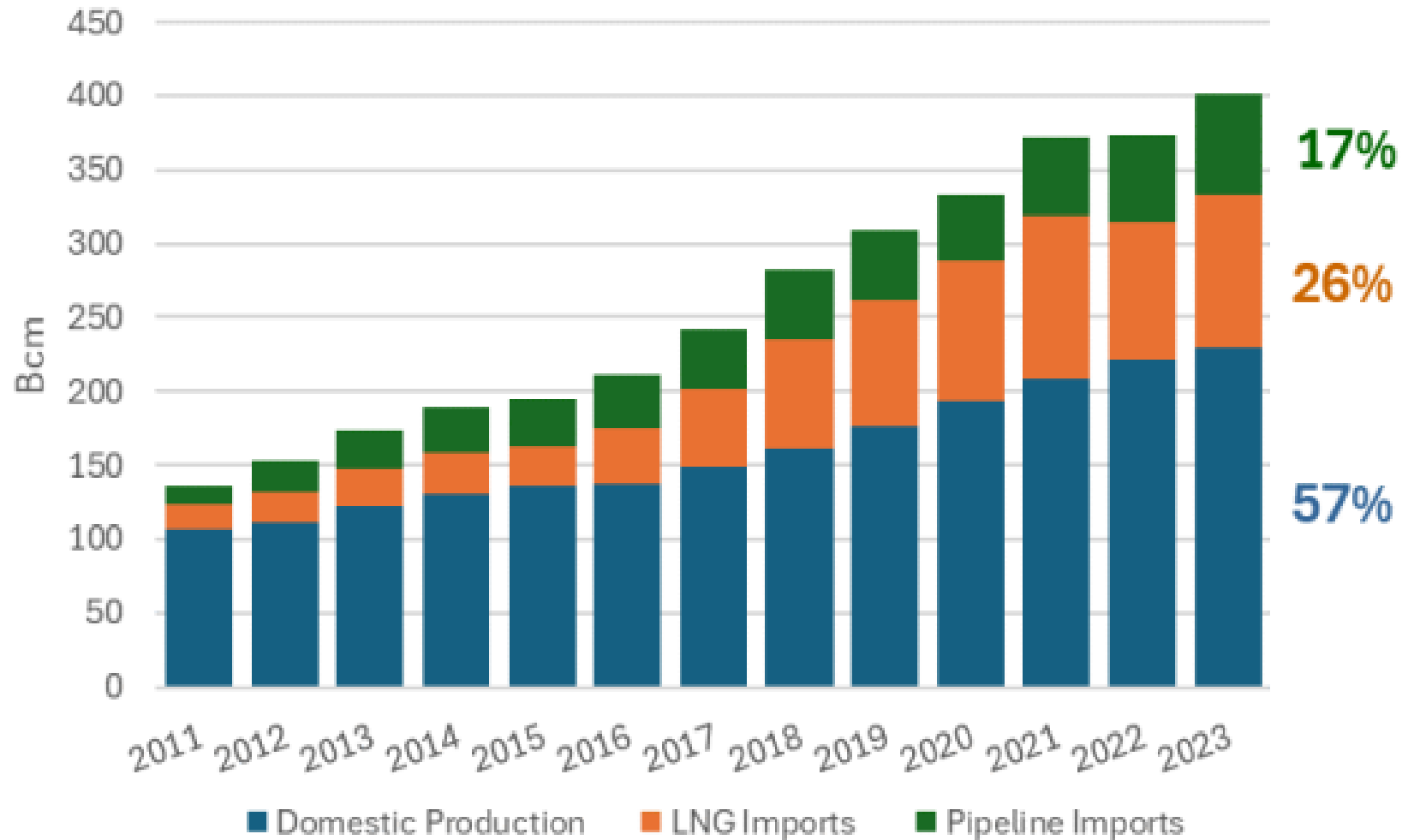
(G.m³)



Data from IEA WEO 2025



China Natural Gas Supply by source (2024)



Source: Energy Institute. Statistical Review of World Energy 2023
2023 figures compiled from China's General Administration of Customs,
LNG Prime, Kpler



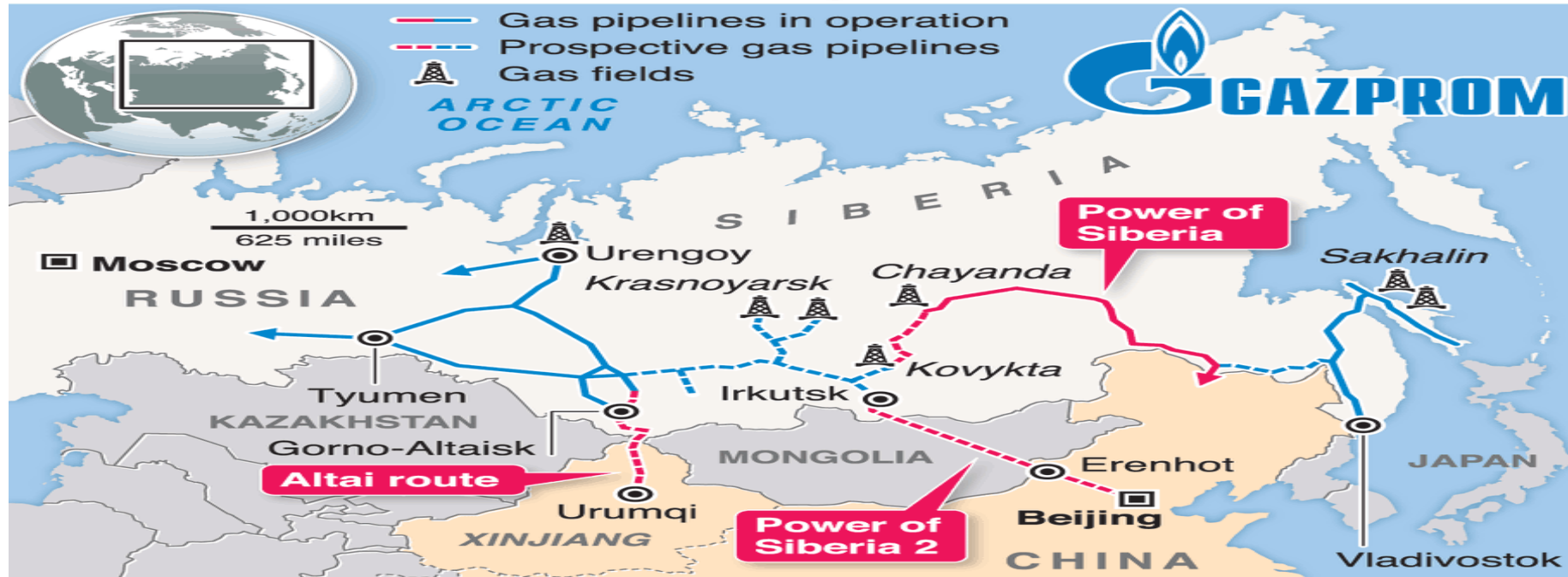
LNG Receiving Terminal – Chiba/Japan



Following cuts of Russian Gas supply to Europe, A zoom on Russian Pipeline routes to China

Russia planning second gas pipeline to China

Russian energy giant Gazprom says it has begun design work for a new pipeline project, dubbed **Power of Siberia 2**, that would more than double the volumes of natural gas it could deliver to China



■ POWER OF SIBERIA

Launch date: Dec 2019 – Russia to supply gas to China for 30 years
Capacity: 5 billion cubic metres (bcm) expected in first year, rising to 38bcm per year by 2025. Pipeline due to receive gas from Kovykta field in late 2022

■ POWER OF SIBERIA 2

Possible launch date: 2030
Capacity: Up to 50bcm
Route: Gazprom looking at building pipeline across Mongolia instead of through Russia's Altai region – option preferred by China to avoid restive Xinjiang province

Sources: Gazprom, Reuters, Petroleum Economist, S&P Global

© GRAPHIC NEWS



Top 10 Gas Companies in the World



Top 10 Company by Natural Proven Gas Reserves Situation Year 2016

IRAN	NIOC	33,5
RUSSIA	GAZPROM	18,6
QATAR	QATAR PETRO.	17,7
TURKMENISTAN	TURKMENGAS	16,3
S. ARABIA	ARAMCO	8,4
VENEZUELA	PDVSA	5,7
ALGERIA	SONATRACH	4.5
IRAK	INOC	3.7
CHINA	CNPC	3,5
UAE	ADNOC	3.4

T.m³

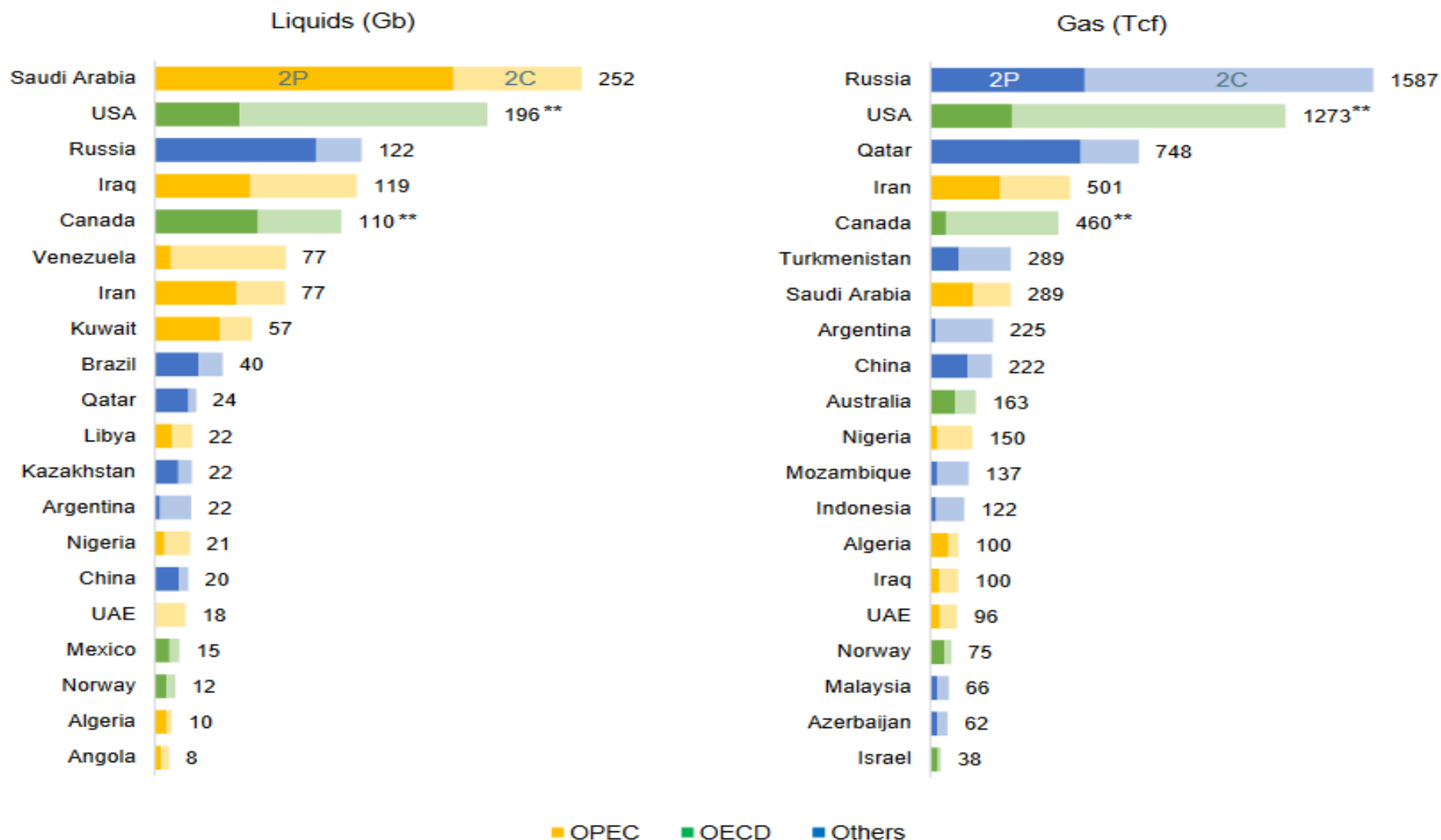


Top 10 Companies by Natural Gas Production Year 2016

	Mm3/d
GAZPROM (Russia)	1155
NIOC (Iran)	555
QPC (Qatar)	344
CNPC (China)	331
SHELL	301
ARAMCO (Saudi Arabia)	300
EXXONMOBIL	287
SONATRACH (Algeria)	229
BP	200
PETRONAS	191



Top 20 Resources by Countries

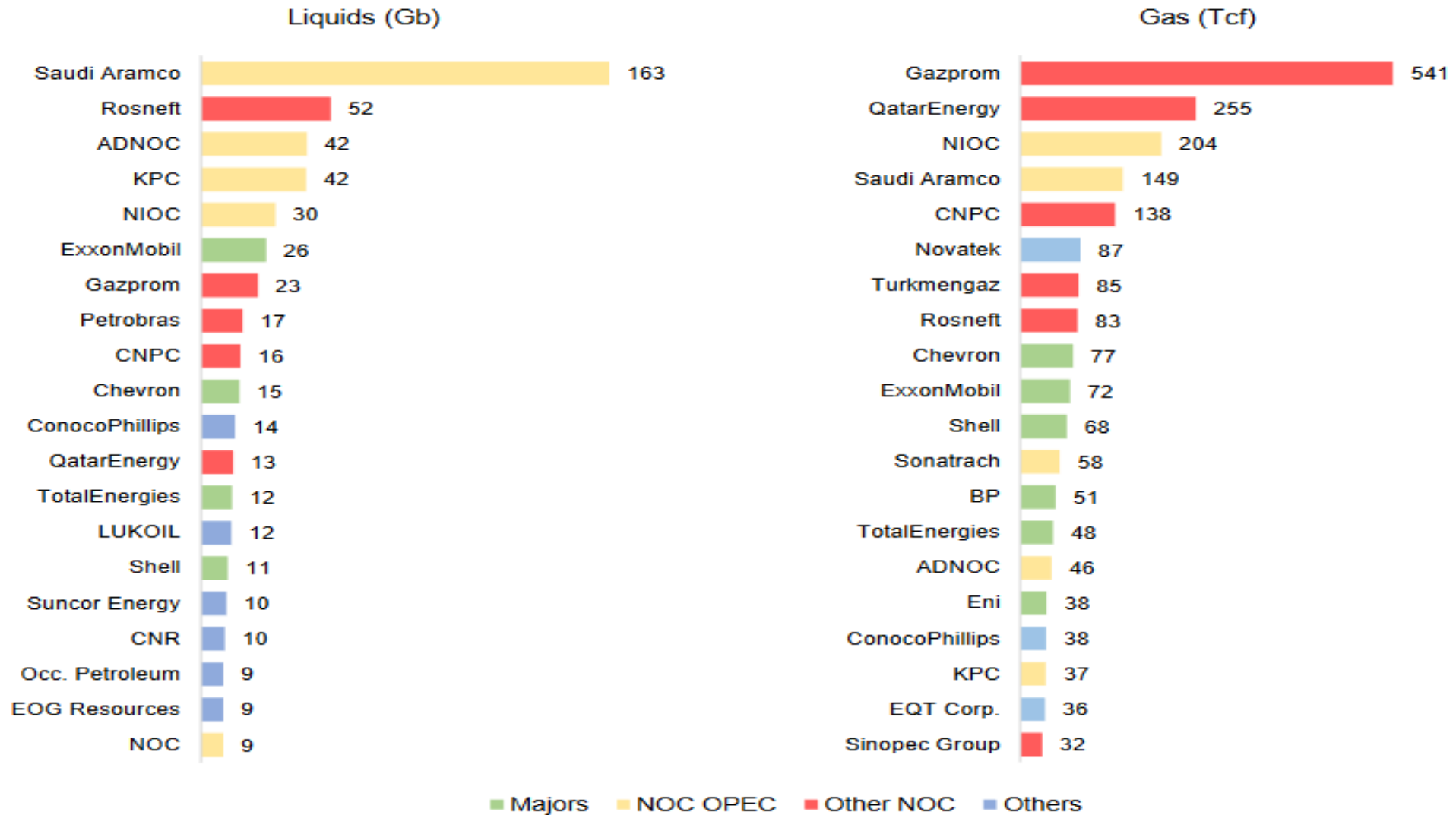


Source: TotalEnergies E&P Data Book 2023

Source: Profil Mondiaux Hydrocarbures 2023. Exclude unlikely contingent and YtF
 **Consideration of shale production until 2050



Top 20 Resources by Companies

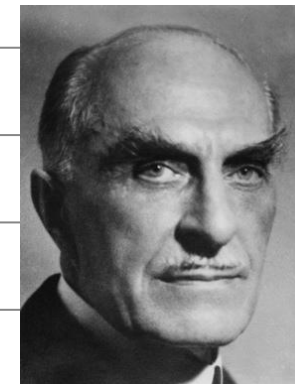
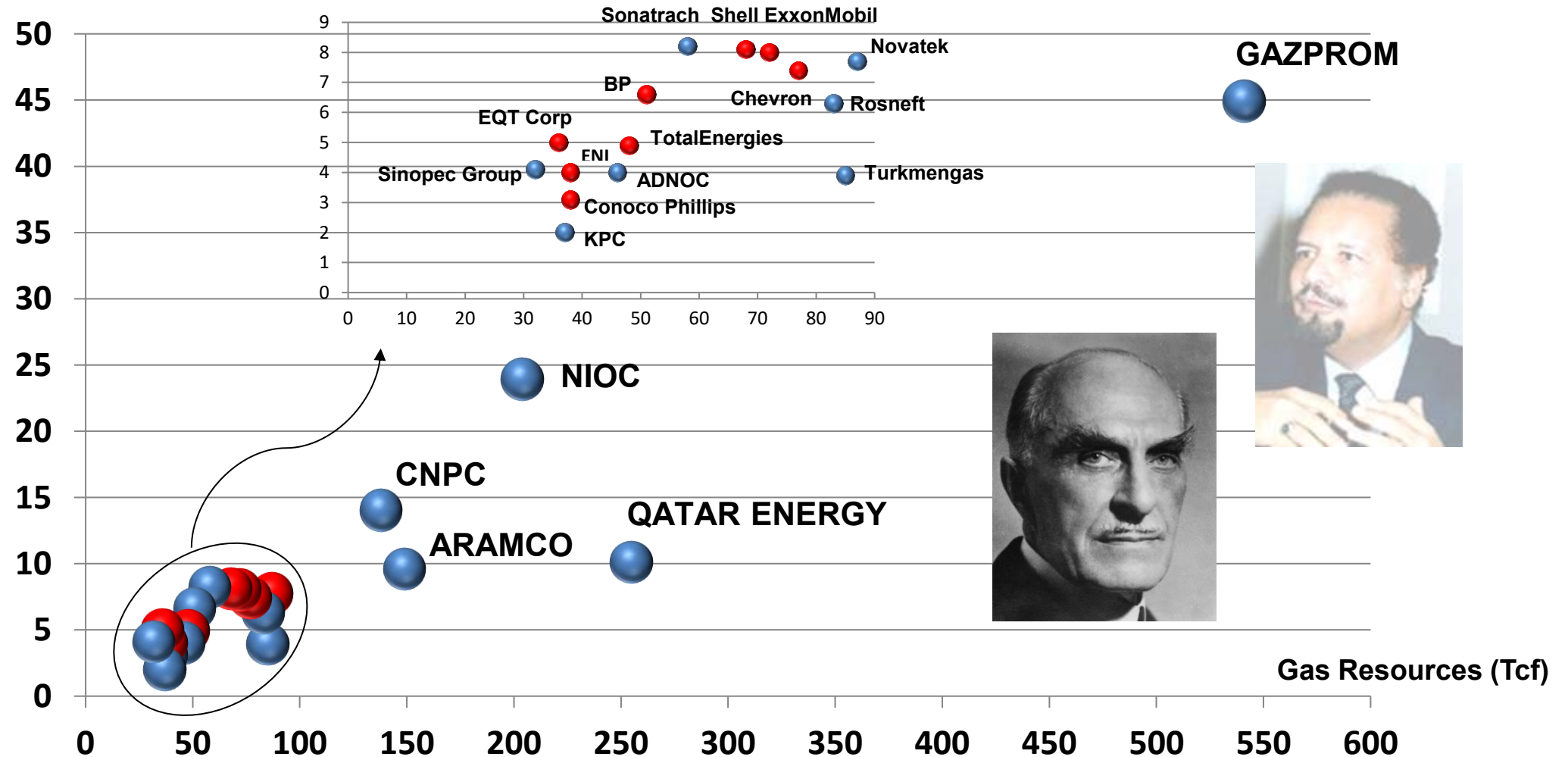


Source: TotalEnergies E&P Data Book 2023



International Majors weight # 18% in the World Gas Resources Assets- Year 2022

Gas Production (Bcf/d)



The gas chain components and their economics: Production & Processing

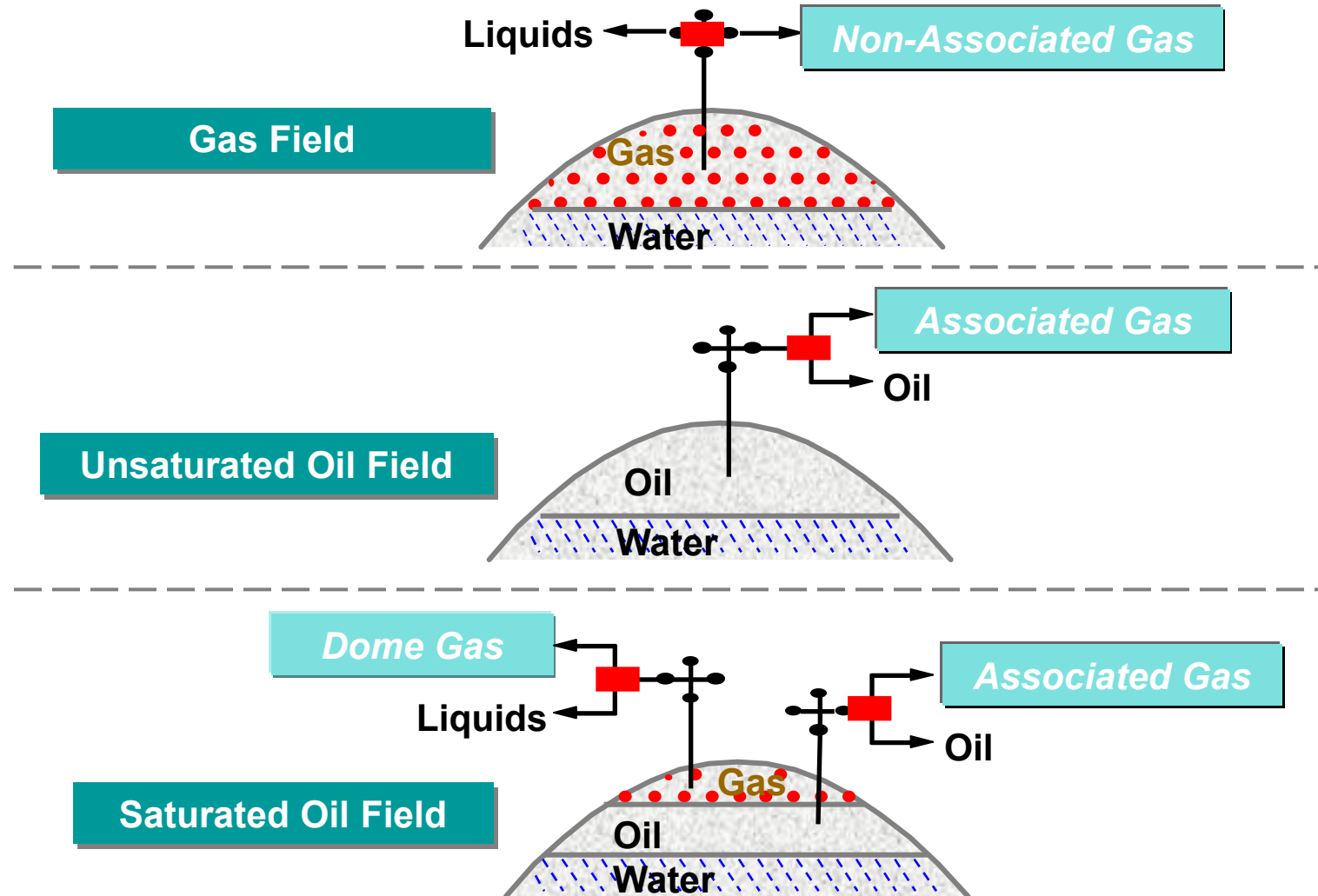


TABLE OF CONTENTS

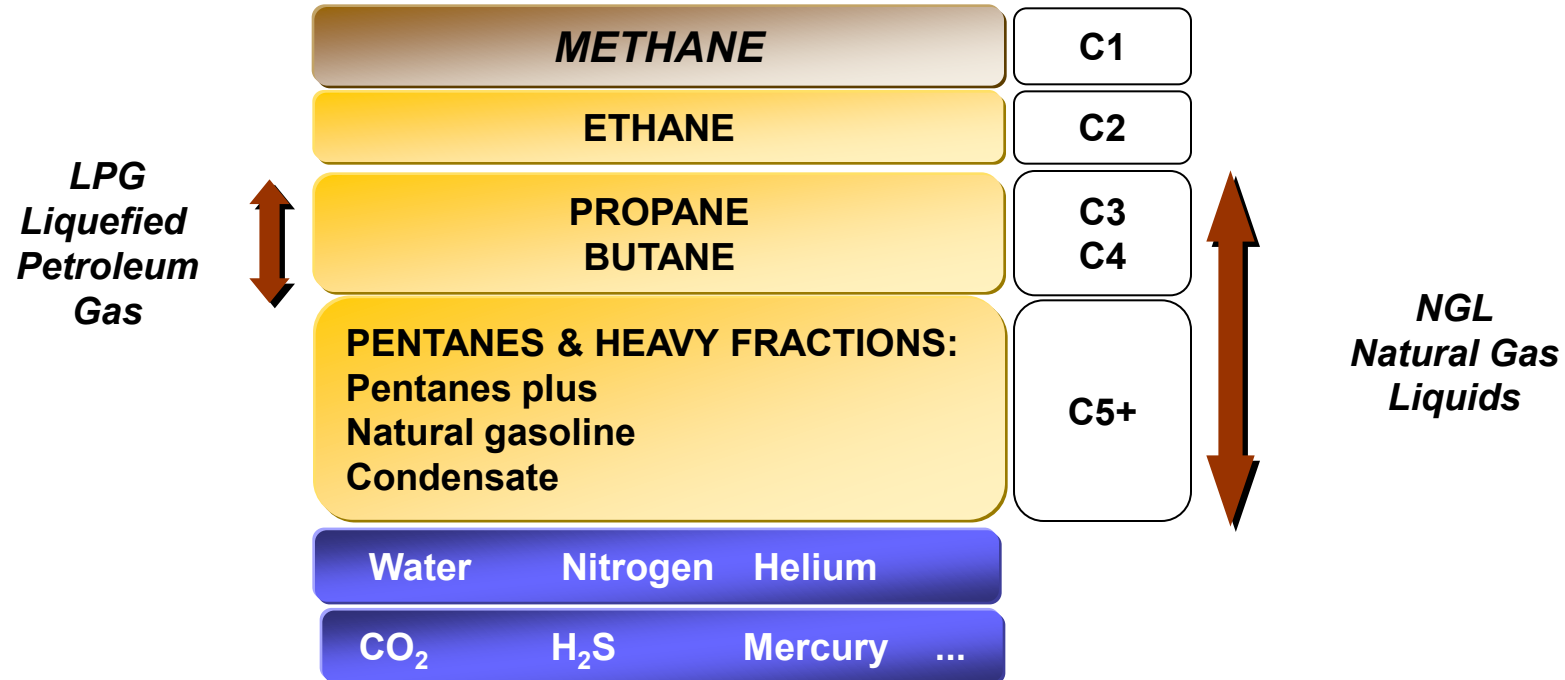
1. General considerations
2. Resources, reserves
3. Conventional and Unconventional Gaseous Hydrocarbons
4. Production, consumption: past and present
5. Production, consumption: perspectives
6. A zoom on Liquefied Natural Gas (LNG)
7. Three independant world markets
8. The gas chain components and their economics: Production & Processing
9. The gas chain components and their economics: Transportation
10. The gas chain components and their economics: Storage
11. Technology and innovation
12. Competing fuels and Gas prices
13. Evolution of national gas markets towards liberalization & globalization
14. Example of challenging gas projects: Shtokman & Yamal



Natural Gas Production



Natural Gas Processing



- Separate liquids and gases for efficient transportation and distribution.
- Remove unwanted materials such as hydrogen sulfide and water.
- Meet specifications set by buyers of gas.



Natural Gas Quality

<i>Acid Gas</i>	High in CO ₂ and/or H ₂ S
<i>Lean (Dry) Gas</i>	Low in NGLs
<i>Rich (Wet) Gas</i>	High in NGLs
<i>Sweet Gas</i>	Low in H ₂ S
<i>Sour Gas</i>	High in H ₂ S
<i>Low Cal Gas</i>	High in CO ₂ / N ₂

Gas quality has a major economic impact.

- ◆ Presence of heavy components (LPG, Condensate) improves the economics of a gas project.
- ◆ Presence of H₂S, CO₂ and Nitrogen induces higher processing costs and thus lowers the value of a gas project.



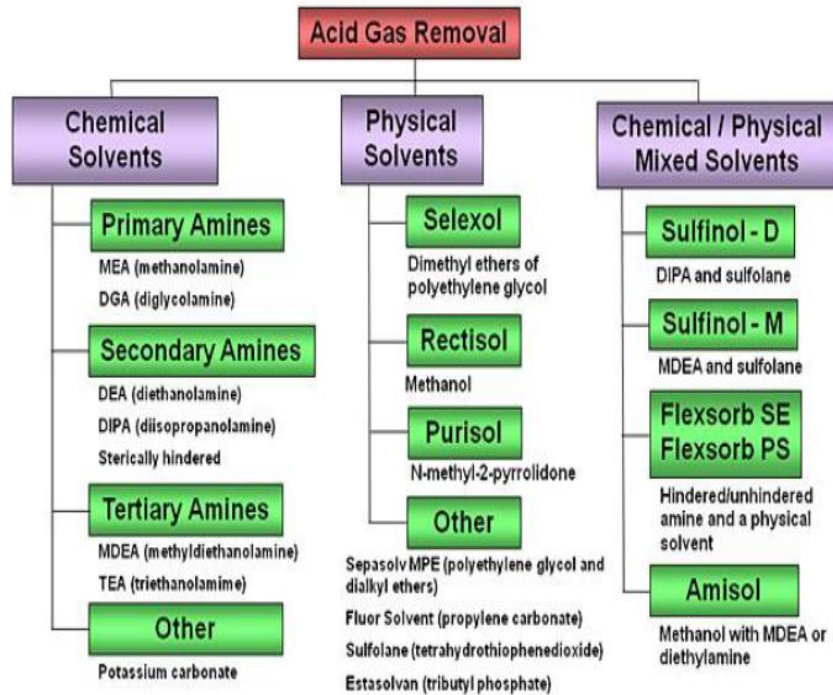
Hydrates – Potential problems



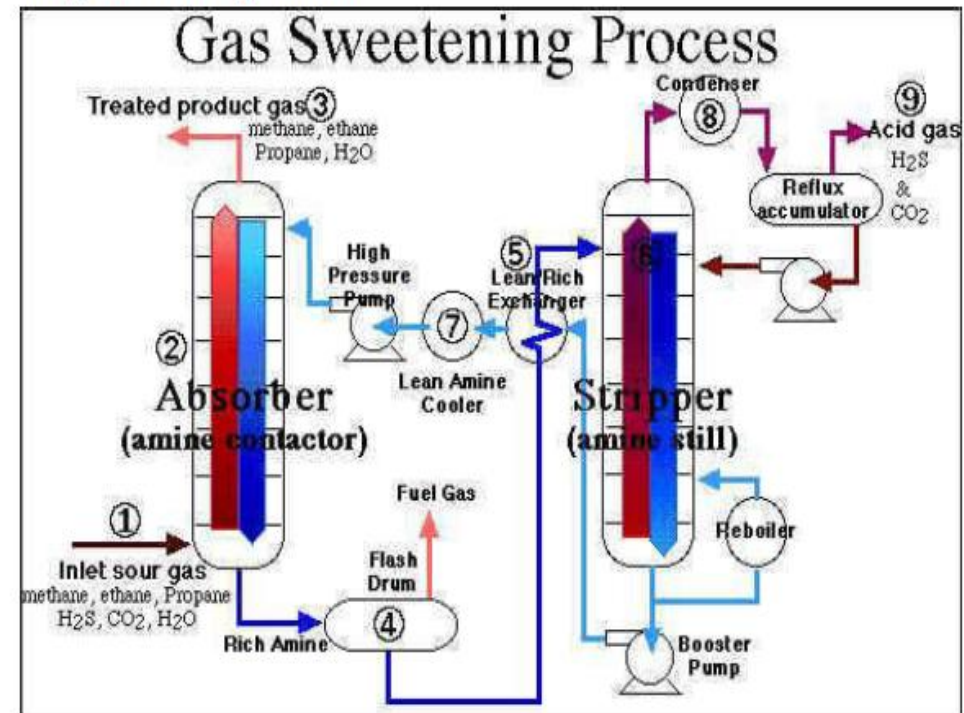
Solid crystals looking like compact snow or porous ice



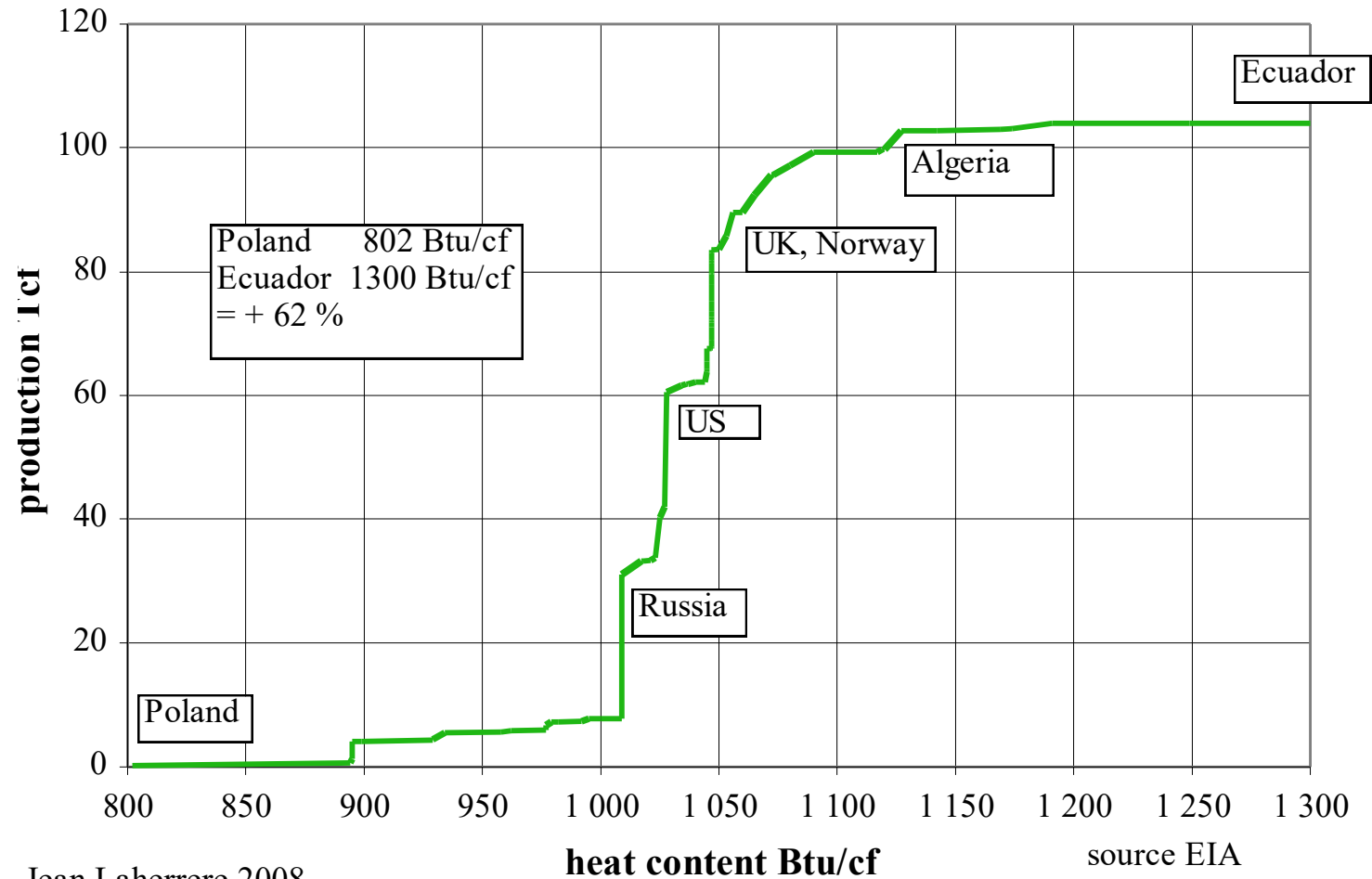
Processing examples: Acid Gas Removal & Gas Sweetening and Drying



Chemical absorption by specific solvent
Regeneration of solvent



Natural Gas heat content by country



Jean Laherrere 2008



Natural Gas processing costs

(Costs can substantially fluctuate depending upon economic environment)

◆ Natural Gas Processing costs depend on

- **Field Location**
- **Field Size**
- **Gas Components**
- **Type of use envisaged for the products**
- **Means of transportation for the products**

Processing Costs may vary significantly

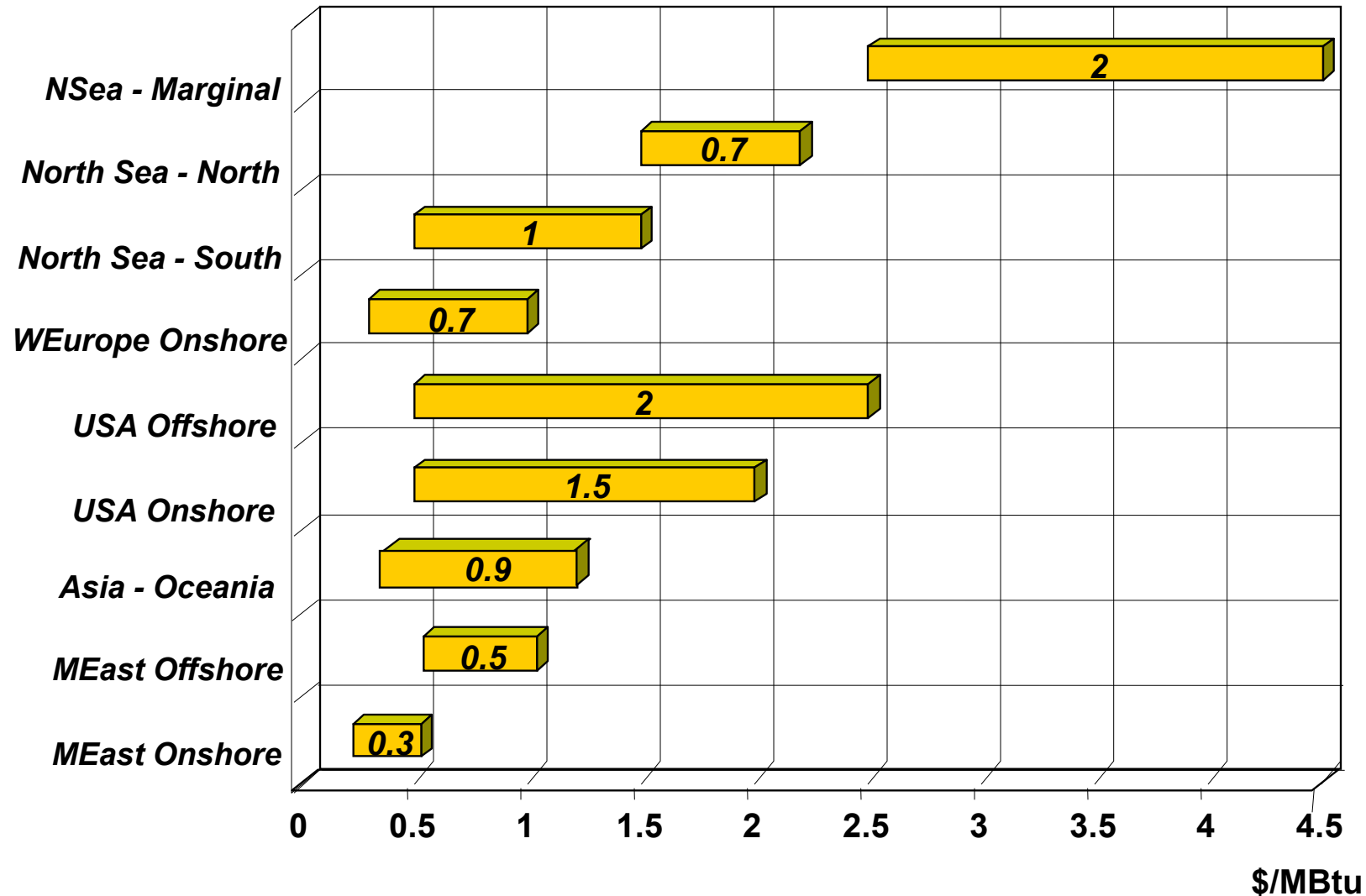
Important Economies of Scale

- ◆ **\$0.20/MBtu to \$0.60/MBtu for an Onshore Processing Plant of 6 to 8 Bm³/year capacity**
- ◆ **Multiplying Factor of 2 for a 1 G.m³/year Processing Plant**
- ◆ **Multiplying Factor of 3 for an Offshore Processing Plant**



Natural Gas production costs

(Costs can substantially fluctuate depending upon economic environment)



The gas chain components and their economics: Transportation



TABLE OF CONTENTS

1. General considerations
2. Resources, reserves
3. Conventional and Unconventional Gaseous Hydrocarbons
4. Production, consumption: past and present
5. Production, consumption: perspectives
6. A zoom on Liquefied Natural Gas (LNG)
7. Three independant world markets
8. The gas chain components and their economics: Production & Processing
9. The gas chain components and their economics: Transportation
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13. Evolution of national gas markets towards liberalization & globalization
14. Example of challenging gas projects: Shtokman & Yamal



Natural Gas Transportation Pipeline - LNG tanker



Gas Pipeline vs LNG



Pipe Laying



Source: GRT Gaz/Artère de Guyenne



Pipe Laying



Source: BP Trans-Anatolian pipeline in Turkey



LNG Carriers



**804 active LNG
vessels in the world
at end 2025**



Natural Gas Transportation

(Costs can substantially fluctuate depending upon economic environment)

Natural Gas fills a volume 1000 times larger than Crude Oil for the same energy content.

*Long-distance transportation costs
for gas are higher than those for oil by a factor of five to ten.*

LNG TANKER

135 000 m³

250 M\$



OIL TANKER

70 000 t

100 M\$

GAS PIPELINE

100 TWh/yr

1.5 M\$/km

Ø = 900 mm = 36"

OIL PIPELINE

500 TWh/yr

0.7 M\$/km



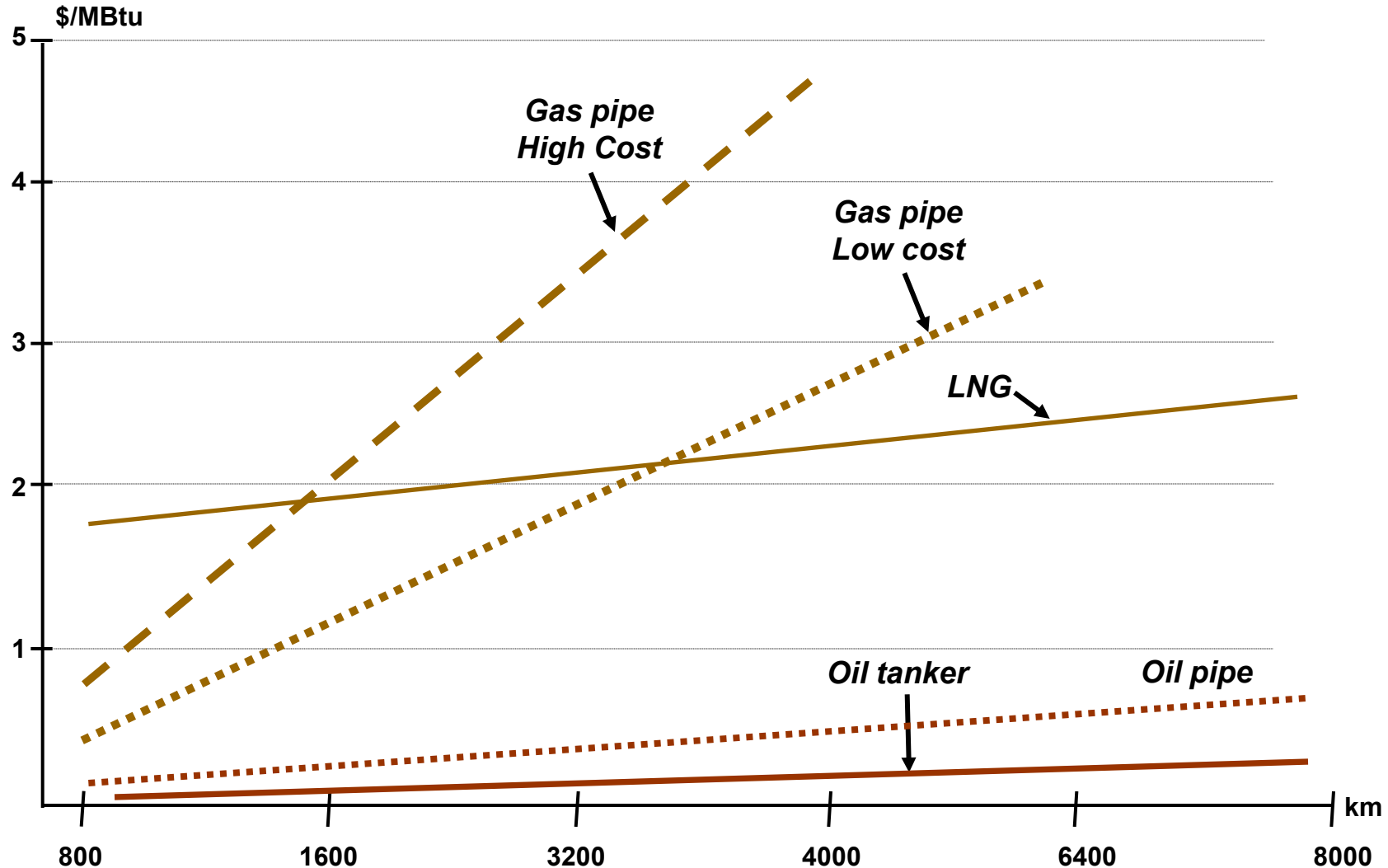
Transportation Selection

- ◆ **Transport by pipeline**
 - fixed capacity
 - sensitive to distance
 - compression requirements
- ◆ **Transport by LNG tanker**
 - high initial investment
 - capacity can be increased by steps
- ◆ **other criteria**
 - Terrain
 - Transit rights
 - Destination flexibility
 - Geopolitics ...



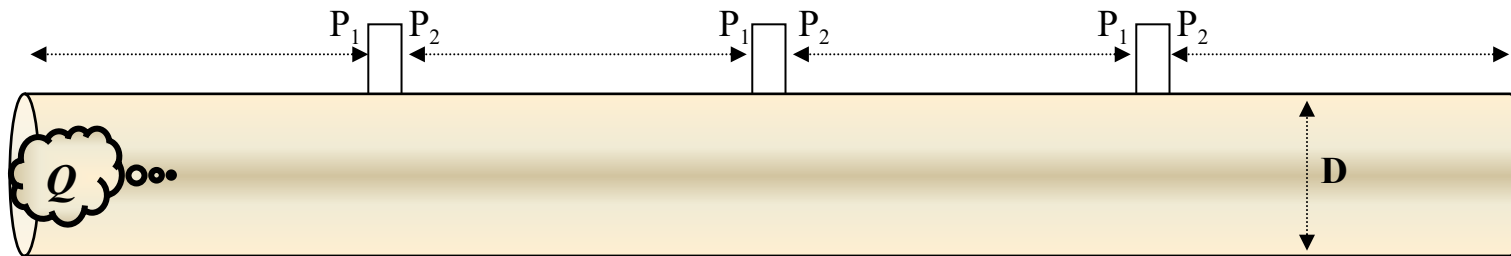
Natural Gas transportation costs

(Costs can substantially fluctuate depending upon economic environment)



Natural Gas pipeline transportation

(Costs can substantially fluctuate depending upon economic environment)



Pipe Investment: $k_p \cdot D^c$ for $D > 500$ mm
 $0.8 \text{ M\$/km} < k_p < \text{M\$}1.0/\text{km}$ $1.3 < c < 1.5$ D in meters

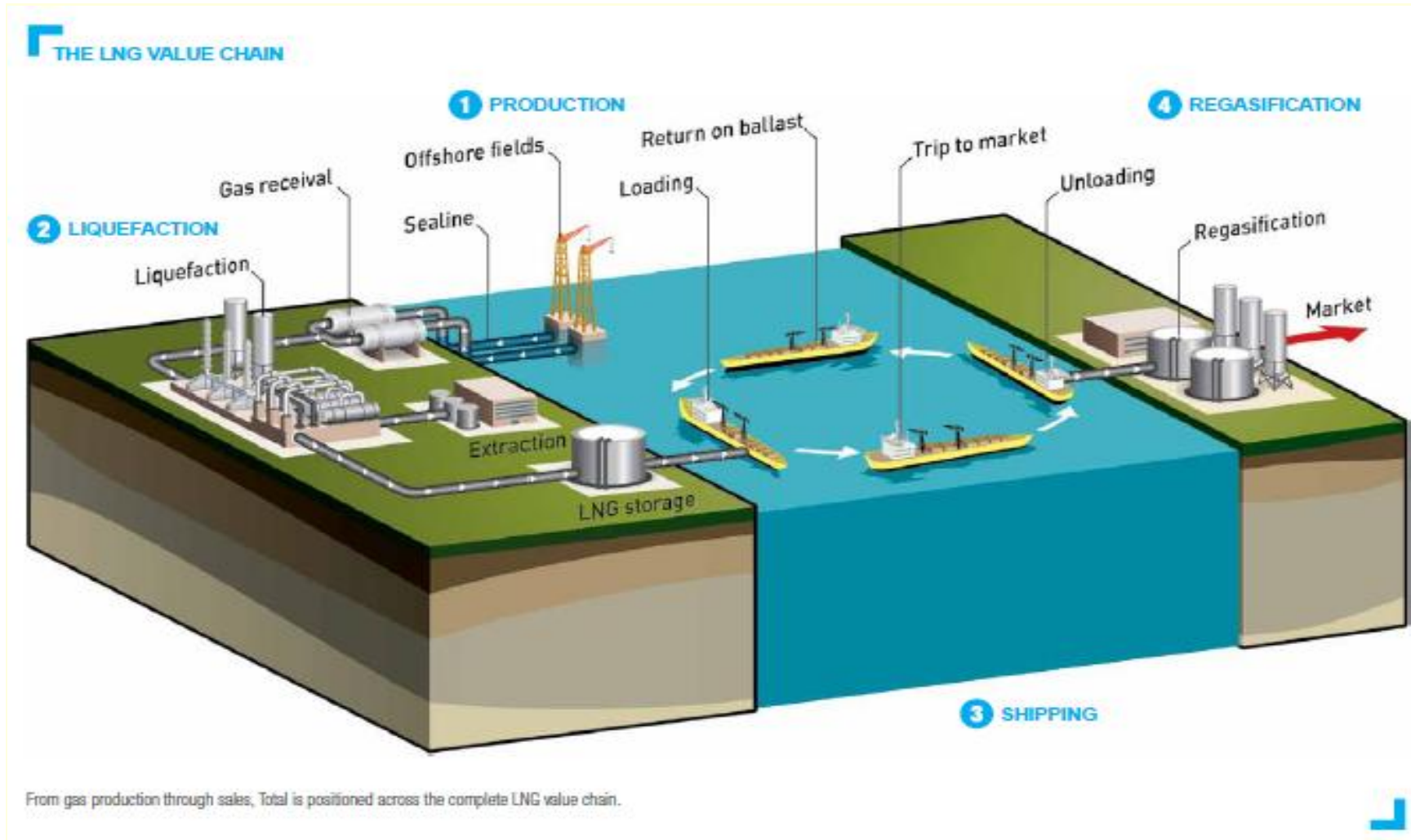
Diameter	mm	800	1000	1200	1400
	inches	32	40	48	56
Investment (M\$/1000 km)		660	900	1160	1440

Annual Pipe Operating Costs: 1 to 3% of Investment

Compressor Stations
Investment: $a + b P$ **Energy Costs:** $\propto P$, $\propto (\text{Load Factor})^2$
Annual Operating Costs: 3 to 7% of Investment



The LNG Value Chain



Liquefied Natural Gas chain costs

(Costs can substantially fluctuate depending upon economic environment)

◆ LNG CHAIN :

- 6 to 9 Bcm/yr (4.4 to 6.6 Mt/y)
- 5 to 6000 miles

◆ LIQUEFACTION (plant, storage, terminal)

- Investment: 5.0 – 8.0 G\$
- Unit Cost: 2.3 – 3.6 \$/MBtu

◆ TRANSPORTATION (135 000 cu.m, 7 to 8 tankers):

- Investment: 1.8 – 2.0G\$
- Unit Cost: 0.8 – 0,9 \$/MBtu

◆ REGASIFICATION (storage, terminal)

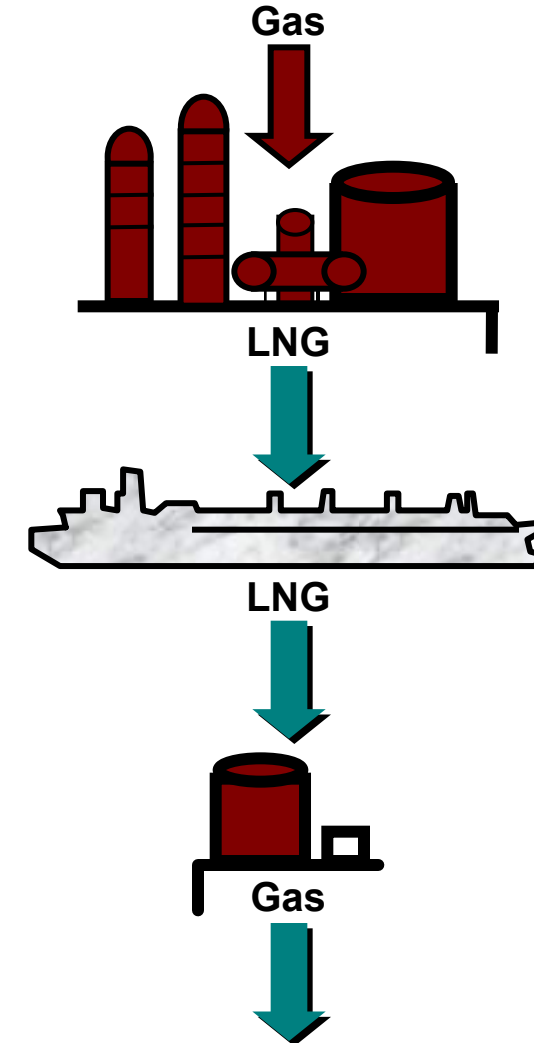
- Investment: 0.8 – 1.3G\$
- Unit Cost: 0.4 – 0.6 \$/MBtu

◆ TOTAL LNG CHAIN

- Investment: 7.6 – 11.3 G\$
- Unit Cost: 3.5 – 5.1 \$/Mbtu

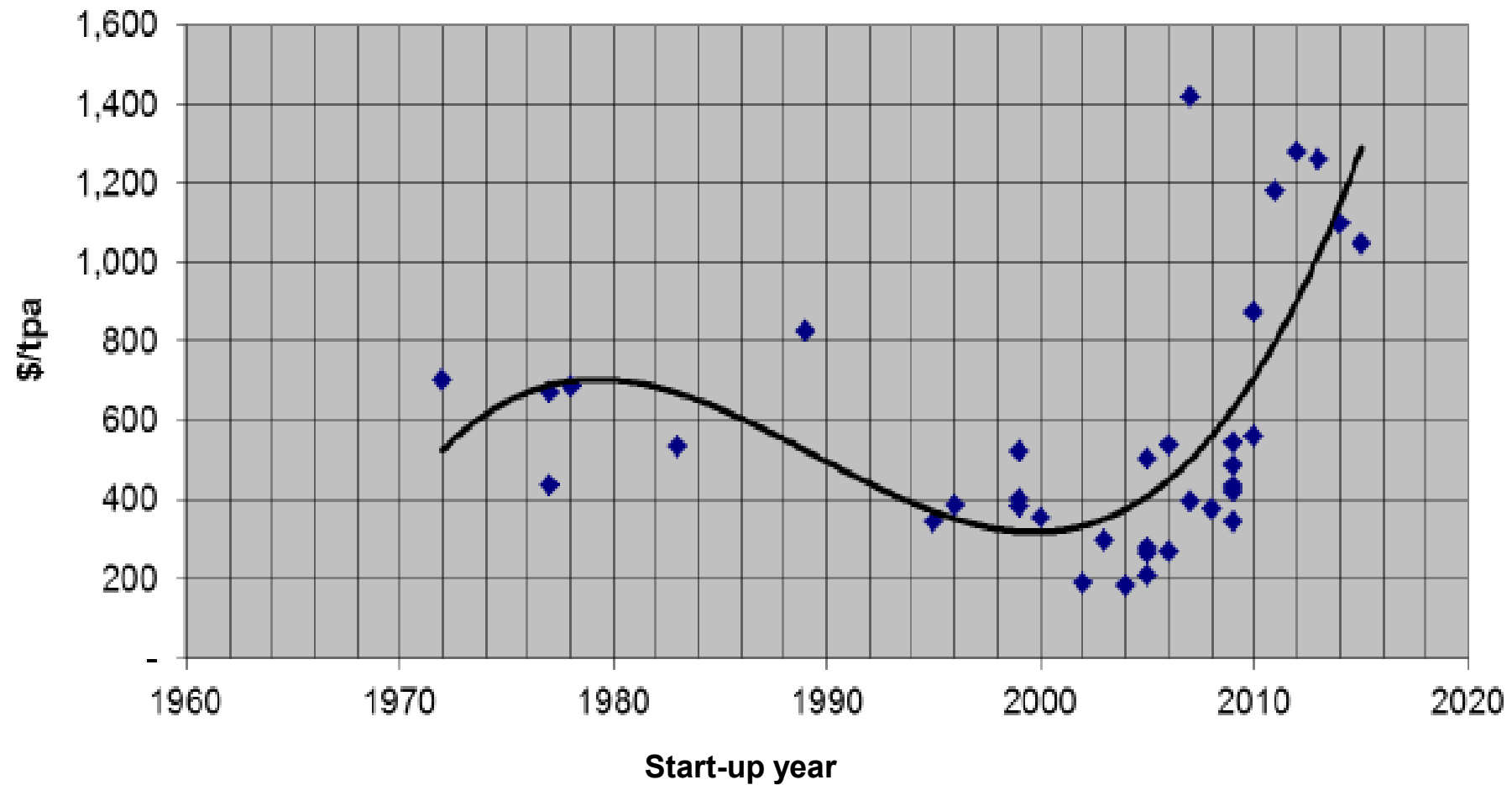
Nota: 1 T LNG # 1300 m3 # 50 Mbtu

Unit cost are based on discounted production 258



LNG Issues : Costs and Timing – 1970 - 2015

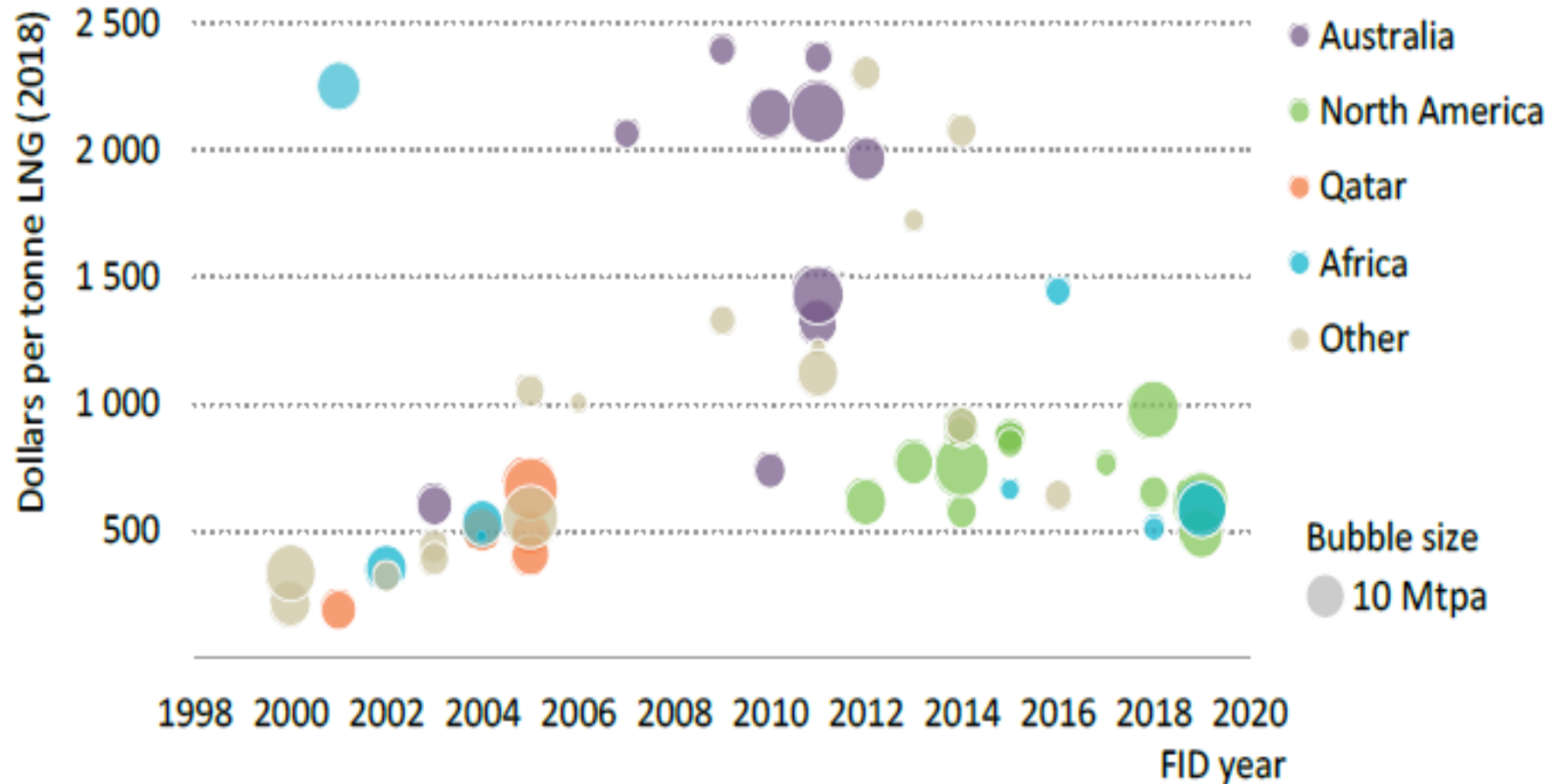
Liquefaction Capex



Source: Wood Mac Kenzie



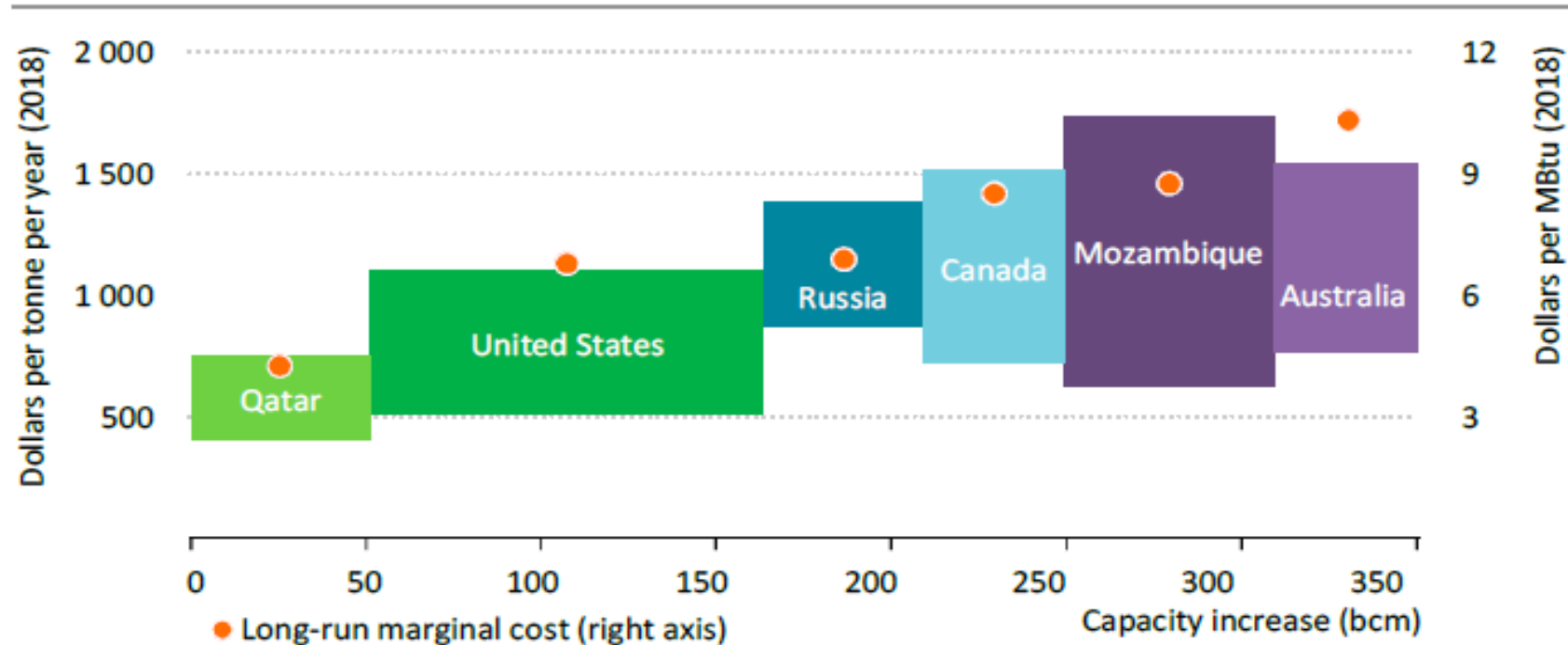
Capital Costs evolution of LNG Projects by country



Liquefaction costs have come down from their pre-2014 highs



Capital Costs & marginal Costs of LNG Projects by country

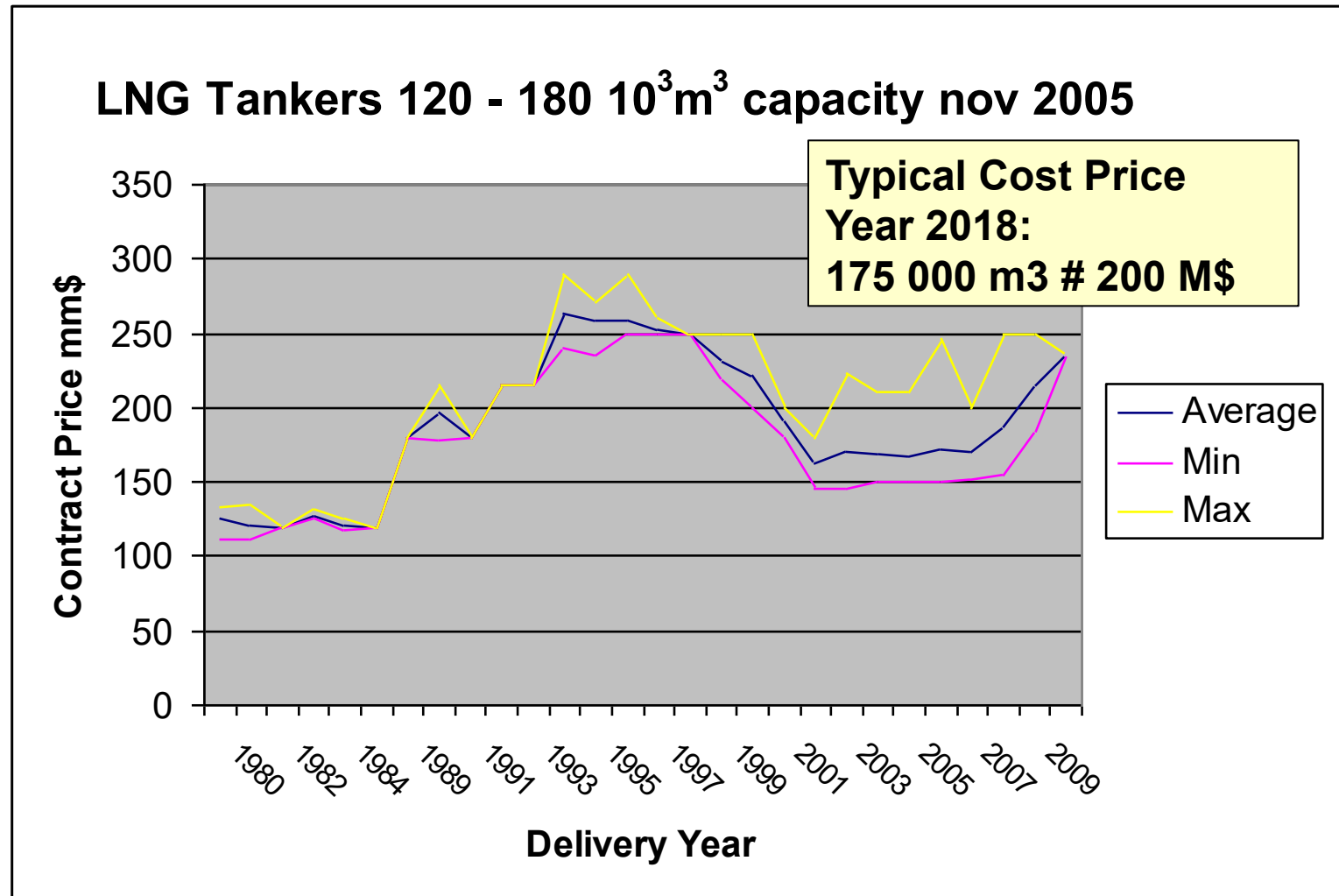


There is a wide range of investment costs for liquefying gas; along with feed gas and shipping costs, LNG project economics set the marginal price of gas in several markets

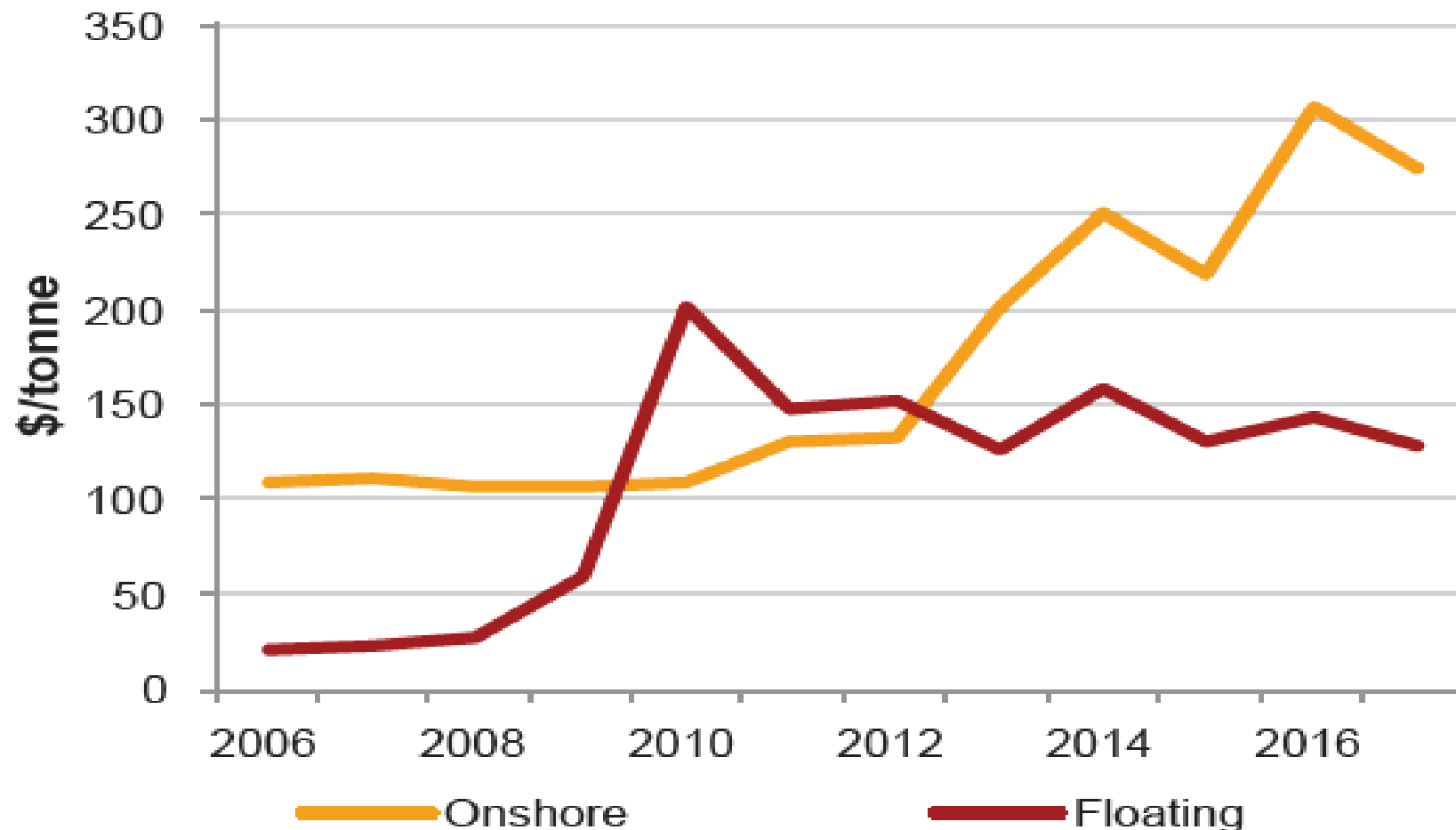
Notes: Long-run marginal costs equal the weighted average costs in each country of developing gas resources, building liquefaction terminals and shipping the total LNG volumes delivered over the projection period. Shipping costs reflect the volume-weighted average cost of delivery to importing regions in the Stated Policies Scenario. Assumed asset lifetime is 30-years with a cost of capital in the range of 5-10%.



Prices for LNG carriers 1980 - 2009



Regasification Unit Costs by Project Type



**Indicates the size of onshore storage relative to onshore terminal capacity.*

Sources: IHS Markit, Company Announcements

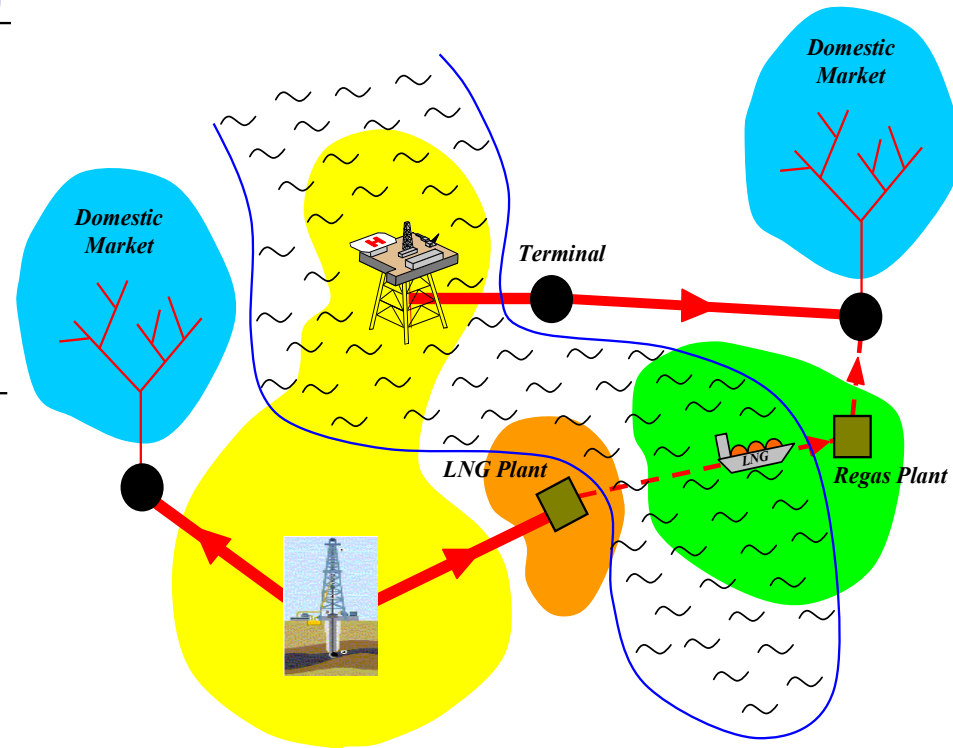
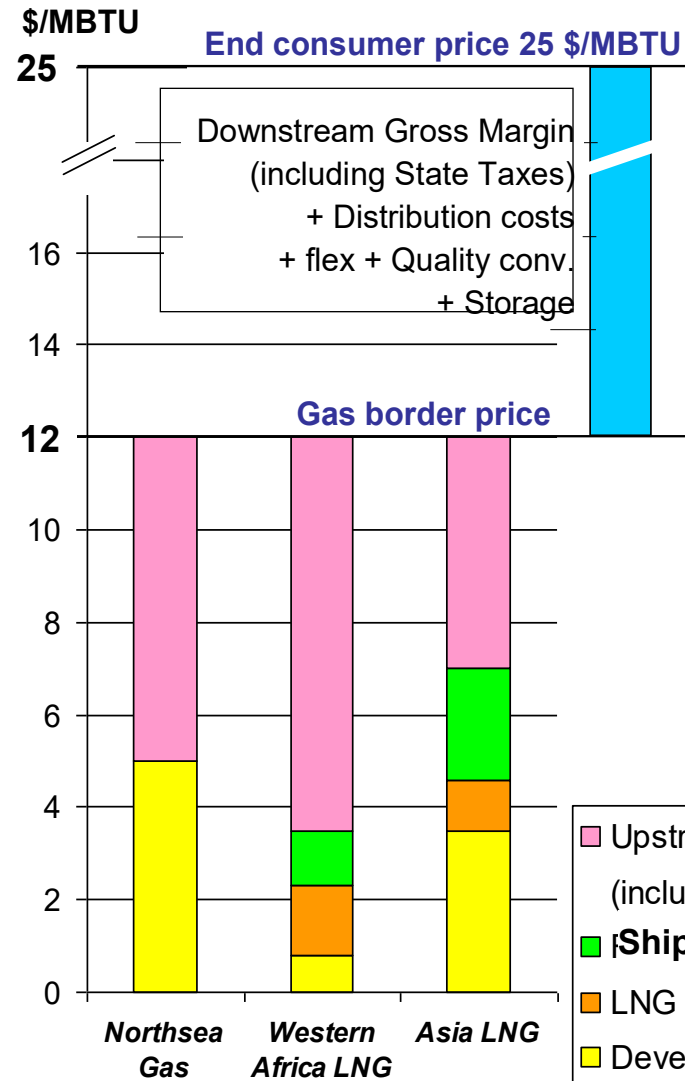


**The Economics of various Gas projects,
from the well to the final consumer
One illustration**



Gas Border Price & End Consumer Price – Illustration 2008 Environment

Break Down Gas & LNG Unit Technical Costs (2008 environment)



10

The gas chain components and their economics: Storage

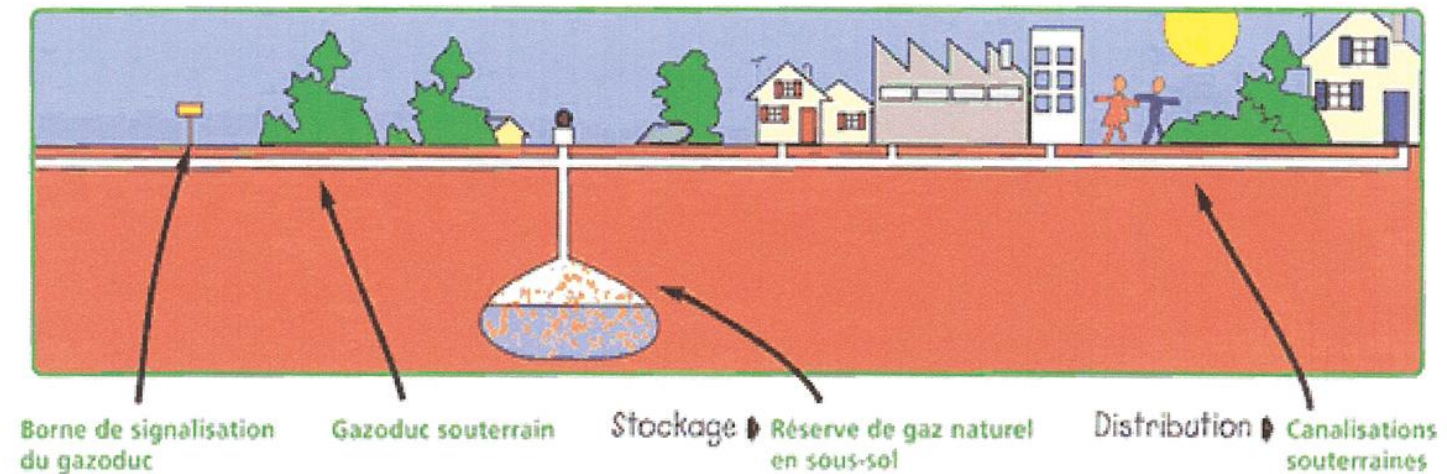
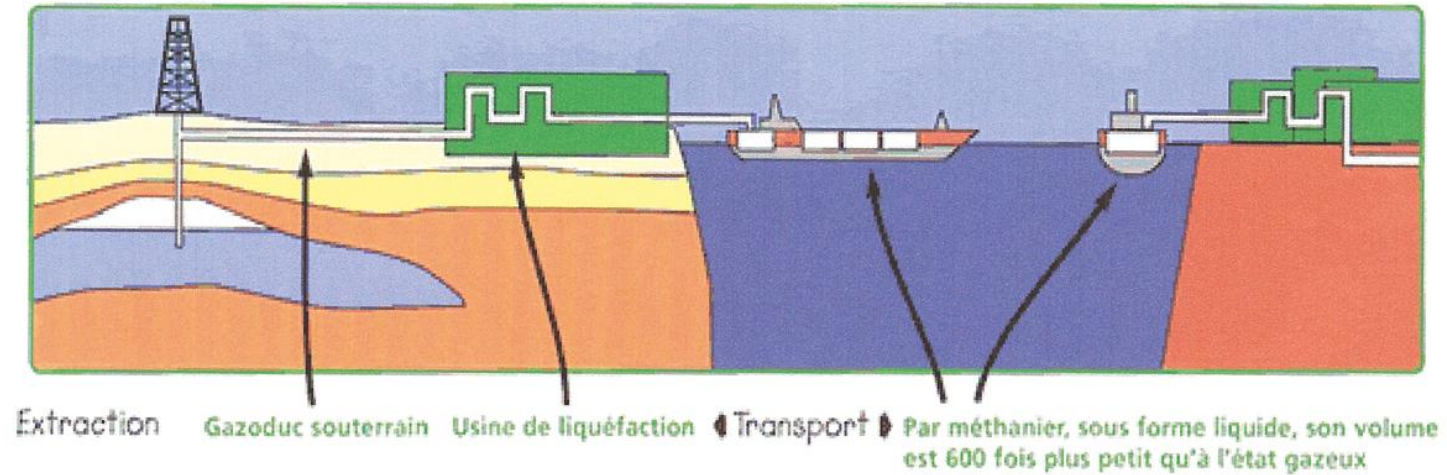


TABLE OF CONTENTS

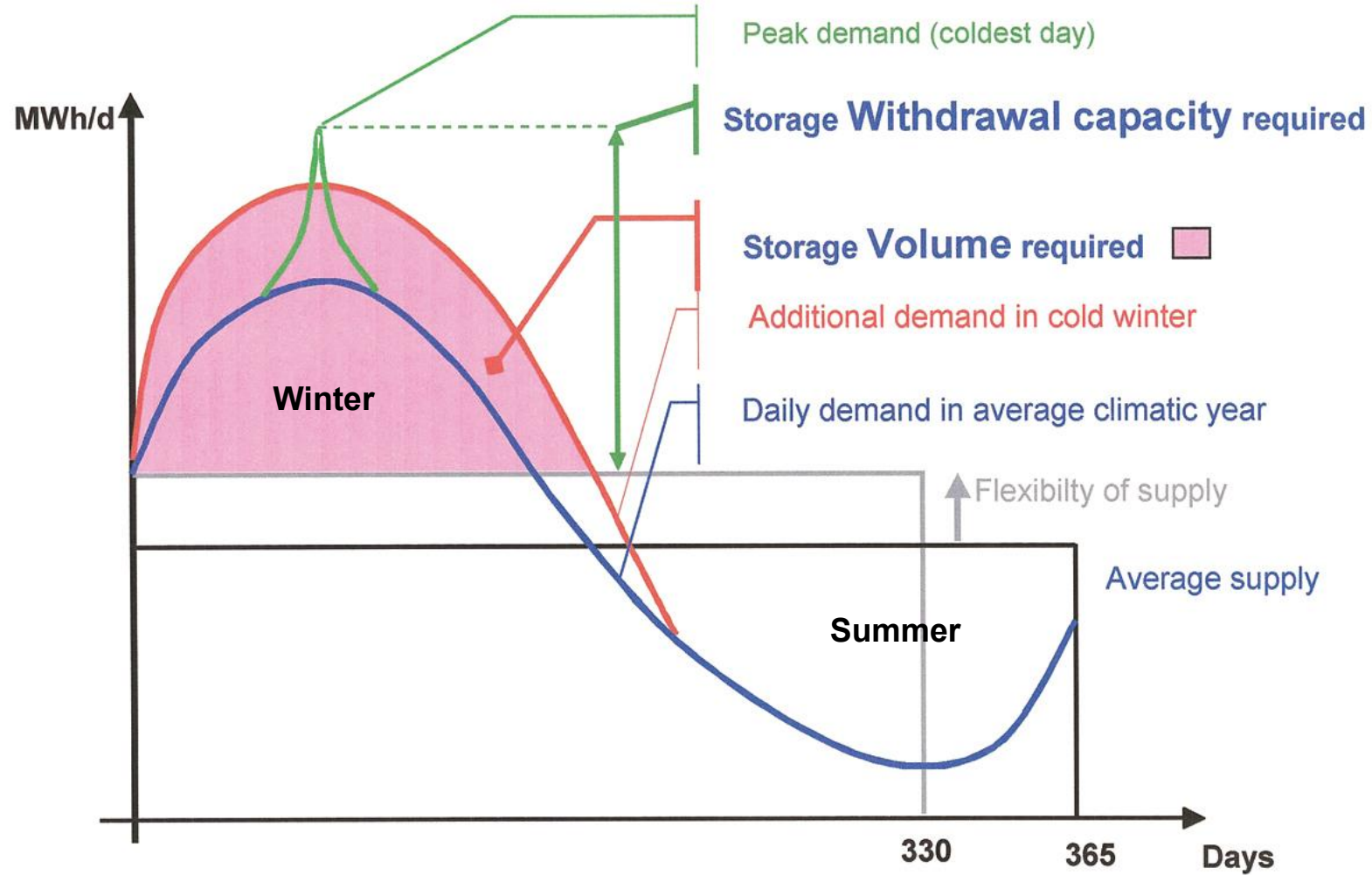
1. General considerations
2. Resources, reserves
3. Conventional and Unconventional Gaseous Hydrocarbons
4. Production, consumption: past and present
5. Production, consumption: perspectives
6. A zoom on Liquefied Natural Gas (LNG)
7. Three independant world markets
8. The gas chain components and their economics: Production & Processing
9. The gas chain components and their economics: Transportation
10. The gas chain components and their economics: Storage
11. Technology and innovation
12. Competing fuels and Gas prices
13. Evolution of national gas markets towards liberalization & globalization
14. Example of challenging gas projects: Shtokman & Yamal



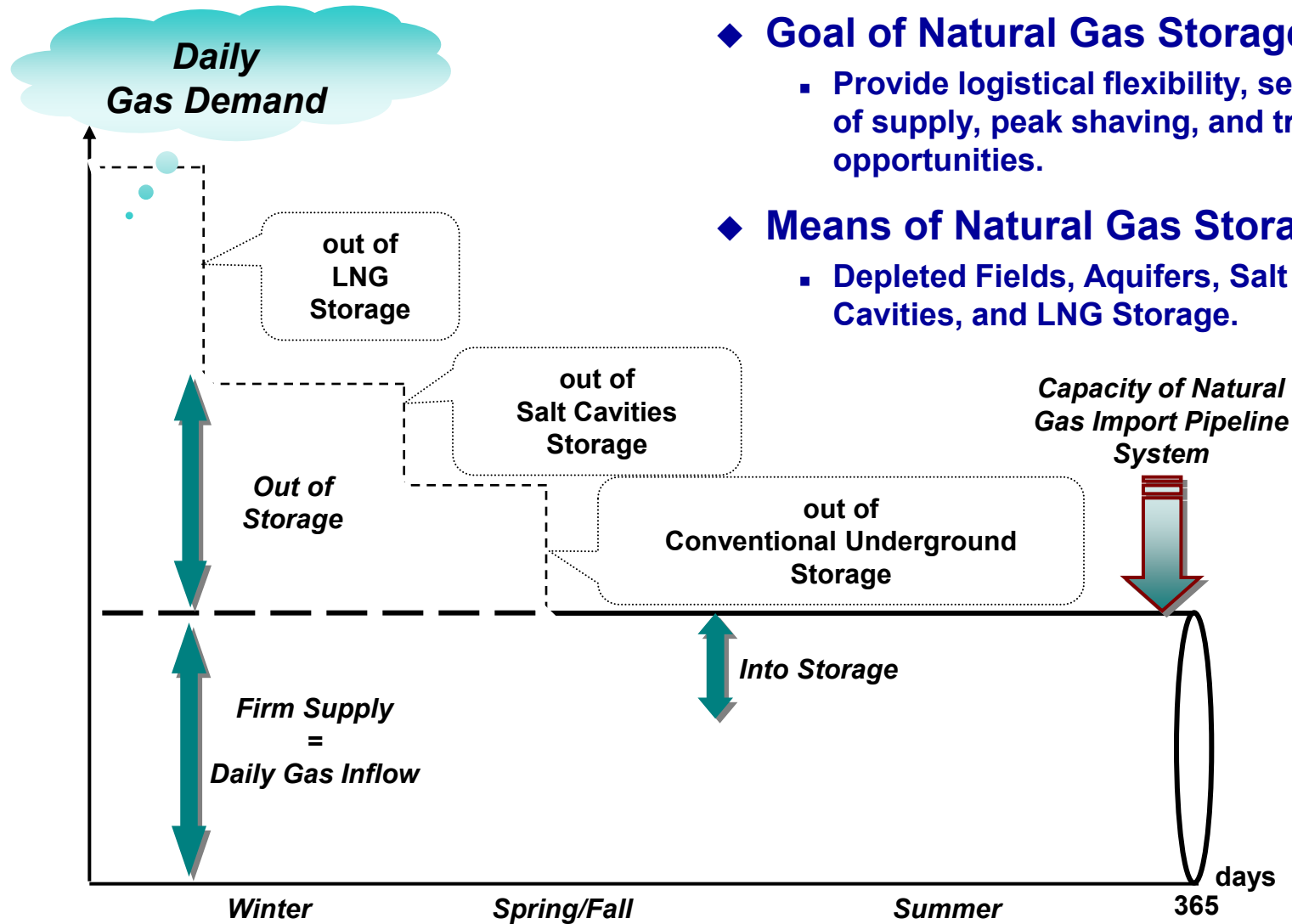
Transport-Storage: spinal column of the gas chain to route gas towards and inside consumption zones



Natural Gas Storage - Traditional use



Natural Gas Storage



◆ Goal of Natural Gas Storage:

- Provide logistical flexibility, security of supply, peak shaving, and trading opportunities.

◆ Means of Natural Gas Storage:

- Depleted Fields, Aquifers, Salt Cavities, and LNG Storage.



Natural Gas Storage

- ◆ The safest, most secure and economically viable form of natural gas storage is storage in natural or man-altered underground formations.
- ◆ The three principal types of gas storage sites are:
 - Reservoirs in oil or gas fields
 - Aquifers
 - Salt cavern formations
- ◆ In addition, above ground storage facilities can be built (LNG peak shavers)
- ◆ The most important characteristics of a storage facility are its capability to hold large volumes of natural gas for future use and the rate at which the gas inventory can be withdrawn (its delivery rate).



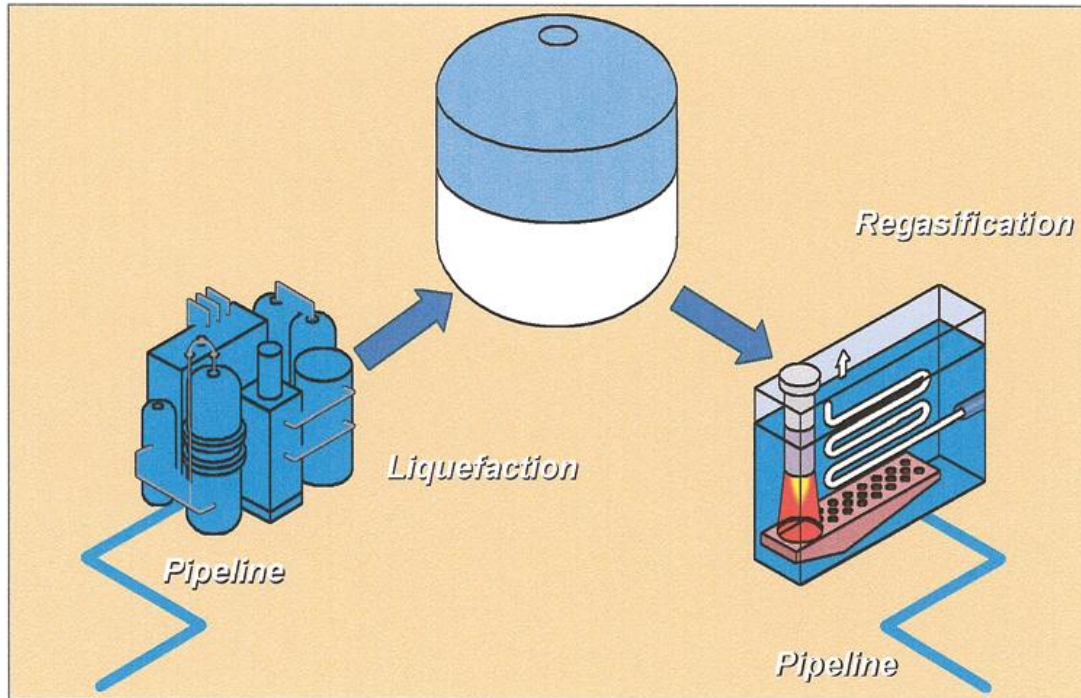
Natural Gas Storage costs

(Costs can substantially fluctuate depending upon economic environment)

	Depleted Fields	Aquifers	Salt Cavities
Working Capacity (10^6 m ³)	300 - 5000	200 - 3000	50 - 500
Flexibility (Flow/Capacity)	low	low	high
Investment (\$/m ³)	0.2 - 0.3	0.2 - 0.3	0.6 - 0.8
Exploitation Costs (\$/MBtu)	0.3 - 0.5	0.3 - 0.5	0.3 - 2.5



Peak shavers LNG

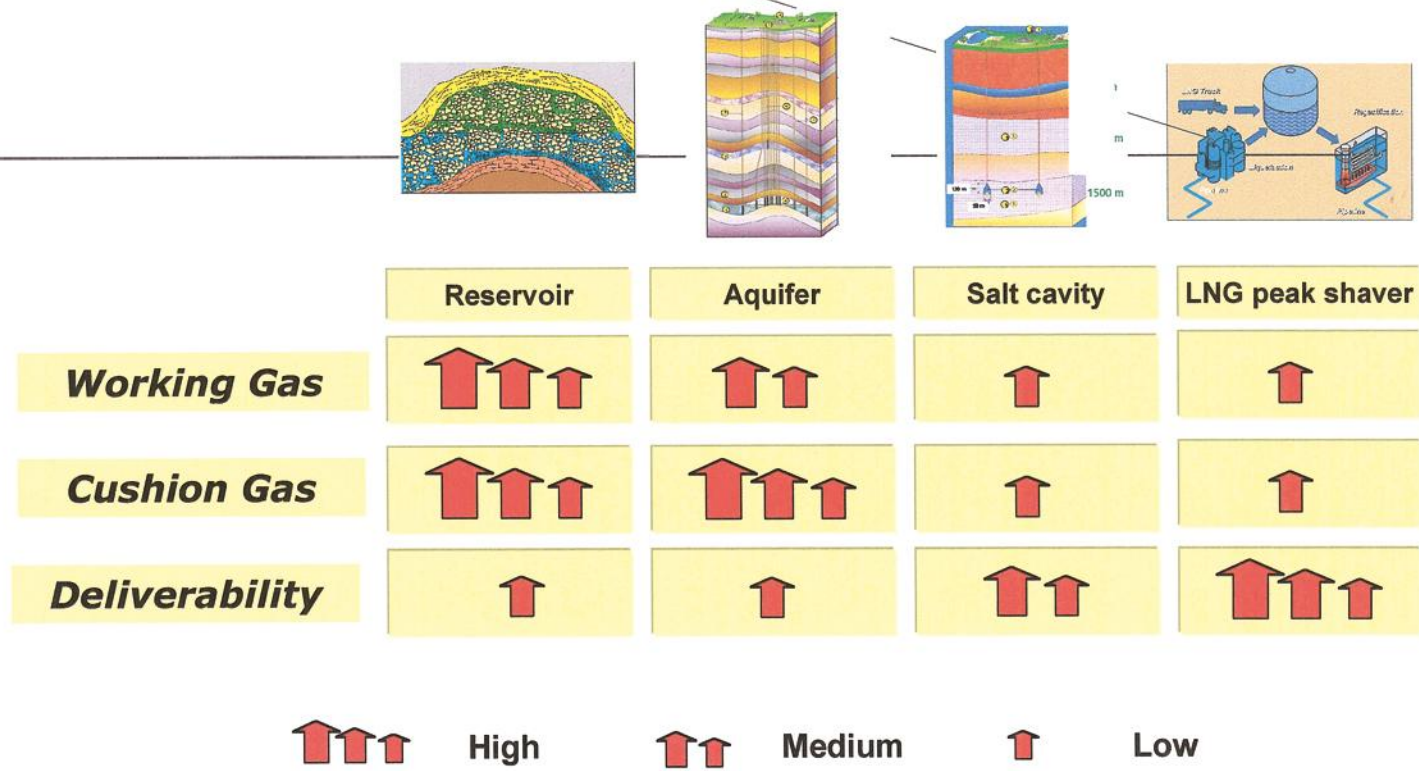


- Low Working Volume
- High Withdrawal Capacity
- Low Injection Capacity



Synthesis

Synthesis



11

Technology and innovation



TABLE OF CONTENTS

1. General considerations
2. Resources, reserves
3. Conventional and Unconventional Gaseous Hydrocarbons
4. Production, consumption: past and present
5. Production, consumption: perspectives
6. A zoom on Liquefied Natural Gas (LNG)
7. Three independant world markets
8. The gas chain components and their economics: Production & Processing
9. The gas chain components and their economics: Transportation
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Technological progress

Exploration

Production



- ◆ Specific gas exploration
- ◆ Arctic /Siberia
- ◆ Offshore marginal fields
- ◆ Multiphase systems

Liquefaction



- ◆ Efficiency
- ◆ Simplification
- ◆ Size increase
- ◆ Floating LNG

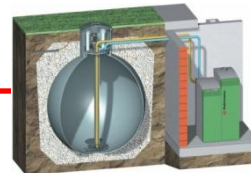
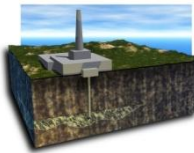
Transportation



- ◆ Size increase
- ◆ Diesel propulsion
- ◆ Multiphase pumping
- ◆ Optimal control / complex networks

Underground

Storage



- ◆ Better investigation
- ◆ Safer exploitation

Use



- ◆ Efficiency
- ◆ Innovation
- ◆ Compressed Natural Gas
- ◆ Gas to Liquids



Technical innovation – Floating LNG



Technical innovation – Floating LNG

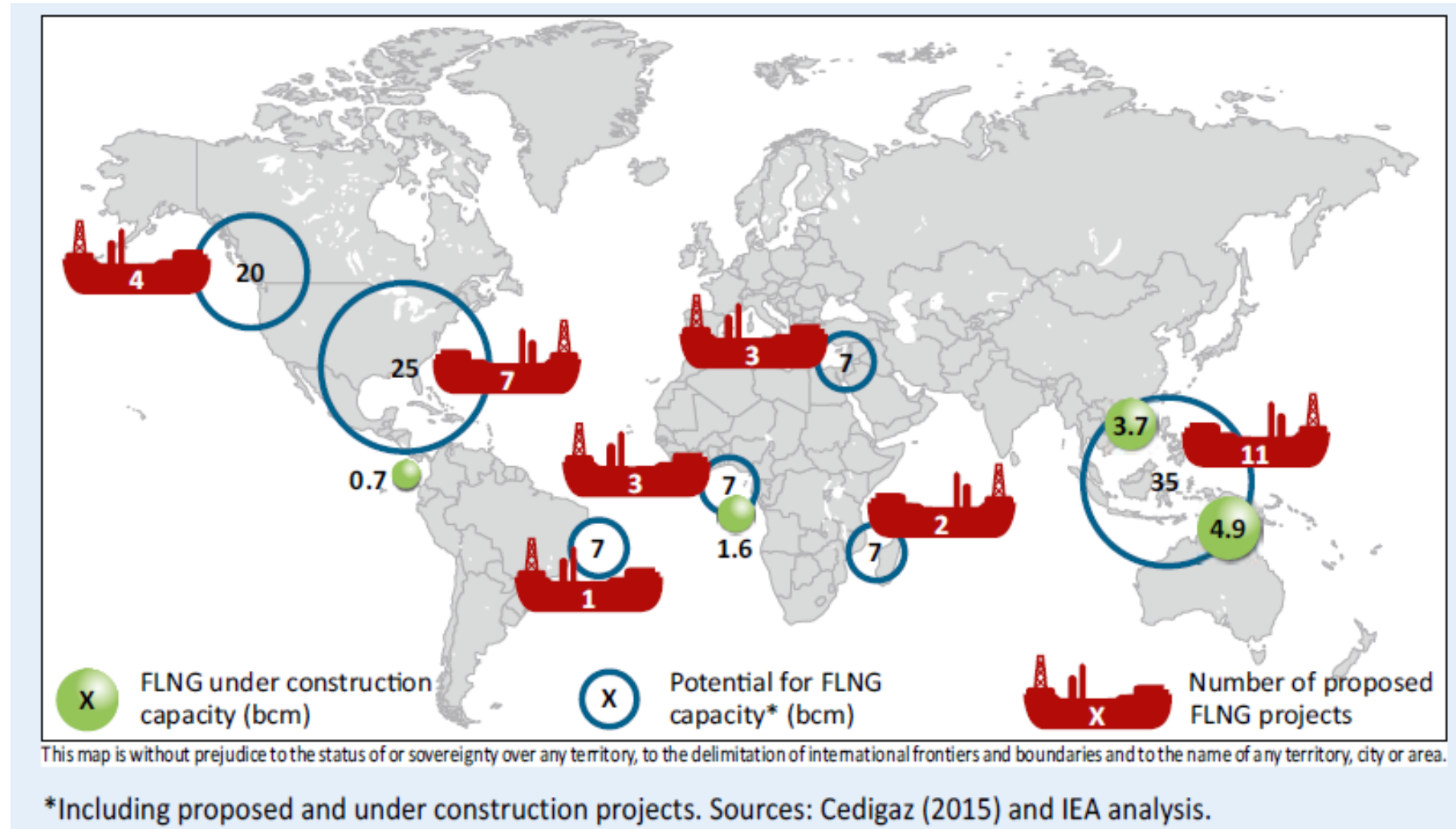
FLNG is built on industrial experience.....



The Coral-Sul FLNG to operate at the Coral South project Offshore Mozambique



Reminder - Floating LNG projects - 2015



Floating LNG: Shell Prelude project

Floating Liquefied Natural Gas From Concept to Reality

Shell Floating Liquefied Natural Gas

Technip Samsung Consortium Contracts

● Master Agreement	28/07/2009
The design, construction and installation of multiple FLNG facilities over 15 years	
● Generic FLNG – FEED	28/07/2009
● Prelude FLNG – FEED	08/03/2010
Offshore Western Australia	
● Prelude FLNG – EPCI	08/03/2010
Contract under which the FLNG would be built when the project receives the final investment decision (FID announced 20 th May 2011)	



Generic FEED – finalised
Prelude – start up 2016
Sunrise – to come

Picture courtesy of Shell

Source: Technip



Floating LNG: Shell Prelude project

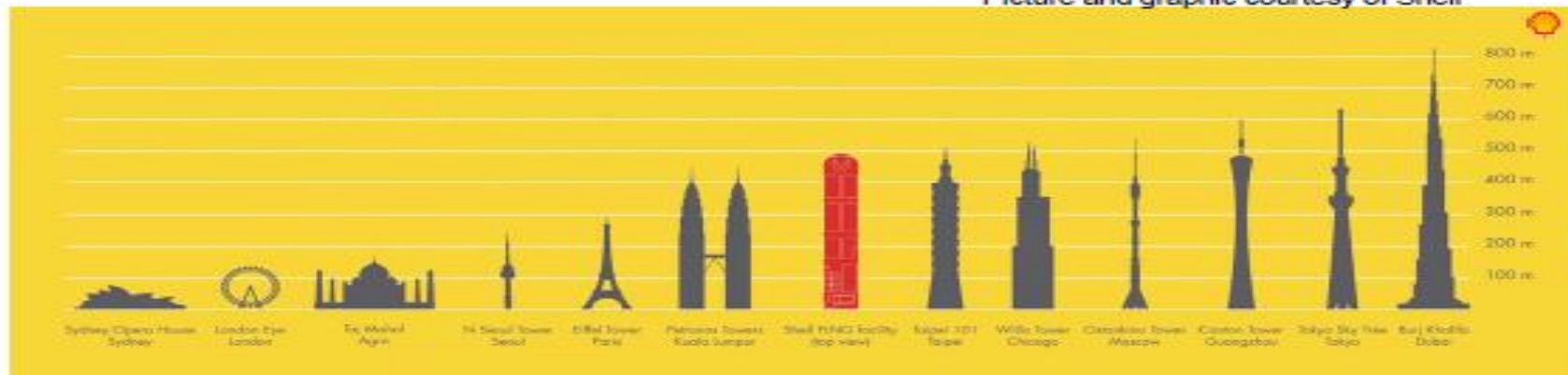
Floating Liquefied Natural Gas From Concept to Reality

Shell Prelude

- 488 m x 74 m
- 600 000 t displacement with tanks full
- 3.6 Mtpa LNG capacity
- 1.3 Mtpa condensate production
- 0.4 Mtpa LPG production
- Total liquid production 110 000 boe/day



Picture and graphic courtesy of Shell



Source: Technip

Floating LNG: Shell Prelude project

- **LNG project in Australia**
- **FLNG: 488 m length, 74 m width**
- **Two helidecks**
- **Capacity: 3,6 MT LNG, 1,3 MT Condensate and 0,4 MT LPG**
- **Technip in charge of the construction**
- **Operational start-up: 2017**
- **Operated by Shell (67,5%). Joint-venture with Inpex (17,5%), Kogas (10%) and OPIC (5%)**



Floating LNG: Shell Prelude project



Floating LNG: Total project

TOTAL FLNG pre-FEED

- Client : TOTAL
- Technip leader of the topside design
- Pre-FEED completed in Q4 2011
- Capacity 2.5 Mtpa LNG
- Length: 410m +
- N2 cycle



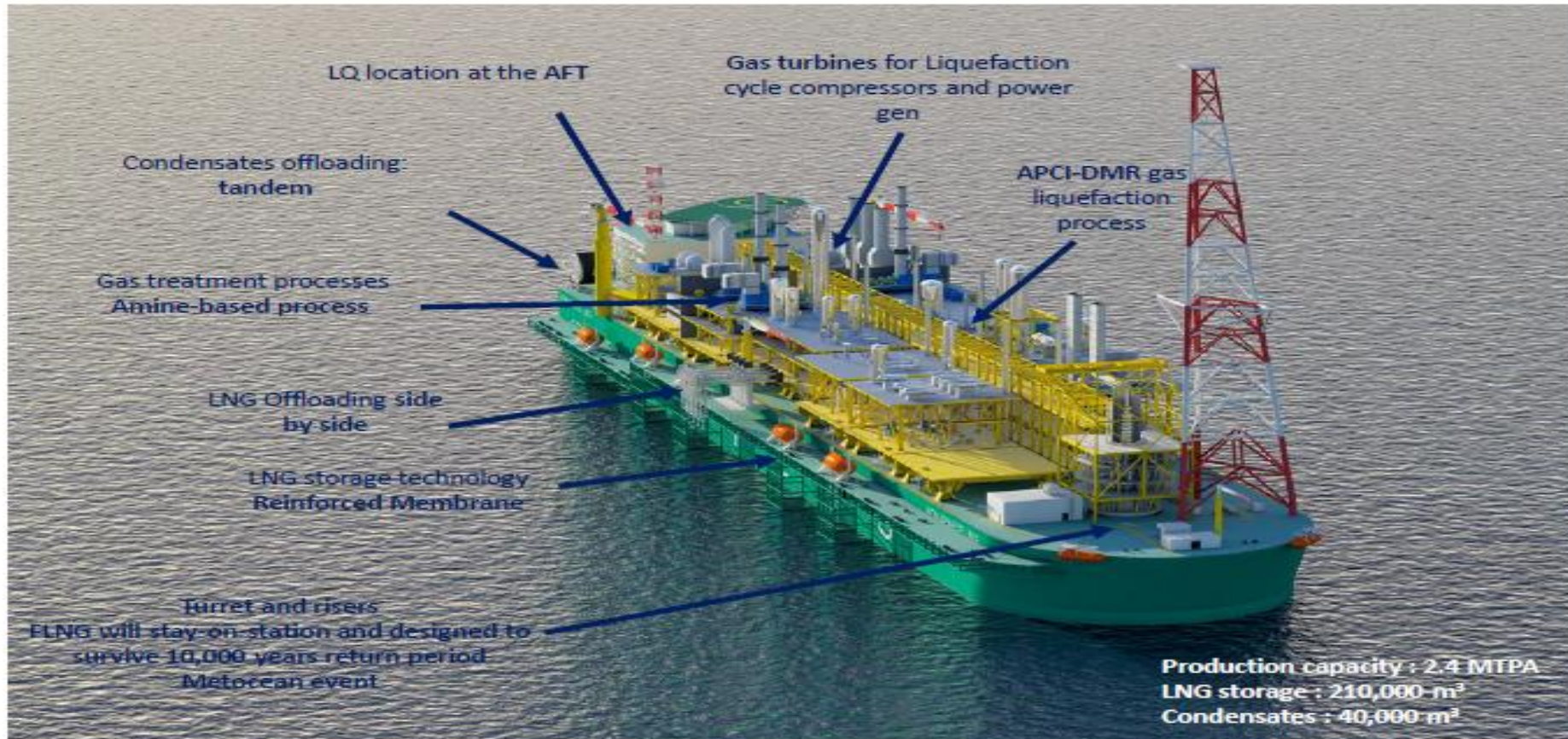
<http://www.total.com/fr/nos-energies/gaz-naturel>

Source: Technip



Bonaparte Floating LNG

BLNG – FLNG main characteristics



Source: GdF Suez

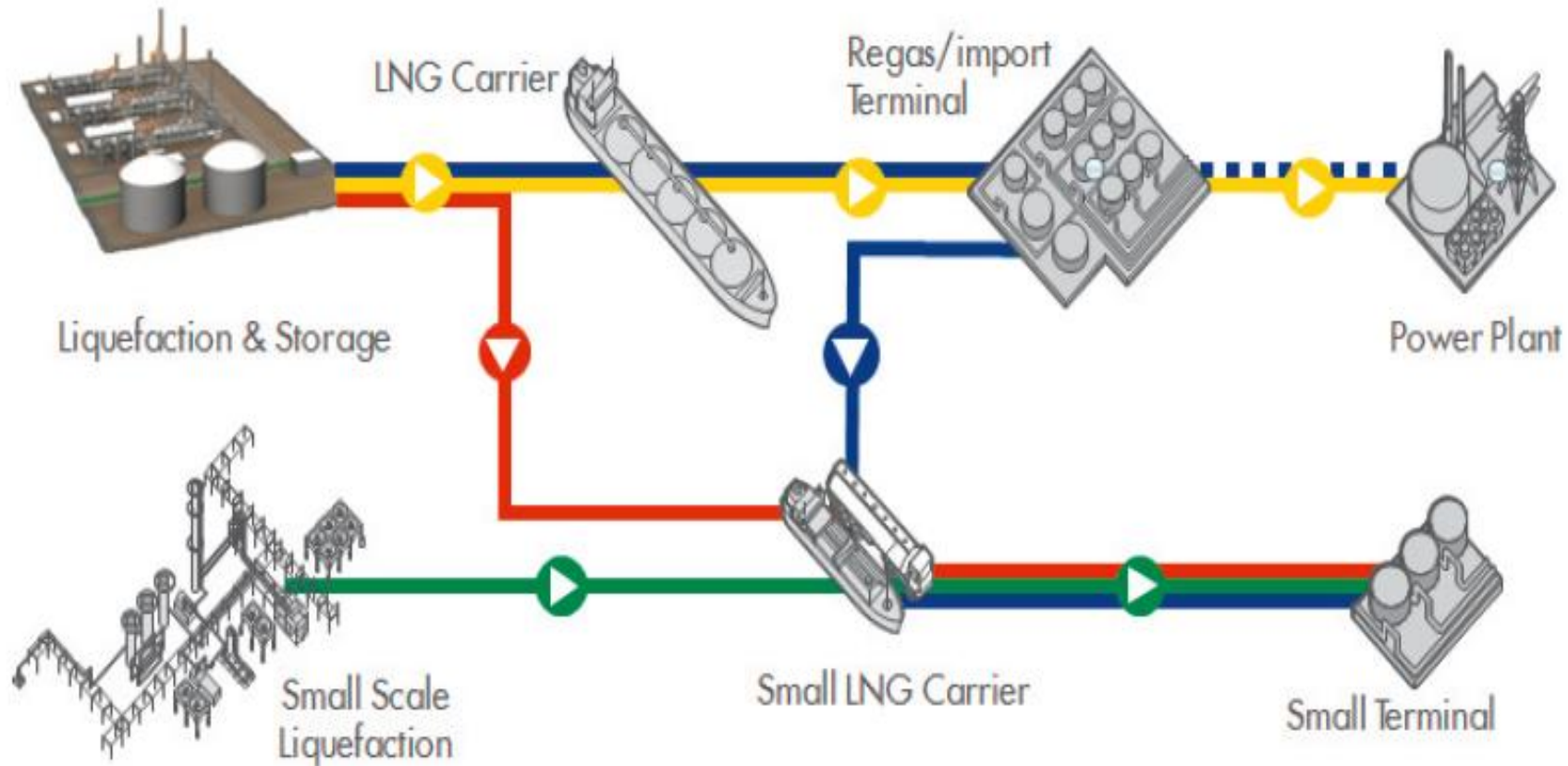
Petronas Floating LNG



The PETRONAS FLNG SATU has been completed and is expected to commence production in 2016. Photo courtesy PETRONAS.



Business/Market Evolution: Small Scale LNG (SSLNG).....



Source: IGU 2015, Shell



Gas to Liquids (GTL)Technology



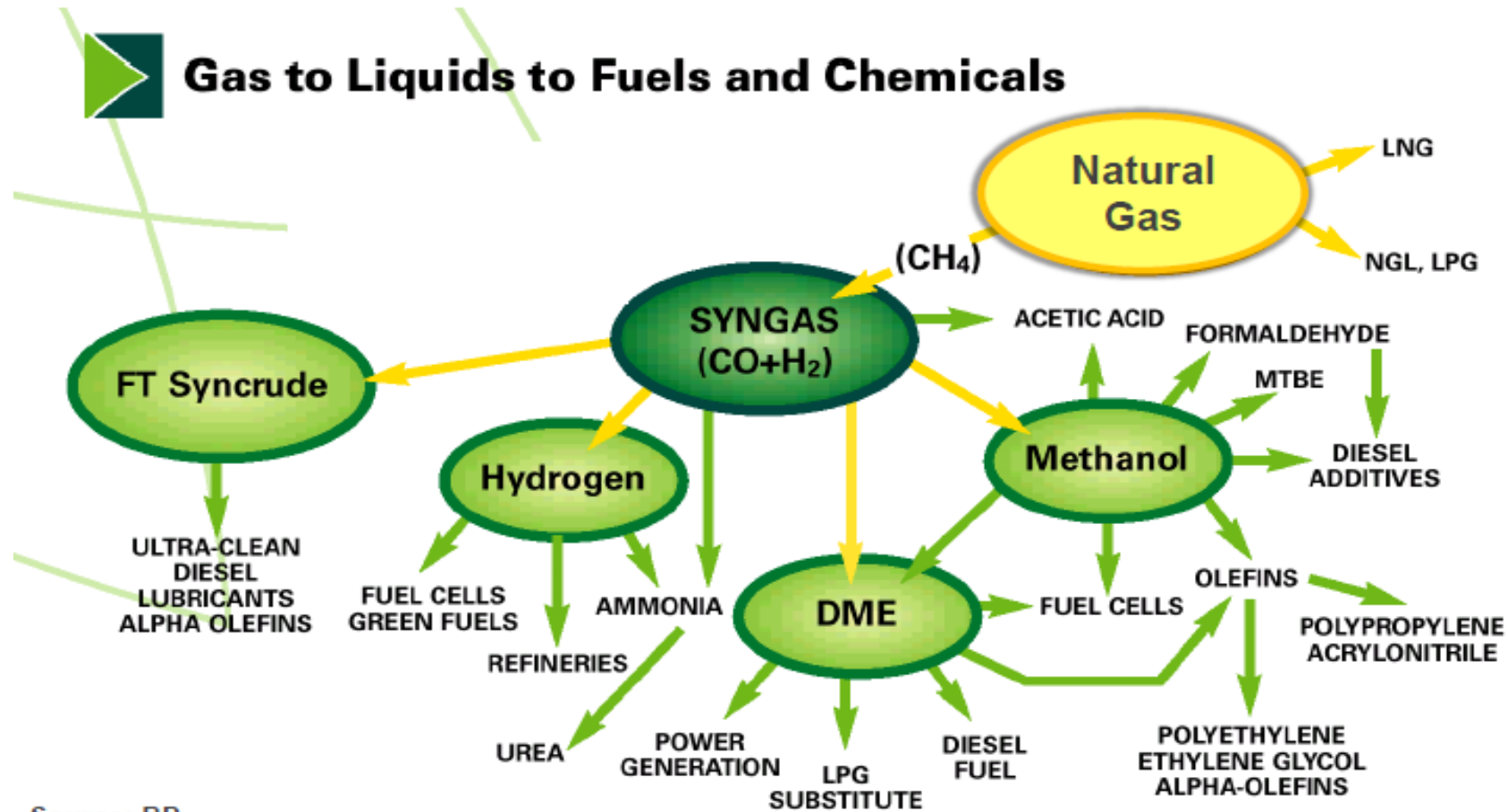
GTL Technology



- GTL pilot plant in Italy
 ➡ **High-grade gasoil**
- Large experience in products work-out
- Reduction in the cost :
integration of units and best technological choices.



GTL Technology



Source: BP

DME: dimethyl ether

FT: Fischer-Tropsch



12

Competing fuels and Gas prices



TABLE OF CONTENTS

1. General considerations
2. Resources, reserves
3. Conventional and Unconventional Gaseous Hydrocarbons
4. Production, consumption: past and present
5. Production, consumption: perspectives
6. A zoom on Liquefied Natural Gas (LNG)
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9. The gas chain components and their economics: Transportation
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Market segments and competing fuels

◆ Residential



- Electricity
- Domestic FO
- LPG

◆ Commercial



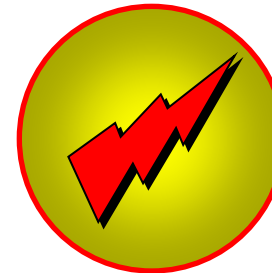
- Small industry
- Electricity
- Domestic FO
- LPG

◆ Large industry



- Heavy fuel oil
- Coal

◆ Power Generation

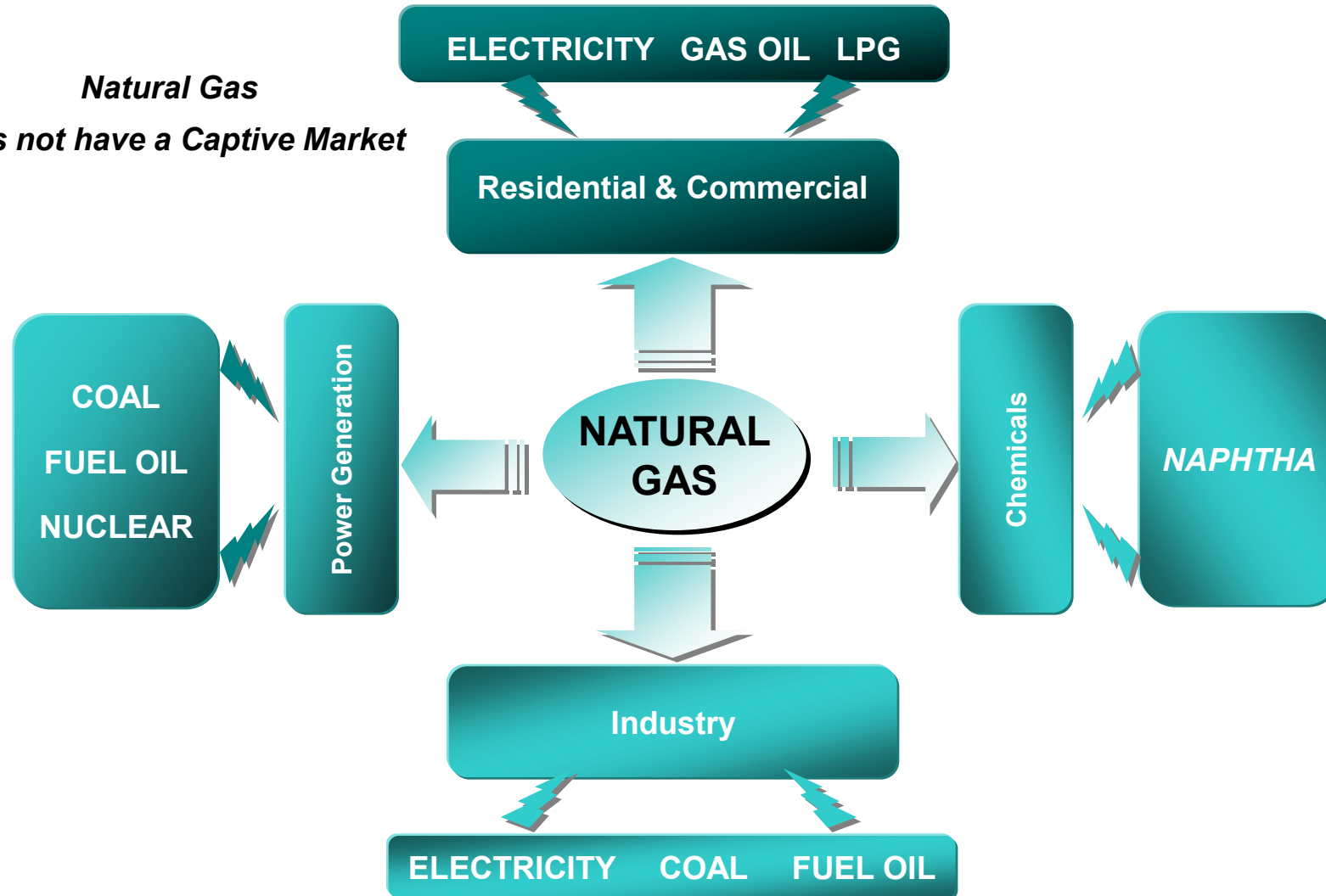


- Coal
- Heavy fuel oil
- Nuclear



Natural Gas markets

*Natural Gas
does not have a Captive Market*



Natural Gas uses

Average % Period 2005 – 2017

Global percentages evolve with time

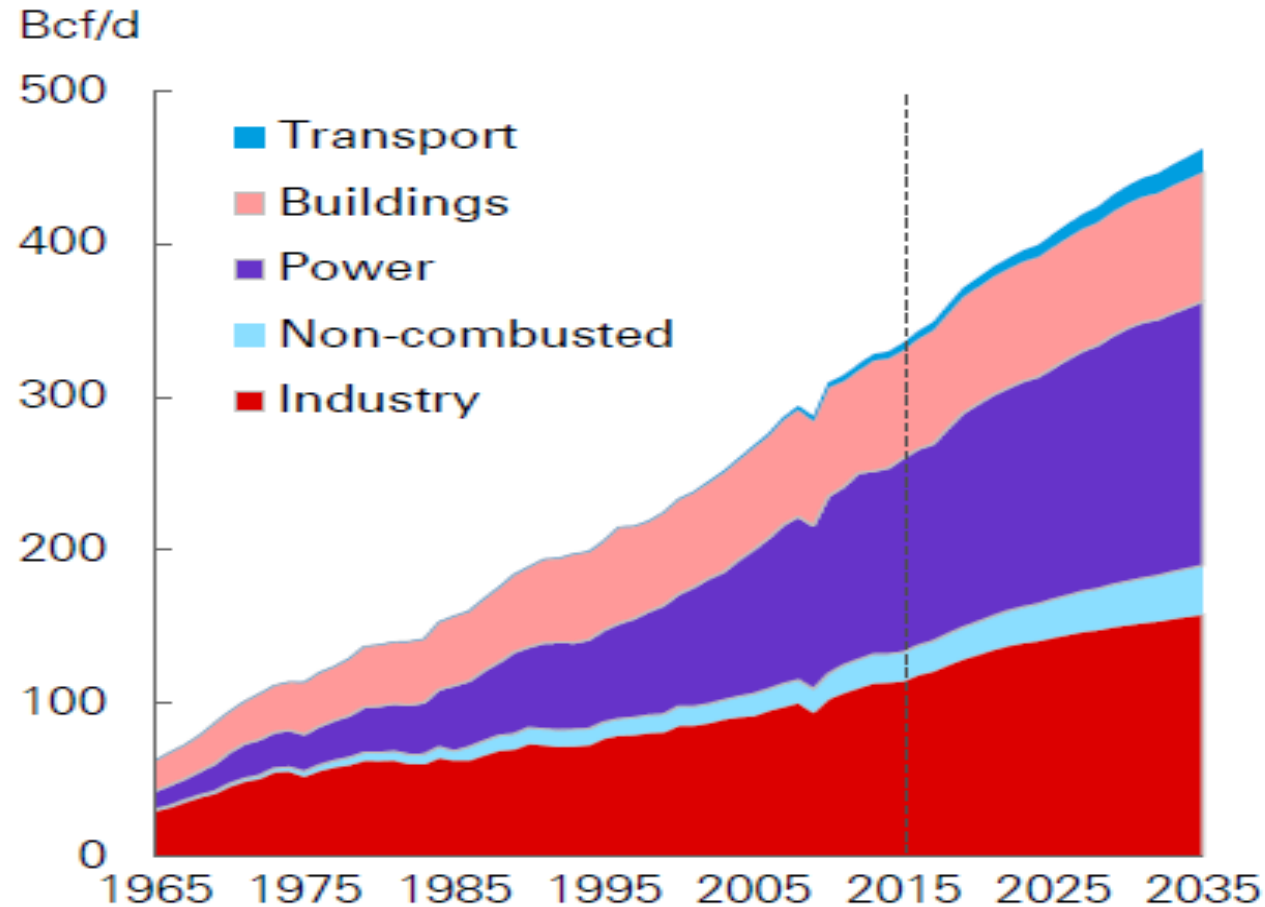
	%	Oil	<i>Natural Gas</i>	Solid Fuels
Transport Fuel		# 54	-	-
Heating Fuel		# 25	# 57	# 40
Power Production Fuel		# 7	# 36	# 60
Petrochemicals/Non combusted		# 15	# 7	-



Natural Gas uses

Global percentages evolve with time

Gas consumption by sector



Source: BP Energy Outlook 2035 2017 Ed.



CCGT, An Efficient Technology

Combination of a gas turbine and a steam turbine

◆ Gas turbine

- compresses air and mixes it with fuel that is heated to a very high temperature. The hot air-fuel mixture moves through the gas turbine blades.
- drives a generator that converts spinning energy into electricity.

◆ Heat recovery system

- captures exhaust heat from the gas turbine
- generates steam from the exhaust heat and delivers it to the steam turbine.

◆ Steam turbine

- drives a generator converting spinning energy into additional electricity
- additional step increasing the global yield to 60%+

CCGT (Combined Cycle Gas Turbine) : a modular & flexible solution

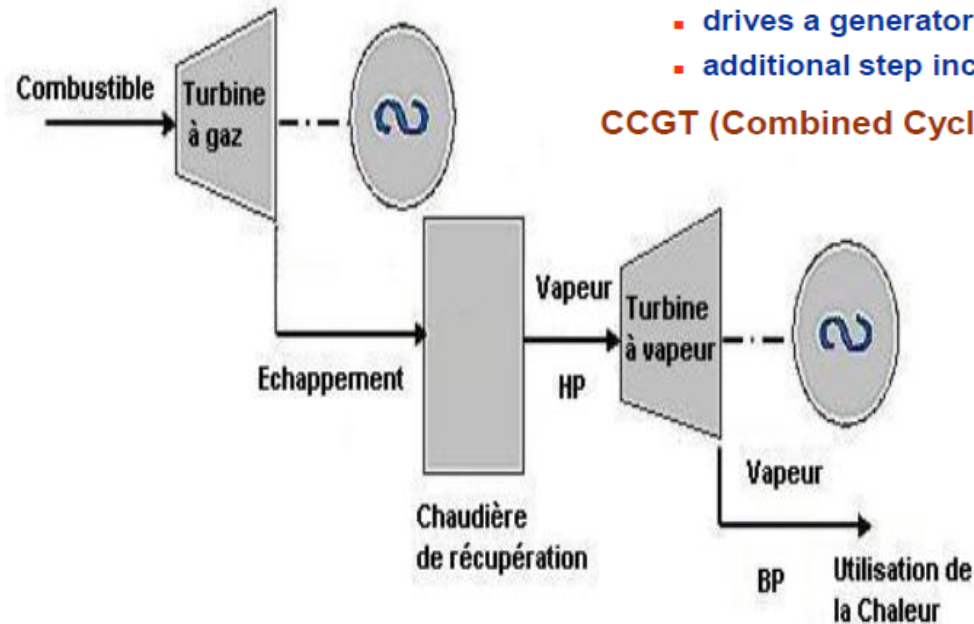


Illustration: Seasonal profiles, typical of different gas market sectors

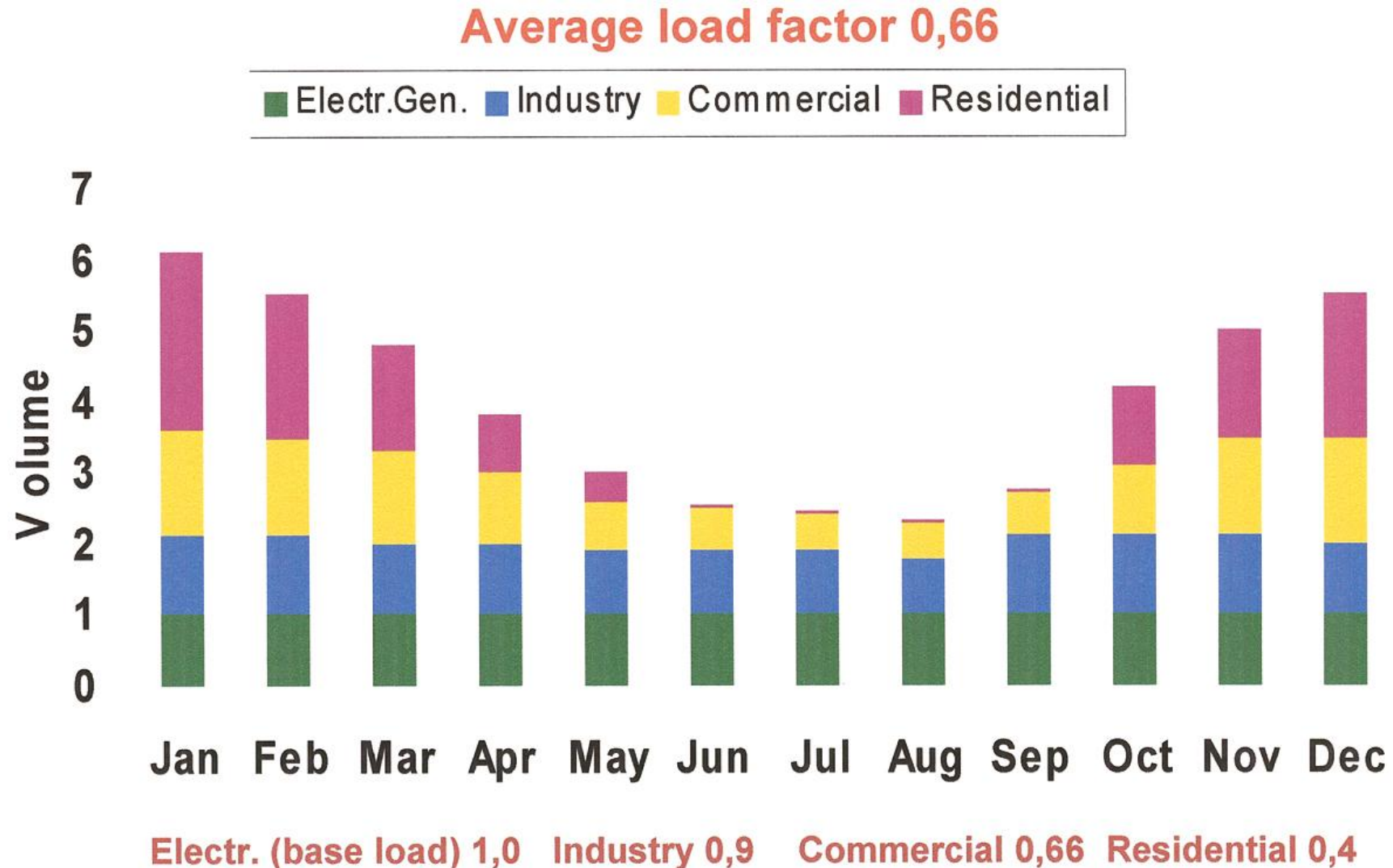
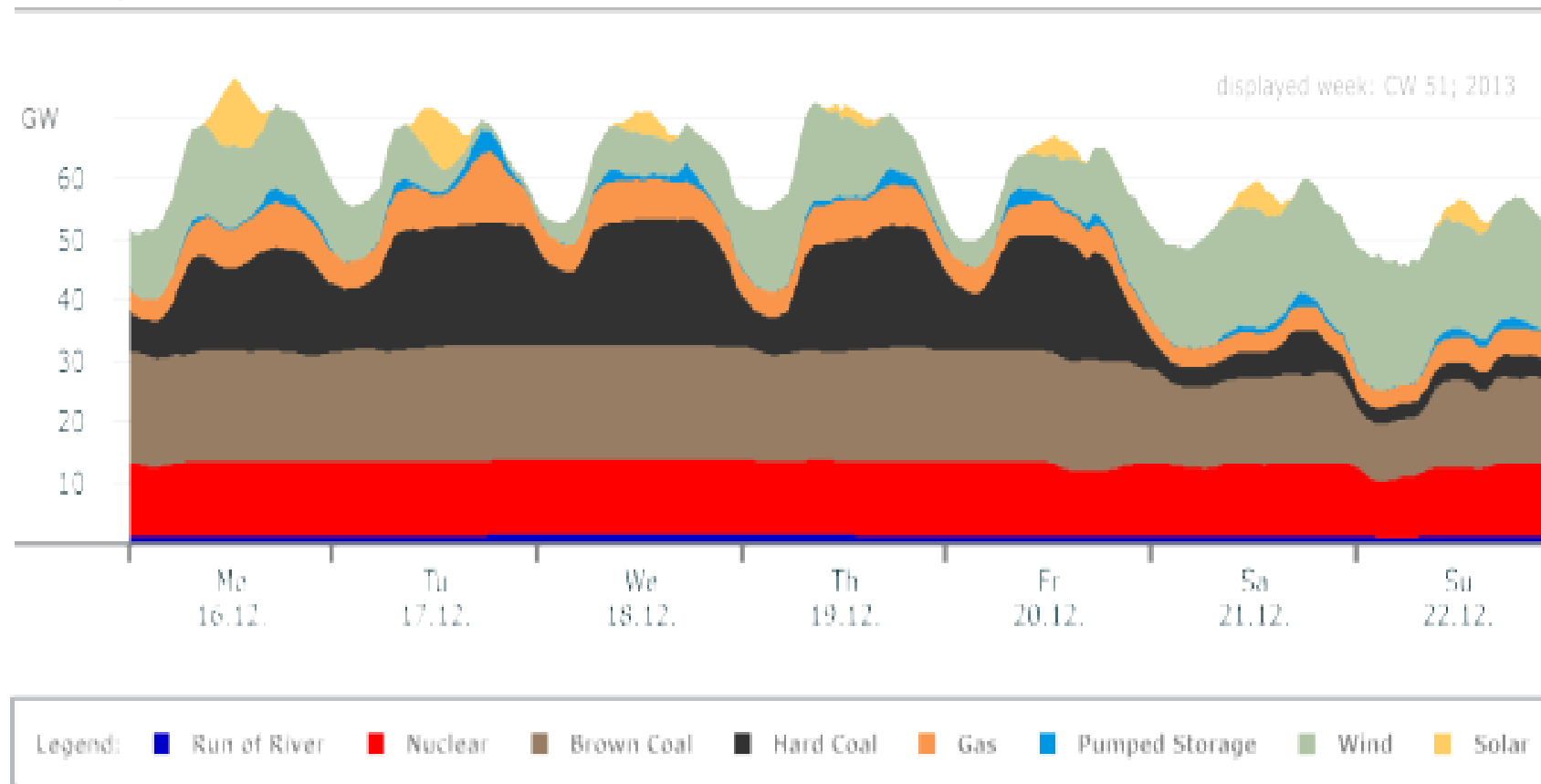


Illustration: Detailed Electricity Generation Mix in Germany Week 51 in December 2013

Actual production



Source: Fraunhofer ISE, based on EEX data, commissioned by MSC, 2014.

Source: Mycle Schneider Consulting

Gas Sales Contracts Main Characteristics



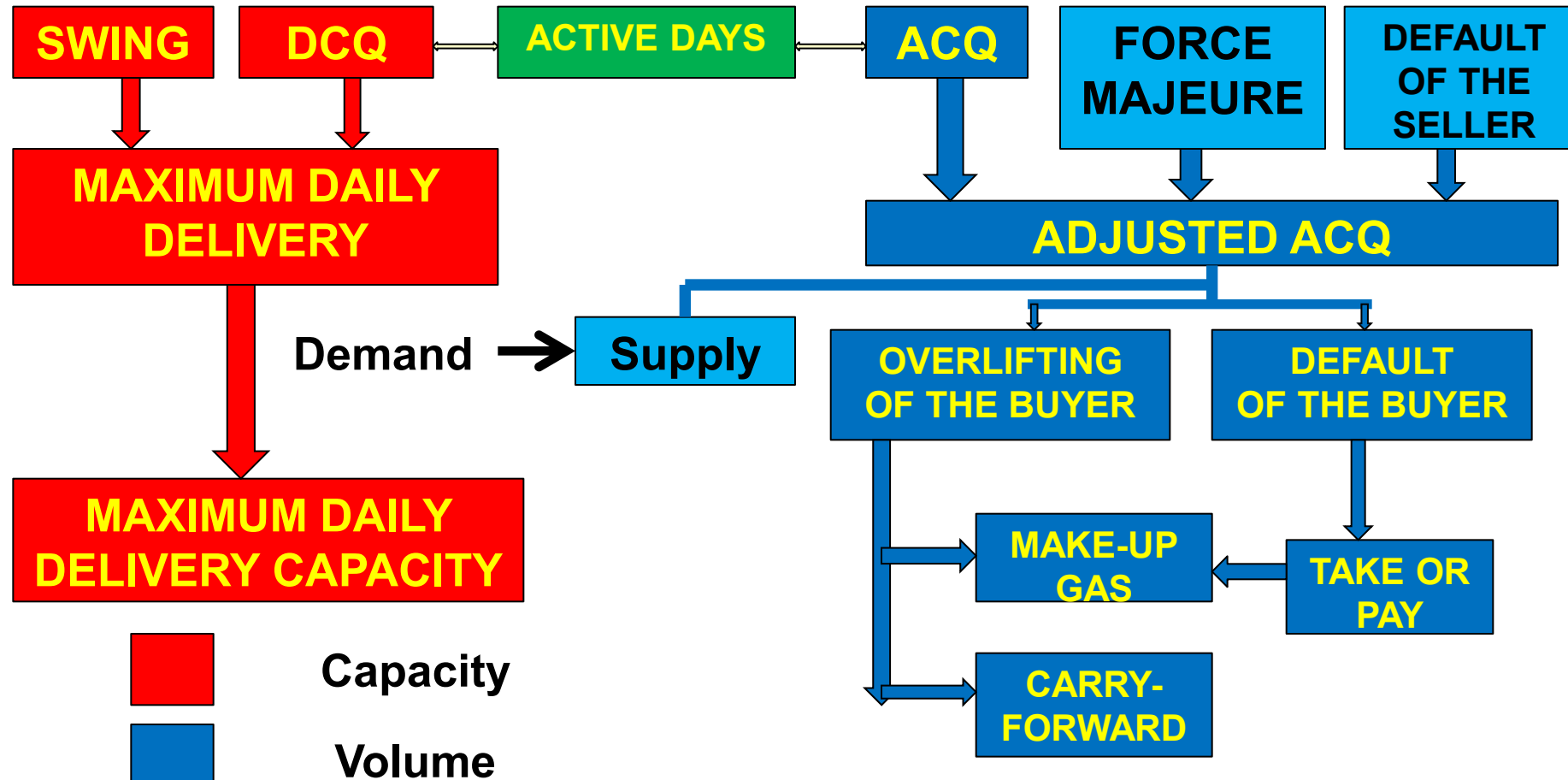
Gas Sales Contracts

- ◆ Quantities
- ◆ Quality
- ◆ Measurements
- ◆ Facilities/Delivery Point
- ◆ Price
- ◆ Billing
- ◆ Duration
- ◆ Other Clauses
 - Force majeure
 - Termination
 - Assignment
 - Law
 - Revision



Flowchart of a Gas Contract

N.B: Contracts are all different. All terms do not necessarily appear , the wording may vary



Gas Sales Contracts

◆ Quantities

■ Volumes

- Total Contractual Quantity: TCQ
- Annual Contractual Quantity: ACQ
- Daily Contractual Quantity: DCQ
- Nominated Quantities
- Take or Pay
- Climatic Corrections

■ Variations

- Flexibility
- Interruption
- Priorities

■ Default and adjustment

- Make-Up gas
- Short Fall gas, Carry Forward



Gas Sales Contracts

◆ Quantities

◆ Quality

- Pressure conditions
- Gas composition
- Gas Specifications
- Non-acceptable impurities
- Impact on gas price
- Entitlement to refuse the gas



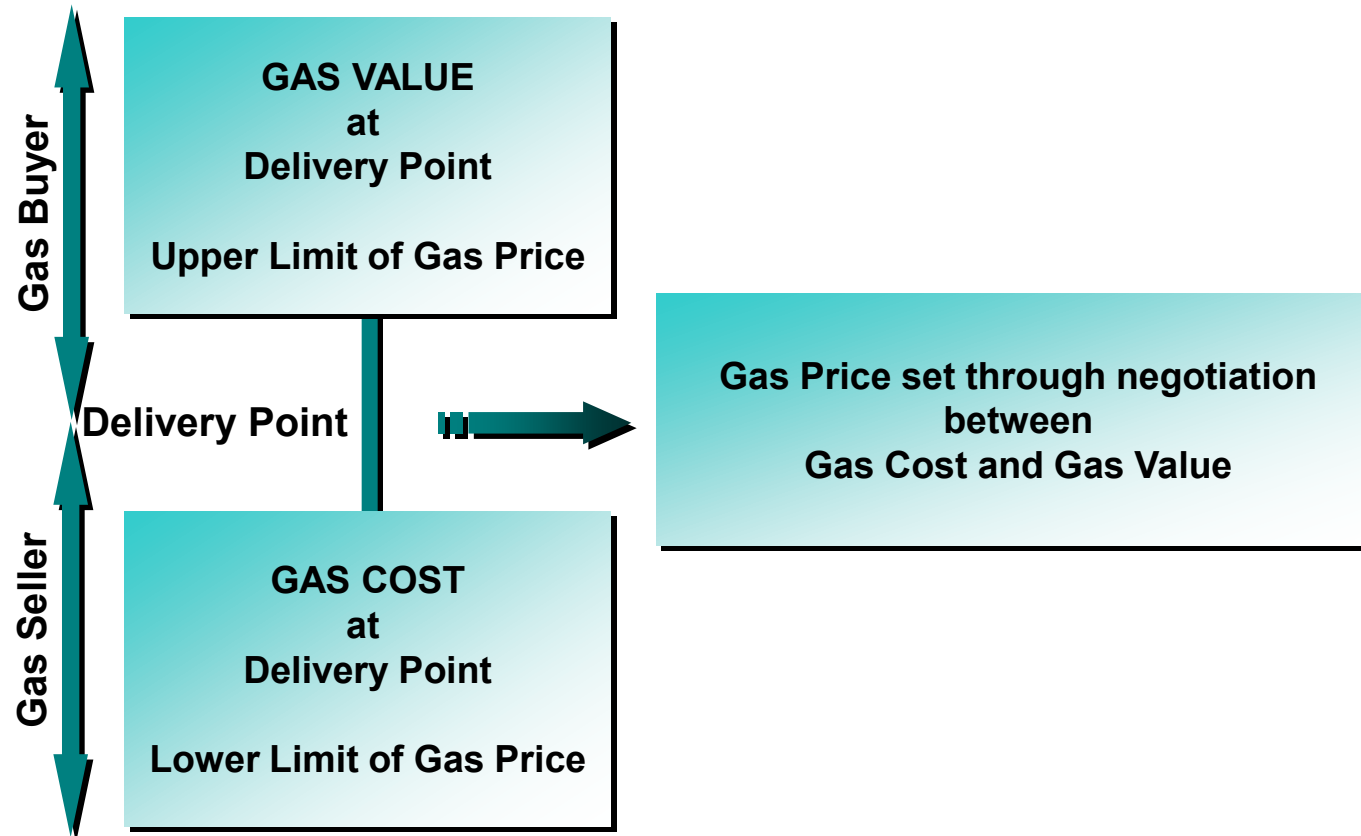
Gas Sales Contracts

- ◆ Quantities
- ◆ Quality
- ◆ Measurements
- ◆ Facilities
- ◆ Price
 - Base Price (P0)
 - Indexation Formula
 - Currency
 - Reference period
 - Price Review

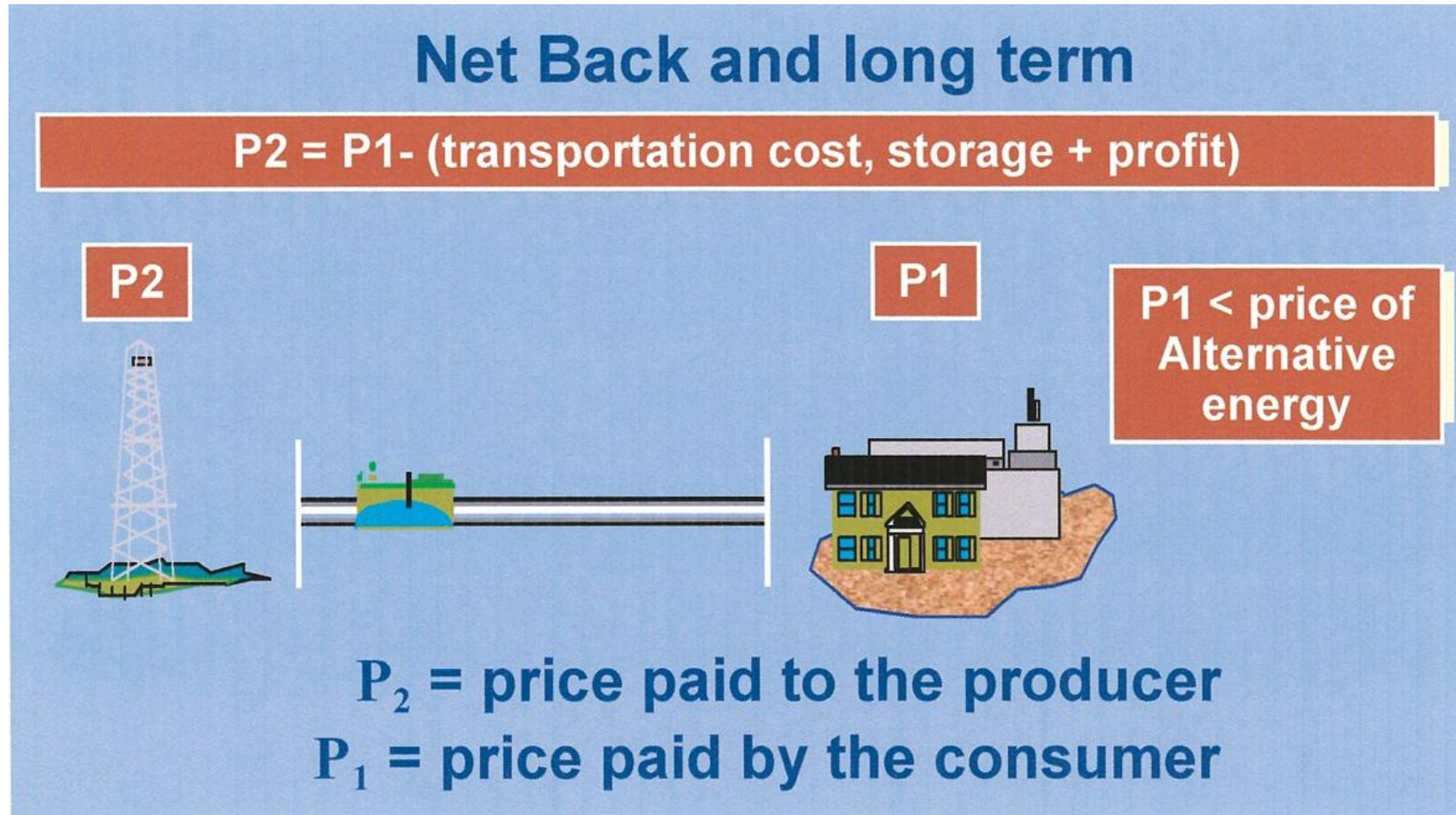


Natural Gas Price

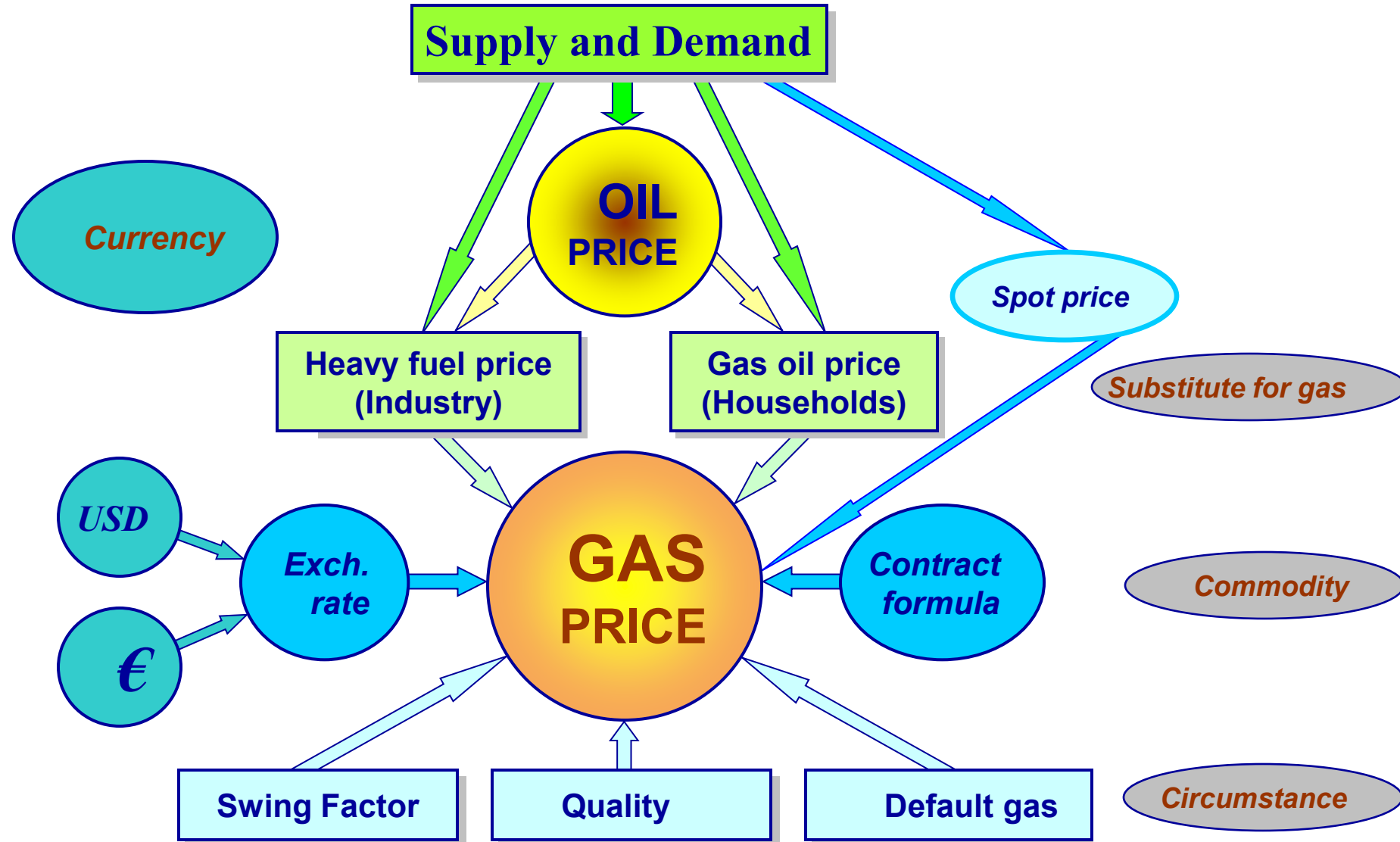
Without an international marker, it is indexation that is used in setting gas prices. Indexation is an instrument used to reflect the specificity of the demand zone, and therefore to ensure the marketability of gas.



Gas pricing: Europe (Border price)



WHAT WILL INFLUENCE THE GAS PRICE IN LT CONTRACTS



Gas price formulas – Some examples

$$P = P_0 + a (X - X_0) + b (Y - Y_0)$$

- ◆ Values of indices X and Y are computed over a reference period (3 to 12 months), preceding the period over which the gas price P, derived from the formula, is applied.
- ◆ Gas price P derived from the price formula is usually used for a period of 3 months before being readjusted with new values of the indices.

$$P = P_0 + 60\% \cdot 0.8 (GO - GO_0) + 40\% \cdot 0.9 (FO - FO_0)$$

$$P = P_0 (30\% \cdot GO/GO_0 + 30\% \cdot FO/FO_0 + 40\% \cdot I/I_0)$$

LNG

$$P(\text{GNL ex ship}) = 0.15 \cdot \text{JCC} + \text{Cst} \cdot \text{Inflation}$$

JCC : average price of a basket of imported crudes

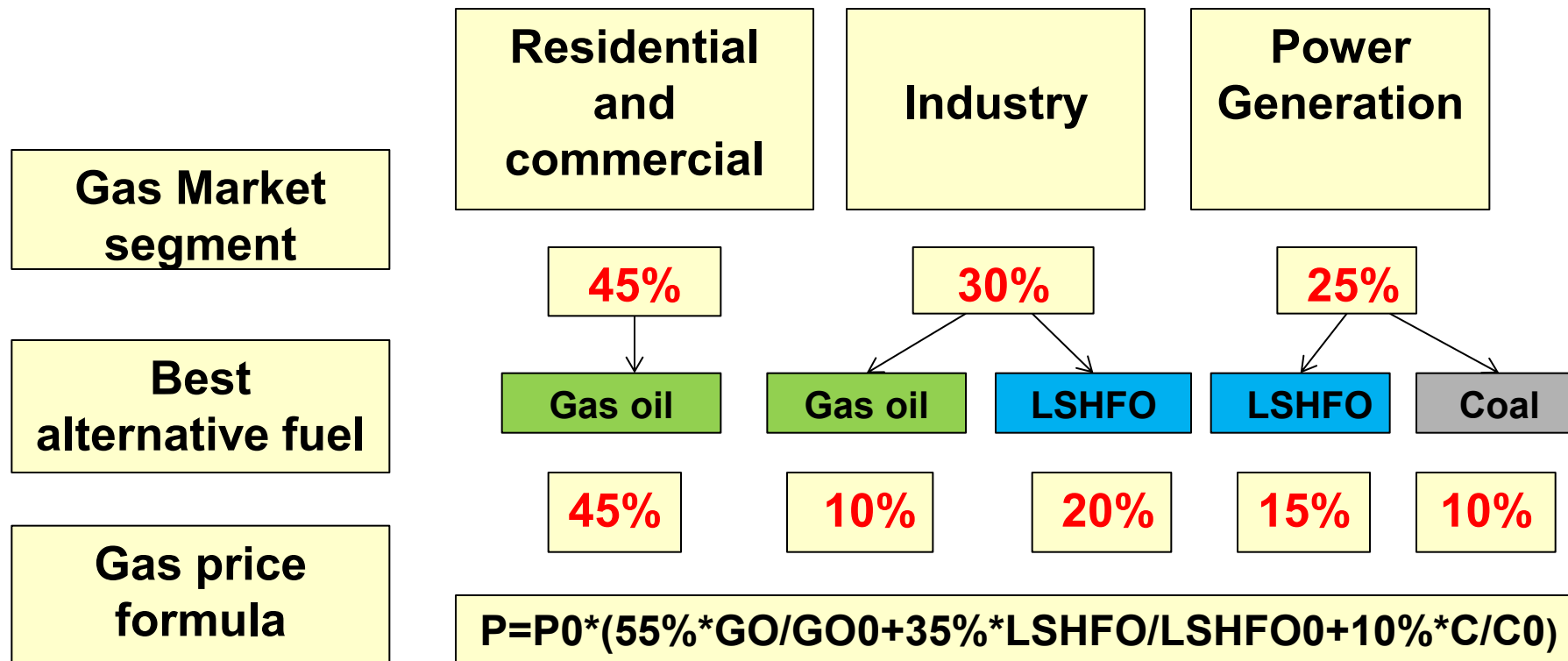
Gaz to Power

$$P = P_0 (35\% \cdot C/C_0 + 20\% \cdot E/E_0 + 20\% \cdot I/I_0 + 20\% \cdot S/S_0 + 5\% \cdot T/T_0)$$

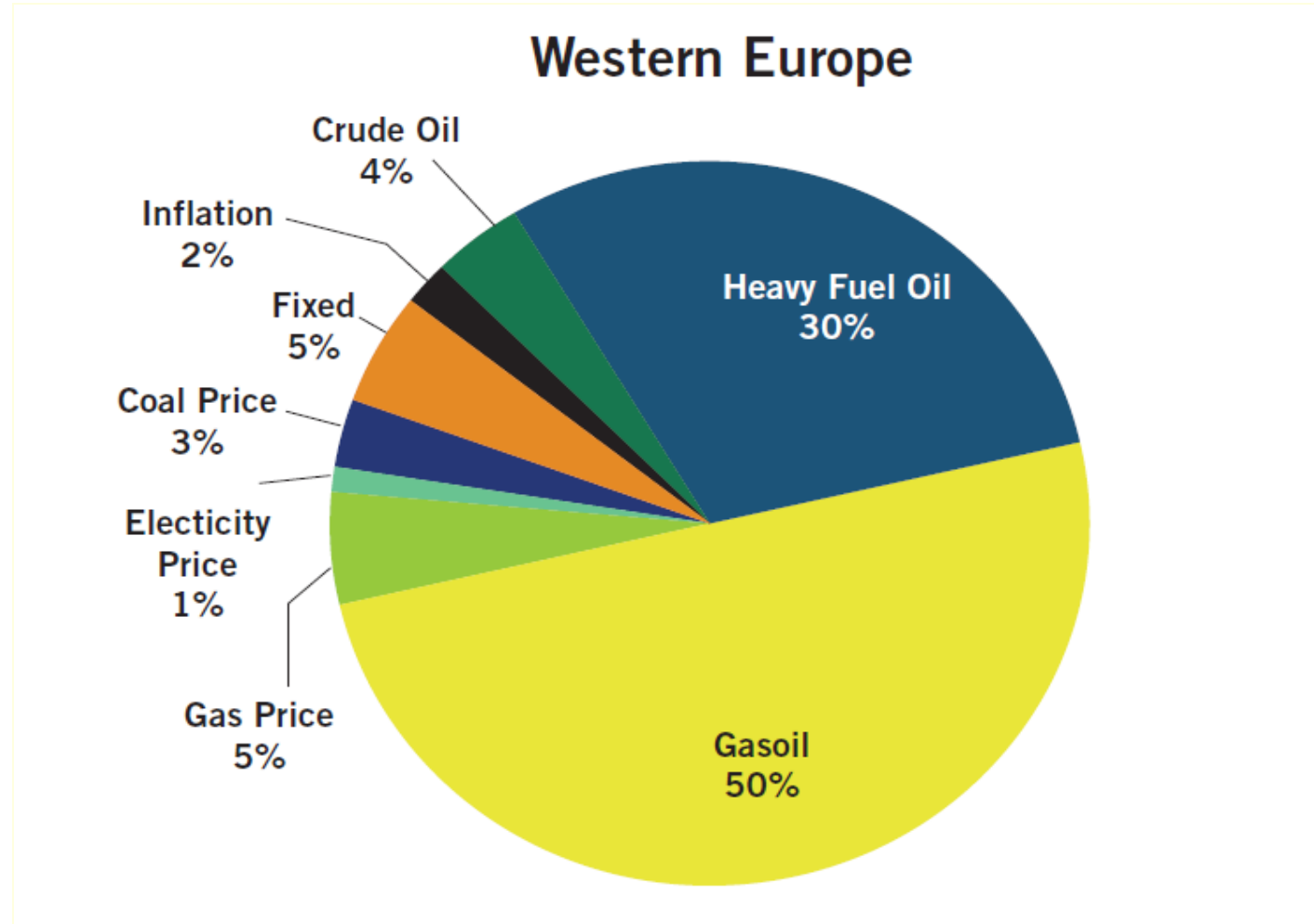


Market segments and competing fuels: impact on pricing

- ◆ In LT contracts, escalation of price is traditionally based on various energy indices, initially aimed at reflecting the structure of the gas market in the BUYER's country. One example:



Competing fuels weighting factor in LT pricing



Price Reviews

(Important aspect to cover Price risk)

- ◆ **Price Reviews may be triggered every 3 to 5 years (usually on the 1st of October) by either Party, and shall be justified by:**
 - **A change in the « economic circumstances in the country of the Buyer » ...**
 - **This change shall be beyond the control of the Parties;**
 - **The change shall impact the value of the natural gas in the end user market of the Buyer;**
 - **The Buyer shall always be able to market the gas economically**
- ◆ **Changes taken into account have to occur during the « Reference Period ».**

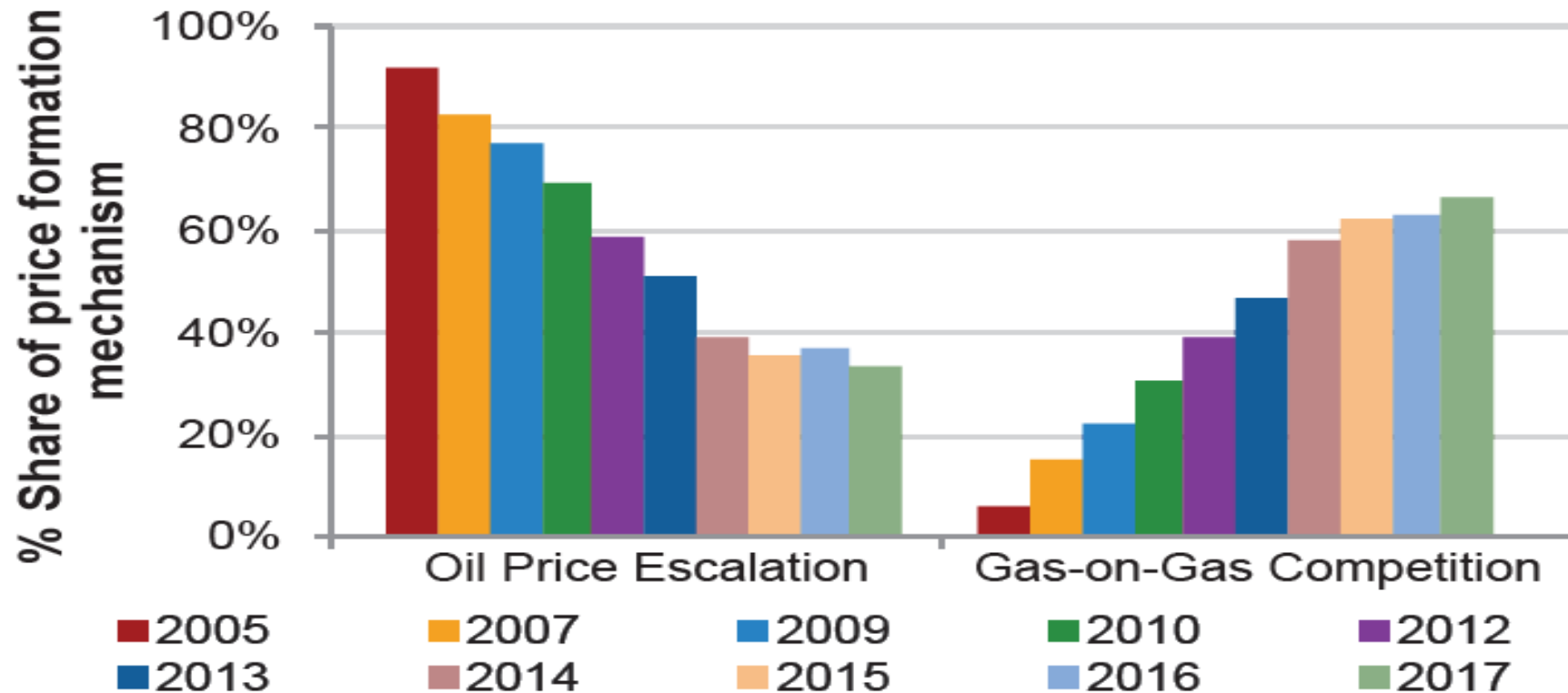


**Gas Price indexation on Oil will become less
and less important in the future**



Weighting Factors are changing upon Time

Example: From 2005 to 2017



Note: Oil Price Escalation = prices linked, usually through a base price and an escalation clause, to competing fuels, typically crude oil, gas oil and/or fuel oil. Gas-on-Gas Competition = prices determined by the interplay of supply and demand – gas-on-gas competition – that are traded at physical or notional hubs.

Sources: IGU Wholesale Gas Price Survey – 2018 Edition

Source: International Gas Union (IGU) 2018



Weighting Factors are changing upon Time Example: From 2005 to 2017

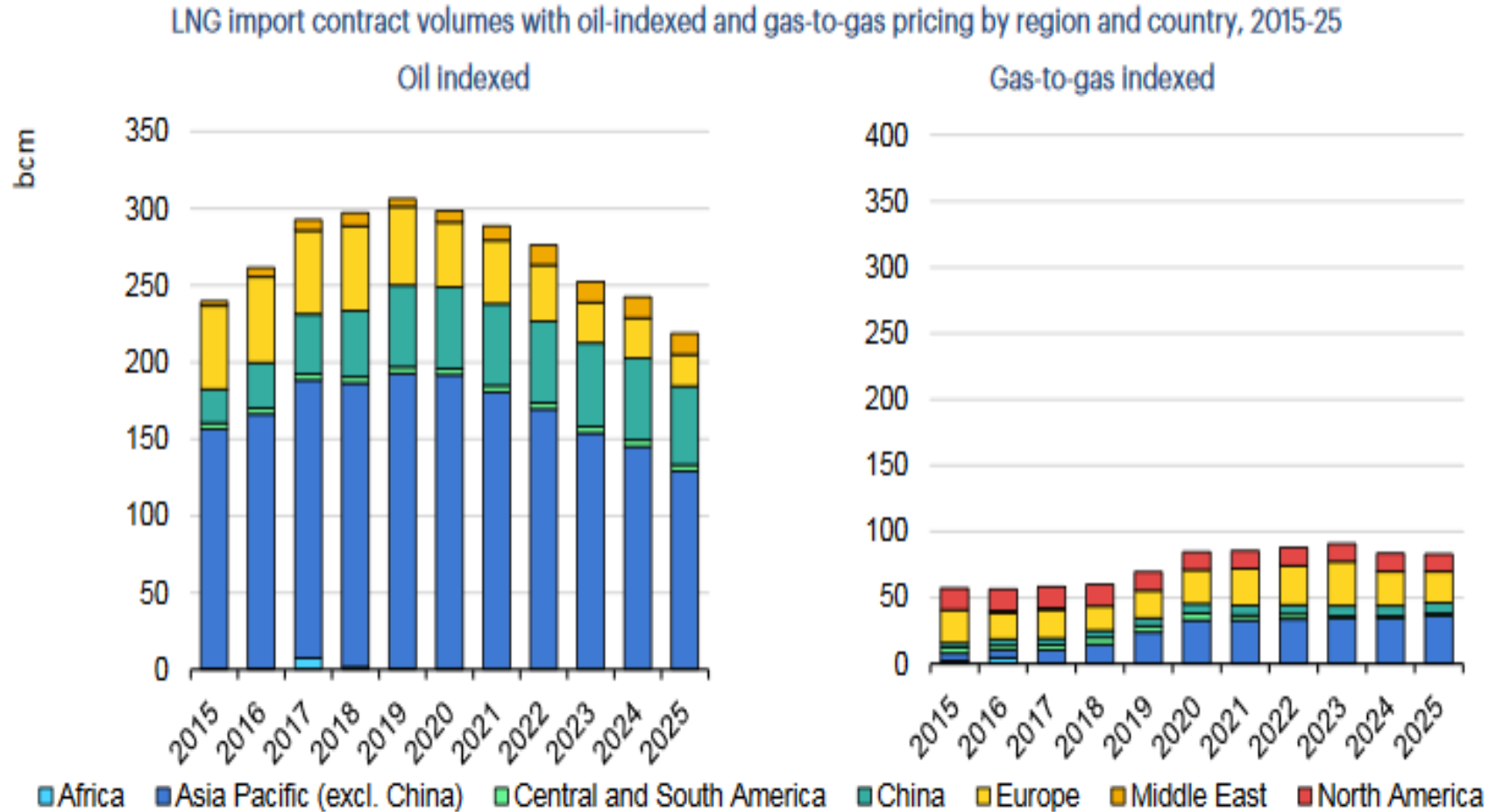


Source: IGU (2018), *Wholesale Gas Price Survey 2018 Edition*.

Gas-to-gas competition increased in most regions with the development of market pricing, especially in Europe where it massively replaced oil indexation.

LNG Import Contracts

Oil – indexed vs Gas – to – Gas Pricing



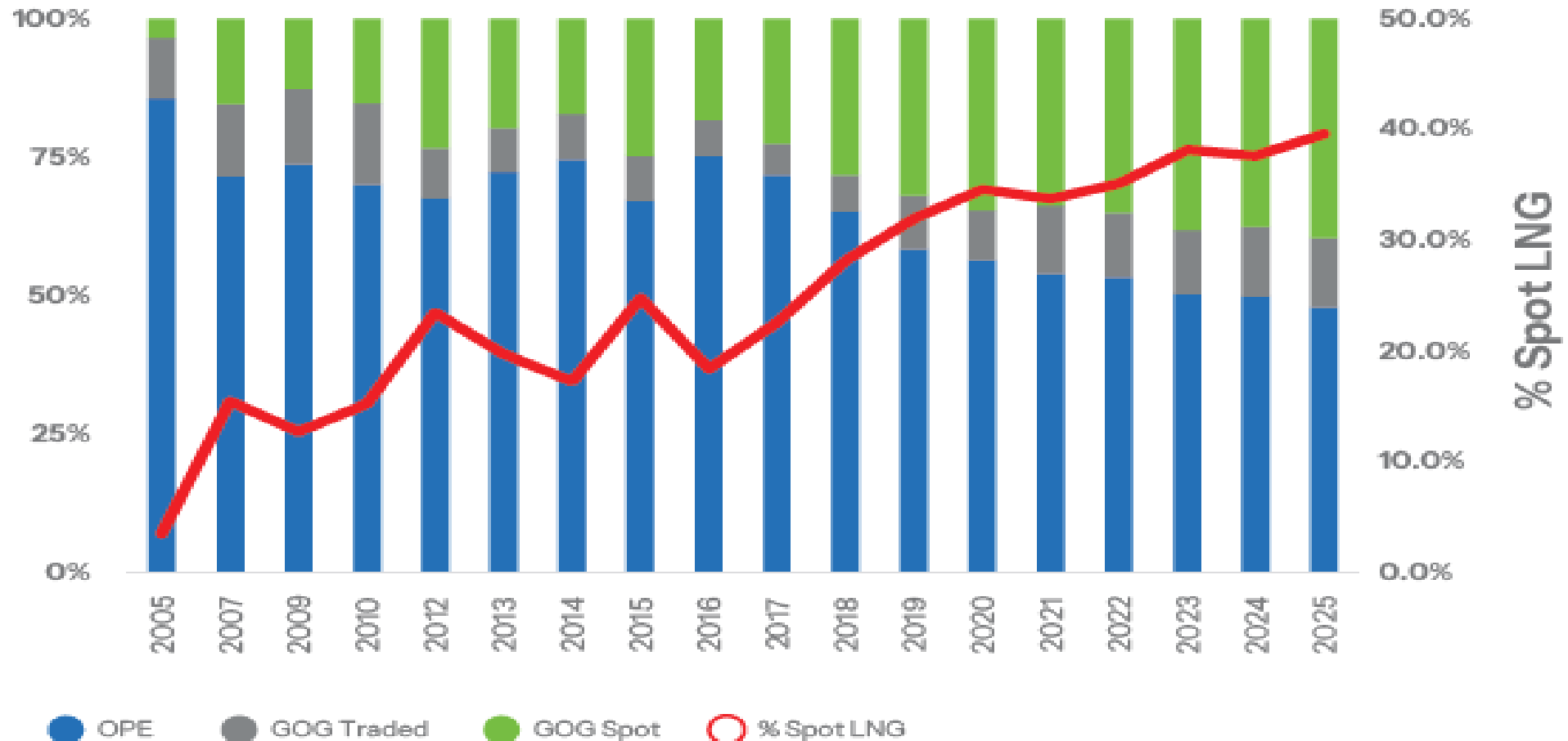
Source: IEA Global Gas Security Review 2020



LNG Import Contracts

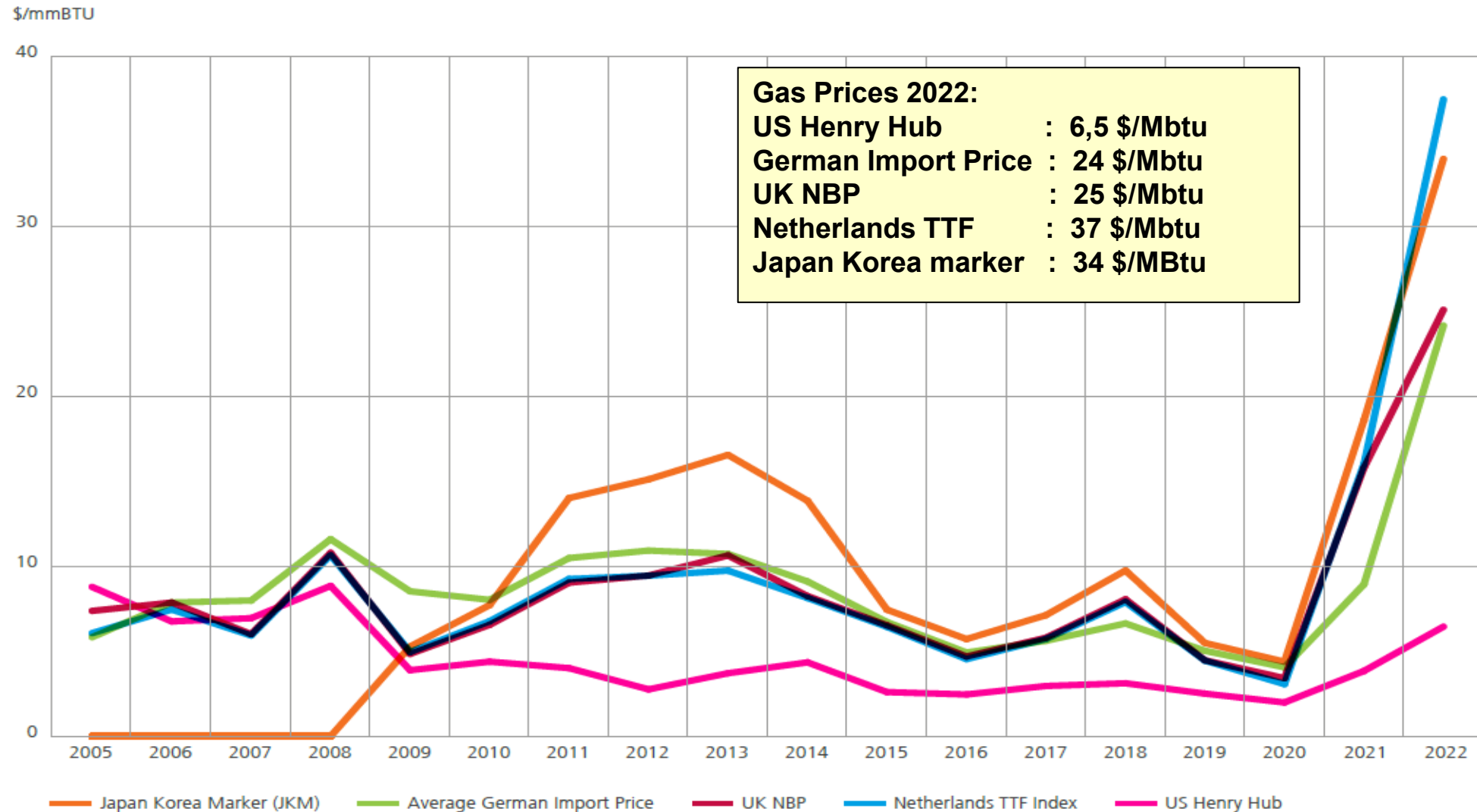
Oil Price Escalation (OPE) vs Gas – on – Gas (GOG) Pricing

Figure 4 - World Price Formation 2005 to 2025 – LNG Imports



Evolution of Natural Gas Prices 2005 – 2022

A huge jump in 2022: Invasion of Ukraine by Russia



Source: EI Statistical review 2023



Evolution of Gas Prices 1984 – 2025

A huge jump in 2022 for Natural Gas & LNG (Invasion of Ukraine by Russia)
followed by a sharp decline in 2023



Natural gas Prices

	LNG US dollars per million Btu						Natural gas US dollars per million Btu				Ammonia \$/mt			
	Japan ¹	South Korea ²	Japan Korea Marker ² (Platts JKM)	China ² (Mainland)	West India marker ² (Platts WIM)	North West European marker ² (Platts NWE)	Zeebrugge ²	UK NBP ³	Netherlands TTF ³	US Henry Hub ⁴	US Gulf Coast ⁵	Northwest Europe ⁵	Middle East ⁶	Far East Asia ⁶
1984	5.10	—	—	—	—	—	—	—	—	—	—	—	—	—
1985	5.23	—	—	—	—	—	—	—	—	—	—	—	—	—
1986	4.10	—	—	—	—	—	—	—	—	—	—	116	88	—
1987	3.35	—	—	—	—	—	—	—	—	—	—	140	102	139
1988	3.07	3.16	—	—	—	—	—	—	—	—	—	130	160	131
1989	3.10	3.22	—	—	—	—	—	—	—	1.70	106	120	75	121
1990	3.49	3.82	—	—	—	—	—	—	—	1.64	118	135	88	153
1991	3.81	3.62	—	—	—	—	—	—	—	1.49	125	139	106	163
1992	3.45	3.49	—	—	—	—	—	—	—	1.77	110	113	86	120
1993	3.37	3.25	—	—	—	—	—	—	—	2.12	128	130	99	129
1994	3.05	2.98	—	—	—	—	—	—	—	1.92	190	185	159	197
1995	3.29	3.50	—	—	—	—	—	—	—	1.69	217	231	191	239
1996	3.47	3.76	—	—	—	—	—	1.87	—	2.76	207	222	175	214
1997	3.70	3.71	—	—	—	—	—	1.96	—	2.53	—	—	—	—
1998	2.92	2.82	—	—	—	—	—	1.86	—	2.08	—	—	—	—
1999	3.01	2.97	—	—	—	—	—	1.58	—	2.27	—	—	—	—
2000	4.48	4.71	—	—	—	—	—	2.71	—	4.23	—	—	—	—
2001	4.39	4.81	—	—	—	—	—	3.17	—	4.07	—	—	—	—
2002	4.09	4.17	—	—	—	—	—	2.37	—	3.33	—	—	—	—
2003	4.57	4.87	—	—	—	—	—	3.33	—	5.63	—	—	—	—
2004	4.94	5.61	—	—	—	—	—	4.46	—	5.85	—	—	—	—
2005	5.79	7.20	—	—	—	—	7.11	7.11	5.81	8.80	—	—	—	—
2006	6.87	8.52	—	3.23	—	—	7.63	7.49	7.26	6.74	—	—	—	—
2007	7.49	8.85	—	3.99	—	—	6.09	5.98	5.90	6.95	—	—	—	—
2008	12.21	12.98	—	5.44	—	—	10.78	10.66	10.67	8.84	—	—	—	—
2009	8.80	10.07	5.28	4.45	—	—	4.84	4.79	4.91	3.92	—	—	—	—
2010	10.54	9.60	7.72	6.20	7.00	7.23	6.61	6.52	6.69	4.38	—	—	—	—
2011	14.37	12.25	14.02	9.07	12.76	10.61	9.14	9.00	9.18	3.99	—	—	—	—
2012	16.17	14.29	15.12	10.77	12.93	10.75	9.39	9.42	9.37	2.75	—	—	—	—
2013	15.54	14.49	16.56	11.15	14.97	12.61	10.52	10.60	10.52	3.72	—	—	—	—
2014	15.74	15.82	13.86	11.76	13.18	10.84	8.13	8.22	8.11	4.34	—	—	—	—
2015	10.12	10.54	7.45	8.66	7.42	6.33	6.41	6.52	6.45	2.61	—	—	—	—
2016	6.77	6.82	5.72	6.54	5.68	4.77	4.50	4.65	4.53	2.81	—	—	—	—
2017	7.85	7.83	7.13	7.33	6.98	5.94	5.66	5.78	5.71	2.96	—	—	—	—
2018	9.74	9.97	9.76	9.43	9.34	7.95	7.84	7.97	7.88	3.12	—	—	—	—
2019	9.75	9.57	5.49	9.15	5.17	4.71	4.39	4.46	4.46	2.51	—	—	—	—
2020	7.64	7.47	4.39	6.73	4.13	3.19	3.07	3.17	3.13	1.99	—	—	—	—
2021	9.90	10.56	18.60	10.66	17.37	16.18	15.57	15.45	15.67	3.84	—	—	—	—
2022	16.86	20.47	33.98	15.58	31.85	32.74	30.96	24.55	37.09	6.38	1174	1242	1043	1000
2023	13.24	15.56	13.77	12.12	13.14	12.25	12.69	12.30	12.87	2.53	507	542	433	501
2024	11.69	11.95	11.91	11.03	11.49	10.74	10.84	10.69	10.89	2.25	489	527	367	417
2025	11.12	10.80	12.16	10.14	11.84	11.42	11.79	11.65	11.89	3.53	509	571	400	363

Gas Prices 2025:

US Henry Hub	: 3,5 \$/Mbtu
UK NBP	: 11,7 \$/Mbtu
Netherlands TTF	: 11,9 \$/Mbtu
Japan Korea LNG	: 12,2 \$/Mbtu
South Korea LNG	: 10,8 \$/Mbtu

¹ Source: EDMC Energy Trend, bp analysis to 1987. From 1988, S&P Global Energy. ©2026 by S&P Global Inc.

² Source: S&P Global Energy. ©2026 by S&P Global Inc.

³ Source: ICIS Heren Energy Ltd to 2004. From 2005, S&P Global Energy. ©2026 by S&P Global Inc.

⁴ Source: US Energy Information Administration (EIA) to 2004. From 2005, S&P Global Energy. ©2026 by S&P Global Inc.

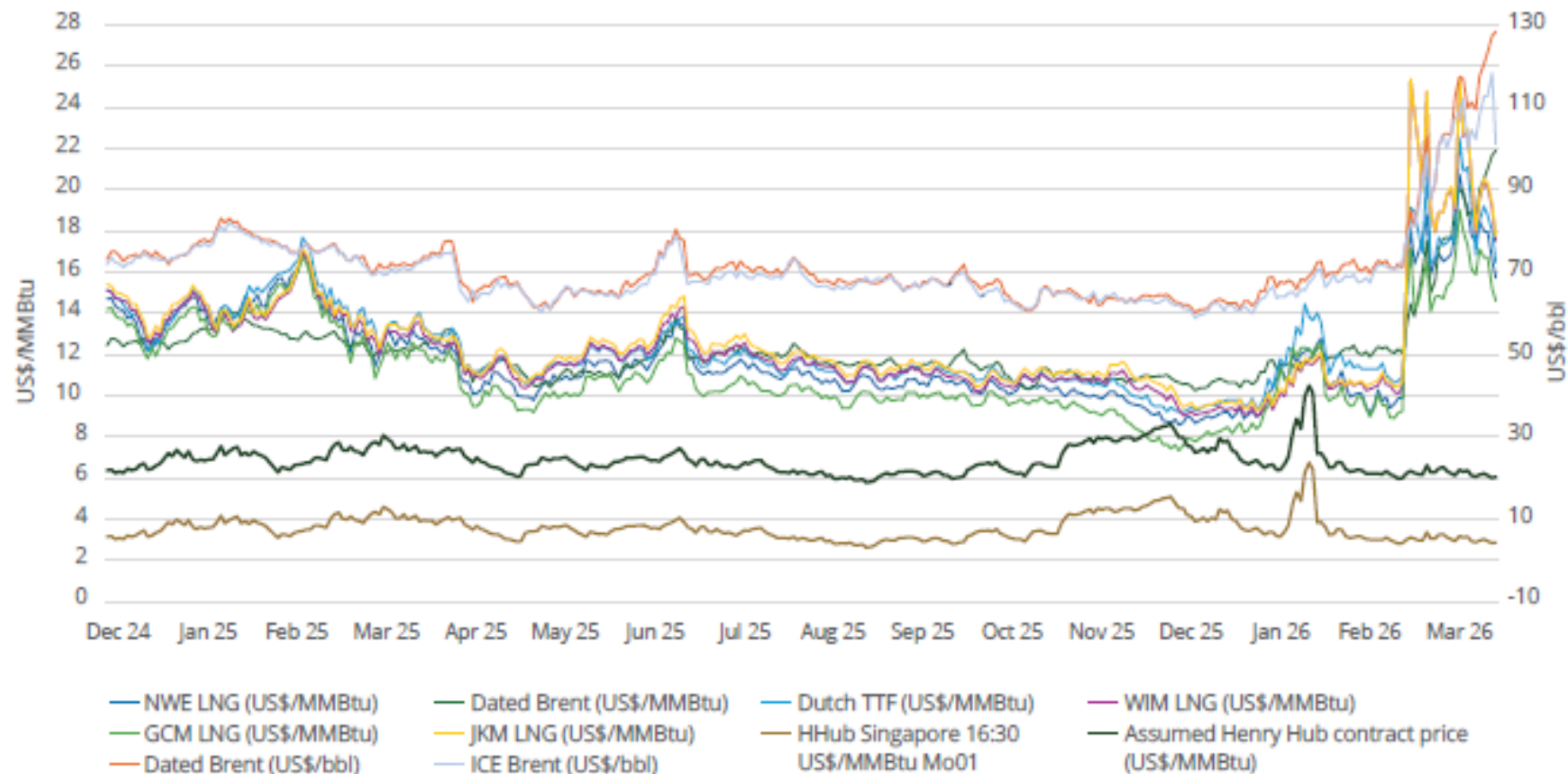
⁵ Source: S&P Global Energy. ©2026 by S&P Global Inc. CFR \$/mt.

⁶ Source: S&P Global Energy. ©2026 by S&P Global Inc. FOB \$/mtt.

Note: cfr = cost+freight (average prices), fob = free on board (average prices)



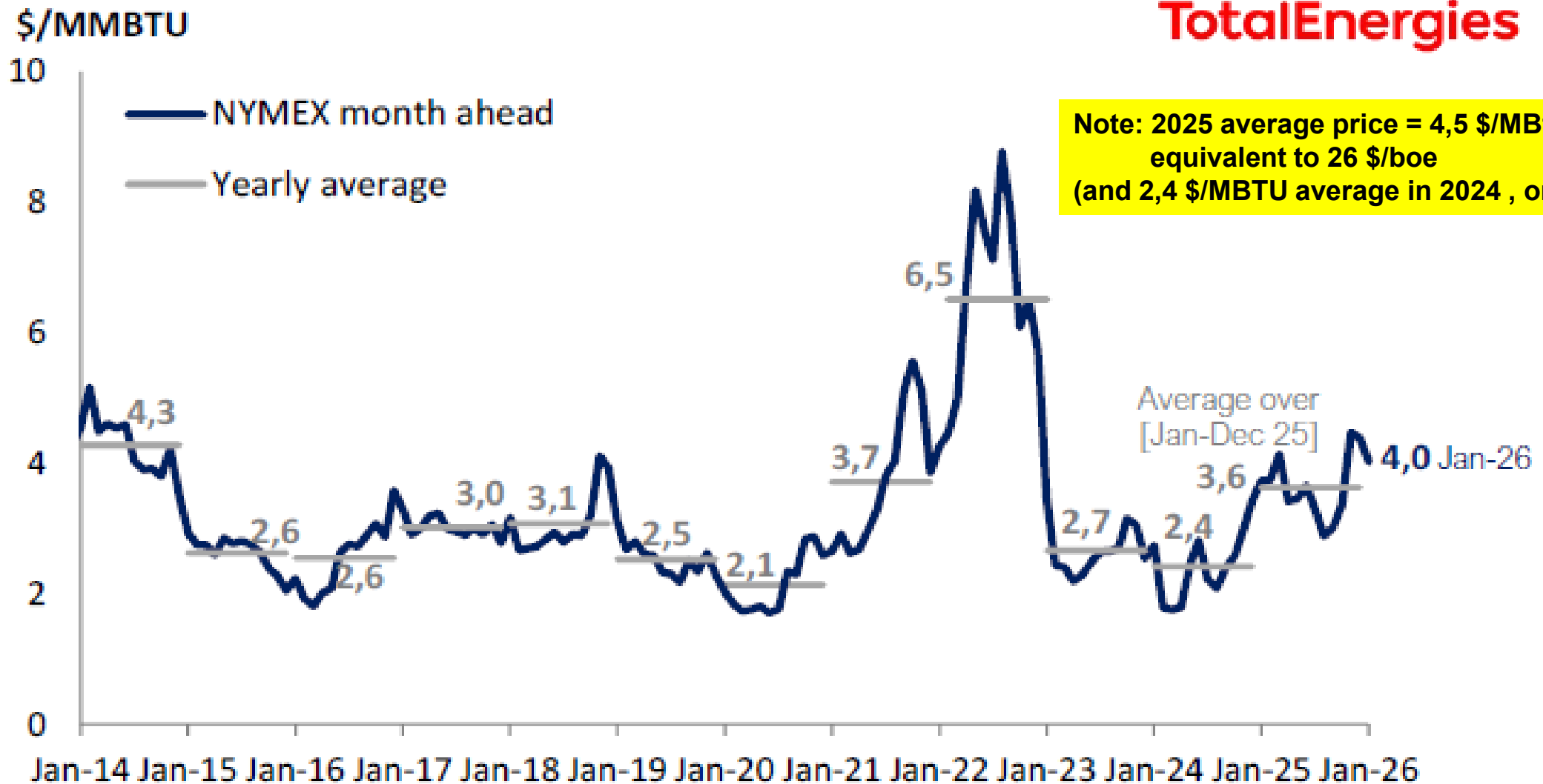
Evolution of Monthly Natural Gas Prices Dec. 2024 – March 2026



Note: Assumed Henry Hub Term Contract Price = $HH \times 115\% + US\$2.75/MMBtu$

Source: S&P Global Energy

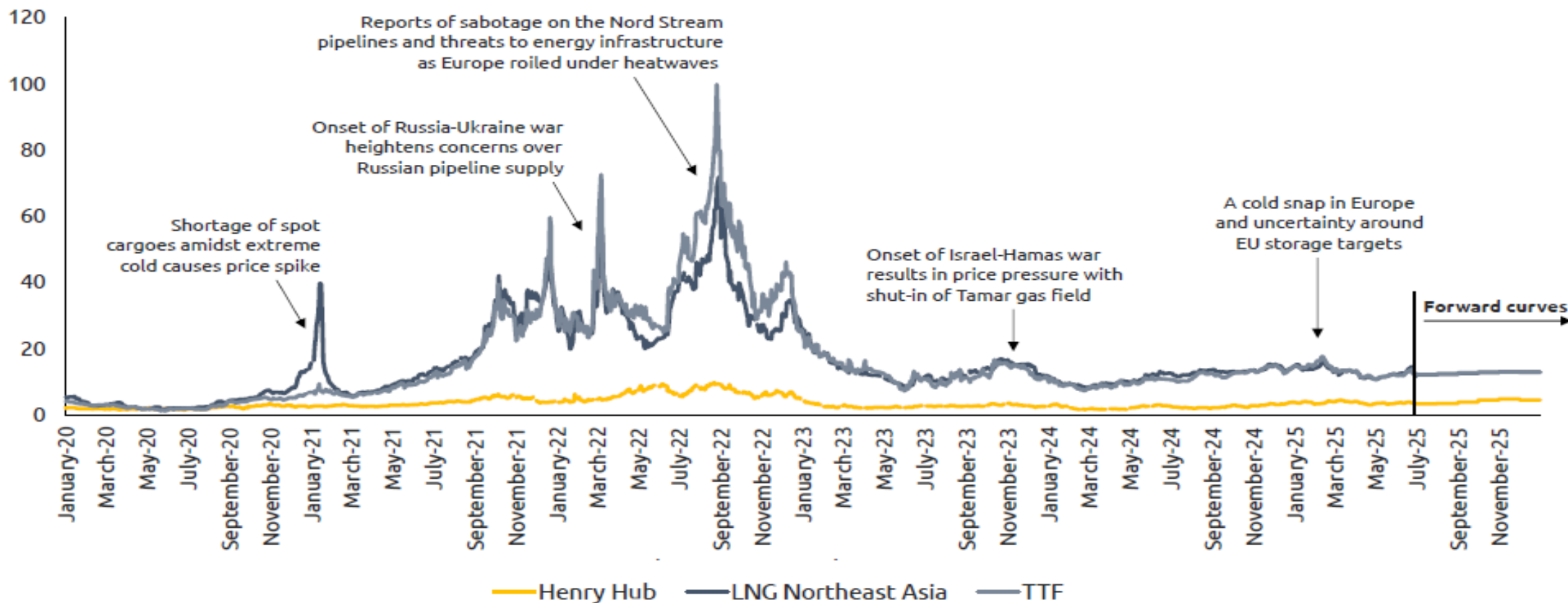
Henry Hub Prices (US Gas Price Reference) - 2014-2026



Natural Gas Pricing Jan. 2020 – Nov. 2025

Record Lows in 2020 due to Covid. Peak at # 100 \$/Mbtu (# 600 \$/b) in September 2022!

USD (real) per MMBtu



Note: Forward curves outline Futures contract pricing for each benchmark and are not a forecast.

Source: Rystad Energy, Argus (LNG Northeast Asia)

Source: International Gas Union (IGU) Global Gas Report 2025
/Rystad Energy

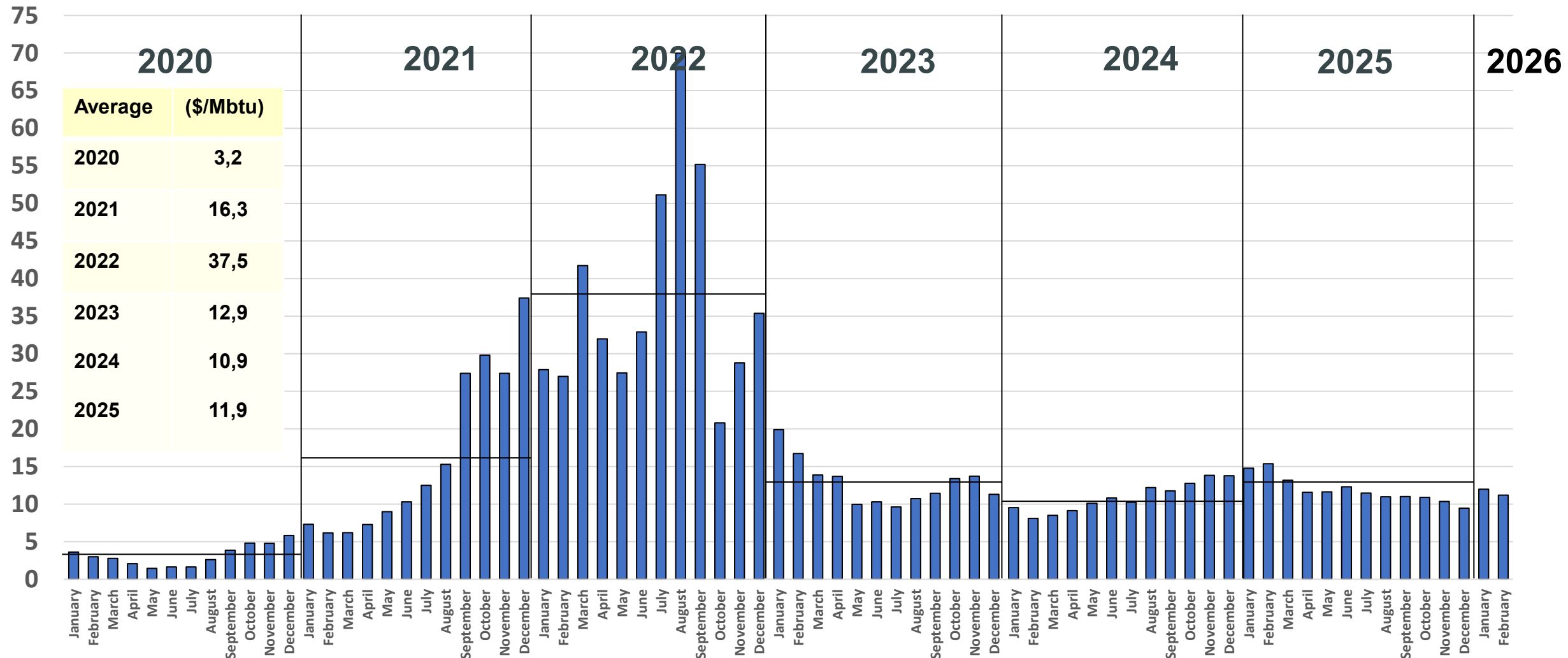


Gas & Electricity Prices evolution in Europe 2020 - 2025



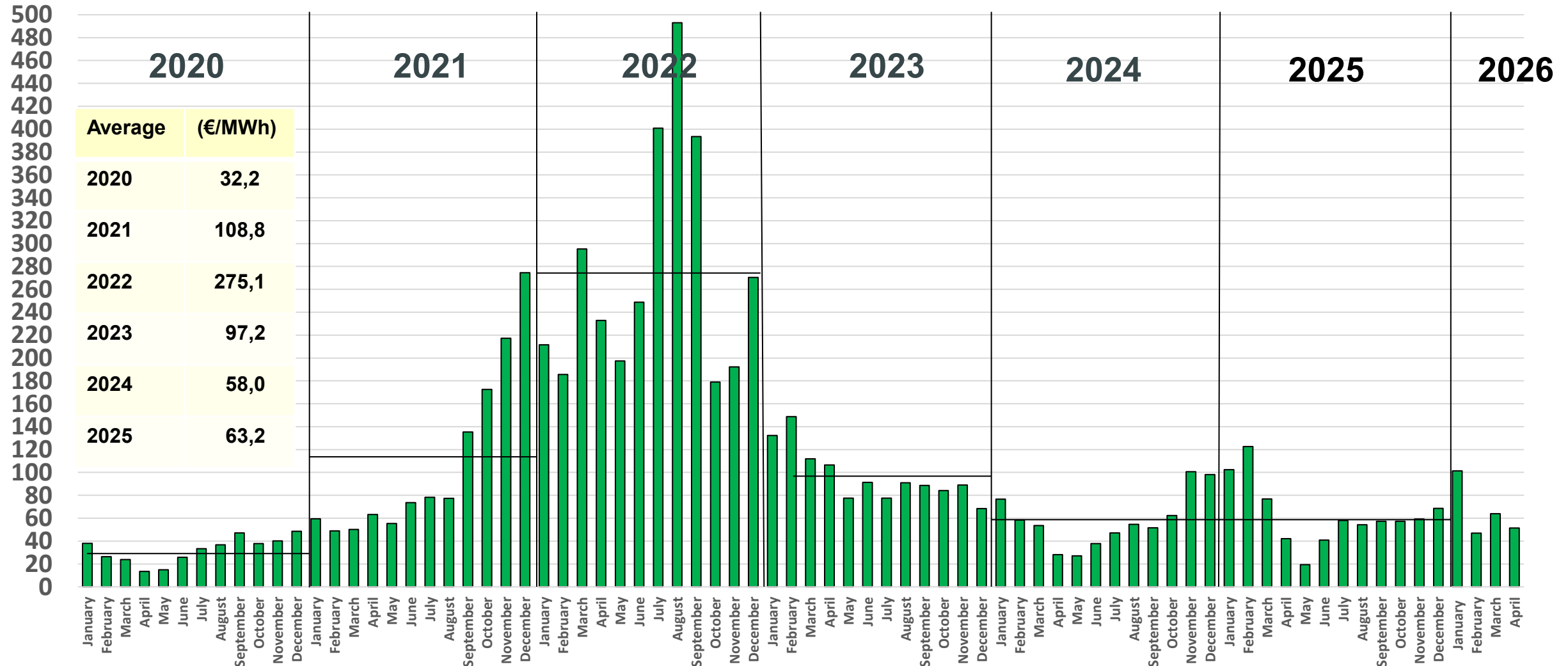
Monthly German Border Gas Prices Evolution 2020 – 2025 (\$/Mbtu)

The impacts of economic & geopolitical turmoils are great



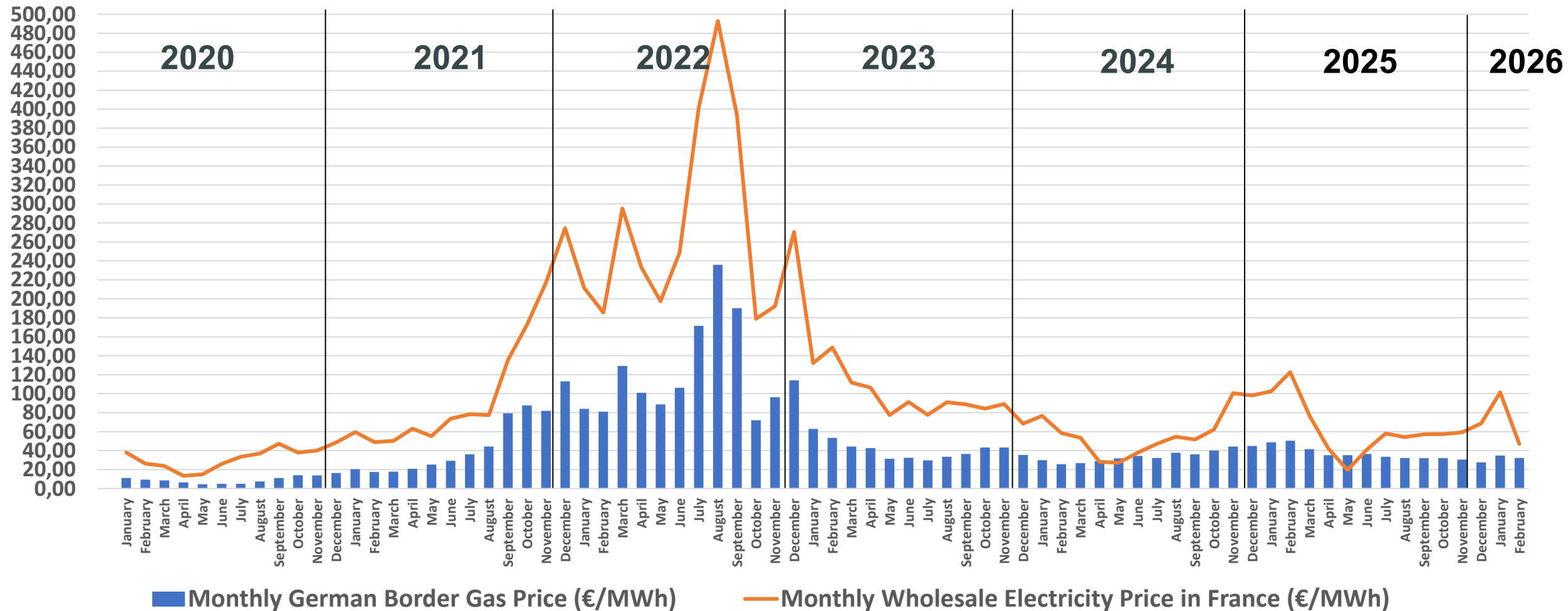
Monthly Wholesale Electricity Prices France 2020 – 2025 (€/MWh)

The impacts of economic & geopolitical turmoils are great



Strong correlation Electricity Price/ Gas Price in Europe (€/MWh)

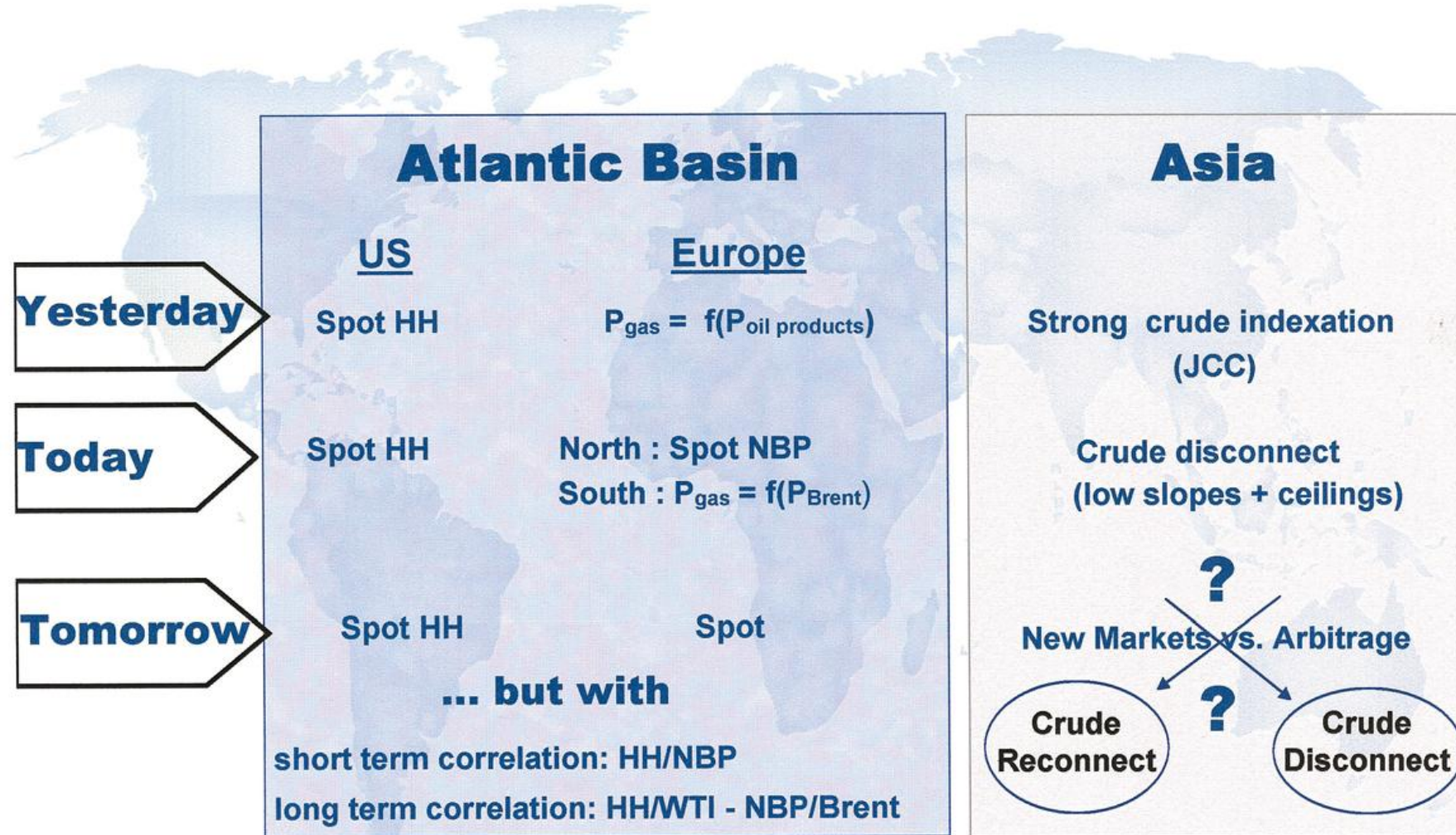
The impacts of economic & geopolitical turmoils are great



Source: Ch.Guérutte/Data from Ember, IMF
Exchange Rate: FRED, US Fed. Reserve system



LNG Price indexation: markets' trend



IEA 2025 Gas & Fuel Prices vs Scenarios

USD (MER, 2024)	2024	CPS		STEPS		NZE	
		2035	2050	2035	2050	2035	2050
IEA crude oil (USD/barrel)	79	89	106	80	76	33	25
Natural gas (USD/MBtu)							
United States	2.2	4.5	5.0	3.9	4.6	2.1	2.2
European Union	10.3	9.1	10.6	6.5	8.4	4.2	4.0
China	10.3	9.9	11.2	7.5	9.1	4.9	4.8
Japan	13.5	11.2	12.9	8.4	9.7	4.9	4.9
Steam coal (USD/tonne)							
United States	56	56	53	41	41	25	23
European Union	112	92	82	78	66	47	39
Japan	151	112	105	100	84	57	49
Coastal China	131	115	105	99	84	59	49

Notes: CPS = Current Policies Scenario; STEPS = Stated Policies Scenario; NZE = Net Zero Emissions by 2050 Scenario. MER = market exchange rate; MBtu = million British thermal units. The IEA crude oil price is a weighted average of import prices among IEA member countries. Natural gas prices are weighted averages expressed on a gross calorific-value basis. The US natural gas price reflects the wholesale price prevailing on the domestic market. Natural gas prices in the European Union and China reflect a balance of pipeline and liquefied natural gas (LNG) imports, while the Japan gas price is solely for LNG imports. LNG prices are those at the customs border prior to regasification. Steam coal prices are weighted averages adjusted to 6 000 kilocalories per kilogramme. The US steam coal price reflects mine mouth prices plus transport and handling costs. Coastal China steam coal price reflects a balance of imports and domestic sales, while the European Union and Japanese steam coal prices are solely for imports. Wholesale prices exclude any emissions pricing applied at the point of use.



Evolution of national gas markets towards liberalization & globalization The History



TABLE OF CONTENTS

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3. Conventional and Unconventional Gaseous Hydrocarbons
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6. A zoom on Liquefied Natural Gas (LNG)
7. Three independant world markets
8. The gas chain components and their economics: Production & Processing
9. The gas chain components and their economics: Transportation
10. The gas chain components and their economics: Storage
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14. Example of challenging gas projects: Shtokman & Yamal

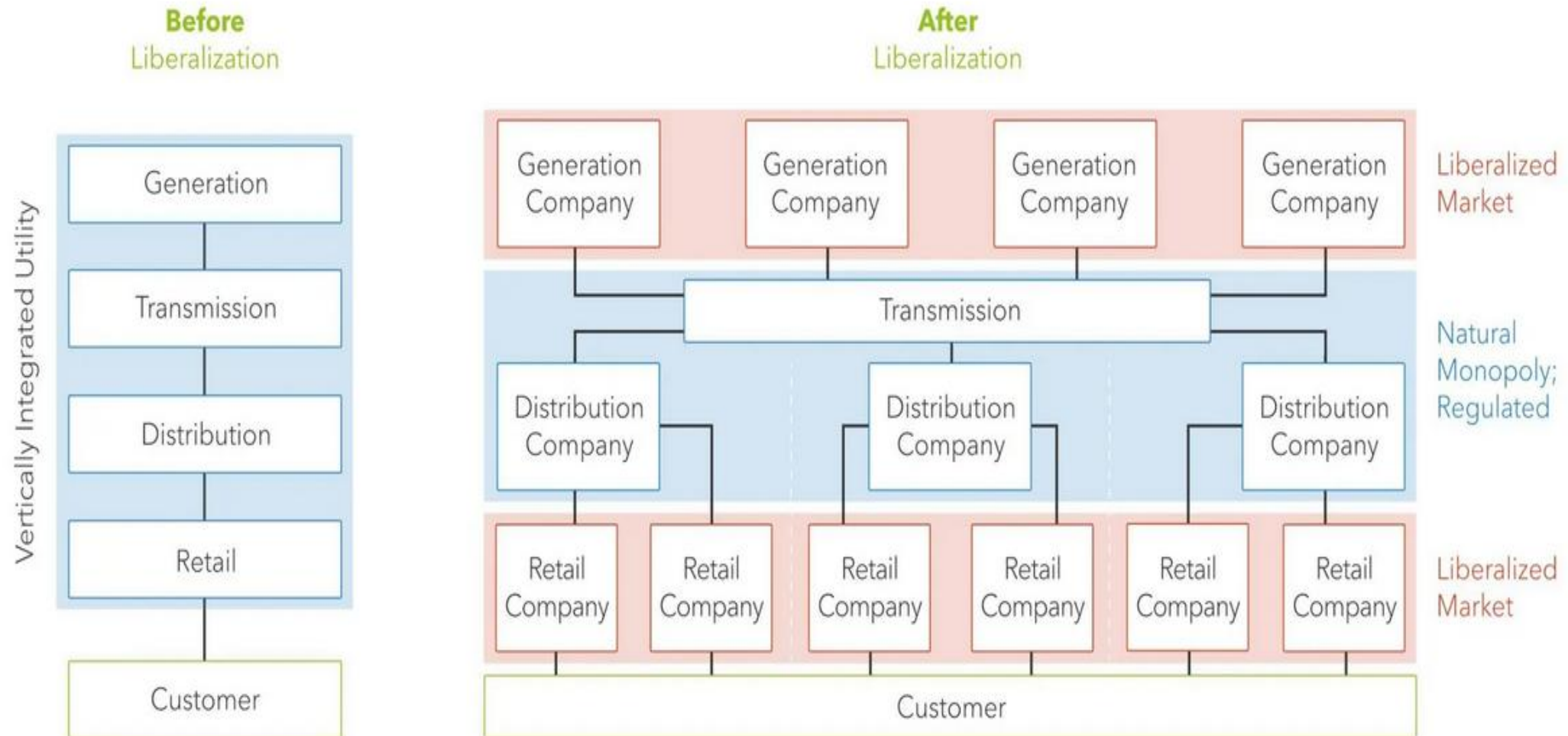


Liberalization of the Energy Markets

- The liberalization of the Energy Market means the **opening of the Electricity and Gas Market to free competition**. This has broken up existing monopolies and opened the market to more participants.
- In most cases, liberalization was accompanied by **unbundling**, which made a distinction between generation, transmission and distribution/retail in the Energy sector. The aim was to make Electricity supply more efficient by integrating competitive forces where possible and by integrating regulation where necessary.
- **In Europe, liberalization began in 1996** with the adoption of the first European Directive. The legal basis of the liberalization and harmonization of the EU internal energy market is the **Treaty on the Functioning of the European Union (TFEU)**. The aim was to create one single integrated internal European Electricity Market across all EU member states to reduce overall grid costs and benefit from synergies in the security of supply.
- The process is a long one. During the following decades, the regulations on liberalization of Energy markets were reinforced with the second Directive and later the 3rd revision of the Energy package and the Energy Union Winter Package, which strives to achieve a **fully-integrated, further decarbonized electricity market and ensures security of supply through solidarity and cooperation between EU member states**.



Liberalization of the Energy Markets



Evolution of national Gas Markets towards liberalization & globalization The History



Markets liberalization and globalization: what are the key differences between Oil and Gas & Electricity ?

Oil and Gas can be qualified as Primary Energies. Electricity is not a Primary Energy, it is produced through industrial tools: power plants, solar farms, wind farms,....

Oil

- ◆ Is a concentrated form of energy: twice more energy per cubic meter or per ton than most powerful explosives.

Gas

- ◆ Is a diffuse form of energy: thousand time less energy than oil per normal cubic meter... but nearly same energy amount per ton.

Oil

- ◆ Is liquid, therefore easy to handle through interruptible and flexible chains.

Gas

- ◆ Is gaseous, therefore difficult to handle and requires practically non interruptible and rigid chains.



Fundamental consequences for Gas Economics and Gas Marketing

MAJOR CHALLENGE

- ❑ How to « concentrate » the diffuse energy of natural gas, i.e
- ❑ How to increase its volumic energy density:
 - ❑ Pressure (practical range from 70 to 200 bars)
 - ❑ Temperature (liquefaction at -160°C)
 - ❑ Chemical processes (methanol, ammonia, GTL)
- ❑ MAJOR CONSTRAINT
- ❑ Whatever type of « concentration technologies » is used, on average Gas logistics are more than five time more costly (per unit of energy) than Oil products logistics.



Oil and Gas Markets: how do the fundamental differences impact liberalization and globalization ?

- ❑ Because costs for Gas logistics are five times higher than for oil:**
 - ❑ Natural monopoly is a far more important phenomenon for Gas than for Oil**
 - ❑ Markets liberalization is far easier for Oil**
 - ❑ Market globalization is also far easier for Oil**
- ❑ For Oil the FOB versus CIF value difference is small, making market globalization easy (including pricing).**
- ❑ For Gas the FOB versus CIF value difference is high, making market globalization difficult (including pricing).**
- ❑ Similar differences impact the whole « value chains » for Gas versus Oil.**



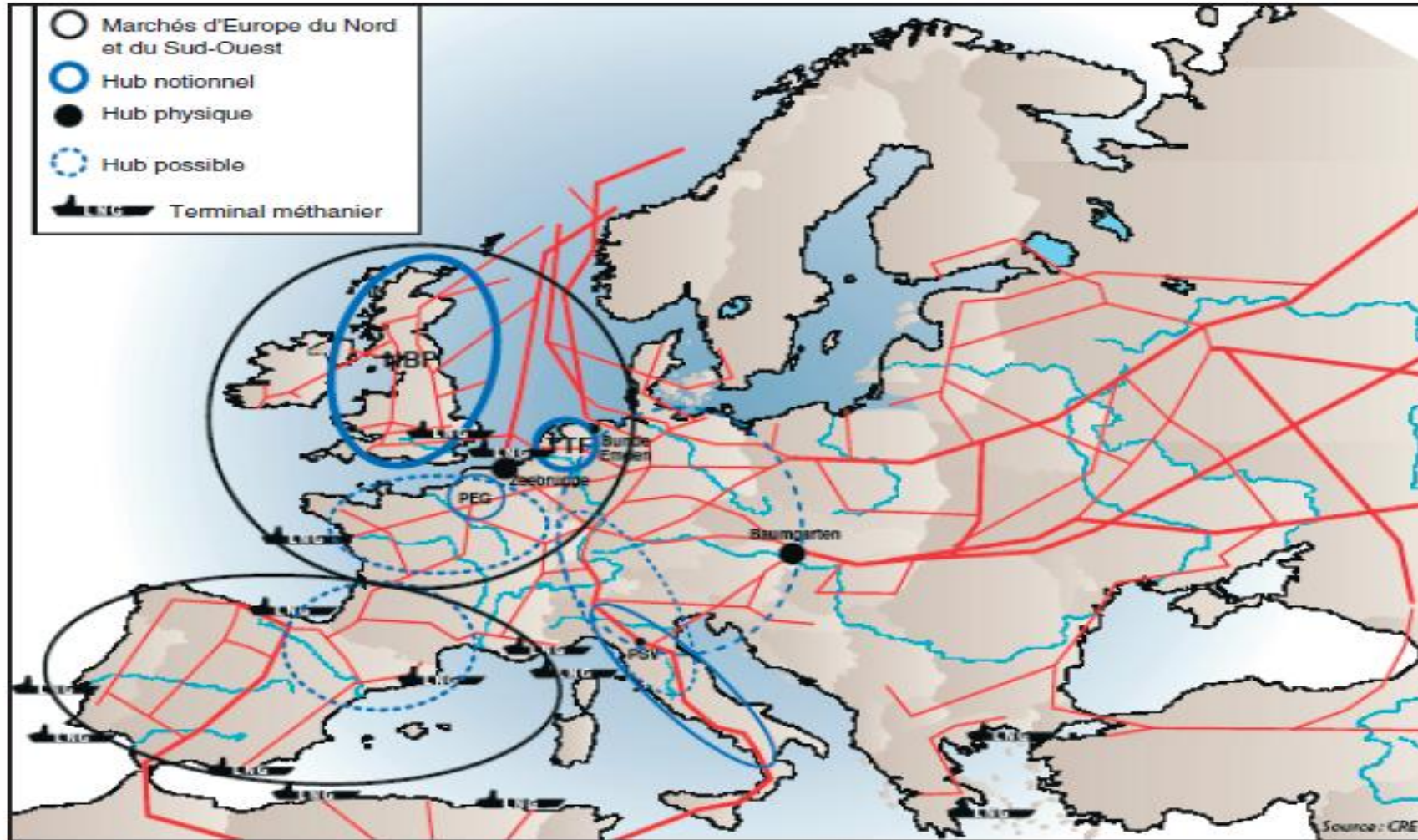
Oil and Gas markets: the fundamental differences on economic values and therefore on pricing

- ❑ Gas is fully substituable for all its Markets... while Oil is not: this is the key point about their respective economic values and pricing systems.**
- ❑ Gas can enjoy premiums on certain specific Markets (Electricity generation, domestic usages, clean industries...) but can always be substituted by oil products (ceiling value: LPG's or light distillates... or $\pm 150\%$ Oil parity).**
- ❑ Oil has 70% of its markets « not substituable »: 50% for transports, 10% petrochemicals, 10% others. « Not substituable » is an easy word for « very difficult to substitute » (i.e. substitution only possible at very high cost and with a long lead time).**



Main Gas Infrastructures in Europe

A dense, heavy, interconnected industrial network

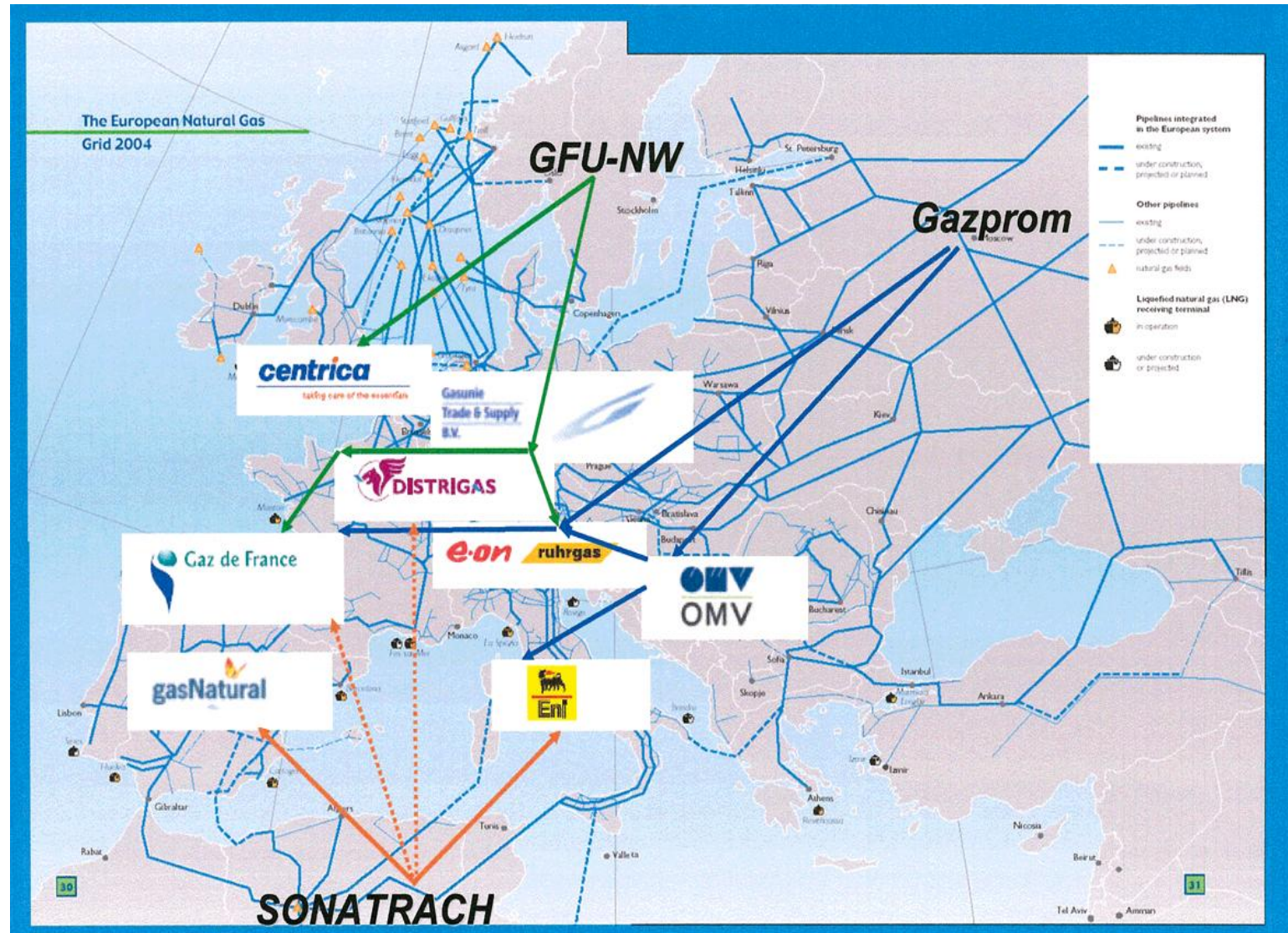


An example of Gas Market liberalization: the European Union

- ❑ The historic background**
- ❑ The basic reasons for change**
- ❑ The rules yesterday, today and tomorrow**
- ❑ The challenges and potential risks**



Pre-opening organisation: the Gas Club



Note: GFU has been dissolved since year 2000

Gas infrastructure = Natural monopolies

**BUILDING =
DISTURBANCES**
(Ex = Road , River
crossings)

**HUGE
INVESTMENTS**

**SAFETY
ISSUES,
permanent
Right Of Way**



To build to the *minimum* required

To use to the *maximum* extent

**To grant building and operations to qualified and
experienced companies**



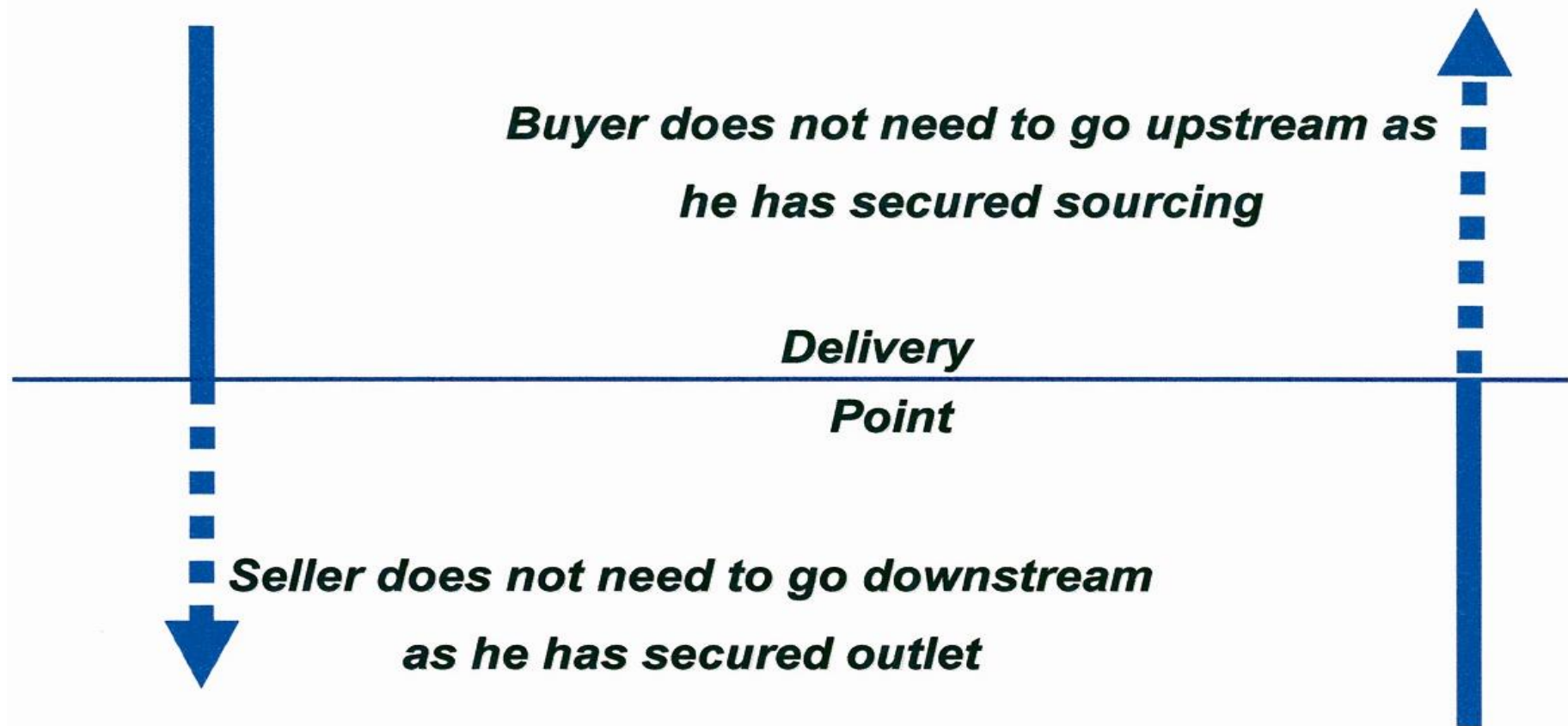
Monopolies: a variety of historical situations

- ❑ **Seller or Buyer is a state company:**
 - ❑ **Gaz de France (now ENGIE), British Gas**
- ❑ **Seller or Buyer is a private company with a monopoly granted by the State:**
 - ❑ **Gasunie, Distrigaz**
- ❑ **Monopoly may cover:**
 - ❑ **A geographical area where gas company has an exclusive right to sell gas (national borders, demarcation areas in Germany)**
 - ❑ **A class of customer (Gasunie, SNAM)**
 - ❑ **Both as was the case for GSO (Gaz du Sud-Ouest) and CFM (Compagnie Française du Méthane) in France.**



Long term contracts = Vertical integration

The key to the «gas club» success story



Life was simple... why did we change a system which worked well ?



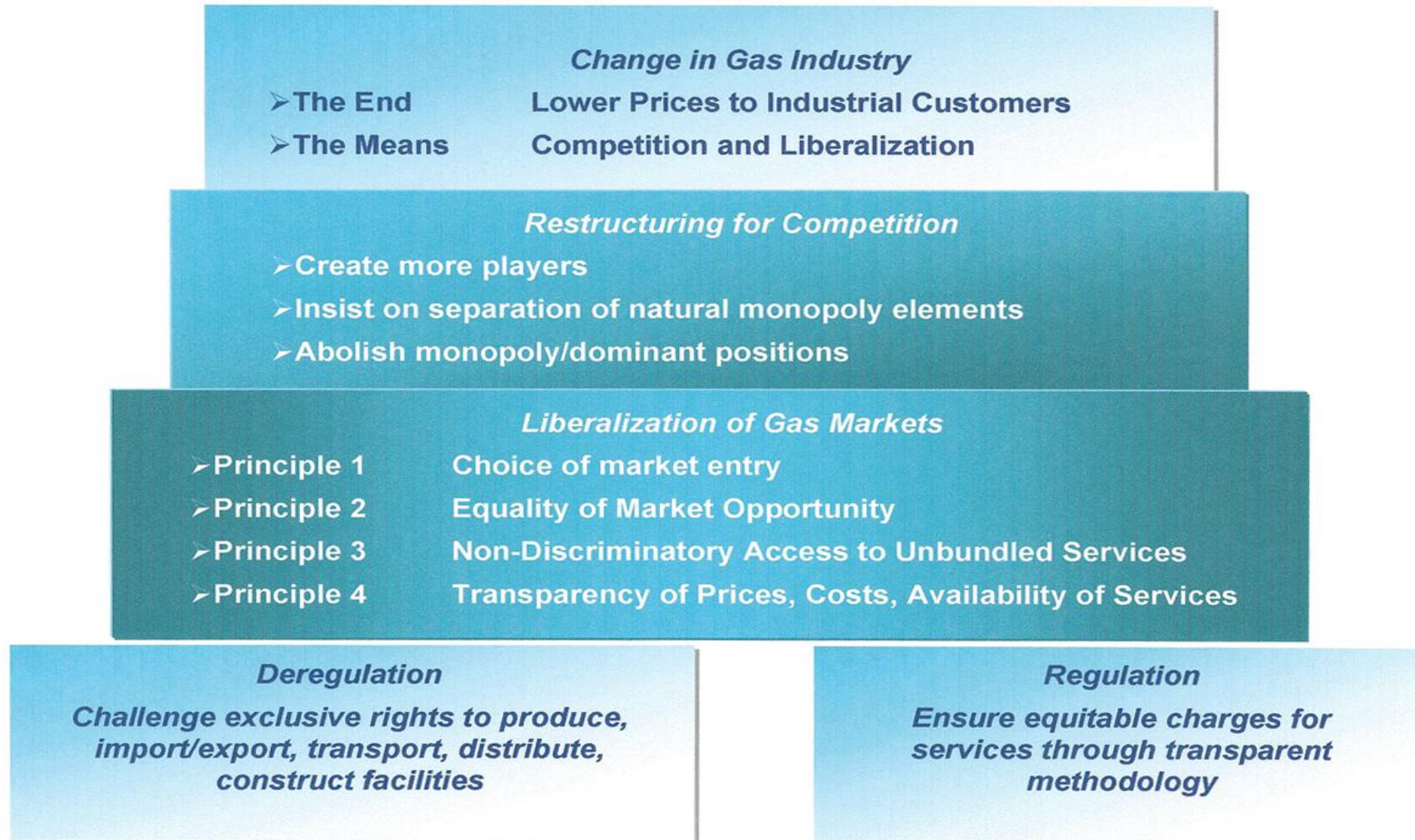
Reasons for change

- ❑ **Post war organization in infringement of EU Treaty:**
 - ❑ **EU / Rome Treaty (Article 81 and 82) deals with competition rules:**
 - ❑ **People and goods shall move freely within EU, without any restriction or barrier. No competition distortion.**
- ❑ **Progress achieved in the development of the EU Gas Market (see above) no longer justify such exemption.**
- ❑ **Merchant monopolies may abuse of their exclusive position.**

CHANGE DRIVEN BY POLITICAL CONSIDERATIONS

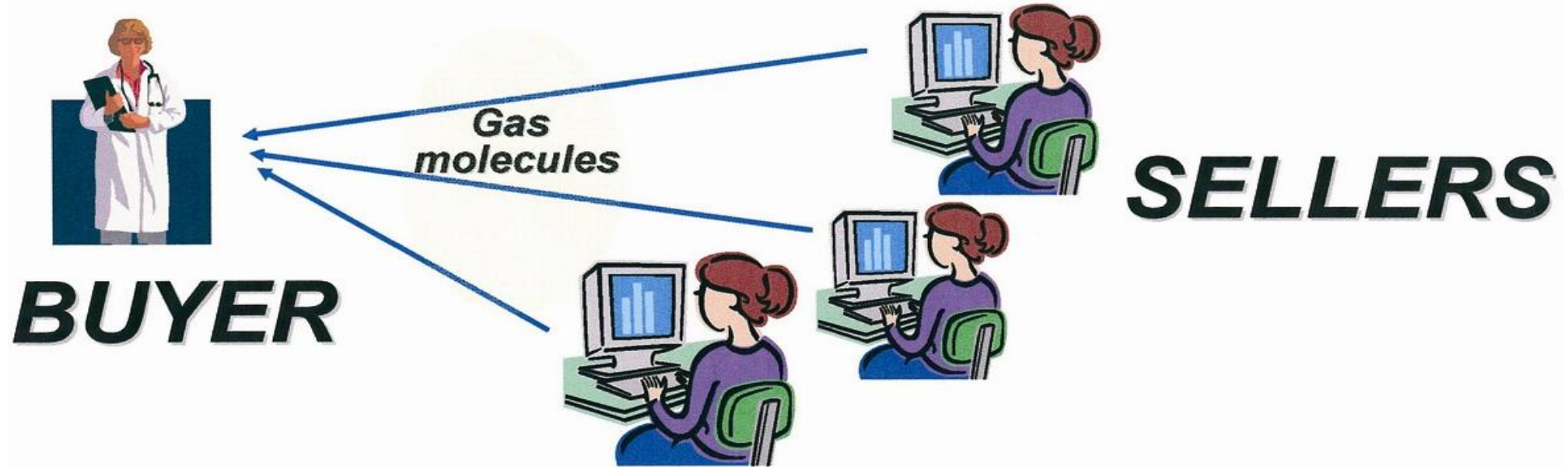


Evolution of Natural Gas markets towards liberalization



Changes

Nothing better than competition to drive price down when it is feasible !



And to keep control on costs when it is not :



Third party access: a revolution !

If competing sellers are to reach one buyer through the same Gas infrastructure, they should be allowed to get access to such infrastructure



Third Party Access: a revolution !

- ❑ To define *available capacity* (not contracted... or not used?).
- ❑ To define *rule of access* (First come - first served, pro-rata, priorities).
- ❑ To define *rule of use* (Communications, Nominations, Quality issues, Balancing)
- ❑ To define *tariffs* (Point to point distance related, entry - exit, post stamp - related to capacity booked only or to capacity booked plus use of such capacity)

A totally new concept for Gas companies who, prior market opening, were sole users of their grids and did not accept third party to ship as in their grids



Access

❑ GRIDS and LNG:

- ❑ Conditions of access and use, and corresponding tariffs are **REGULATED**
- ❑ A regulator has to approve contractual conditions and tariff and tariff methodology is to be published.

❑ STORAGE (+ Line pack and ancillary services)

- ❑ Conditions of access and use, and corresponding tariffs are **NEGOCIATED.**
- ❑ SSO has to publish the main commercial conditions for the use of the storage.

Access must be transparent and non-discriminatory.

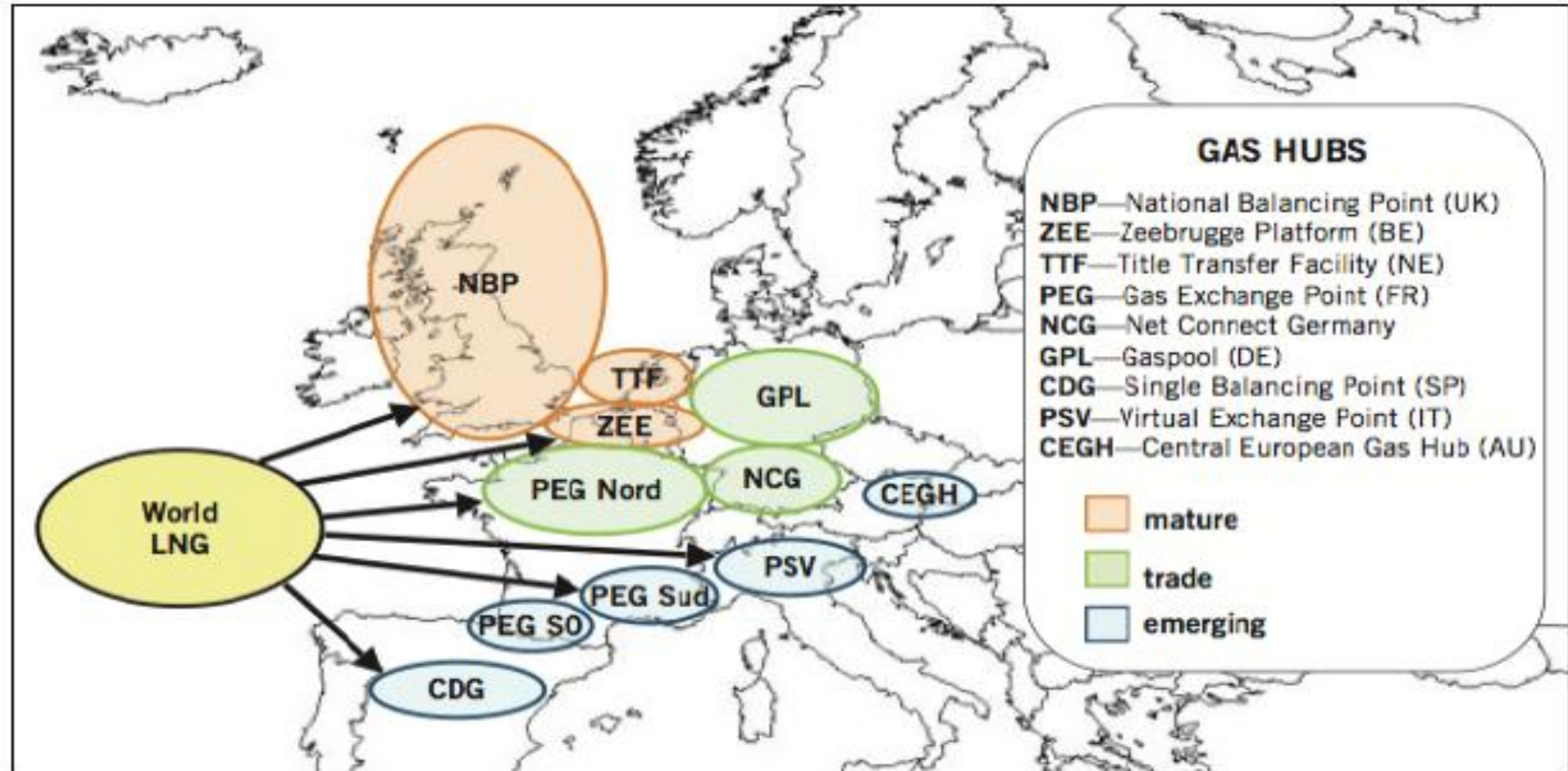


Control

- ❑ **Creation of national regulators for:**
 - ❑ **Regulating access to grids / LNG facilities**
 - ❑ **Addressing complaints against the natural monopolies by shippers who claim to suffer from discrimination, lack of transparency.**
- ❑ **Unbundling of activities along the gas chain**
 - ❑ **Legal unbundling: Transmission system and Distribution system operators shall be each independent in term of legal form, organisation and decision making process from the other parts of a vertically integrated gas company.**
 - ❑ **Account unbundling: Separate accounts shall be kept for each of Transmission, Distribution, Storage and LNG activity.**
 - ❑ **Ownership unbundling.**



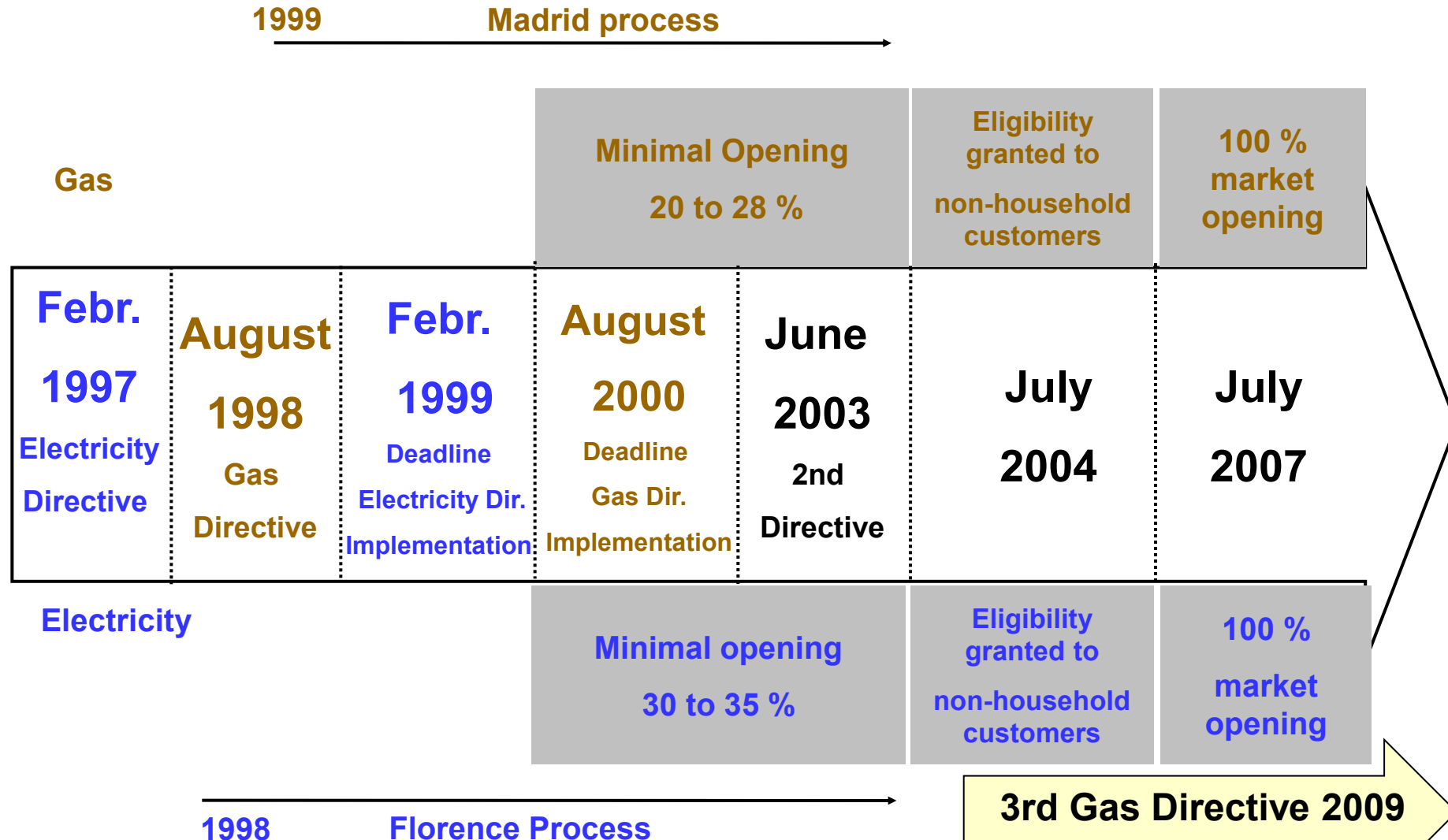
European Gas Hubs



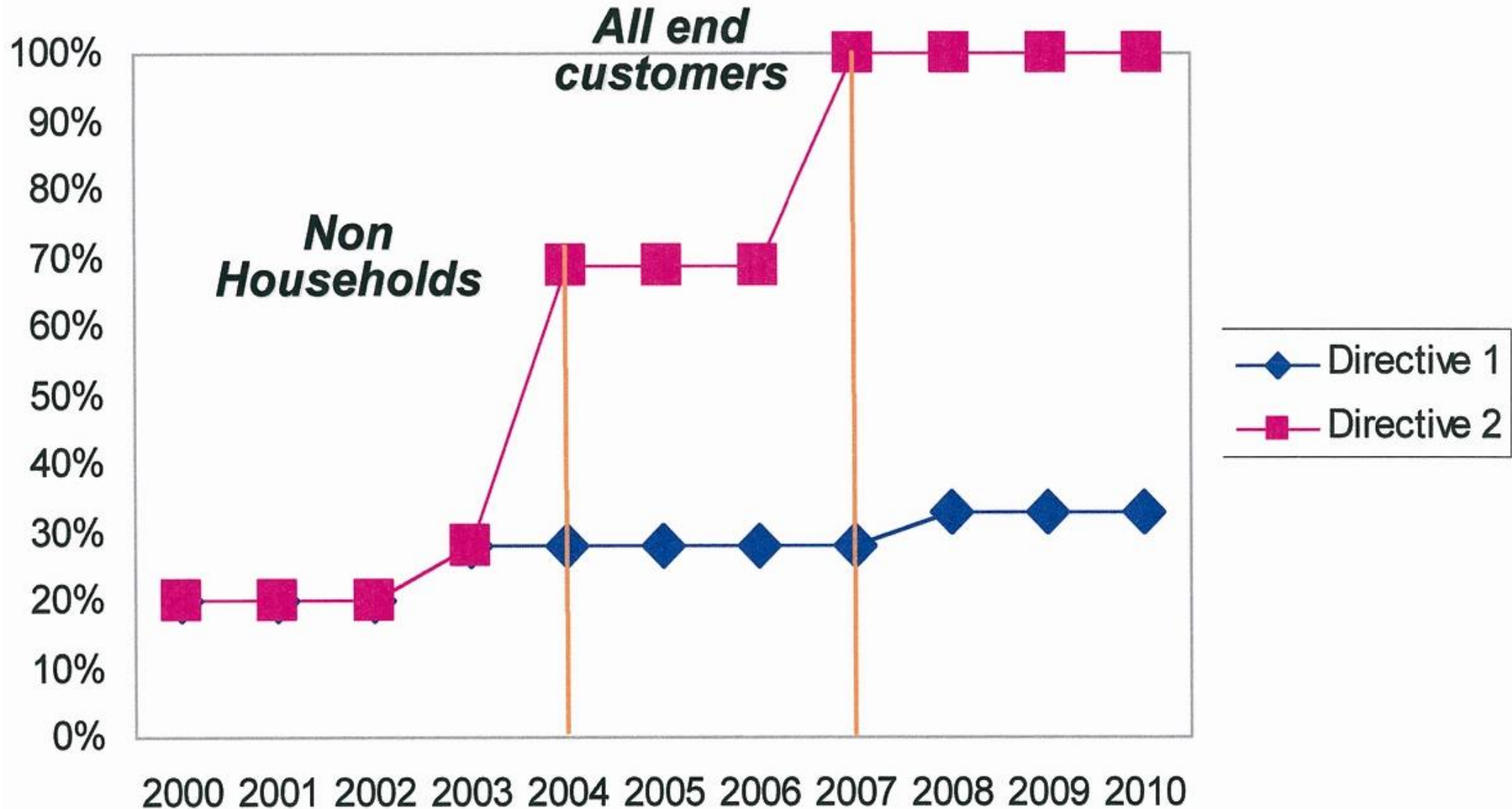
Source: (Melling, 2010)



Market liberalization - European schedule



Eligibility: the whole market at 01/07/2007

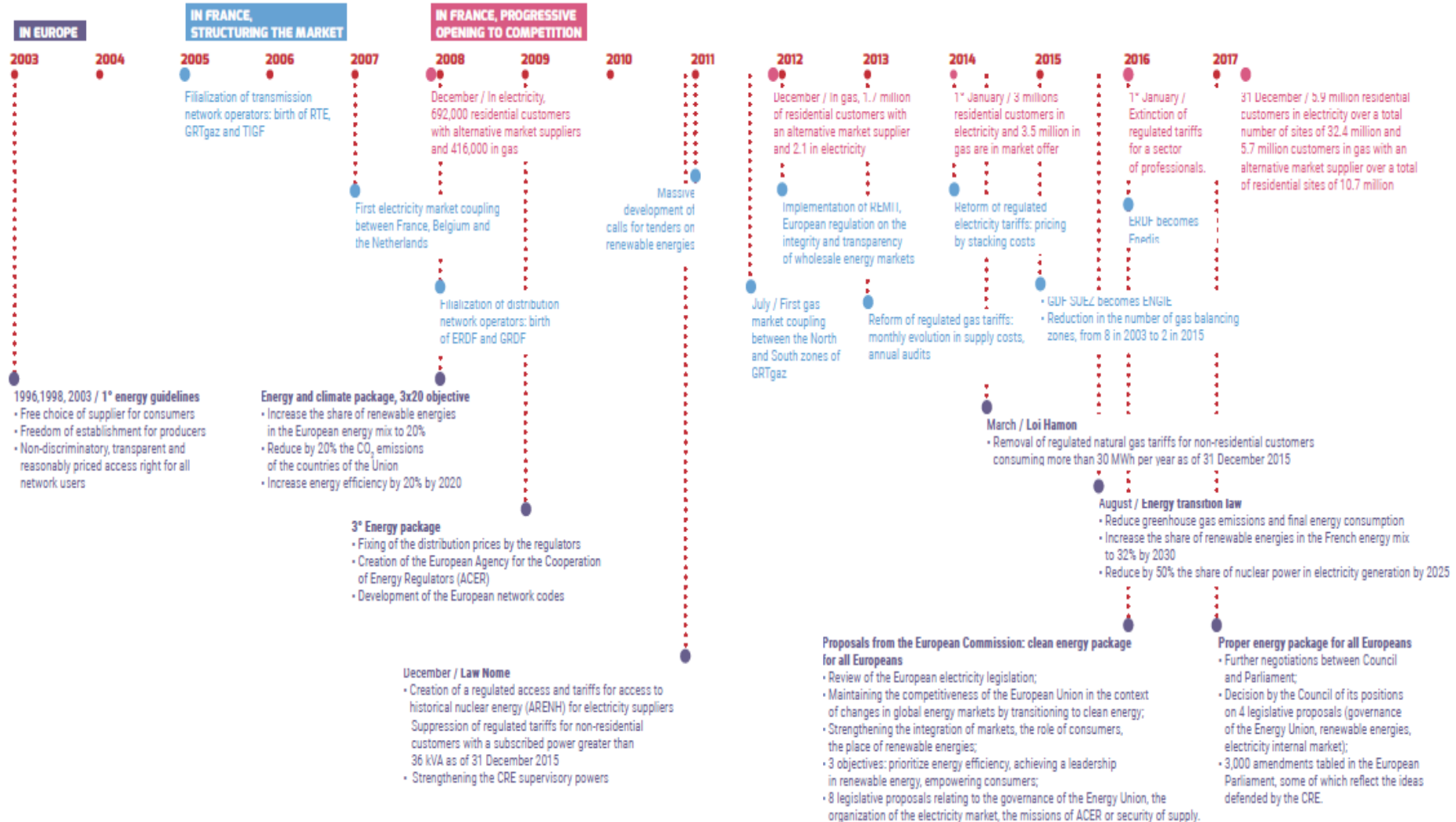


Regulators in the EU

United Kingdom	OFGEM : Office of Gas and Electricity Markets Indépendant (ATR)
France	CRE Indépendante (ATR, ATT, ATS)
Italy	Autorità Per l'Elettrica e il Gas Indépendante (ATR, ATT, ATS)
Belgium	CREG : Commission de Regulation de l'Electricité et du Gaz Indépendante - Régulateurs régionaux (ATR, ATS, ATT)
Spain	CNE : Comision Nacional de Energie Rôle uniquement consultatif (ATR, ATS)
The Netherlands	DTE, Autorité de Régulation pour l'Électricité et le Gaz Chambre du NMA (Autorité Surveillance Concurrence) (ATR)
Austria	E control Relativement indépendant (ATR)
Germany	Bundesnetzagentu (loi du 13 juillet 2005) (vers un ATR réglementé....)



The Energy Market in the EU & France Situation 2019 - Key Dates



**Gas and Electricity Markets
towards liberalization have been moving
slowly since the implementation of the
European Directives 20 years ago.
Freedom to get access to Gas or Electricity
suppliers is fully operational, but Gas and
Electricity prices have not decreased during
the last decades and continue to be subject to
geopolitical turmoils**

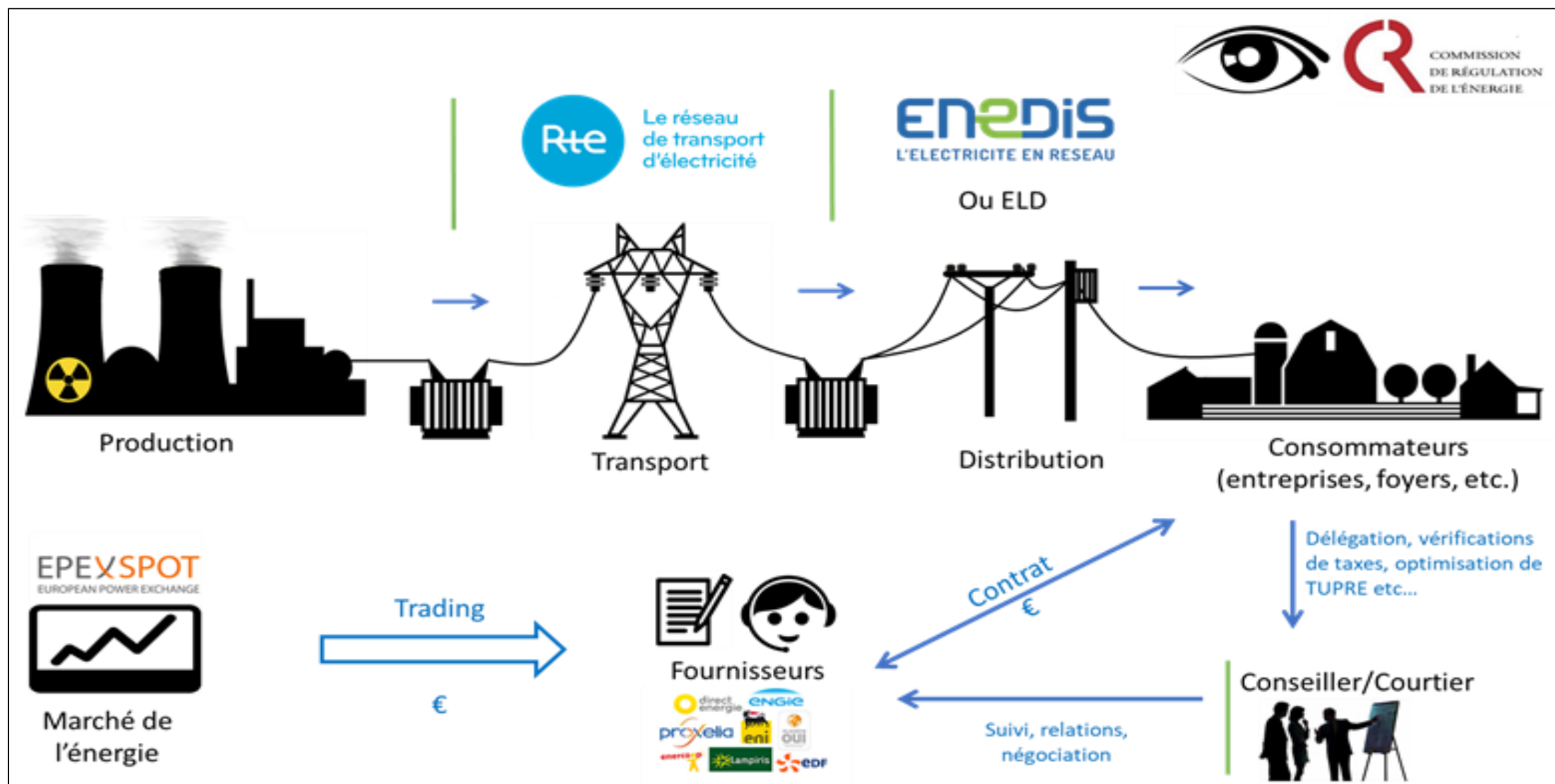


European Power Exchanges

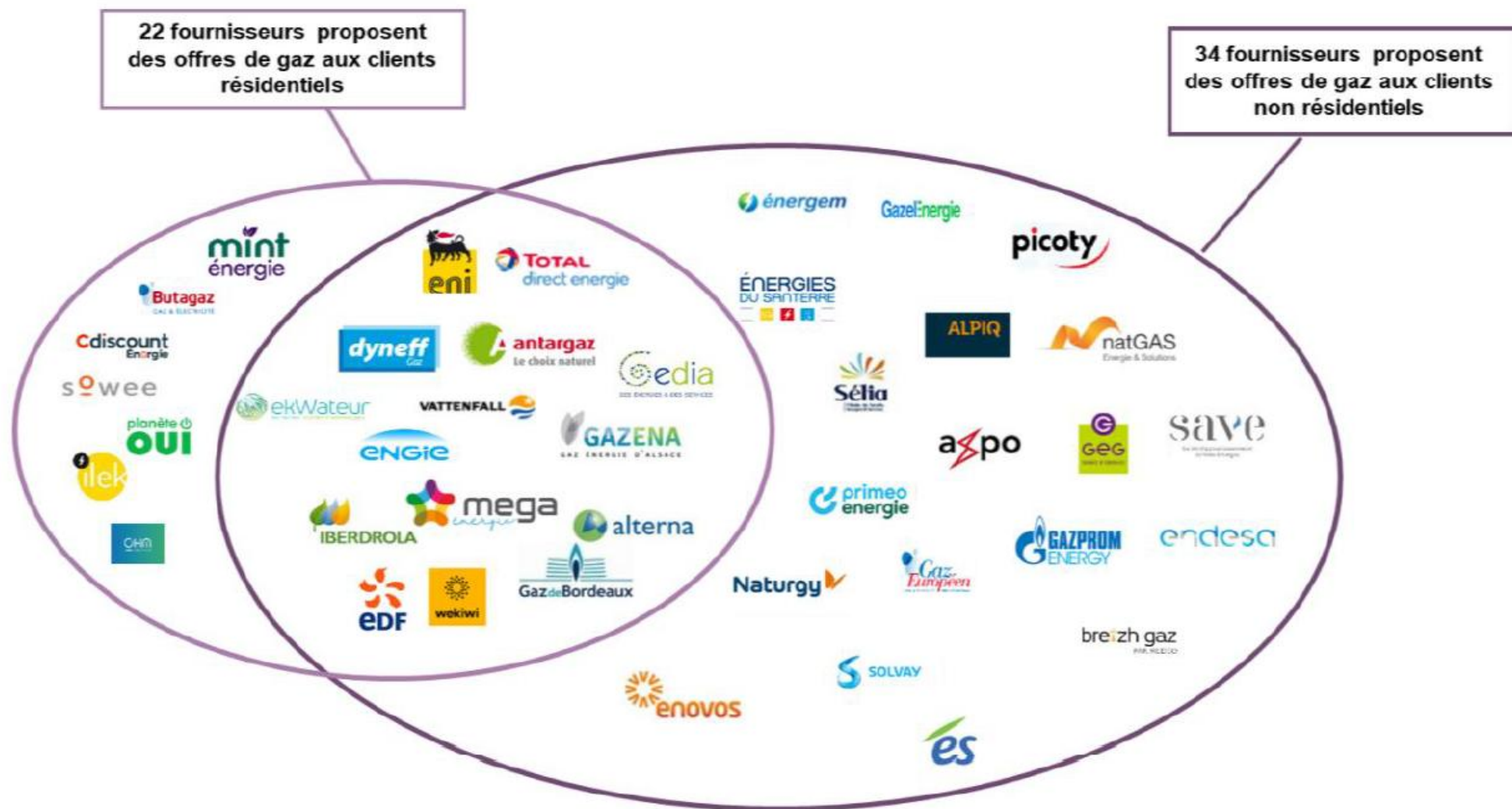
- **Power Exchanges organise trading and operate markets.**
- **Power Exchanges offer a trading platform to their exchange members. The members connect to this platform and submit orders for buying and/or selling power, which are registered in an order book. These orders reflect supply and demand for a specific market area at a certain moment in time.**
- **Based on the order book, Power Exchanges calculate a market price. Since the trades result from a large, open and transparent competition between the orders of the Exchange members, they reflect the best information available at the time under the market conditions. They are hence the most reliable prices available for electricity in short-term delivery.**
- **By matching supply and demand, Power Exchanges ensure a transparent and reliable price formation, and they make sure that the traded electricity is delivered and paid.**



The Electricity Market in France



In 2023, a large number of Natural Gas Suppliers



Source : énergie-info.fr, Analyses CRE



In 2023, a large number of Electricity Suppliers



Source : énergie-info.fr, Analyses CRE



Example of challenging gas projects: Shtokman & Yamal



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The Shtokman Project The History



Shtokman - Innovative partnership with Gazprom as Leader



Harsh Conditions

◆ Discovered 1988, GIP: 3700 Gm³

◆ Partnership

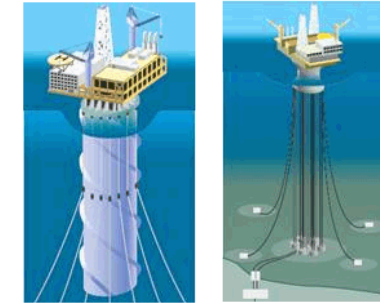
- Gazprom 51%
- Total 25%
- Statoil 24%

◆ Markets :

- LNG
- Export to Europe via Nord Stream
- Domestic market

◆ Phase 1 milestones (24 Bm³/y.)

- 2008/2009 : FEED
- 2009/2010 + : FID
- > 2016 : Gas production & LNG Export



Phase 1: 3 clusters (20 wells)
SPAR, FPU or TLP
580 km pipe multiphase



Murmansk Terminal
1 train LNG 7,5 Mt p.a. (Ph. 1)

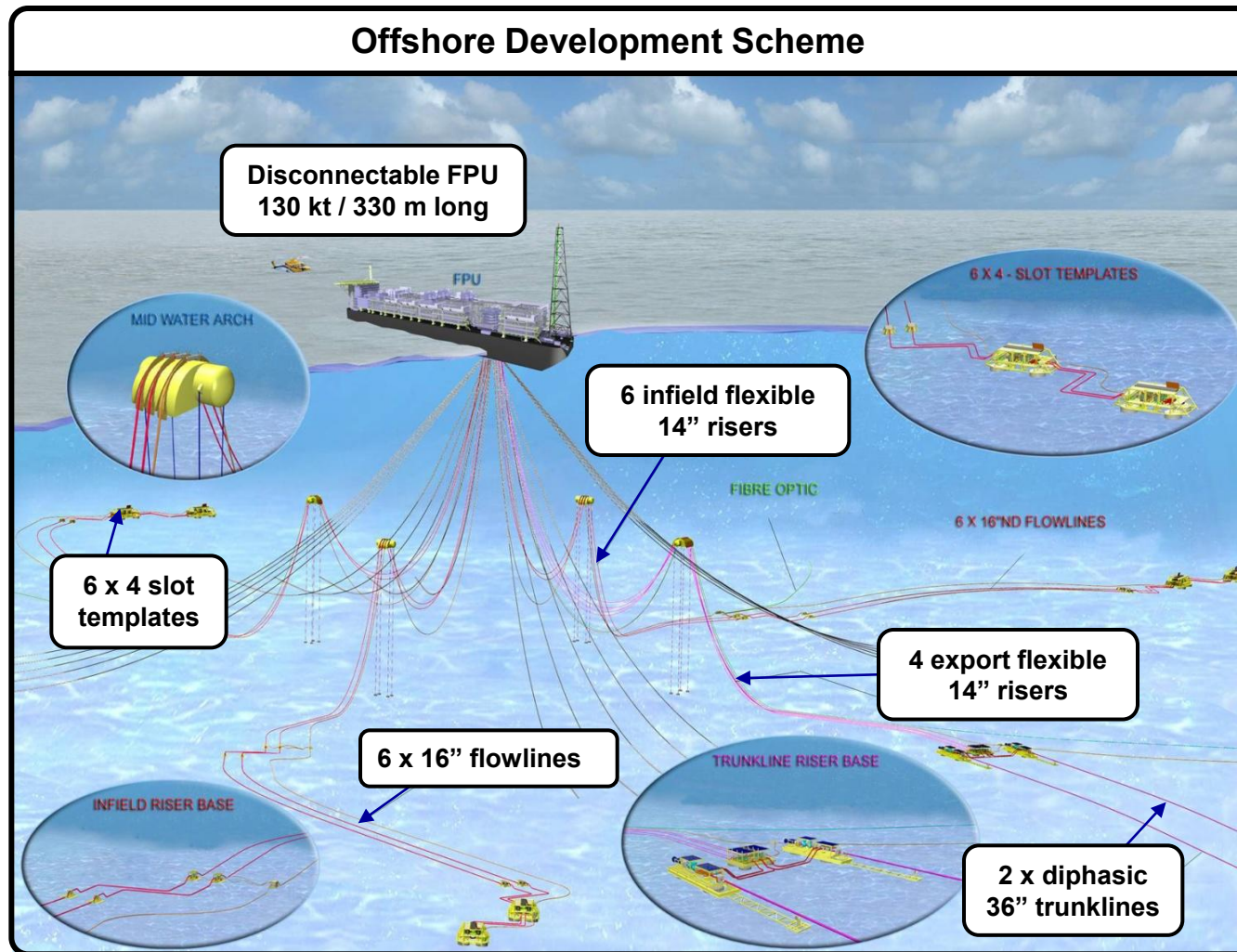
High value-added partnership

◆ Addressing together main challenges : technology, environment, marketing..

◆ Technological & financial risks sharing over 25 years



Shtokman : largest known undeveloped offshore gas field



Field

- 500 km offshore, 350 m water depth
- Giant field 140 Tcf of gas in place

Development

- Plateau 2.3 Bcf/d with 7.5 Mt/y LNG
- Planned start-up in 2016-2017



Russia: Shtokman Project phase 1

◆ Shtokman Development ag:

- Gazprom 51% - SMNG (Gazprom) holder of the Shtokman license
- Total 25%
- StatoilHydro 24%

◆ Proposed development plan:

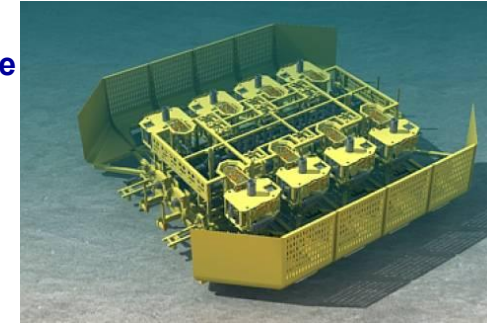
- Offshore floating production unit - 20 production wells
- 600 km sea line with dry 2 phases transport
- Onshore: LNG plant and pipe gas treatment plant

◆ Development in harsh arctic offshore

- Gas & Condensate field, 120 Tcf gas in place (Full Field = 50 years of France's 2007 gas consumption)
- 600 km from shore = most remote offshore development
- Technically challenging in extreme weather conditions & sensitive ecosystems

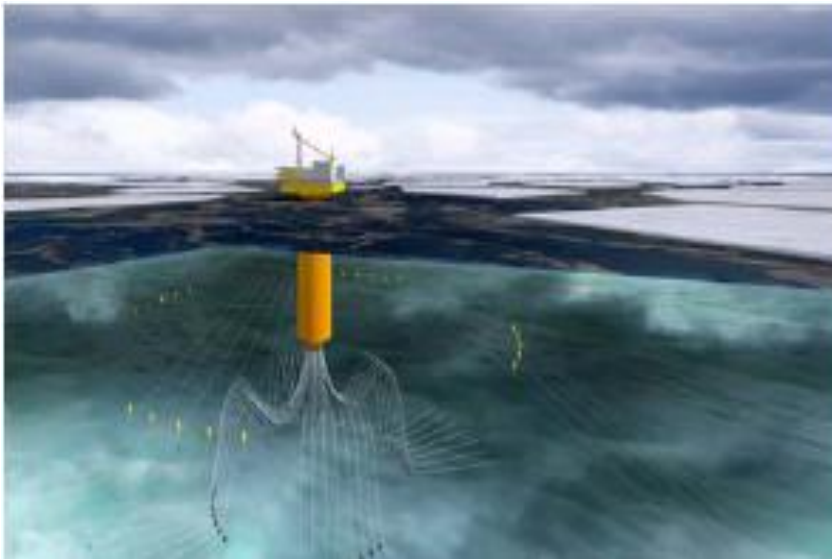
◆ Phase 1 development

- Production 23,7 Gm3/y:
 - 7,5 MT/y, LNG to US market
 - 11 Gm3/y gas pipe (Western Europe + 5% local market)
- First gas: 2016 +
- 2P reserves: 600 Gm3 (14 years of France's 2007 gas consumption)



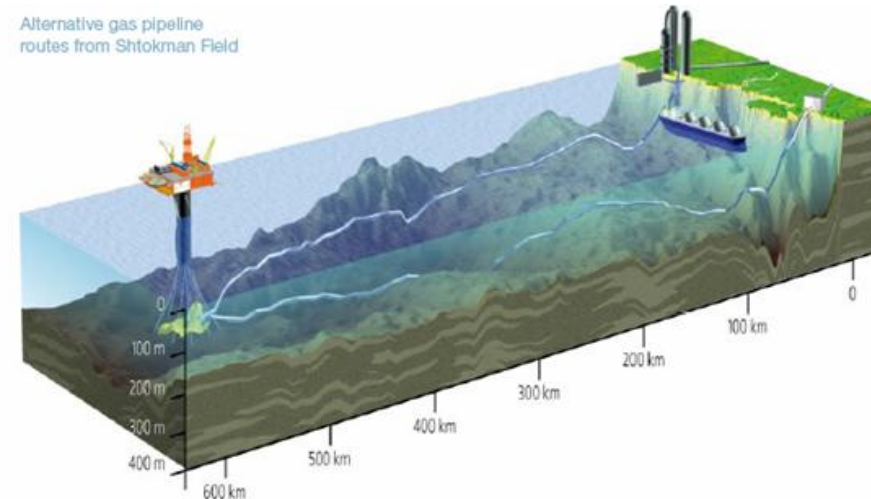
Shtokman: balanced relationships

- ◆ Tailored licence scheme
- ◆ Tailored operating scheme
- ◆ Risk sharing
- ◆ Reward sharing



Shtokman

Alternative gas pipeline routes from Shtokman Field



Building Mutual Support



Due to the its complexity and the evolution of the world gas market, as of mid 2012, the Shtokman project was reviewed by the partners and put on stand-by.

Statoil then transferred its share to the Consortium.

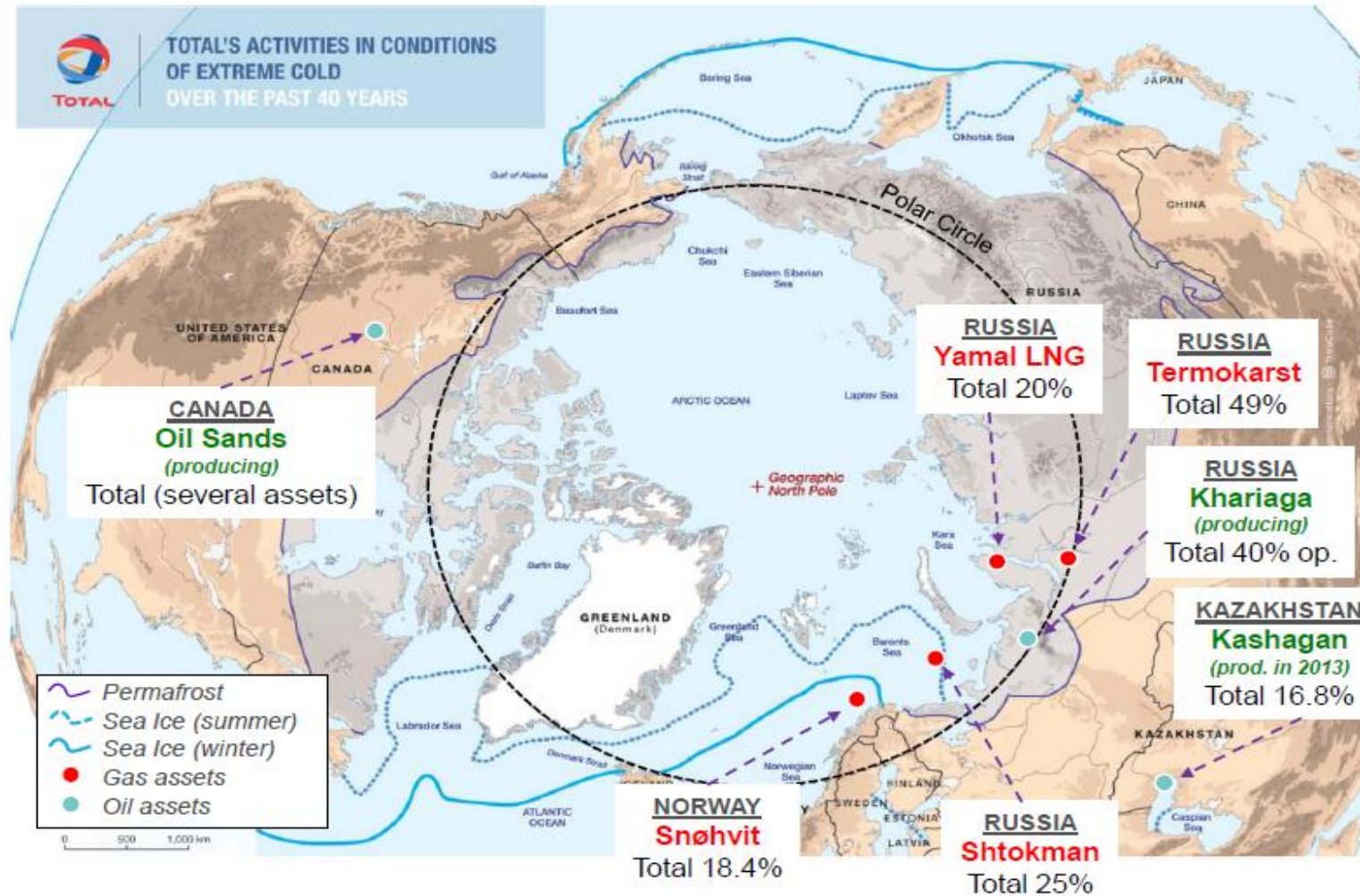
On 24 June 2015, Total announced the transfer of its 25% interest share in the project to Gazprom.



The Yamal Project The History



The Yamal Project



Nota: In 2015, Total transferred their share of Shtokman to Gazprom.



The Yamal Project



Partnership as per september 2015: Novatek (60%), Total (20%), CNPC (20%), Silk Road Fund (9% taken from Novatek, which share is now 51%)



The Yamal Project



The Yamal Project

Total in Russia: Yamal LNG project

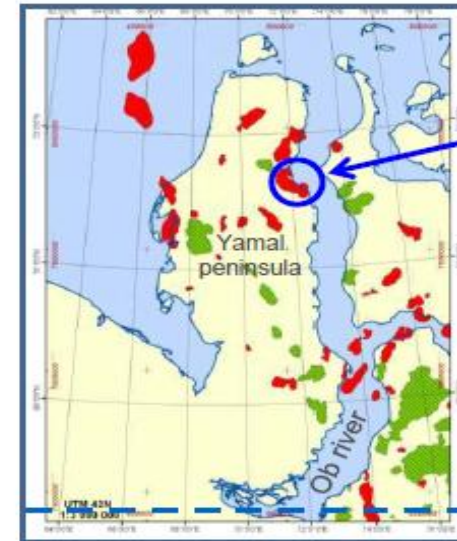
- ▶ **A major gas & condensate field, an integrated project**

Project over ~1000 km², developing 3.9 Gboe with cut-off in 2045, 465 kboe/d at plateau



LNG – Condensate production: 3 LNG trains each of 5 to 5.5 Mtpa (16 Mtpa)

Port facilities



South
Tambey
(gas in place:
~ 44 tcf of
gas)

Polar Circle

Upstream: 203 wells on 35 well pads

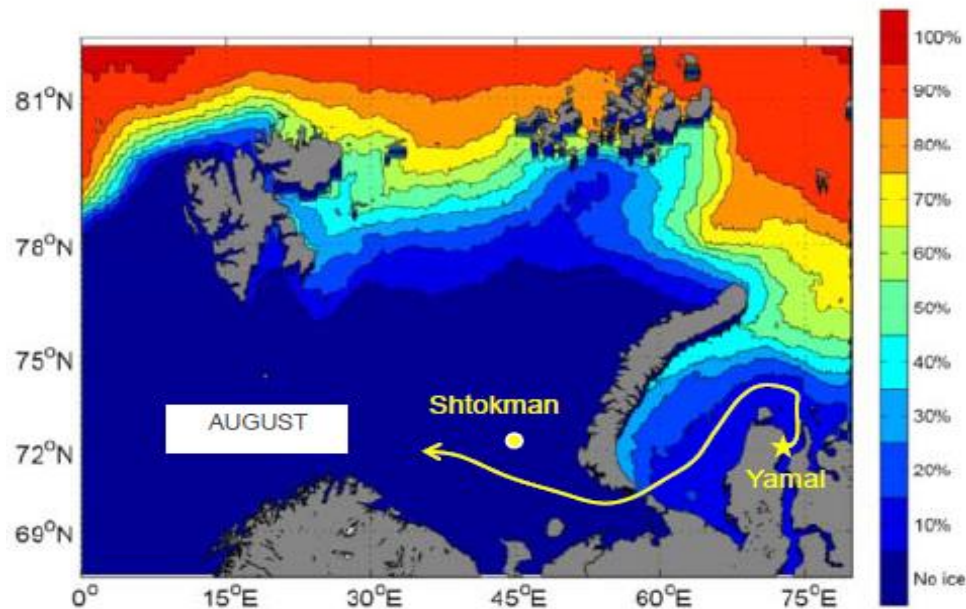
Shipping: Ice breaking specifications

Trading and Marketing



The Yamal Project

Yamal LNG harsh environment



Extent of sea ice

- **Weather conditions:** North of Arctic polar circle
- **Kara Sea:** free of ice 3 months / year + land fast ice (ridges)
- **Limited water depth in Ob bay:** dredging and discharge of products / impact on fishes.
- **Sensitive environment:** slow growth rate of tundra / ground sensitive to heat / 3 national parks & protected species / comprehensive Oil Spill Contingency Plan (OSCP) to establish.
- **Permafrost on Yamal:** continuous permafrost (active layer: 0.5 to 1m / temperature: - 5 to - 9°C / thickness uncertain: 200 to 400 m)

The Yamal Project

Yamal LNG ice breaker design



Ice Class ARC7 (Russian Classification)

- To ship through Kara Sea at all times and in Northern Sea Route during summer
- Optimum Design capacity of #170,000 m3

Double Acting System concept

- Ahead: in open water, 19.5 knots bow forward in thin ice <1 m;
- Astern: 5.5 knots in 1.5 m ice
- Up to 2.3 m ice breaking capability

Winterization

Use of experience from other existing projects

- Lukoil (from Varandey)
- Norilsk Nickel (from Yenissei)

**15 Ice breakers
For Yamal LNG**



The Yamal Project



The *Christophe de Margerie* LNG carrier.



The Yamal Project



YAMAL LNG Carrier "Christophe de Margerie" – Courtesy of SCF-GROUP



The Yamal Project



With the invasion of Ukraine by Russia and its geopolitical and economic consequences, the Yamal project is at stake for the various partners.

Furthermore, Russia's Gas exports are affected by Europe's ban as a consequence of Ukraine invasion.





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