



RystadEnergy

Rebalancing Europe's Gas Supplies

2nd edition

Co-sponsors



Technical input from



Rystad Energy
December 2023

2nd Edition of the Rystad study on Rebalancing Europe's Gas Supplies

- EU has seen record gas prices spurring investment in LNG supplies, however the European market is expected to remain tight in the near to medium term future
- IOGP Europe and American Petroleum Institute **co-funded study** by Rystad Energy with technical input from ENTSO-G and GIE
 - **Unique study** capturing detailed **input from market parties along the full value chain**
- **Study scope** covers supplies to Europe (EU27 plus UK, NO, UA, CH, Balkan) in 2023 – 2040
- Study assesses ...
 - **annual balances (peak-day demand / supply and regional mechanics primarily covered in 1st edition)**
 - **infrastructure capabilities**
 - **supply sources available to Europe in short and longer term, and their cost of supply**
- Study uses on **EU demand forecasts** (EU FF55 Mix net-zero scenario)
- Building on the study, Rystad Energy together with IOGP, API and input from ENTSG, GIE developed **policy consideration** which support the fast and effective rebalancing of supplies
- Separate studies confirm significant need for gas supplies to Europe to enable cost-efficient scale-up **of low carbon hydrogen production using CCUS to achieve net-zero objectives**
- Supply cost and price assessments are exclusively developed by Rystad Energy and were not discussed as part of the study
- Most of the data used in the study was compiled June and July 2023 – appendix slide indicate events that have occurred between summer 2023 and report finalization

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Summary of the key themes:

Europe is still not on safe ground and needs to secure additional long-term supply

Key themes	Comment
1 Required background information	<ul style="list-style-type: none">• Demand outlooks are required to contextualize the supply data, but is not the key focus of this report• A market median view has been established using post-war gas demand outlooks published by various entities
2 2022/2023 in review - market mechanisms kicked in to balance market	<ul style="list-style-type: none">• Europe had the highest average wholesale gas prices in the world during 2022 at 32 USD/MMBtu• This caused demand curtailment and increased LNG imports to replace Russian gas• Infrastructure was expanded to handle more LNG imports and west to east gas flows
3 Gas demand and supply balance likely to be tight towards at least 2027	<ul style="list-style-type: none">• Europe is required to maintain and even grow its record high LNG market share in competition with Asia• Asia has the right of first refusal to 75% of all LNG supply in the period leaving Europe at the mercy of providing sufficient economic incentive to reroute cargoes
4 Maximize domestic supply and piped imports, but realize it will be insufficient to balance	<ul style="list-style-type: none">• Without Russian gas maximizing domestic supply and imports from North Africa and Central Asia should be pursued due to typically lower cost and diversification• However, without Russia it appears inevitable that LNG will grow its market share of European supply
5 Long-term there is sufficient low cost LNG to rebalance Europe's gas markets at about 30 EUR/MWh	<ul style="list-style-type: none">• Abundant North American low-cost gas resources can backstop the global gas markets, be the marginal supply and price setter provided that necessary midstream infrastructure is constructed• Not all LNG is from North America implying that there is an European diversification play possible
6 Avoid political signals / legislative barriers / market interventions that could discourage long-term supply contracts	<ul style="list-style-type: none">• Europe is out of options short term and will likely have to heavily rely on significant growth in LNG market share to reach the 90% storage level mandate• Longer term offers more flexibility should Europe want to increase its right of first refusal LNG supply
7 Addendum: Significant economic pain also for Russia - significant stranded resources	<ul style="list-style-type: none">• Russia is unable to reroute most of its European gas exports resulting in about 3000 bcm of stranded supply• China may provide export relief in the 2030s provided significant new infrastructure is in place

Source: Rystad Energy research and analysis

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Key themes

Comment

1

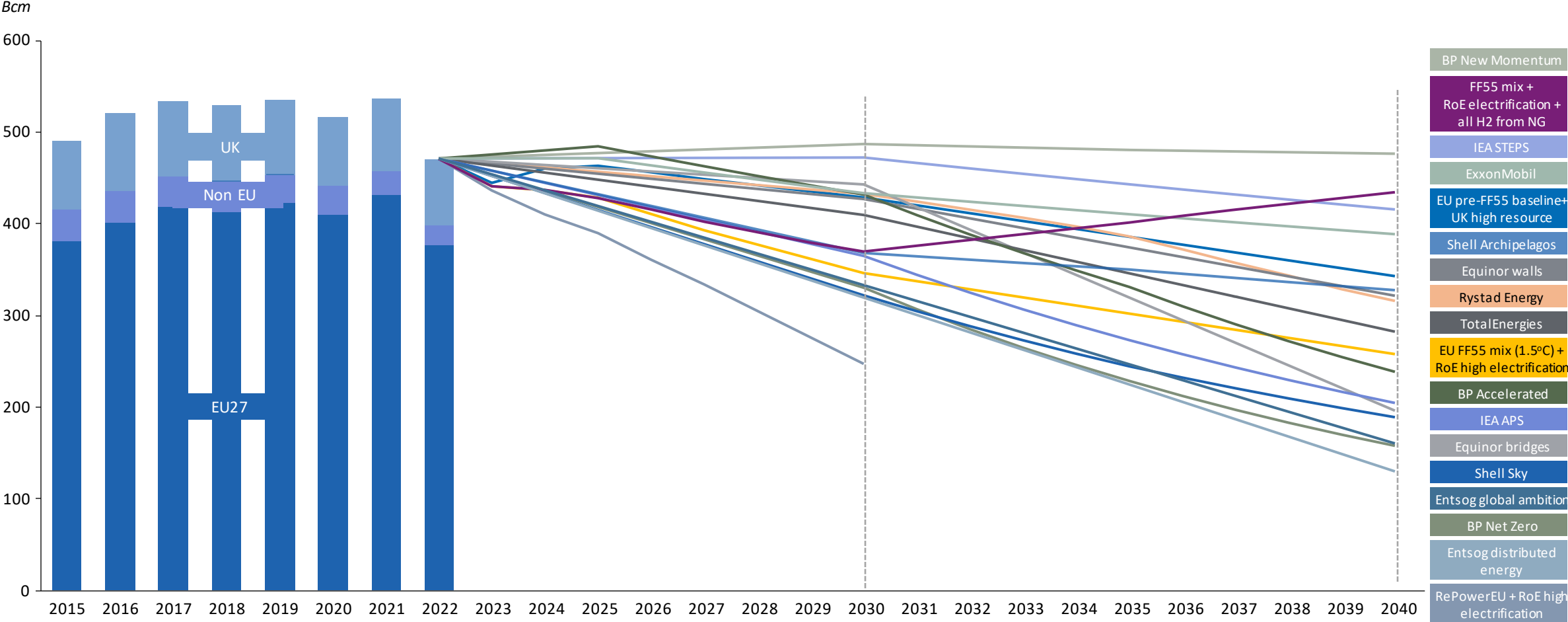
Required background information

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Source: Rystad Energy research and analysis

Forecasts and 'backcasts' range from 180 to 480bcm demand in 2040 - creating investor uncertainty

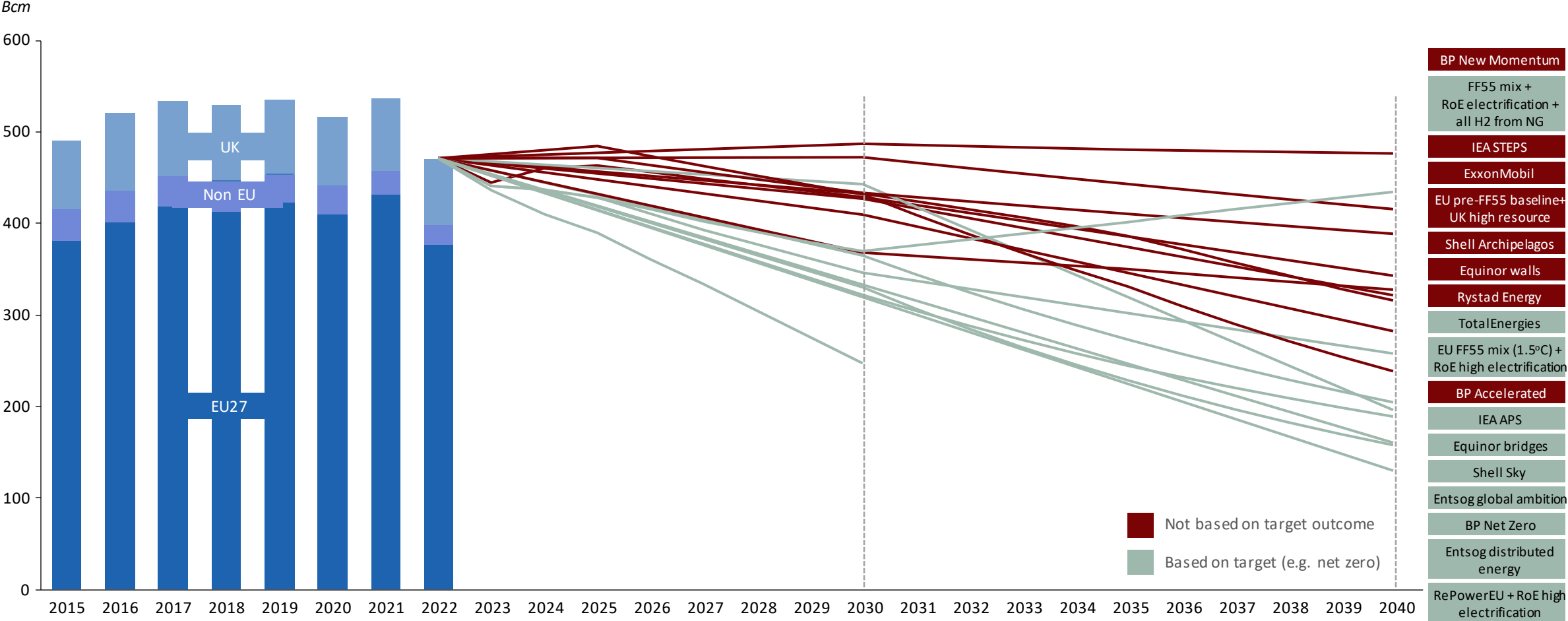
European demand outlook by scenario



Countries included in the scope are: EU, UK, Norway, Albania, Moldova, Montenegro, North Macedonia, Serbia, Switzerland, Ukraine
 IEA, Equinor and TotalEnergies uses relevant growth rate for outlook – geographic coverage is not exactly 1 to 1 with historical data points
 Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy, IEA, Equinor, TotalEnergies

Forecasts (i.e. excluding target outcome-based 'backcasts') indicate higher gas demand

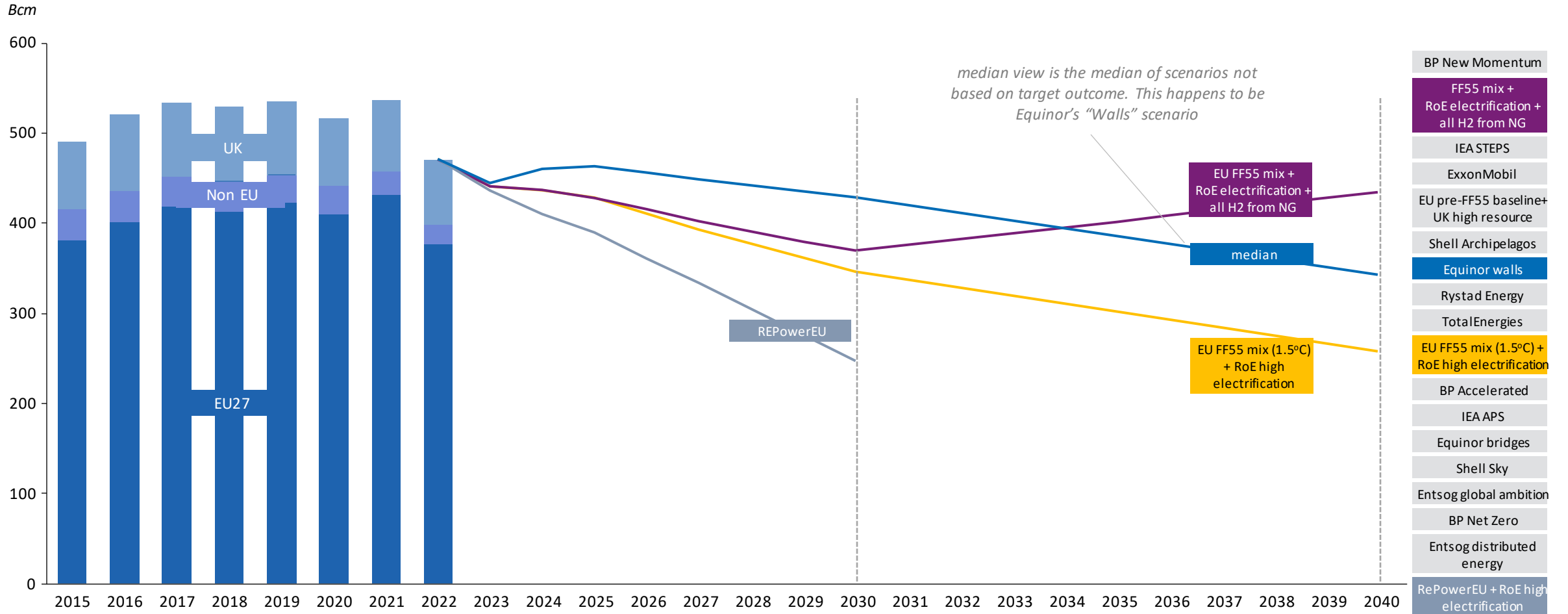
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Selected forecasts used to discuss Europe's supply options

European demand outlook by scenario

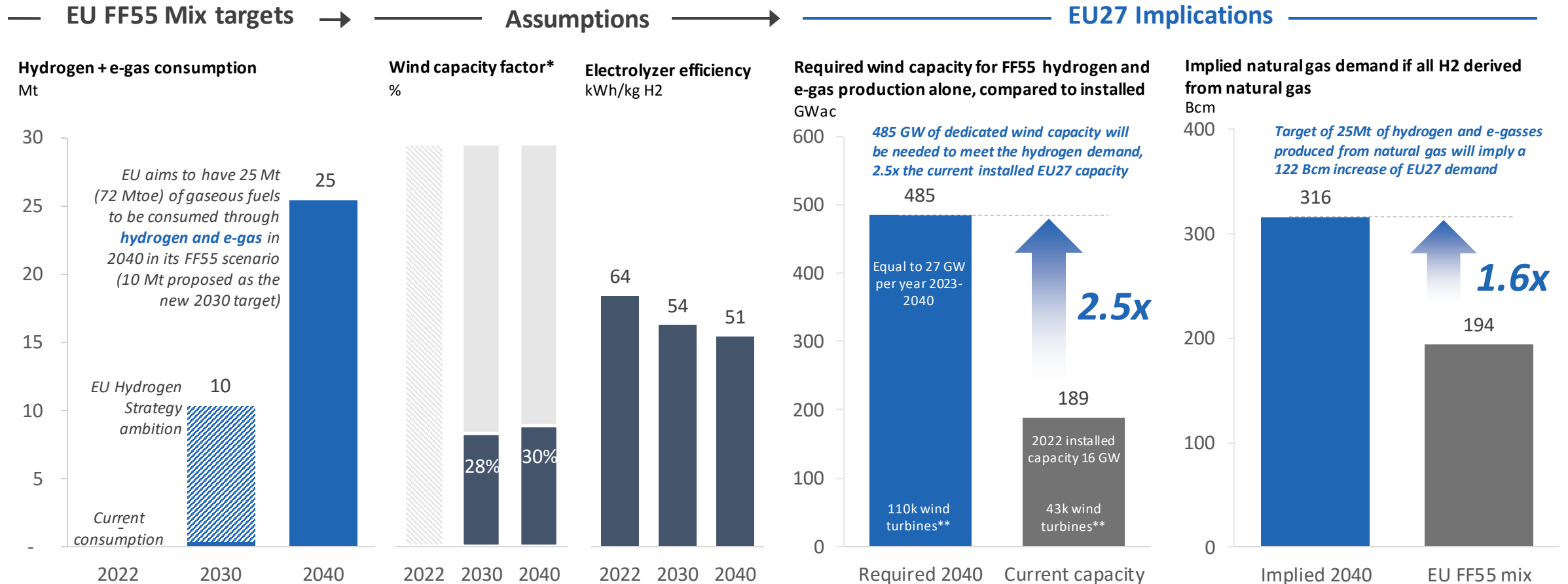


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Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy, IEA, Equinor, TotalEnergies

Producing RES H₂ in EU FF55 requires current wind capacity to increase 2.5 times → Challenging → Suggests role for low-carbon H₂ (natural gas + CCS) in energy transition

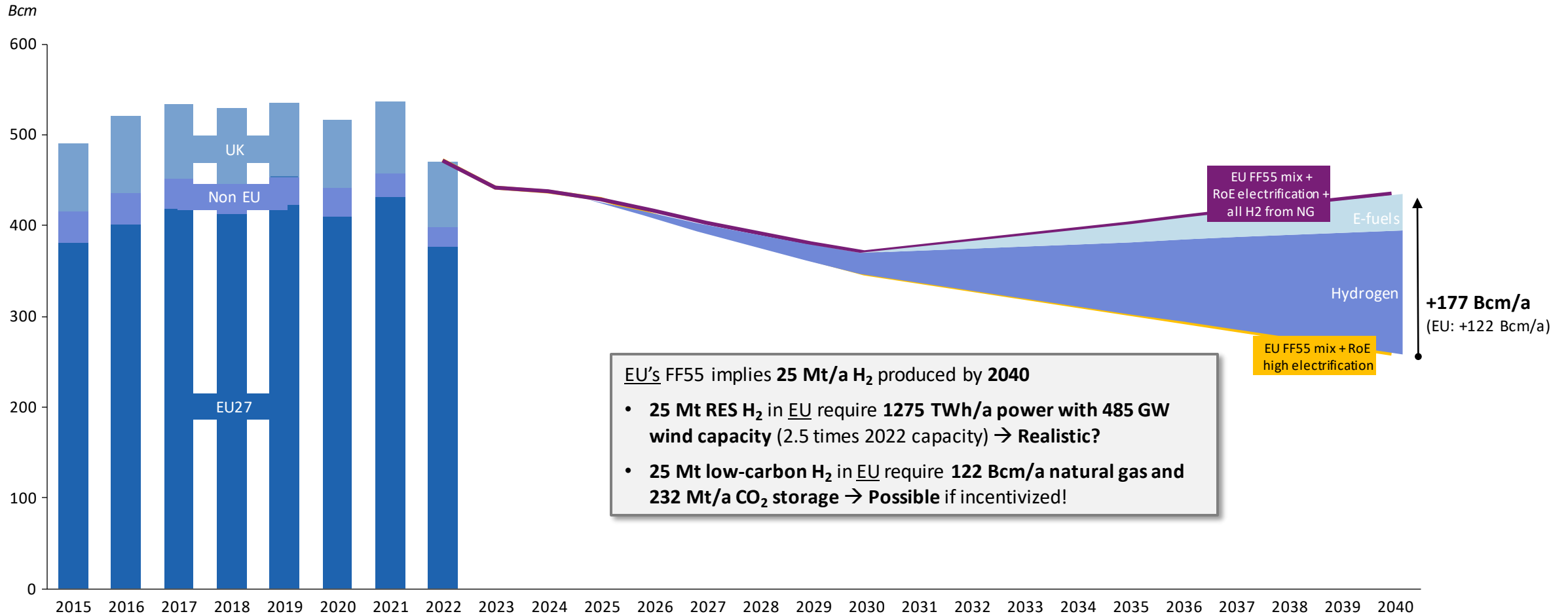


*Average wind capacity factor from EU FF55 Mix scenario
 Source: EU Commission, Rystad Energy research and analysis; Wind Europe; IEA

Sensitivity scenario: EU FF55 scenario with H₂ & e-fuels produced with natural gas / CCS

→ Increases demand for natural gas, CO₂ capture and storage

European demand outlook by scenario



* Final energy output is converted on energy-equivalence basis, whilst natural gas feedstock requirements include the efficiency differences between technologies for each low-carbon gas
 Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy, IEA, Equinor, TotalEnergies

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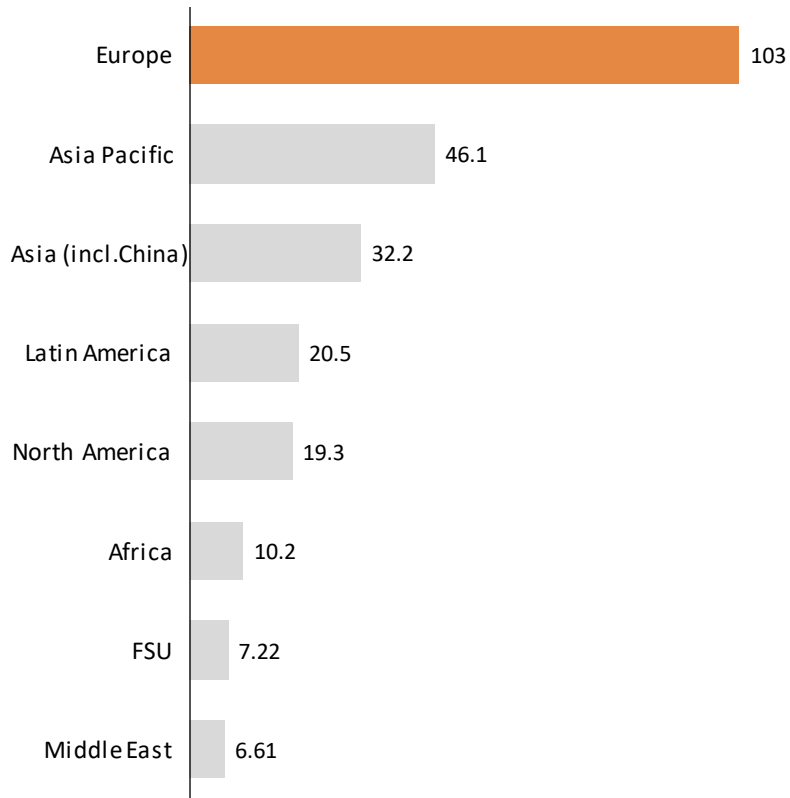
Source: Rystad Energy research and analysis

2022/2023 review:

High gas price reduced demand and attracted LNG replacing Russian gas
 LNG up from 96 Bcm in 2021 to 152 Bcm in 2022

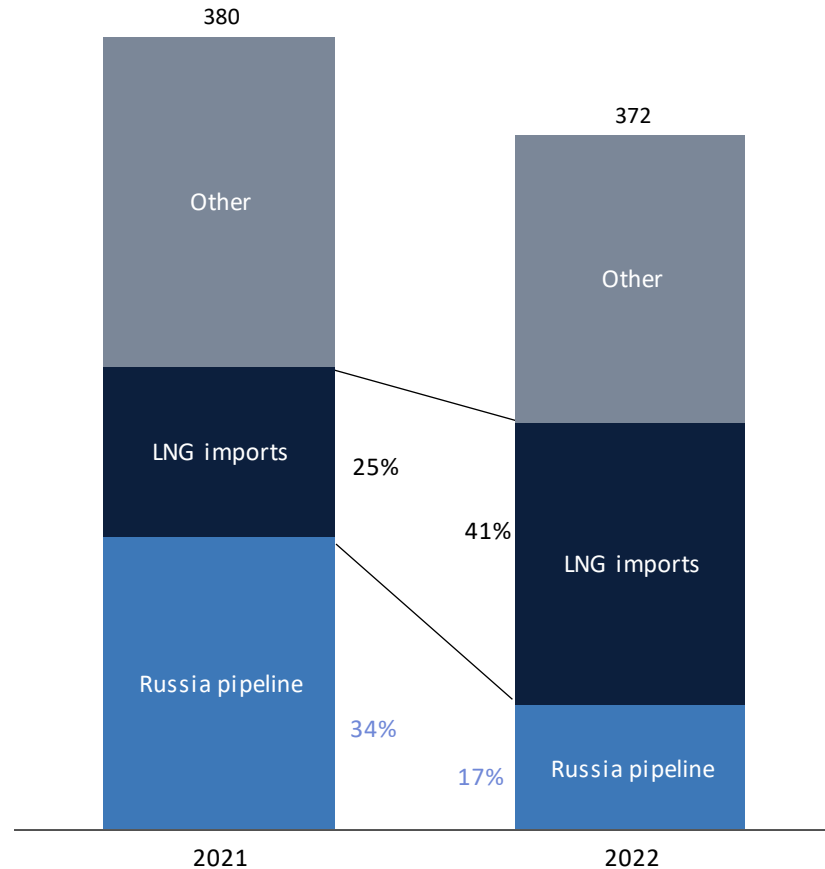
2022 average gas wholesale prices by region*

EUR/MWh



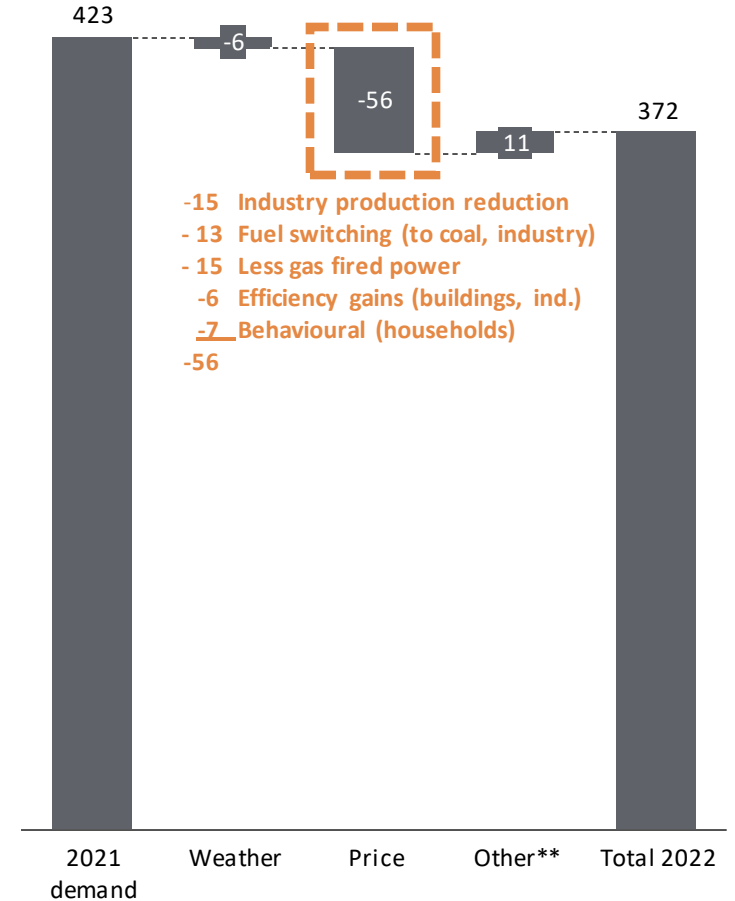
Gas supplies to EU27 from Russia, LNG, and other** imports

Bcm



EU 27 gas demand declined 12% compared to 2021

Bcm



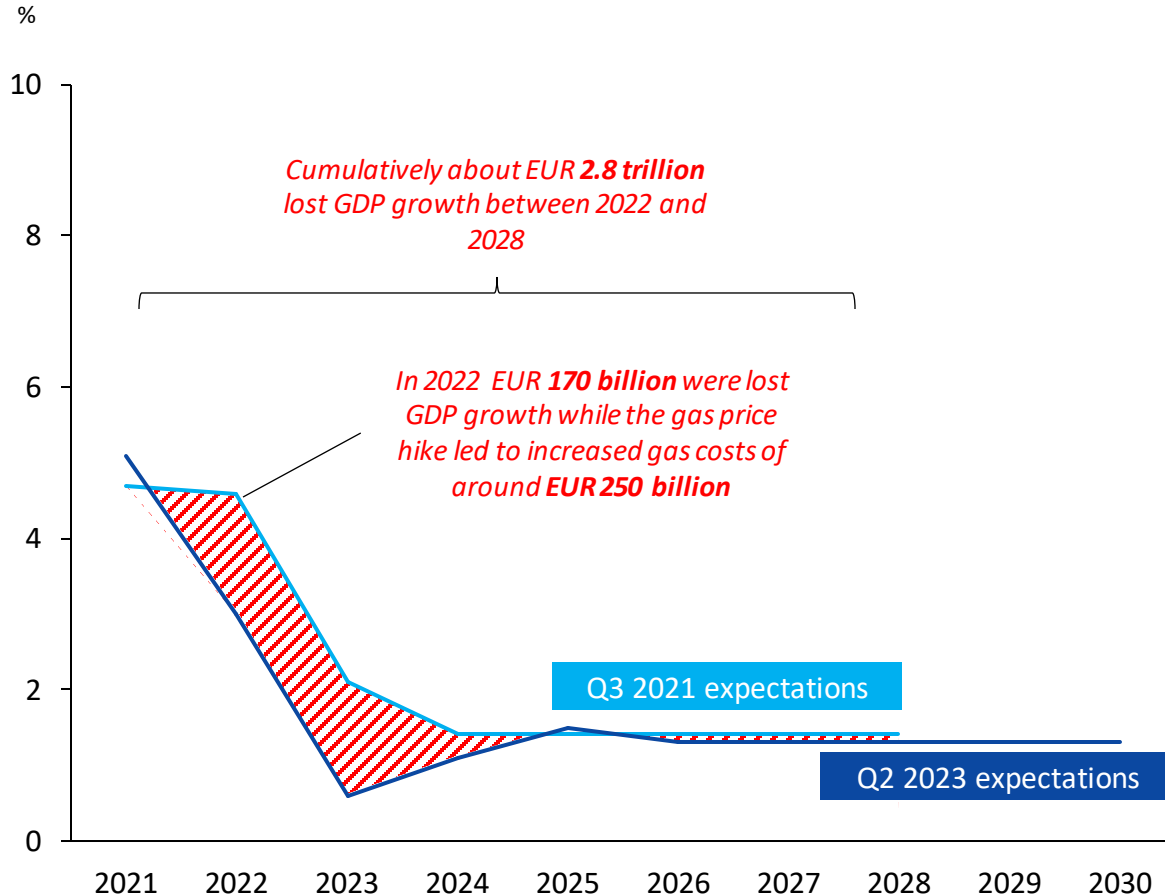
*EUR/USD as of Oct 11th 2023 at 0.94; **Other imports are defined as Norway pipeline, Africa pipeline, and Central Asia pipeline; ***Other is defined as net effect of less nuclear and more renewable power generation

Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube; IGU

2022/2023 review: Supply shock contributed to €2.8 trillion lost GDP, increased inflation

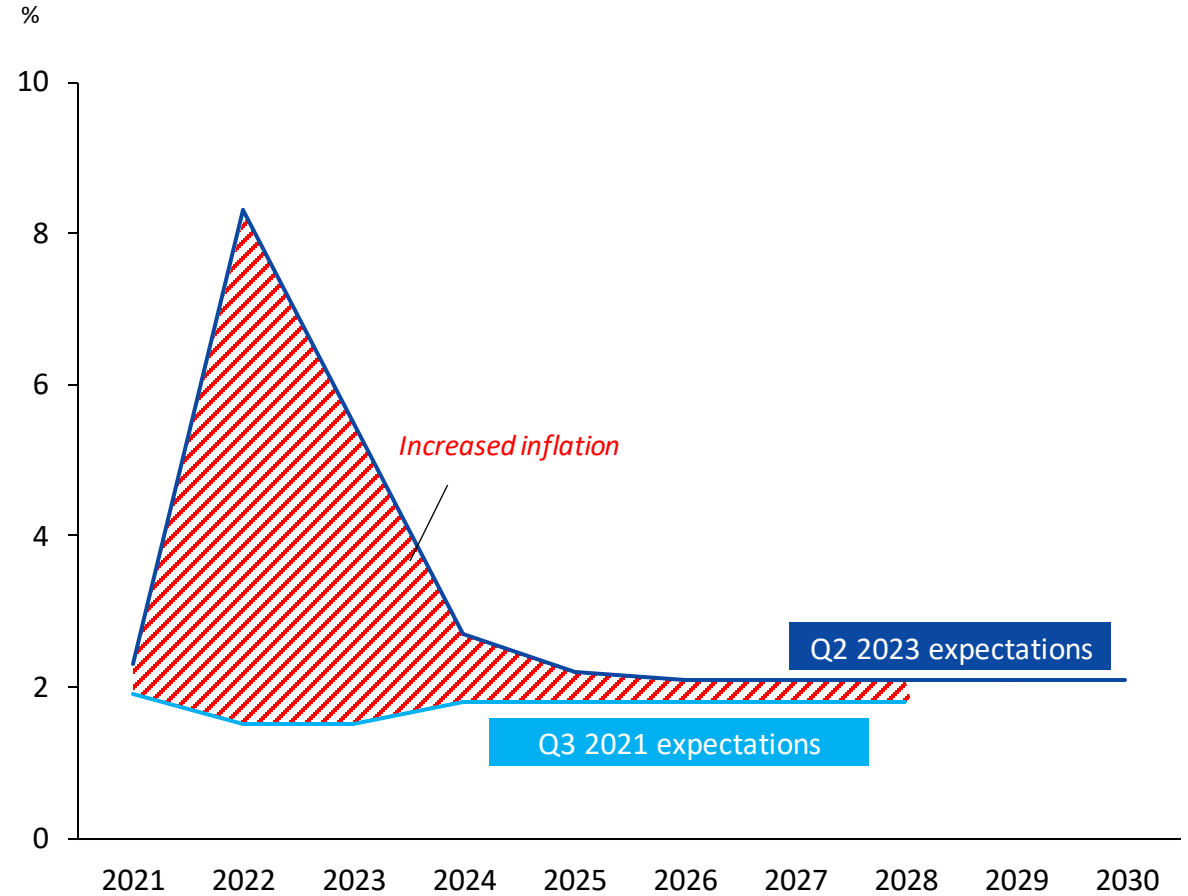
European Central Bank real GDP growth expectations

1



European Central Bank inflation expectations

2

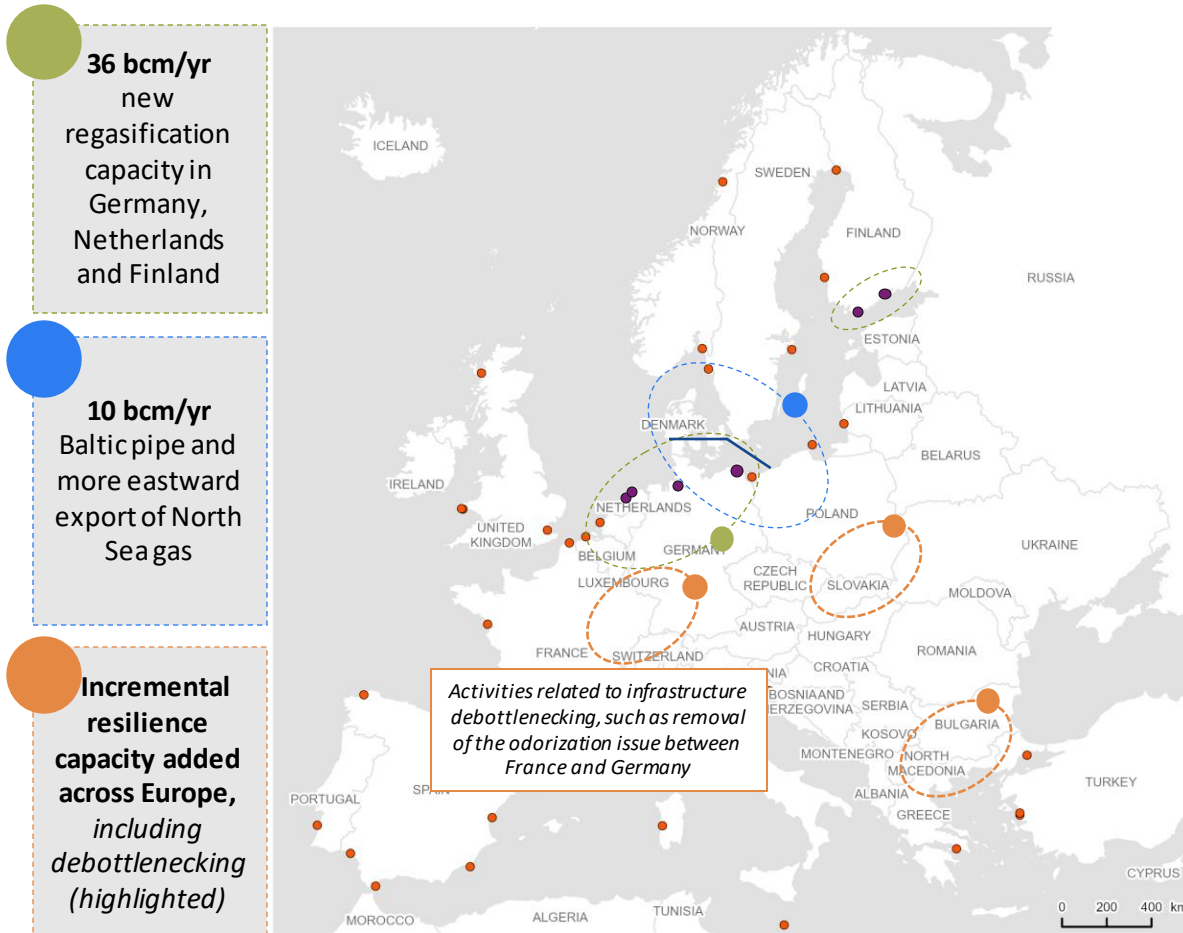


Note that for 2023 the numbers for 2021 and 2022 are based on calendar year estimates from the survey in Q4 2021 and Q4 2022 respectively
Source: ECB SPF

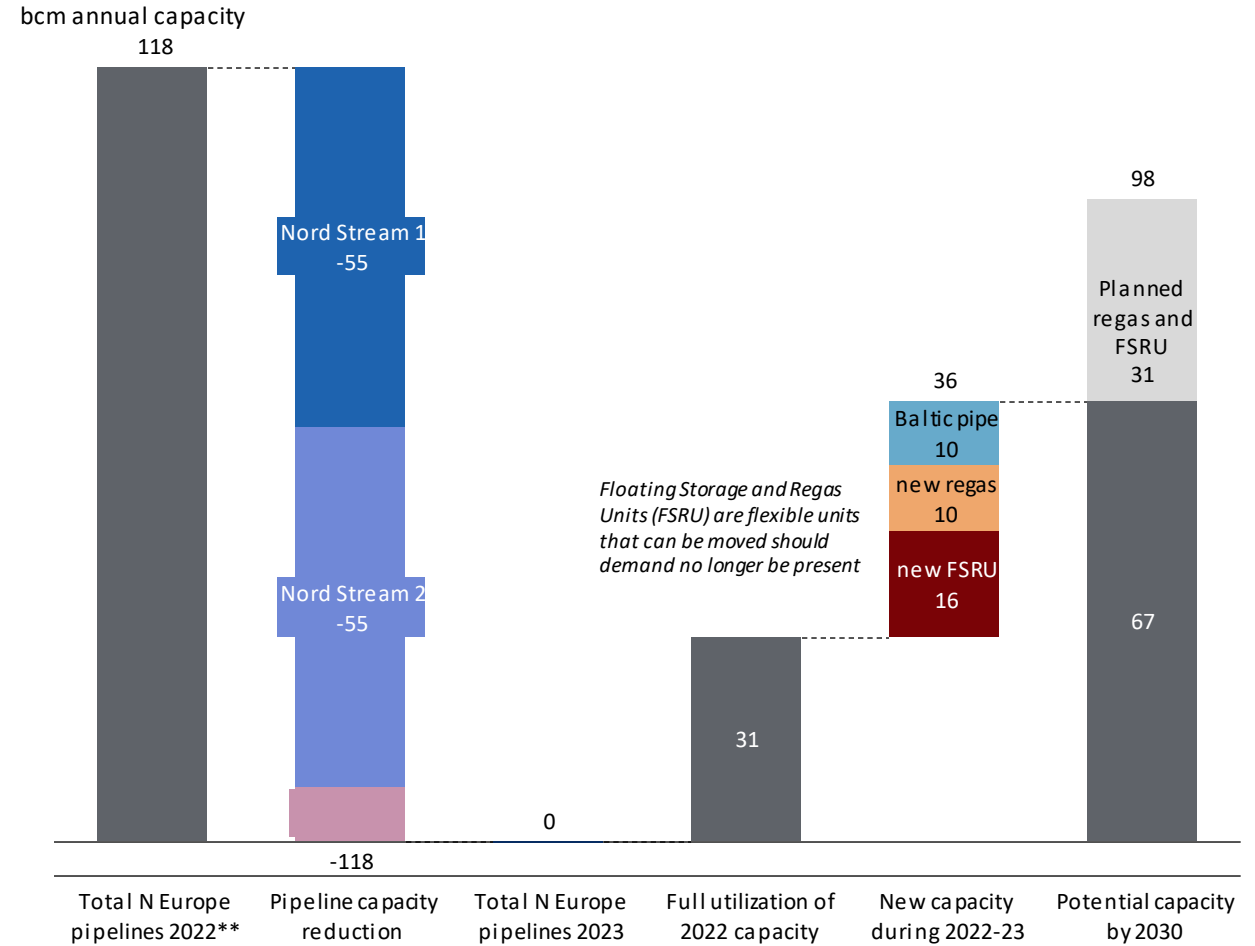
2022/2023 review:

New regas, increased utilization of existing LNG regas capacity, pipeline debottlenecking replaced Russian capacity into Northern Europe

Gas infrastructure expanded across Europe



North Europe* import capacity from Russia replaced by new capacity and full utilization



*Includes Sweden, Finland, the Baltics, Poland, Germany, Denmark and the Netherlands. Future capacity includes projects up to 2030 **Excludes Polish, Estonian, Lithuanian and Latvian capacity as it de facto is unavailable
 Source: Rystad Energy research and analysis, GasMarketCube

2022/2023 review: Europe secured only half of the LNG volumes secured by Asia since the invasion

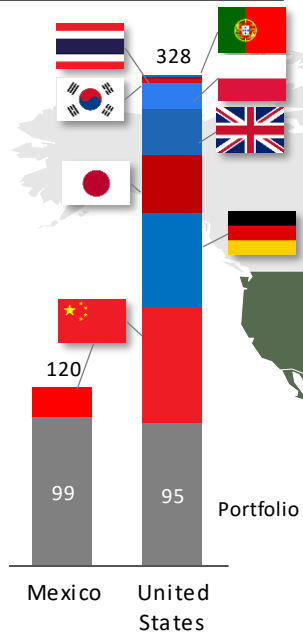
LNG contracts* concluded in 2022&2023

Bcm (aggregated volumes by 2040)

Exporters

N. America contract destination

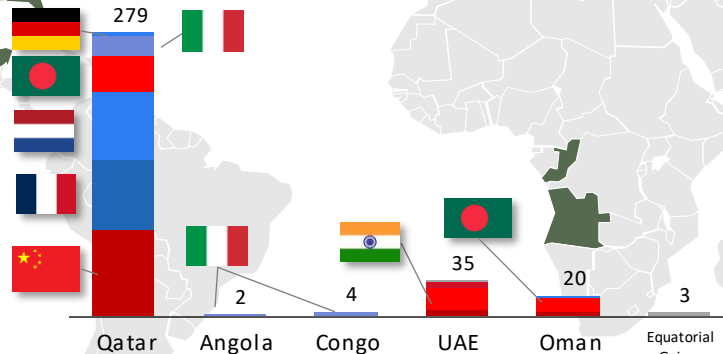
Bcm



Avg. Duration (Years)	23	19
Contract Term	FOB	FOB
Price Indexation	Waha Hub	Henry Hub

Middle East/Africa contract destination

Bcm

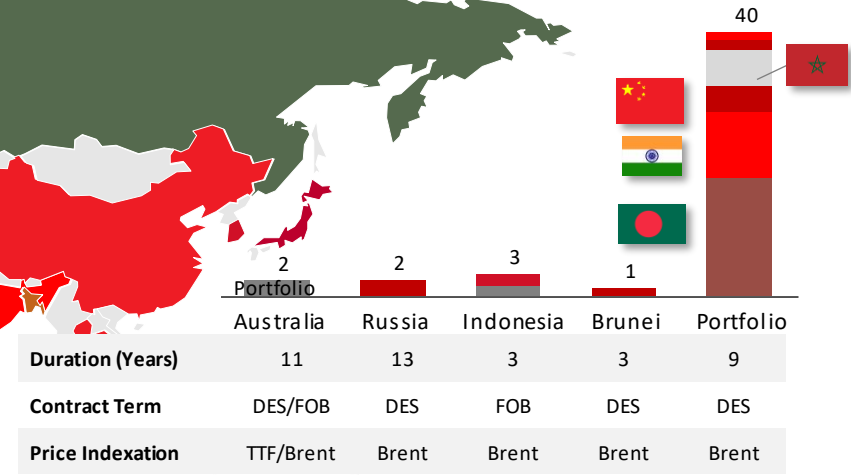


Avg. Duration (Years)	21	20	20	2.59	3.5	5
Contract Term	DES	FOB	FOB	FOB	DES	FOB
Price Indexation	TTF/Brent	Brent	Brent	Brent	Brent	TTF

17 contracts
Europe
324 Bcm
(231 Mt)

RoW contract destination

Bcm



Duration (Years)	11	13	3	3	9
Contract Term	DES/FOB	DES	FOB	DES	DES
Price Indexation	TTF/Brent	Brent	Brent	Brent	Brent

48 contracts
Asia
613 Bcm
(438 Mt)

*Only includes SPA signed in 2022 and up to 31st October 2023, MoUs and HoAs are excluded

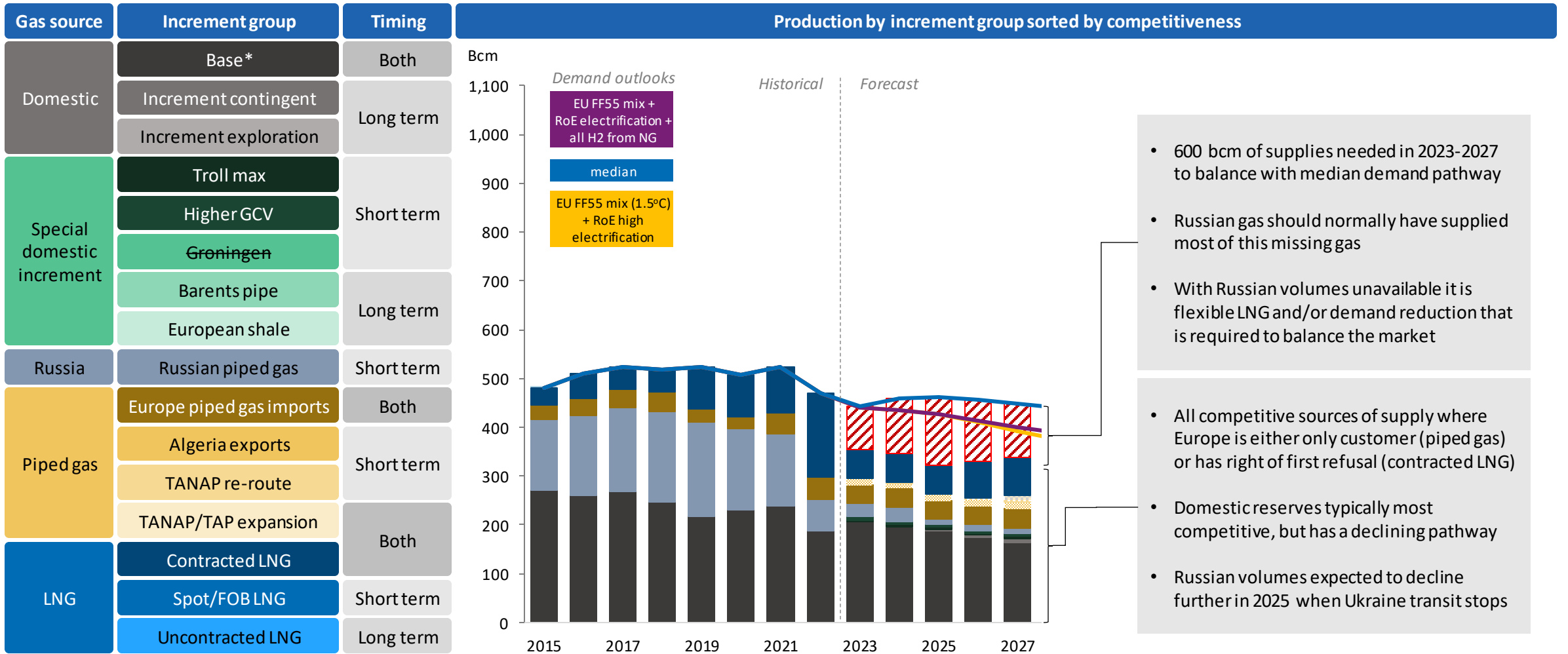
Source : Rystad Energy research and analysis, GasMarketCube

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Source: Rystad Energy research and analysis

Europe needs significant new LNG supplies short-term

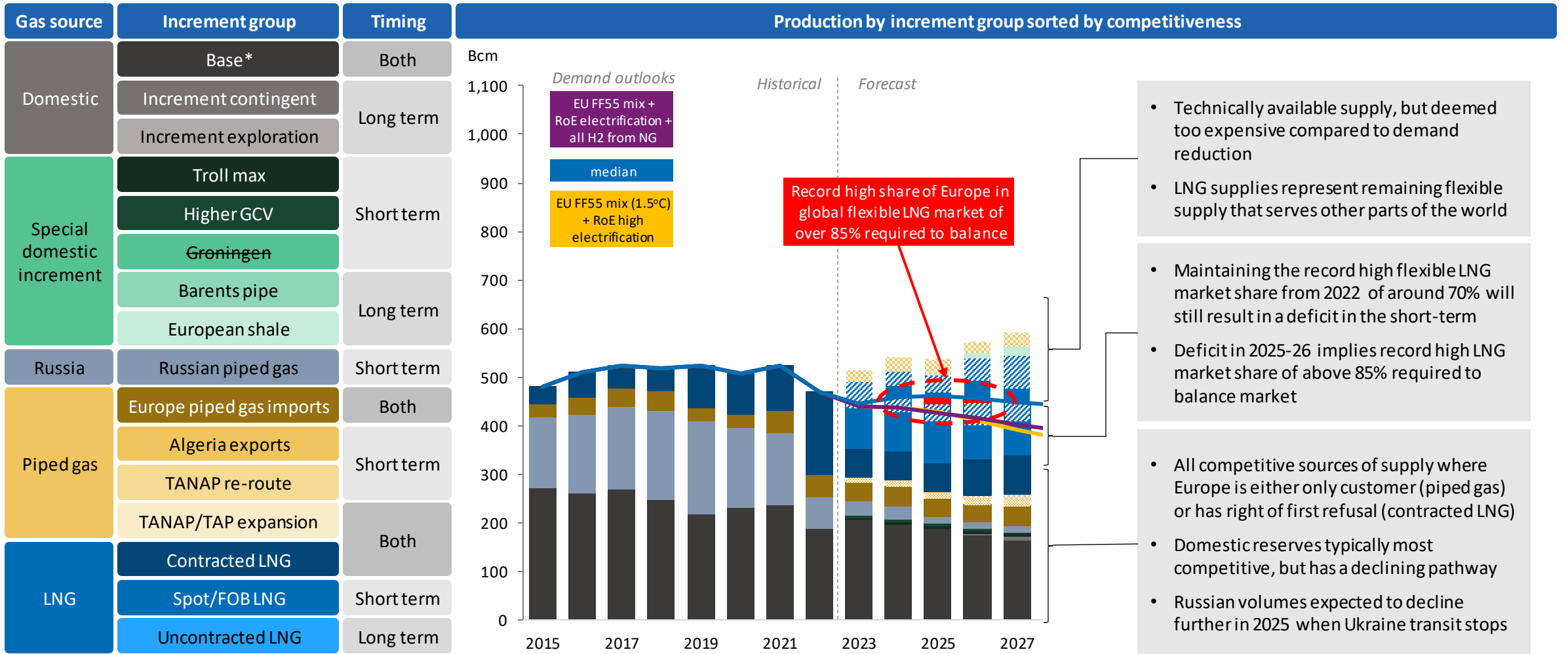


- 600 bcm of supplies needed in 2023-2027 to balance with median demand pathway
- Russian gas should normally have supplied most of this missing gas
- With Russian volumes unavailable it is flexible LNG and/or demand reduction that is required to balance the market

- All competitive sources of supply where Europe is either only customer (piped gas) or has right of first refusal (contracted LNG)
- Domestic reserves typically most competitive, but has a declining pathway
- Russian volumes expected to decline further in 2025 when Ukraine transit stops

Note: Contracted LNG volumes as of end of October 2023; *Base increment group includes storage.
 Source: Rystad Energy research and analysis, GasMarketCube, European Commission, UK BEIS

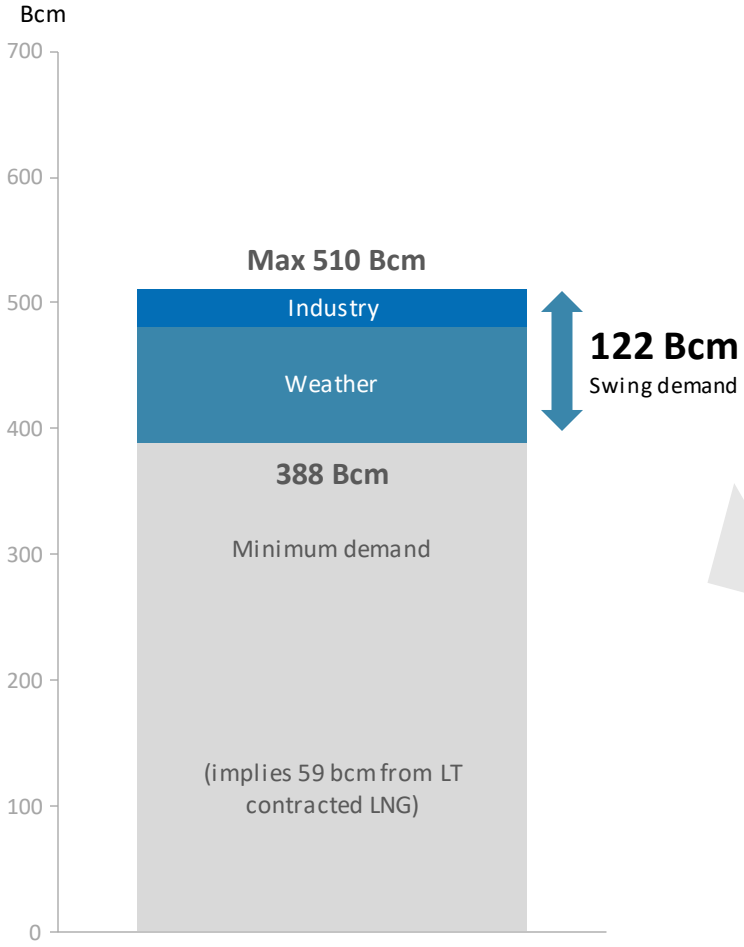
Europe's share in global LNG market to increase to record levels



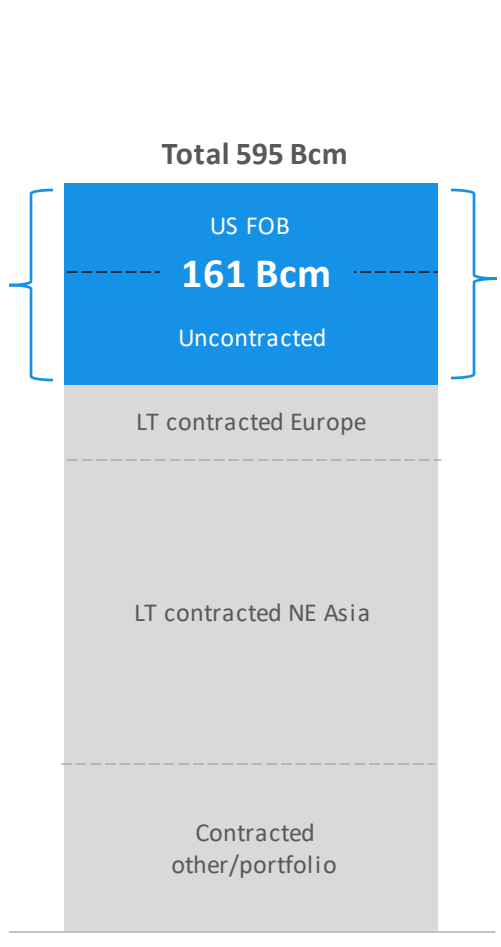
Note: Contracted LNG volumes as of end of October 2023; *Base increment group includes storage.
 Source: Rystad Energy research and analysis, GasMarketCube, European Commission, UK BEIS

Europe and Asia compete for LNG supplies with Europe at record high share in LNG market

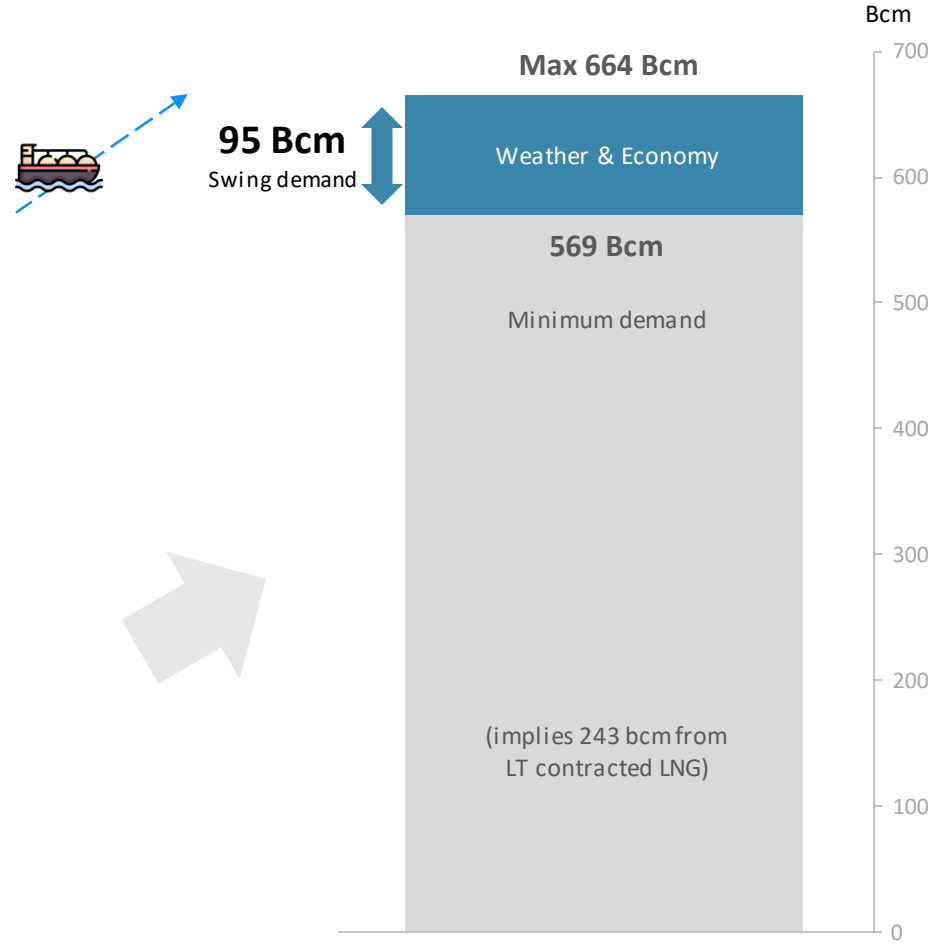
European* gas demand in 2025



LNG market split by contract status in 2025



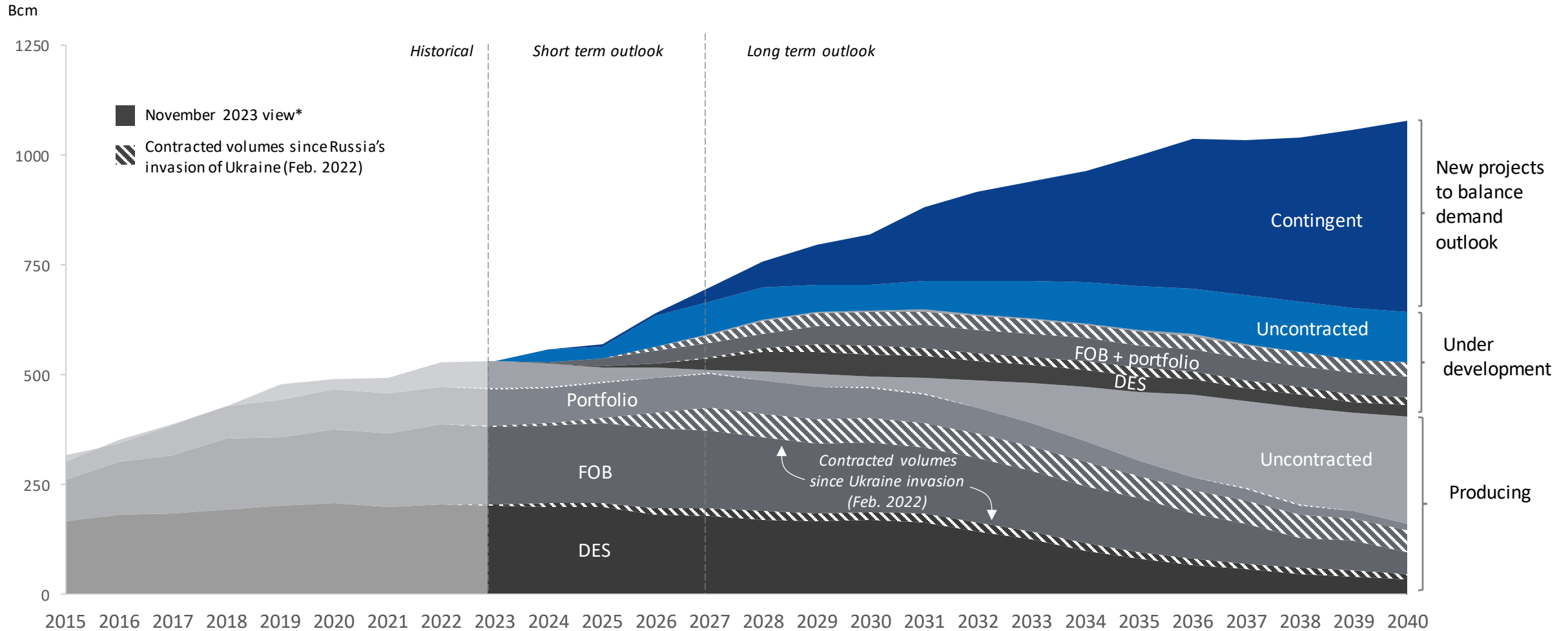
Asian** gas demand in 2025



*Includes selected European countries for the study; ** Variation driven by Japan, China and South Korea
 Source: Rystad Energy research and analysis; Rystad Energy GasMarketCube

Available uncontracted LNG volumes through 2030 reduced from ~ 1,200 bcm to ~ 700 bcm since Russia's invasion of Ukraine

Competitive LNG supply categories split by contracted volume type

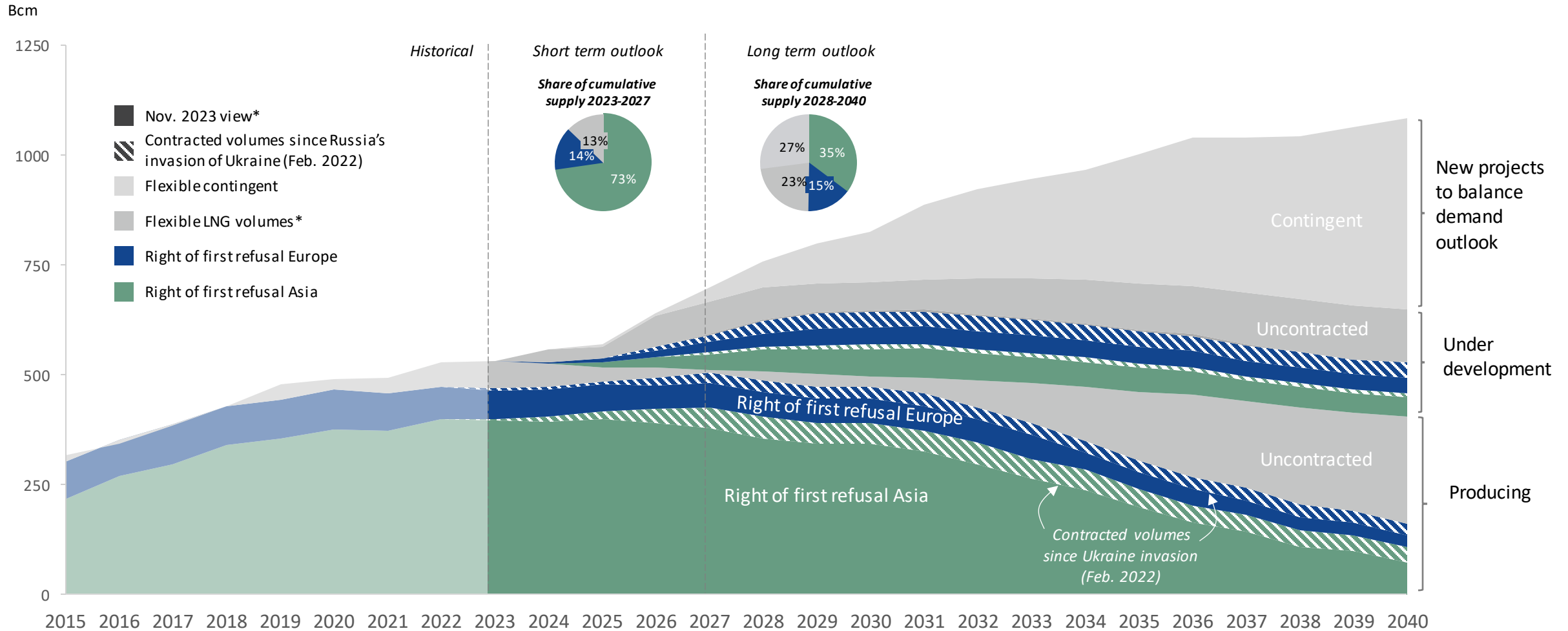


Note: FOB – Free on Board; DES – To destination; * Contracts signed by end of October 2023

Source: Rystad Energy research and analysis

LNG contracting status shows short-term Asian market control while longer-term supplies available to be contracted by Asian and European buyers

Competitive LNG supply categories split by contracted volume type

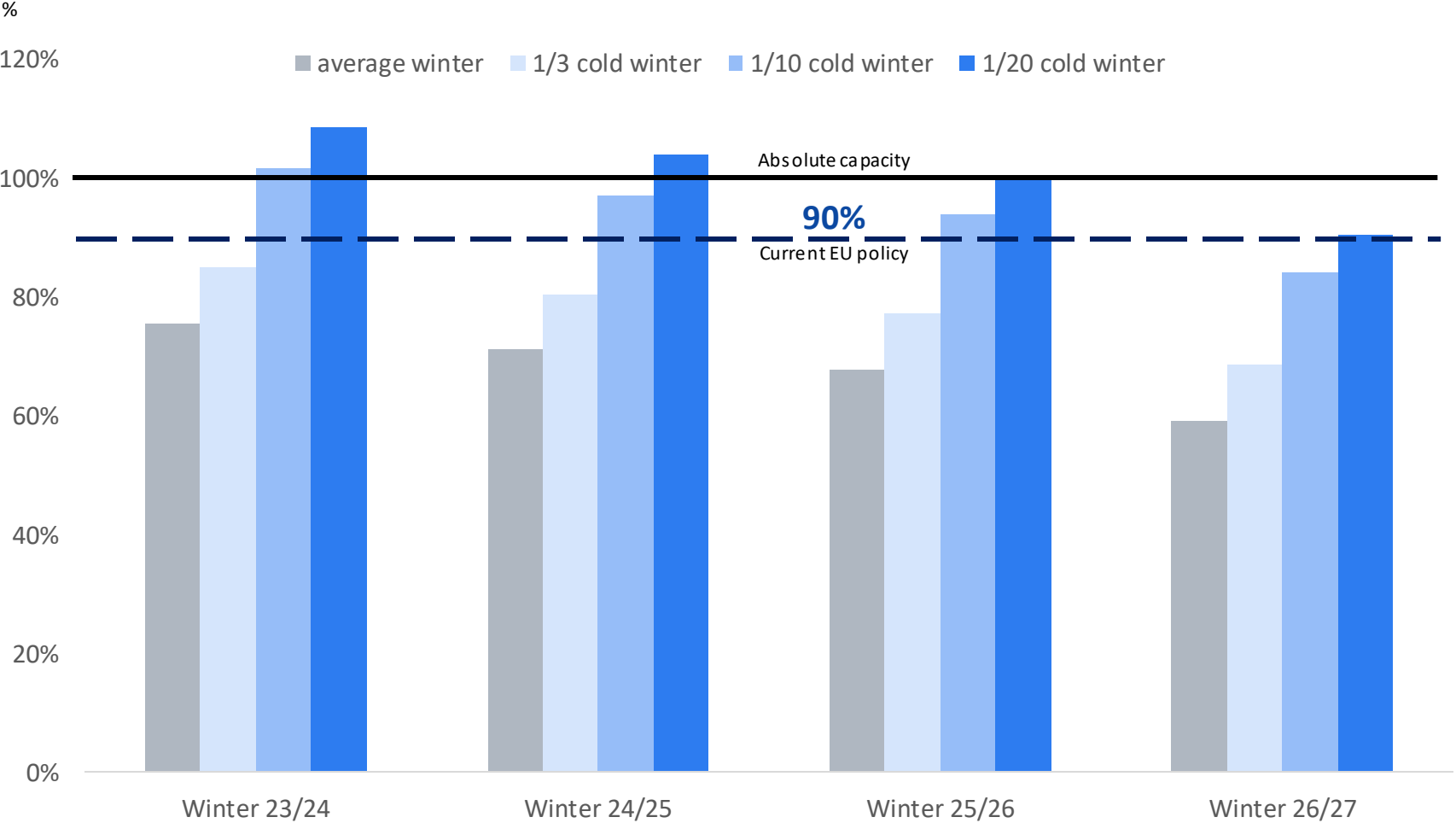


* Includes producing and under development uncontracted volumes; * Contracts signed by end of October 2023

Source: Rystad Energy research and analysis

Loss of flexible winter supply suggests high storage filling levels in the cold weather scenarios

Storage %-level required before withdrawal* vs winter scenarios



Extreme storage levels are required to cope with 1/10 and 1/20 cold winter scenarios. Even though actual shortage of gas is not expected, Europe will have to instead tap into one or several unpleasant options both on supply and demand side. Several key points should be considered here:

- Russian, Troll and Groningen fields acted as big swing producers in the past and were able to ramp up production significantly in the colder months. With Groningen now shut down, Russian flexibility gone and Troll already producing close to maximum there isn't such factor available anymore.
- All other domestic and piped supply is assumed at maximum, so would have to assume higher winter month LNG imports to what was historically observed in order to provide the required flexibility.
- If LNG spot increase is unavailable, further demand side action would be required such as demand curtailment/ gas-to-coal switching, etc....

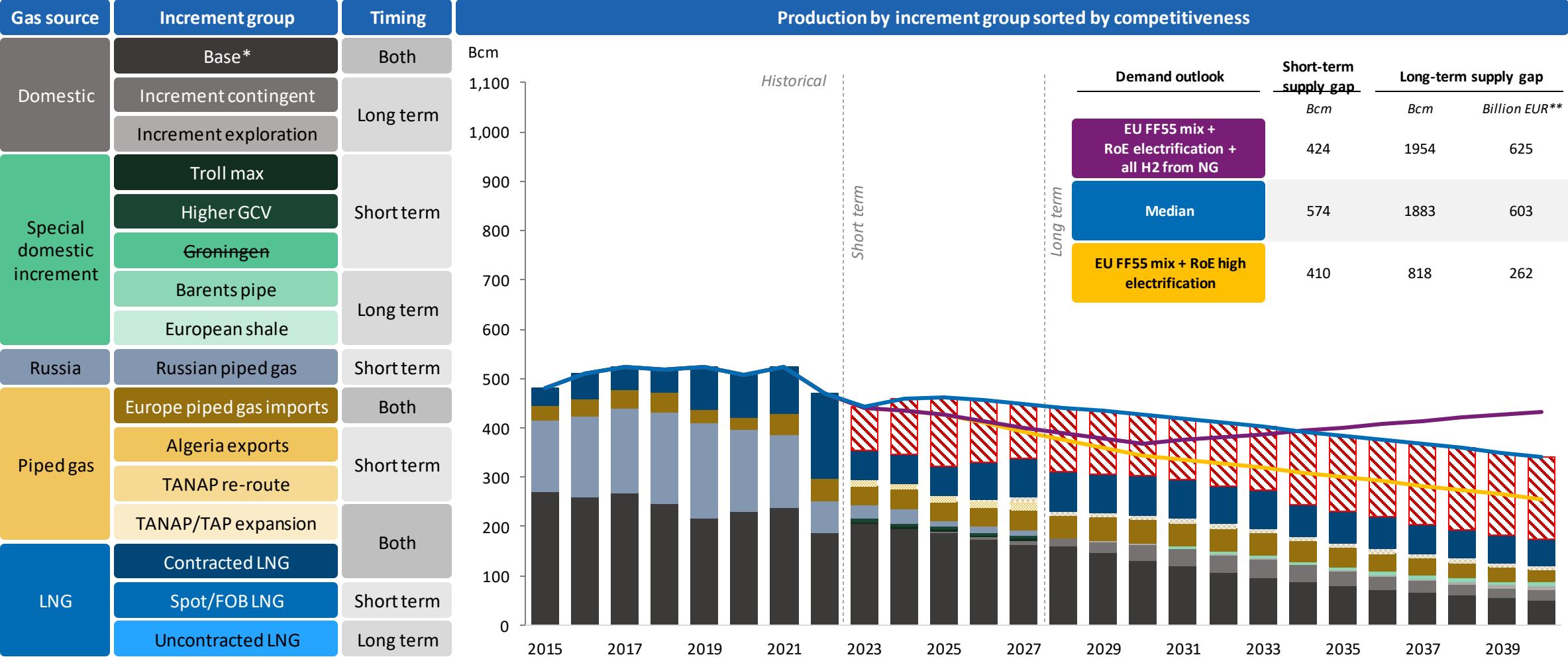
*Assumes 108.8bcm storage capacity of European facilities. Assumes a verage modelled supply with maximum historically observed share of LNG imports

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Source: Rystad Energy research and analysis

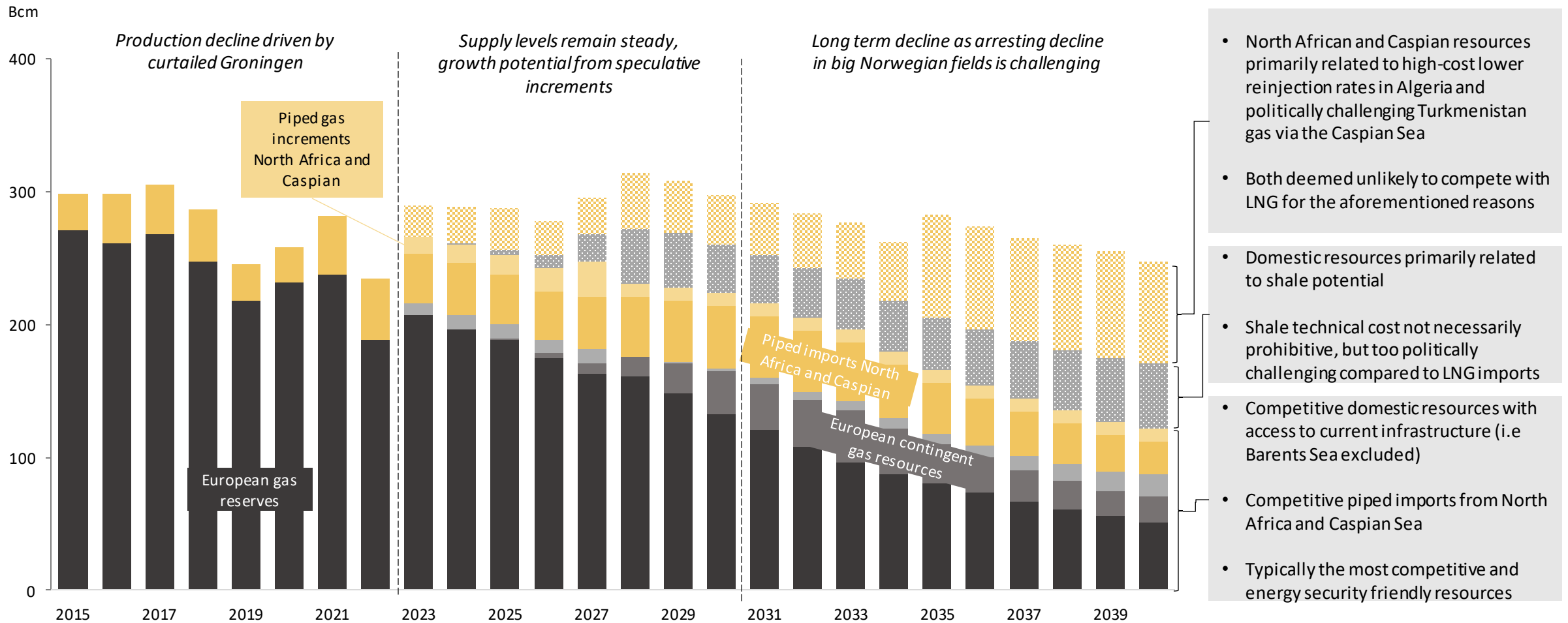
Insufficient domestic, piped gas and contracted LNG → Europe needs 2500 Bcm new LNG supplies through 2040



Note: Contracted LNG volumes as of end of October 2023; *Base increment group includes storage.
 Source: Rystad Energy research and analysis, GasMarketCube, European Commission, UK BEIS

Europe can increase its strategic autonomy by looking for supplies from its own backyard and from reliable neighbors but there are limited options

Overview of European domestic supplies and non-Russian piped imports*



*Does include net storage as in supply stack hence relatively large movements
 Source: Rystad Energy research and analysis, GasMarketCube

Domestic resources typically outcompete uncontracted long-term LNG

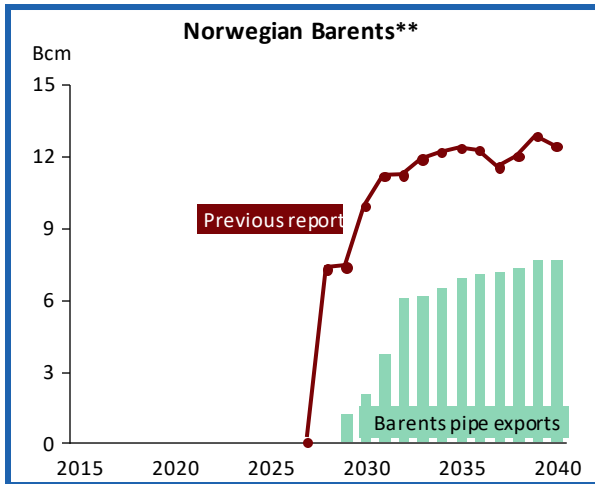
Natural gas supply cost comparison



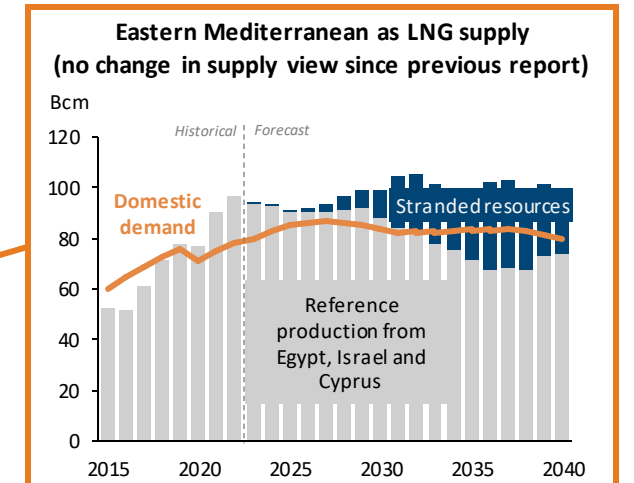
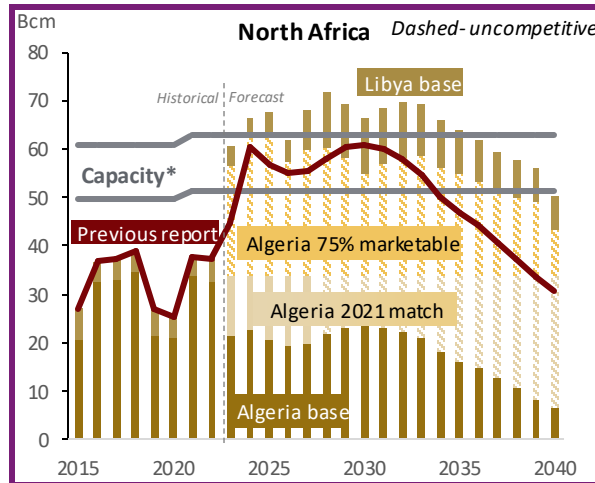
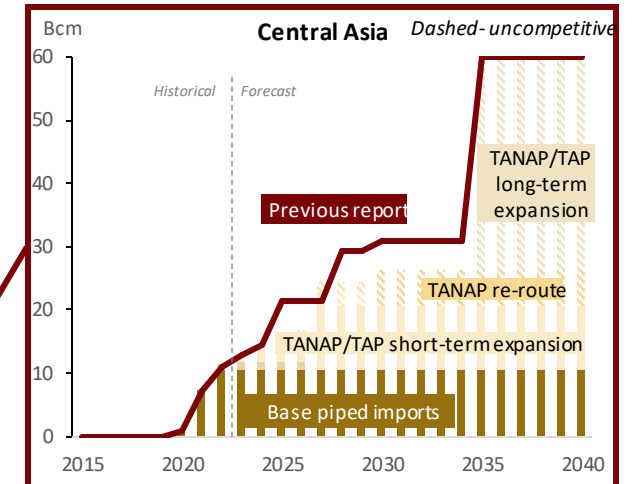
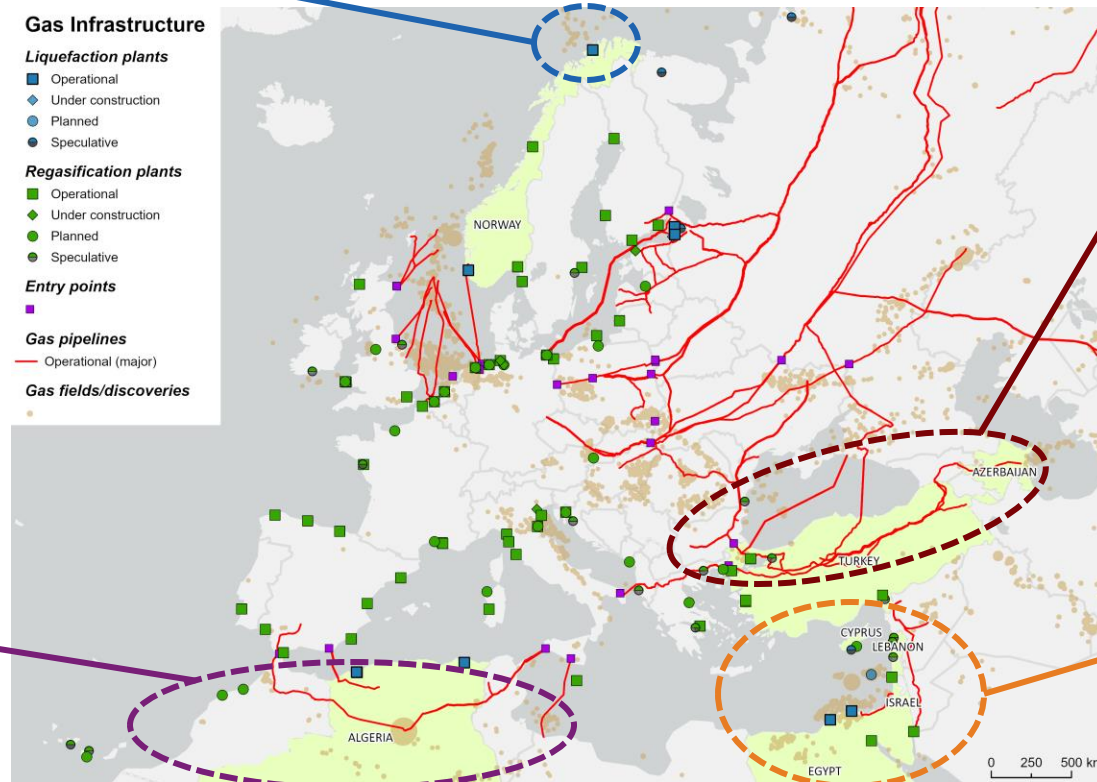
* Figures converted from USD/bbl at 35 USD/bbl and 30 USD/bbl
 Source: Rystad Energy research and analysis; Harbour Energy annual report, Equinor CMD 2023, Vår Energi annual report 2022

Infrastructure expansions around Europe's periphery can help increase supply of piped gas

-However, the full potential from North Africa and Central Asia likely uncompetitive vs LNG



- Gas Infrastructure**
- Liquefaction plants**
 - Operational
 - Under construction
 - Planned
 - Speculative
 - Regasification plants**
 - Operational
 - Under construction
 - Planned
 - Speculative
 - Entry points**
 - Operational
 - Under construction
 - Planned
 - Speculative
 - Gas pipelines**
 - Operational (major)
 - Gas fields/discoveries**



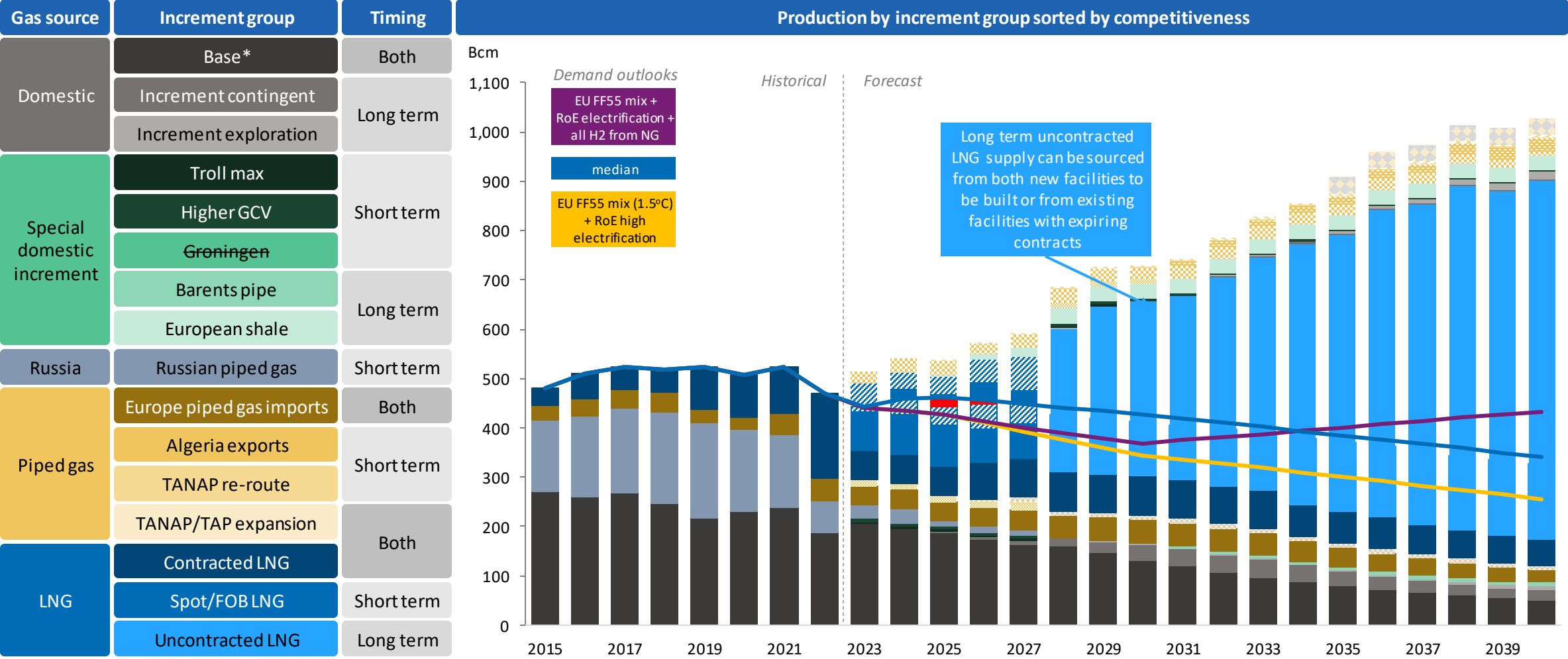
*Solid line indicates capacity given by Medgaz pipeline, Transmed pipeline and Greenstream pipeline. Dashed line includes GME pipeline in addition – GME flows have been suspended since 2021 due to political tension between Algeria and Morocco. **See domestic increments for additional details
Source: Rystad Energy research and analysis

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5	Long-term there is sufficient low cost LNG to rebalance Europe's gas markets at about 30 EUR/MWh	<ul style="list-style-type: none">• Abundant North American low-cost gas resources can backstop the global gas markets, be the marginal supply and price setter provided that necessary midstream infrastructure is constructed• Not all LNG is from North America implying that there is an European diversification play possible

Source: Rystad Energy research and analysis

New LNG supplies available in abundance → Contracts needed to underpin value chain investments

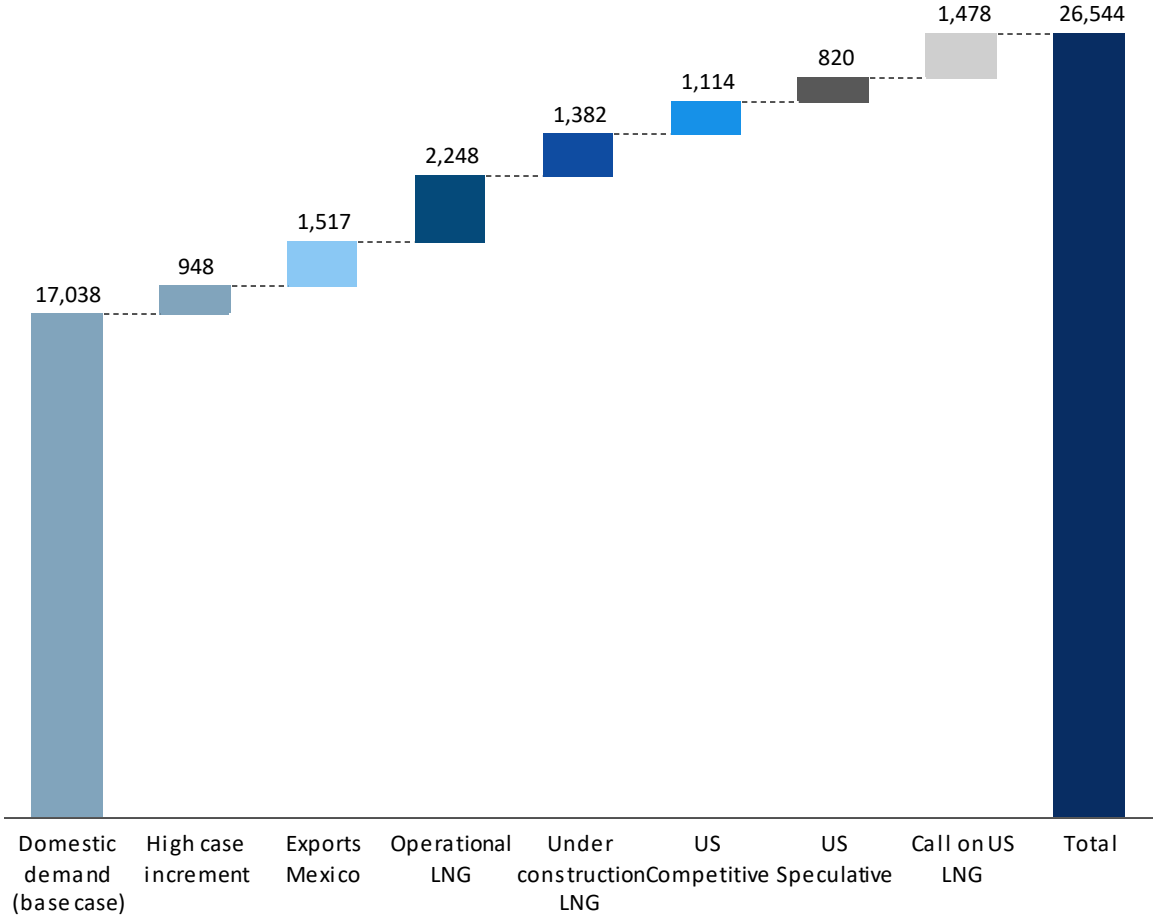


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 Source: Rystad Energy research and analysis, GasMarketCube, European Commission, UK BEIS

US resources are burdened with all LNG growth to see if LNG markets have an effective price ceiling

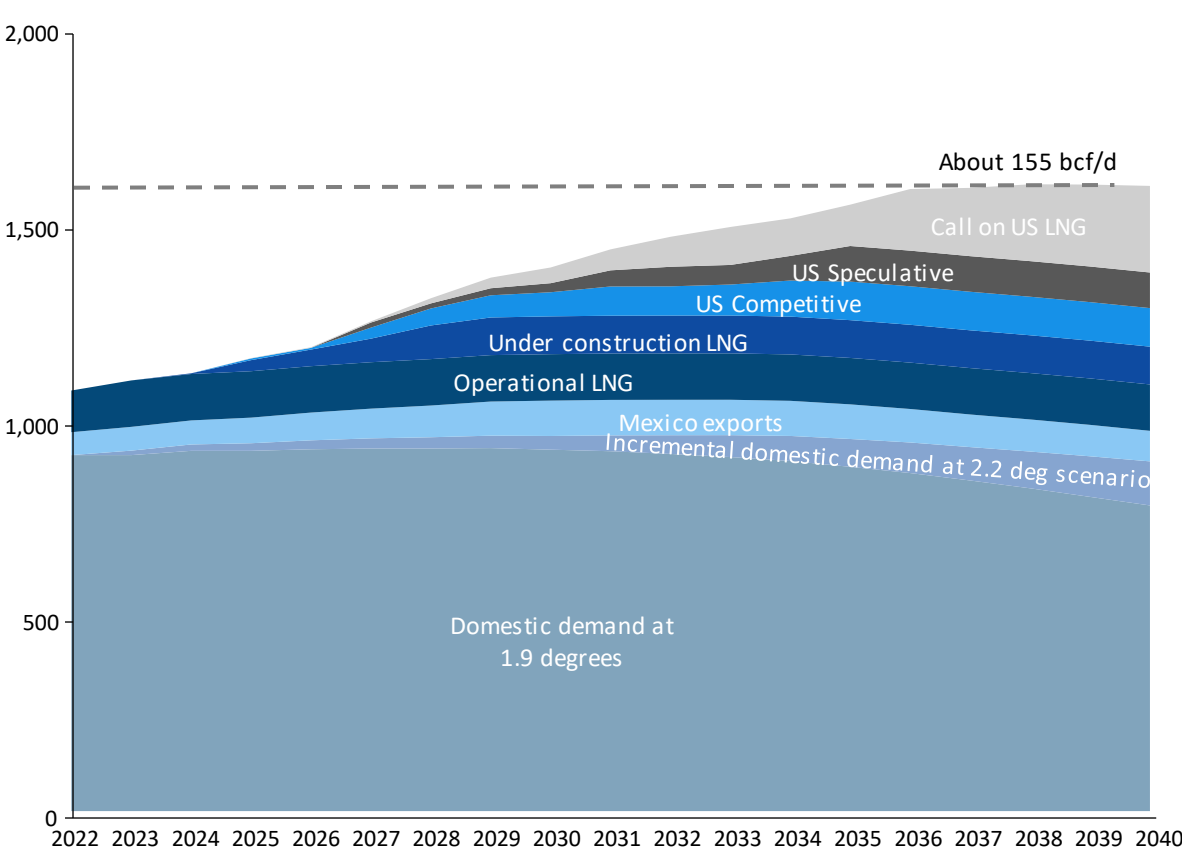
Resources required to meet max call on US gas production 2022-2040

Bcm (cumulative)



Production profile*

Bcm



*The Production profile follows the median scenario
 Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube

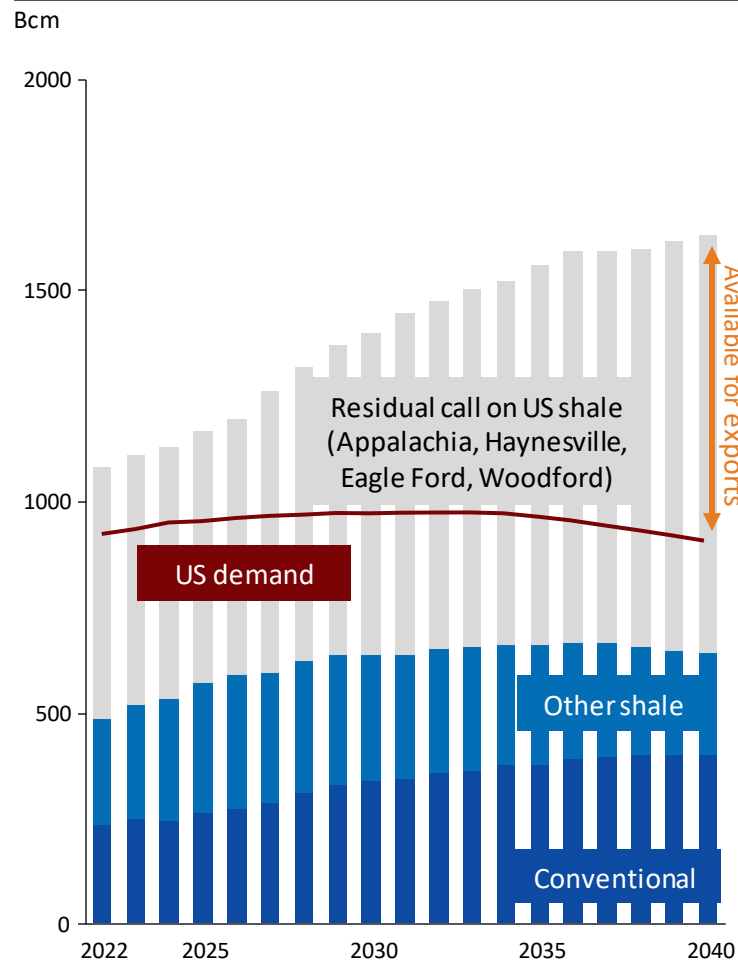
Abundant low-cost US gas resources can effectively support LNG supply and set a price ceiling

- Provided that US midstream infrastructure is developed as required

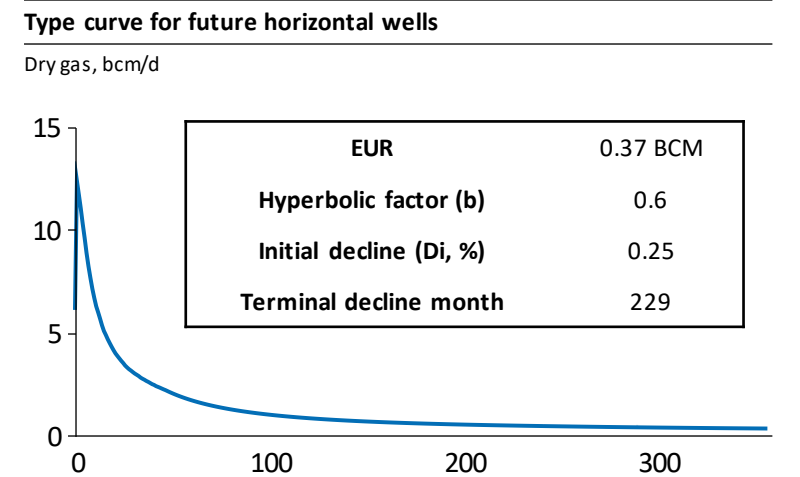
Resource potential, split by shale play

Basin	Remaining wells*	BCM per well	Remaining resources (bcm)
Appalachia	90,000	0.41	36,119
Haynesville	25,000	0.36	8,499
Eagle Ford (dry gas)	20,000	0.24	4,759
Woodford (dry gas)	8,000	0.31	2,323
Other shale	n/a	n/a	11,298
Conventional gas	n/a	n/a	3,745
Sum supply	143,000	0.37	66,743
Maximum demand (2022 - 2050)			44,416

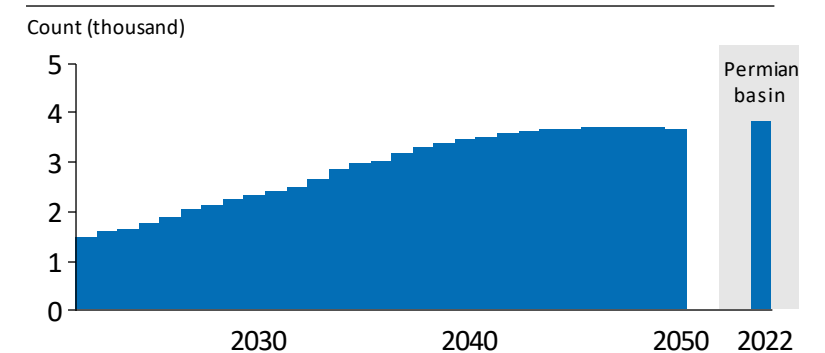
Maximum US gas production, split by resource type



Implied activity



Required well count for maximum call on gas shale plays

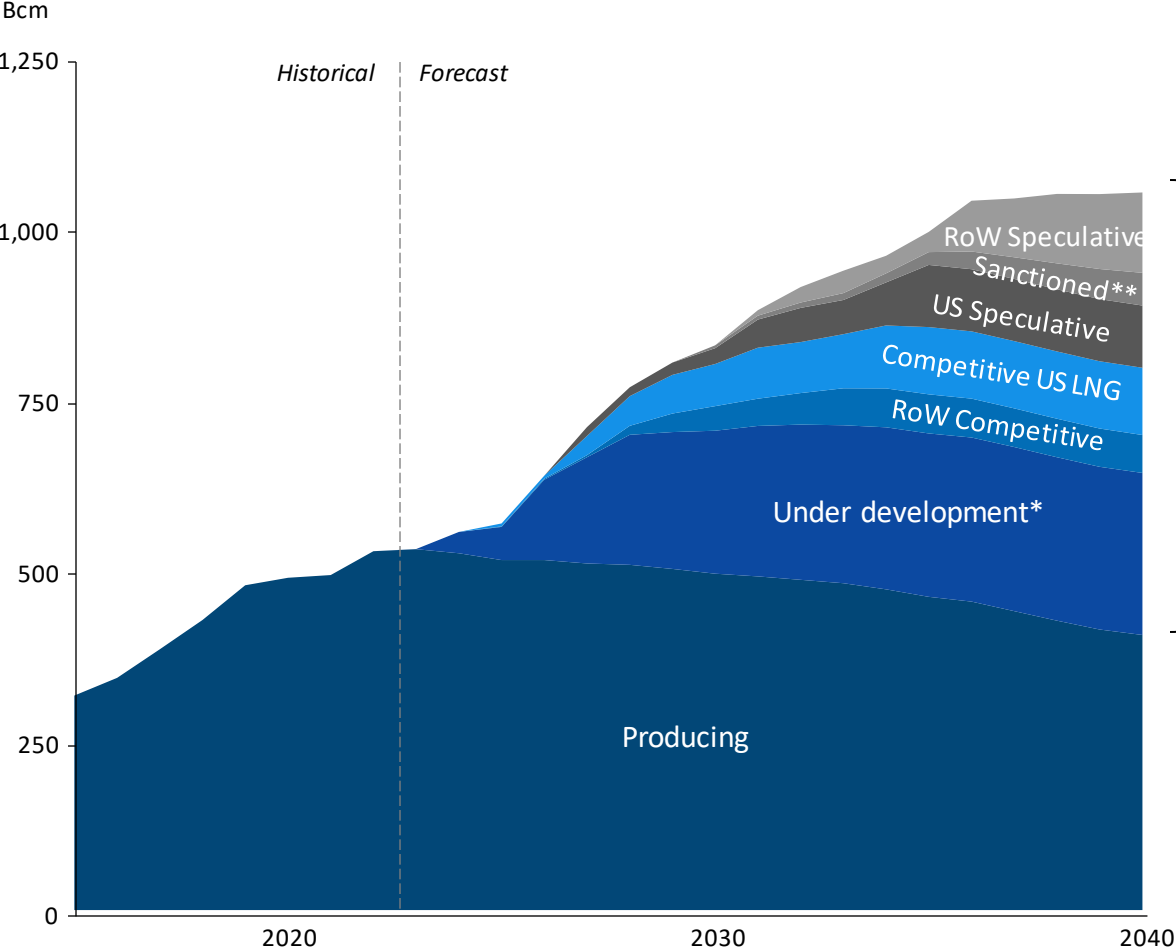


About 3,700 wells per year at an inventory of 143,000 = **39 years of inventory** to maintain max required annual production

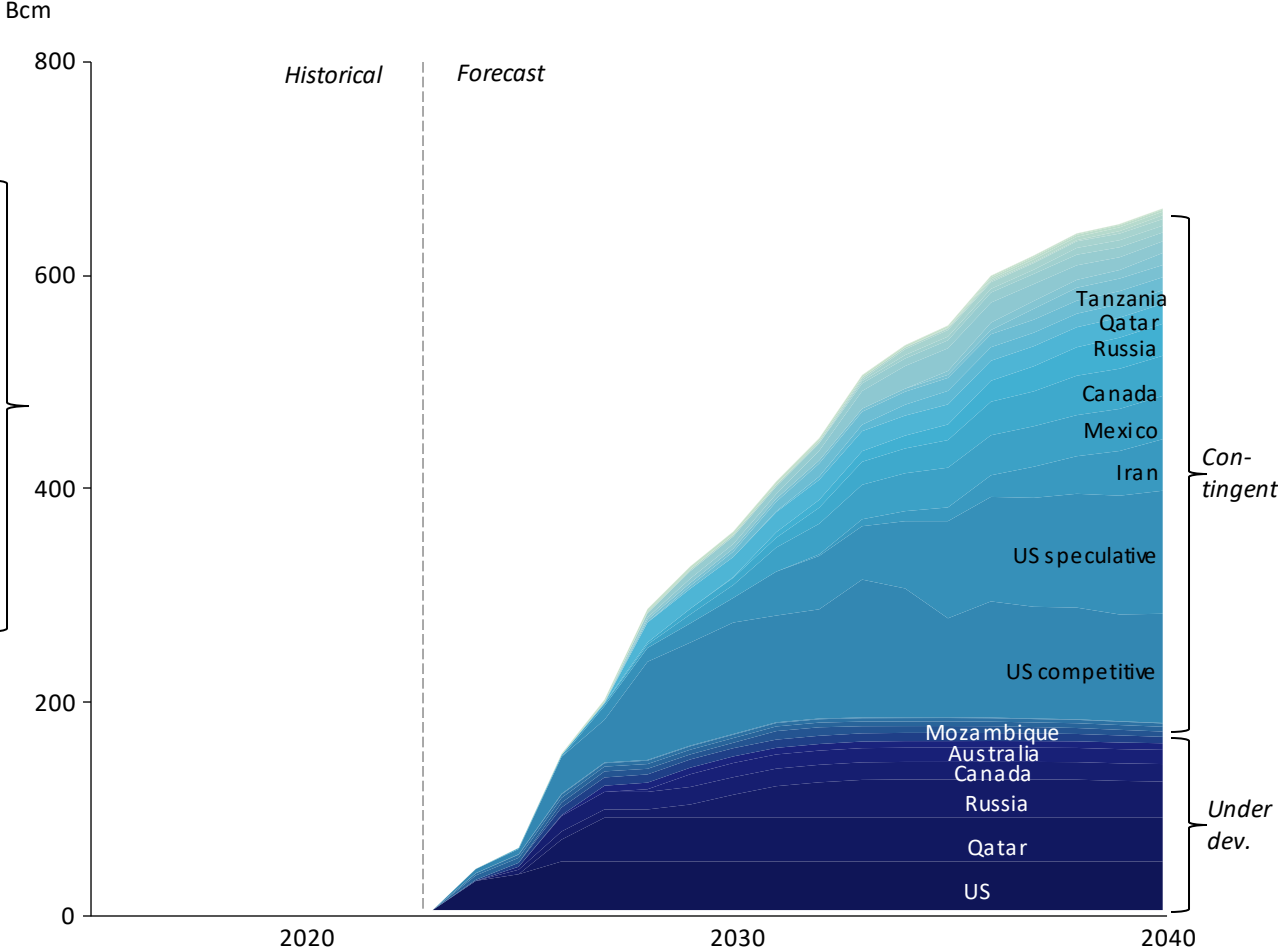
* At 0.11 USD/MCM or 3.8 USD/MMBtu
Source: Rystad Energy research and analysis, Rystad Energy UCube, EQT

New LNG supply is not only coming from the US - Europe can diversify

Competitive supply categories



Under development and Contingent LNG project grouped on country

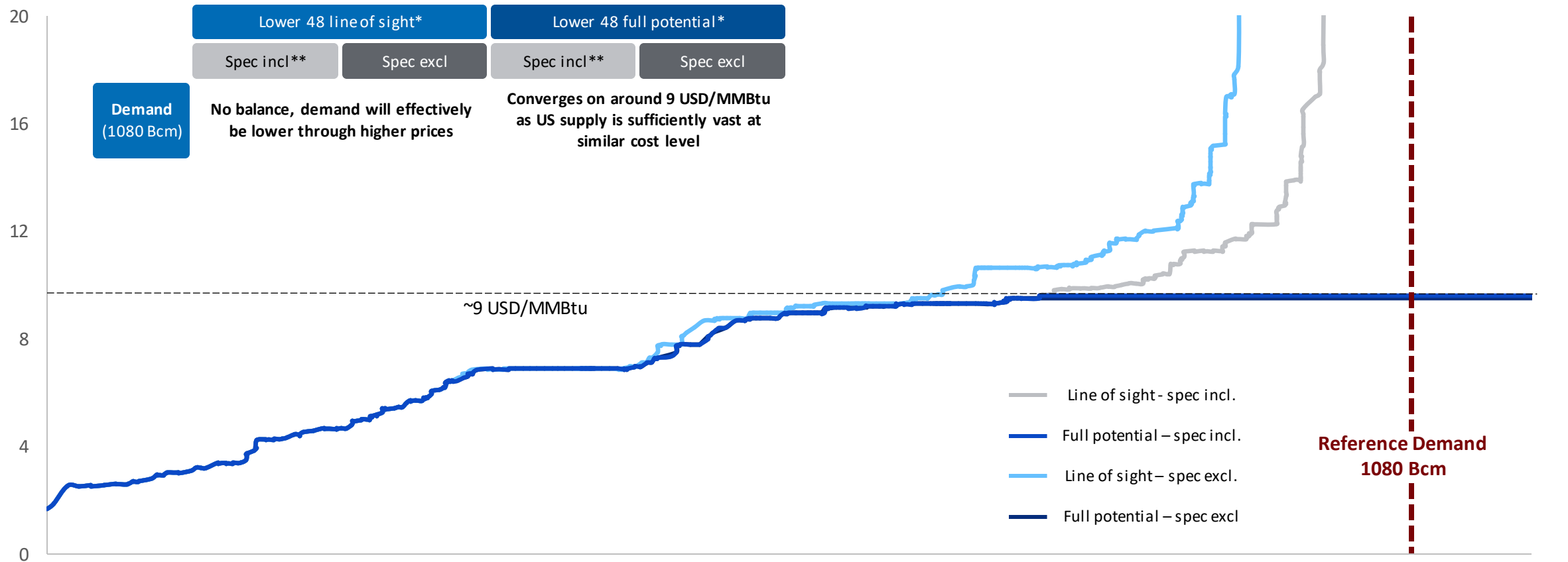


*Including all ex-US under development LNG; **LNG from Russia and Iran
 Source: Rystad Energy research and analysis, UCube

However, it is unlikely that anything but US long run marginal cost will be marginal supply and thereby determine gas prices

Cost of supply build-up in 2040 for various LNG supply permutations

Y-axis: USD/MMBtu; x-axis: Bcm



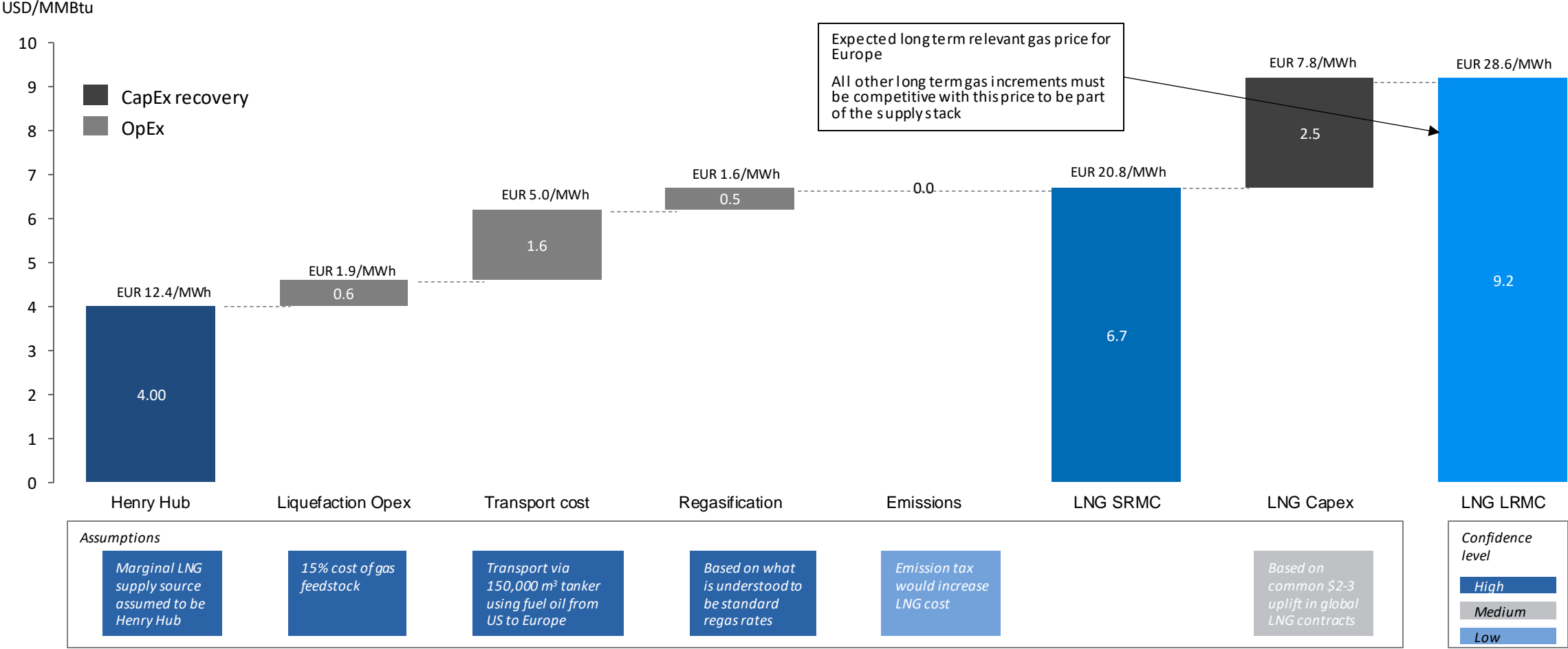
*Refers to all US lower 48 projects where a clear pathway to FID and production is observed. Corresponds to the US competitive wedge on the previous slide. Full potential ignores and infrastructure constraints and pathway to FID

**Refers to speculative projects in Iran, Russia, Mexico and other places where resources in isolation are competitive, but non-technical risk prevents development

Source: Rystad Energy research and analysis

US long run marginal cost of supply setting global gas prices (equal to pre-crisis expectations)

LNG price forecast buildup based on long term Henry Hub assumption



Note: Numbers may not add up due to rounding
Source: Rystad Energy research and analysis; ANGEA report 2023

Content

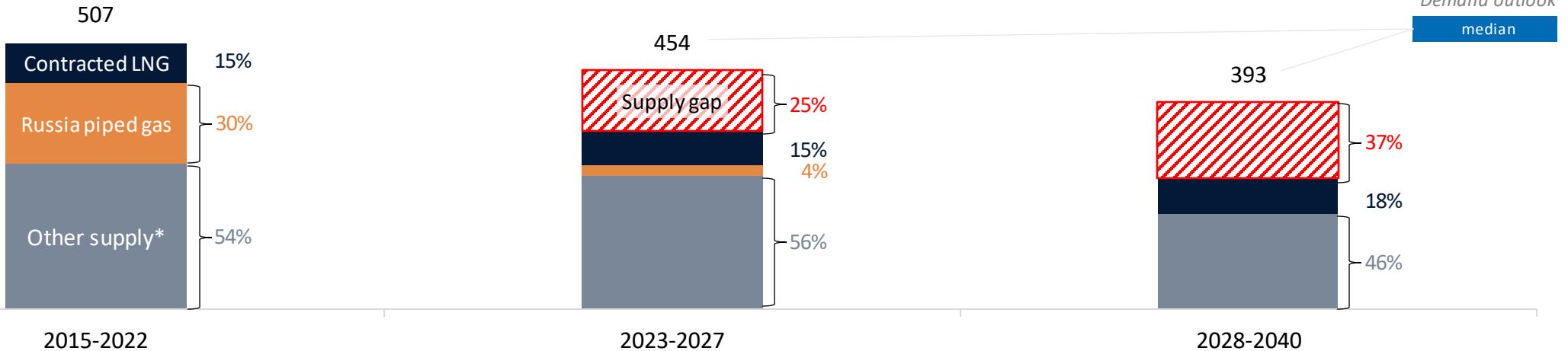
Key themes	Comment
1 Required background information	<ul style="list-style-type: none">• Demand outlooks are required to contextualize the supply data, but is not the key focus of this report• A market median view has been established using post-war gas demand outlooks published by various entities
2 2022/2023 in review - market mechanisms kicked in to balance market	<ul style="list-style-type: none">• Europe had the highest average wholesale gas prices in the world during 2022 at 32 USD/MMBtu• This caused demand curtailment and increased LNG imports to replace Russian gas• Infrastructure was expanded to handle more LNG imports and west to east gas flows
3 Gas demand and supply balance likely to be tight towards at least 2027	<ul style="list-style-type: none">• Europe is required to maintain and even grow its record high LNG market share in competition with Asia• Asia has the right for first refusal to 75% of all LNG supply in the period leaving Europe at the mercy of providing sufficient economic incentive to reroute cargoes
4 Maximize domestic supply and piped imports, but realize it will be insufficient to balance	<ul style="list-style-type: none">• Without Russian gas maximizing domestic supply and imports from North Africa and Central Asia should be pursued due to typically lower cost and diversification• However, without Russia it appears inevitable that LNG will grow its market share of European supply
5 Long-term there is sufficient low cost LNG to rebalance Europe's gas markets at about 30 EUR/MWh	<ul style="list-style-type: none">• Abundant North American low-cost gas resources can backstop the global gas markets, be the marginal supply and price setter provided that necessary midstream infrastructure is constructed• Not all LNG is from North America implying that there is an European diversification play possible
6 Avoid political signals / legislative barriers / market interventions that could discourage long-term supply contracts	<ul style="list-style-type: none">• Europe is out of options short term and will likely have to heavily rely on significant growth in LNG market share to reach the 90% storage level mandate• Longer term offers more flexibility should Europe want to increase its right of first refusal LNG supply

Source: Rystad Energy research and analysis

Europe is transitioning as a gas market and must play a much more active role in global affairs to secure supplies and reduce exposure to the expensive short-term flexible LNG market



Annual average Bcm



- Russia was the ultimate backstop to European gas market whereby it could leverage its enormous fields as swing producers and extensive pipeline network to distribute supplies when, where and at what quantity was needed
- Europe was the market of last resort for flexible LNG supplies awarding Europe with favorable market power on attracting affordable cargoes

- Without regular Russian gas supplies Europe is missing 600 bcm of gas between 2023 and 2027 despite maxing out all other supply options
- Europe has to tap global flexible LNG to fill this gap
- Asia has right of first refusal to about 75% of all LNG in this time period implying that Europe is out of options and needs to provide sufficient economic incentives to reroute cargoes

- 2100 bcm gas is missing between 2028 and 2040 despite maxing out domestic supplies and piped imports
- LNG is the only way to fill this gap, but unlike the immediate future, the long-term time frame awards significant flexibility on how to source these supplies as long as security of demand is provided to suppliers
- US will inevitably be a key LNG supplier, but geographic diversification is nevertheless possible

Note: Contracted LNG volumes as of end of October 2023; *Includes all competitive domestic supply and all competitive piped imports from North Africa and Central Asia
Source: Rystad Energy research and analysis

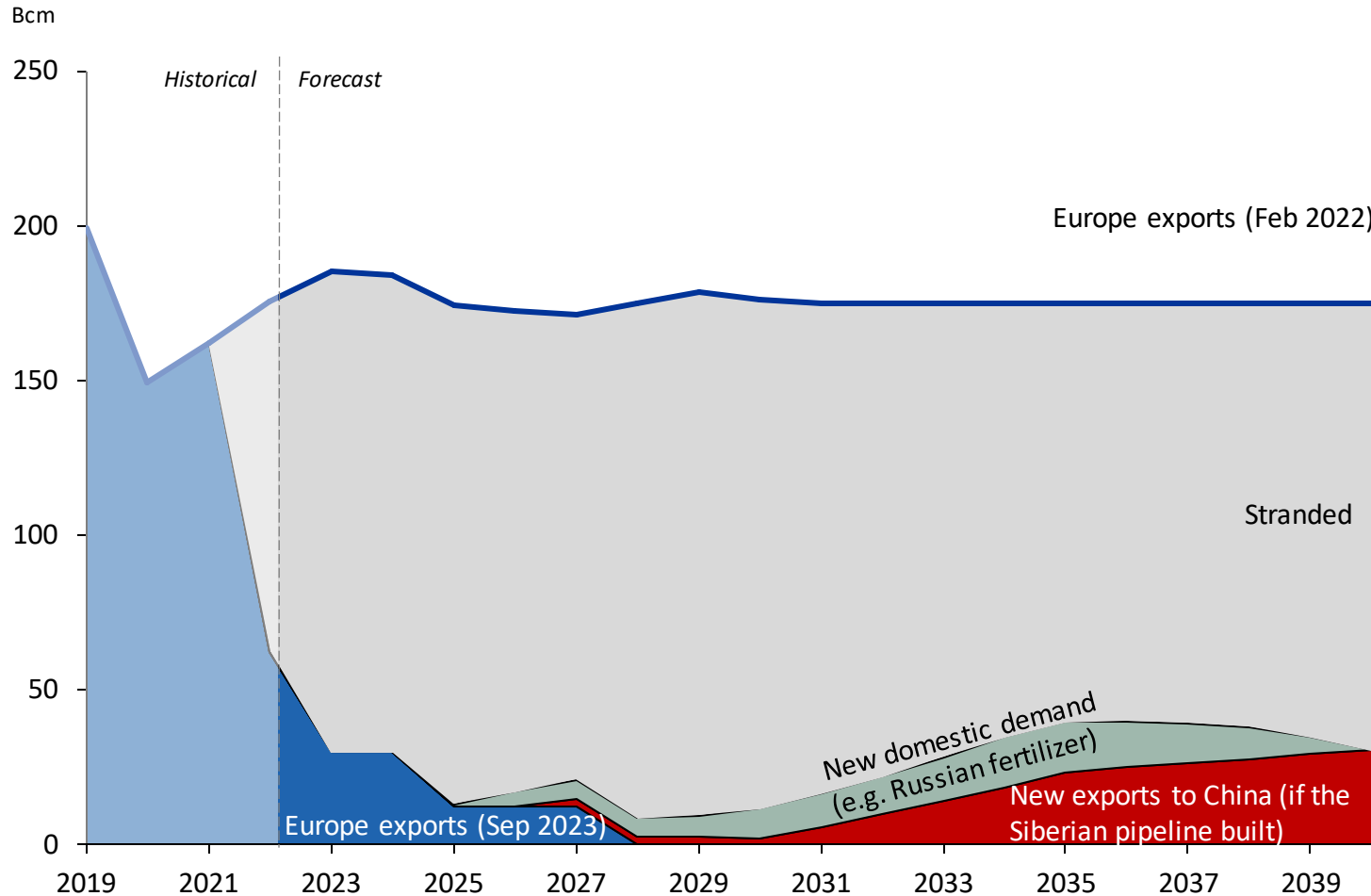
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<p>3 Gas demand and supply balance likely to be tight towards at least 2027</p>	<ul style="list-style-type: none"> • Europe is required to maintain and even grow its record high LNG market share in competition with Asia • Asia has the right for first refusal to 75% of all LNG supply in the period leaving Europe at the mercy of providing sufficient economic incentive to reroute cargoes
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<p>6 Avoid political signals / legislative barriers / market interventions that could discourage long-term supply contracts</p>	<ul style="list-style-type: none"> • Europe is out of options short term and will likely have to heavily rely on significant growth in LNG market share to reach the 90% storage level mandate • Longer term offers more flexibility should Europe want to increase its right of first refusal LNG supply
<p>7 Addendum: Significant economic pain also for Russia - significant stranded resources</p>	<ul style="list-style-type: none"> • Russia is unable to reroute most of its European gas exports resulting in about 3000 bcm of stranded supply • China may provide export relief in the 2030s provided significant new infrastructure is in place

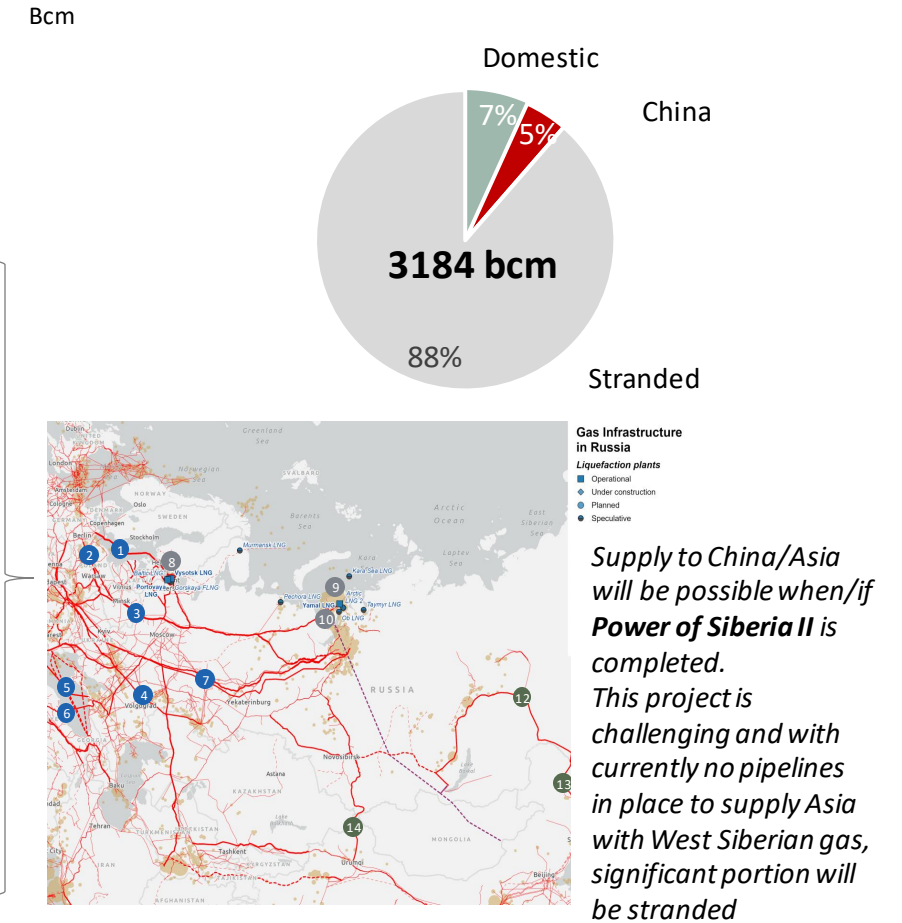
Source: Rystad Energy research and analysis

Reduced pipeline sales to Europe reduces Russian production until 2040 by about 3,200 Bcm equivalent to about EUR 660 billion* lost revenues

Russian natural gas export to Europe 2020-2040, by UCube vintage (2022 vs 2023)



Total change in export volumes to Europe (2020-2040)

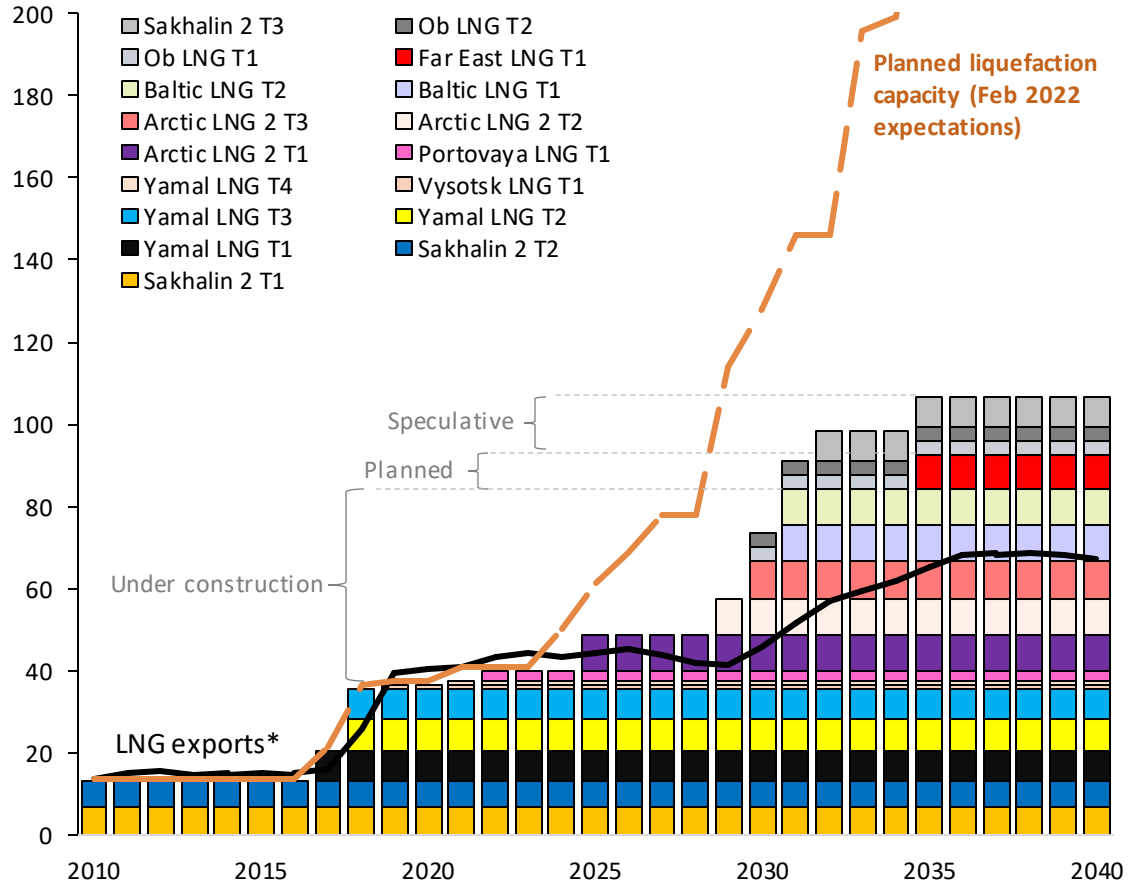


*Assuming average price of \$6/MMBtu in 2019 as published by IGU
Source: Rystad Energy research and analysis; Rystad Energy UCube

Big downgrade on Russian LNG liquefaction capacity and LNG exports due to war and sanctions

LNG exports from Russia vs Liquefaction capacity, split by train

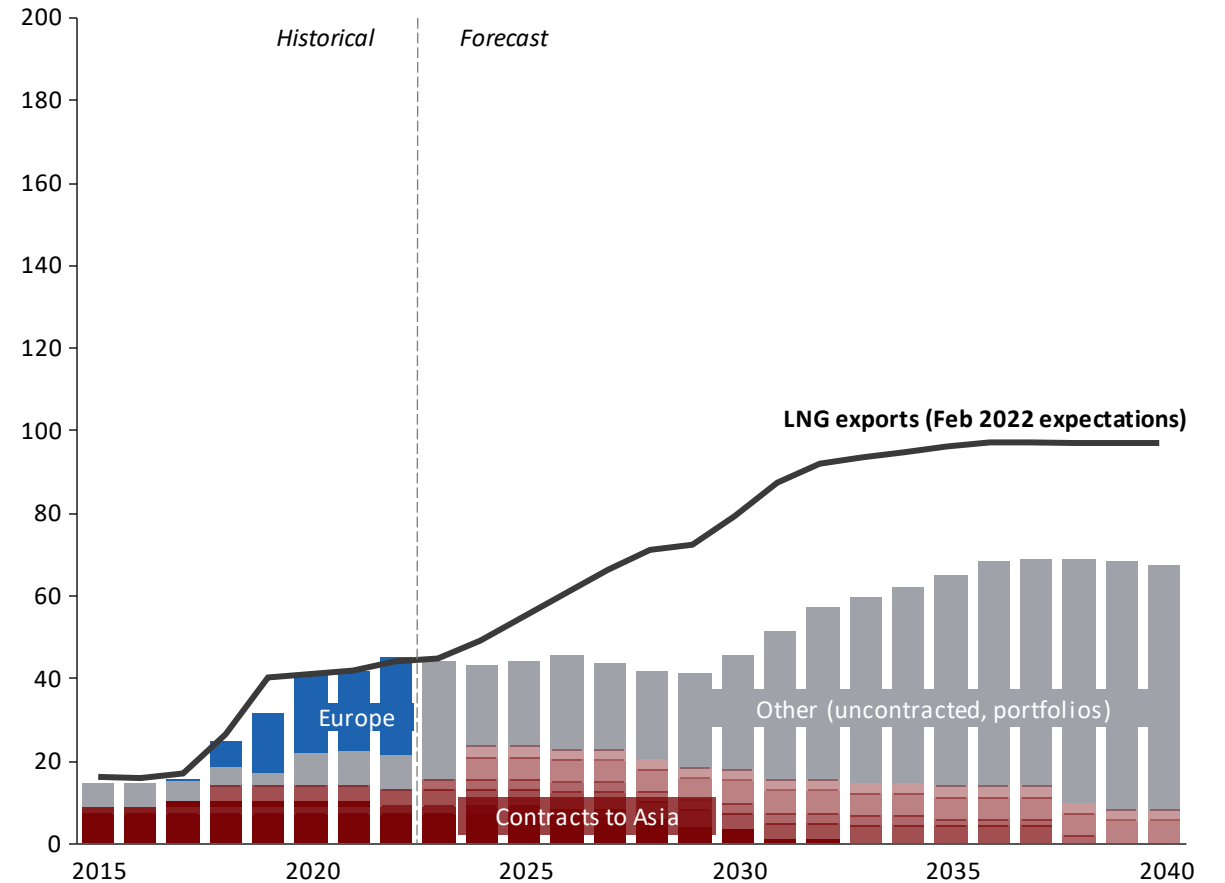
Bcm



* Utilization decline towards 2040 due to diminishing Sakhalin resources
Source: Rystad Energy research and analysis

Russian LNG exports, split by destination

Bcm



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Appendix

EU gas demand dropped 12% from 2021 to 2022; down significantly from pre-invasion forecasts

Sector category	System	Item	Contribution to gas demand change (bcm)	Comment	Caused by high gas prices
2021		Actual gas demand	423	<ul style="list-style-type: none"> 423 bcm in 2021 as a starting point. 	
Power	Weather	Less hydro	12	<ul style="list-style-type: none"> Hydro power production dropped by the equivalent of 12 bcm. 	✗
	Policy	Less nuclear	22	<ul style="list-style-type: none"> Nuclear outages, largely centered on France saw a call 	✗
		More renewables	-11	<ul style="list-style-type: none"> Gas use displaced by output of renewables saw 11bcm of gas demand displaced. 	✗
	Fuel Switching	More coal	-6	<ul style="list-style-type: none"> Coal use increased across the EU by approximately 6 bcm. 	✓
	Demand Destruction	Other avoided demand	-15	<ul style="list-style-type: none"> Other demand reduction saw 15 bcm of gas displaced. 	✓
Buildings	Weather	Weather	-18	<ul style="list-style-type: none"> Winter months in 2022 were significantly warmer than 2021. 	✗
	Policy	Efficiency	-3	<ul style="list-style-type: none"> Continued efficiency gains made a marginal impact on gas demand. 	✓
	Demand Destruction	Behavior and fuel switching	-7	<ul style="list-style-type: none"> Households and businesses reduced their own consumption across the EU. 	✓
Industry	Policy	Efficiency	-3	<ul style="list-style-type: none"> Continued efficiency gains made a marginal impact on gas demand. 	✓
	Demand Destruction	Production curtailment	-13	<ul style="list-style-type: none"> Industry output dropped in response to higher prices. 	✓
		Fuel switching	-7	<ul style="list-style-type: none"> Industry oversaw additional use of other fuel types. 	✓
	Other avoided demand	Other avoided demand	-2	<ul style="list-style-type: none"> Demand destruction led to other drops. 	✓
2022		Actual gas demand	372	<ul style="list-style-type: none"> Demand in 2022 was 12% less than in 2021. 	-56 bcm gas price effect
		Demand shortfall	23	<ul style="list-style-type: none"> There was a shortfall of 23 bcm on pre-invasion forecasts. 	
		RE pre-invasion forecast	395	<ul style="list-style-type: none"> Rystad Energy's December 2021 forecast for 2022 was significantly higher than the actual. 	

Source : Rystad Energy research and analysis, IEA
















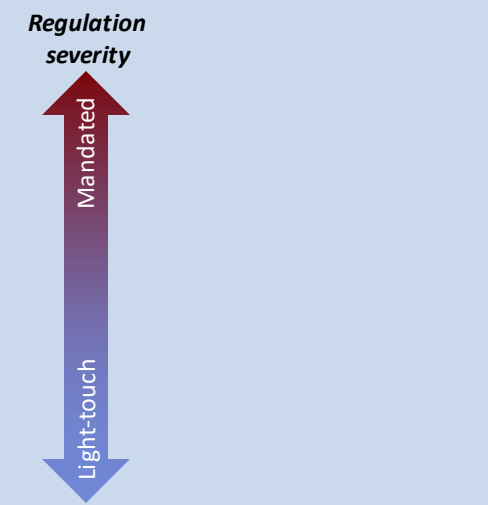












Major European initiatives taken to ease strains on gas markets

European initiatives and infrastructure projects

Initiative	Comment
Minimum gas storage obligations	<ul style="list-style-type: none"> The European Union implemented a storage regulation in June 2022 requiring storage sites to be filled to a minimum of 80% capacity before the winter of 2022-23 and 90% capacity before subsequent winter periods. Some EU Member States went beyond the EU regulation and implemented stricter regulations with filling targets exceeding 90%.
Demand reduction measures	<ul style="list-style-type: none"> EU regulation proposes a voluntary 15% reduction in gas demand between August 2022 and March 2023, based on the five-year average. Reduction target may become mandatory if the EU alert crisis level is triggered.
Energy diplomacy	<ul style="list-style-type: none"> The European Union has increased its efforts in energy diplomacy by actively engaging with important natural gas and LNG suppliers such as Algeria, Azerbaijan, Norway, and the United States. The EU aims to establish stronger energy partnerships with these countries to enhance its energy security and ensure a stable supply of natural gas and LNG.
Joint Gas Purchasing Mechanism	<ul style="list-style-type: none"> The Joint Gas Purchasing Mechanism, established in December 2022, coordinates joint gas purchases by aggregating demand and allowing participation from companies in the European Union and Energy Community Contracting Parties. It aims to improve gas procurement efficiency and promote collaboration through joint purchasing initiatives, extending participation beyond the European Union.
Enhanced solidarity	<ul style="list-style-type: none"> The Council of the European Union adopted new default rules in December 2022 to enhance solidarity among EU member states in sharing natural gas during genuine emergencies. The default rules will be applied when member states have not established bilateral agreements outlining the details of solidarity in such situations.
New FSRUs and the expansion of existing regasification terminals	<ul style="list-style-type: none"> European Union's regasification capacity to increase by 25% in 2023 compared to 2021 through the addition of new FSRUs and expansion of existing terminals. The expected annual increase in capacity is approximately 40 bcm.
New interconnectors	<ul style="list-style-type: none"> Multiple interconnectors were established before the 2022-23 heating season to enhance internal gas flow and increase gas supply diversity, particularly among Central and South-Eastern European nations with a historic dependence on Russian pipeline gas. These interconnectors enabled improved gas transportation and reduced reliance on Russian gas for heating purposes in the mentioned regions.
Faster RE deployment	<ul style="list-style-type: none"> The European Commission proposes increasing the EU's 2030 target for renewables to 45% as part of the REPowerEU Plan. The EU has implemented emergency measures to expedite the permitting process for renewable energy projects.
Electricity emergency measures	<ul style="list-style-type: none"> Implementation of electricity emergency measures, including reduced electricity consumption during peak hours, resulted in positive outcomes such as reduced gas usage for electricity production and alleviated price pressures. These measures effectively addressed the electricity crisis by curbing peak-hour electricity usage, leading to decreased gas dependency and price stabilization.

Source: Rystad Energy research and analysis, IEA

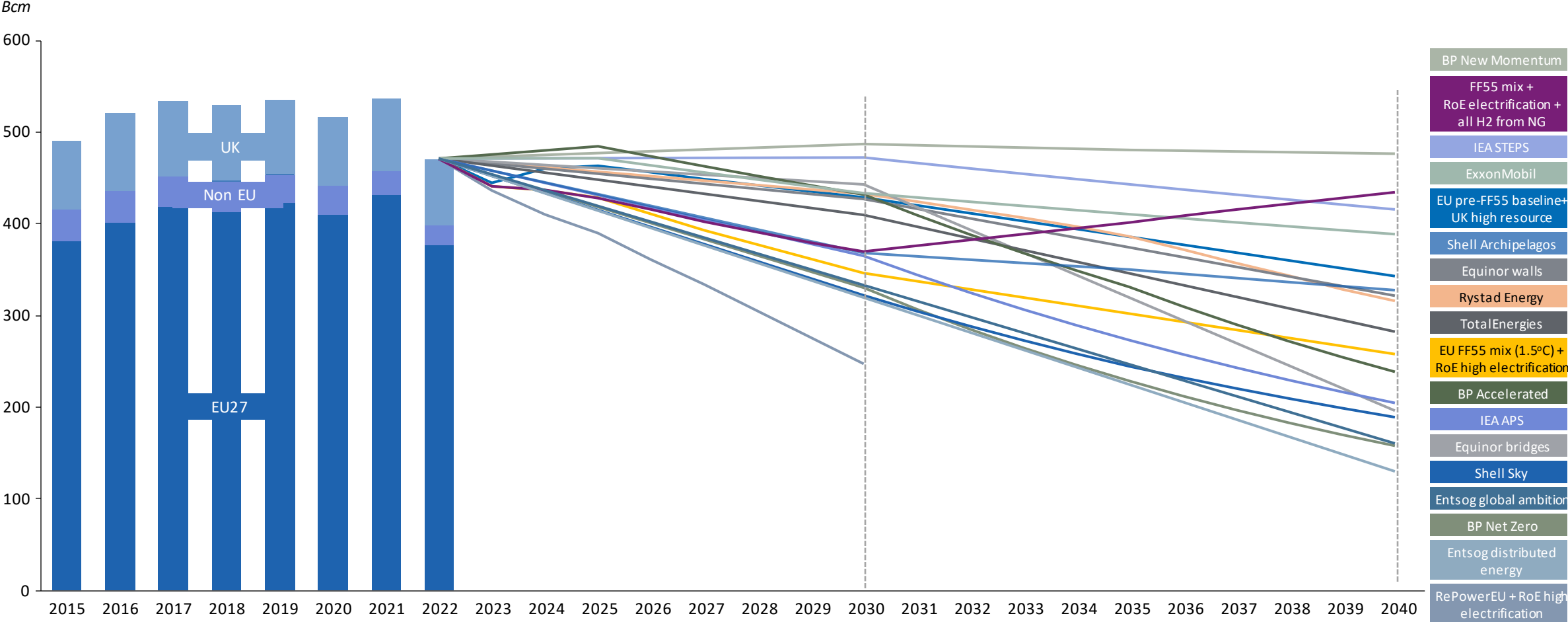
EU countries introduced range of targeted energy-saving measures to reduce gas demand in 2022

Country	2022 situation	Public sector	Households	Industrial sector
 France	President Macron issued a public request for 10% consumption reduction to avoid energy rationing.	 Limits on AC use in government offices (banned at outside temp below 26°C).	 'Tariff reduction formulas' for consumption reduction during peak hours.	 Plans for priority disconnection of large industrial and commercial consumers.
 Germany	Reduce gas consumption by 20% and reopen coal-fired power emergency plants. Ratified energy-saving package in August 2022, aiming at a gas demand reduction of 7%.	 Offer funding and incentives for energy efficiency measures.	 Use smart thermostats and reduce heat leakage by sealing windows and doors.	 Optimize AC systems and lighting systems in large buildings.
 Spain	In situation of marginal energy surplus but large proportion of dispatchable energy is highly valuable.	 Limits on AC and heating in public buildings (above 27°C in summer and below 19°C in winter).	 Discount or free access trips on state-owned rail lines and/or communal public transport.	 Buildings with last energy efficiency inspection before 1 January 2021 to be re-inspected before 31 December 2022.
 Norway	Clear communication of gas and electricity scarcity to households and industries.	 Stipulated that all consumers have smart meters installed by 1 January 2019.	 Market-correlated price-cap to raise consumer awareness of market price and adjust consumption.	 <p>Regulation severity</p> <p>Mandated ↑</p> <p>↓ Light-touch</p>
 Denmark	Government providing incentives and imposing some requirements to reduce power consumption.	 Limits on AC use in government offices (minimum temperature at 19°C).	 Encouraged to turn down the heat, limit hot water use and use electricity during non-peak hours.	
 Poland	Aim to cut gas consumption by 25% in winter 2022 by reducing heating demand in the public sector.	 National and local authorities obliged to reduce electricity consumption by 10% from 1 October 2022.	 Incentive in form of a 10% power price cut for those reducing electricity use by 10%.	
 Hungary	Did not impose mandatory measures but issued guidelines and households have self-regulated to limit spending.	 Limit on heating in public buildings to 18°C, excluding hospitals and residential care institutions.		
 Greece	Goal of 20% reduction in energy consumption.	 Reduce AC use, install window shields and switch off computers after working hours.		
 Lithuania		 Limits on heating use (indoor temperature at 19°C and additional reduction to 17°C Friday to Monday).		

Source : Rystad Energy research and analysis

Forecasts range from 180bcm to 480bcm demand in 2040 creating investor uncertainty

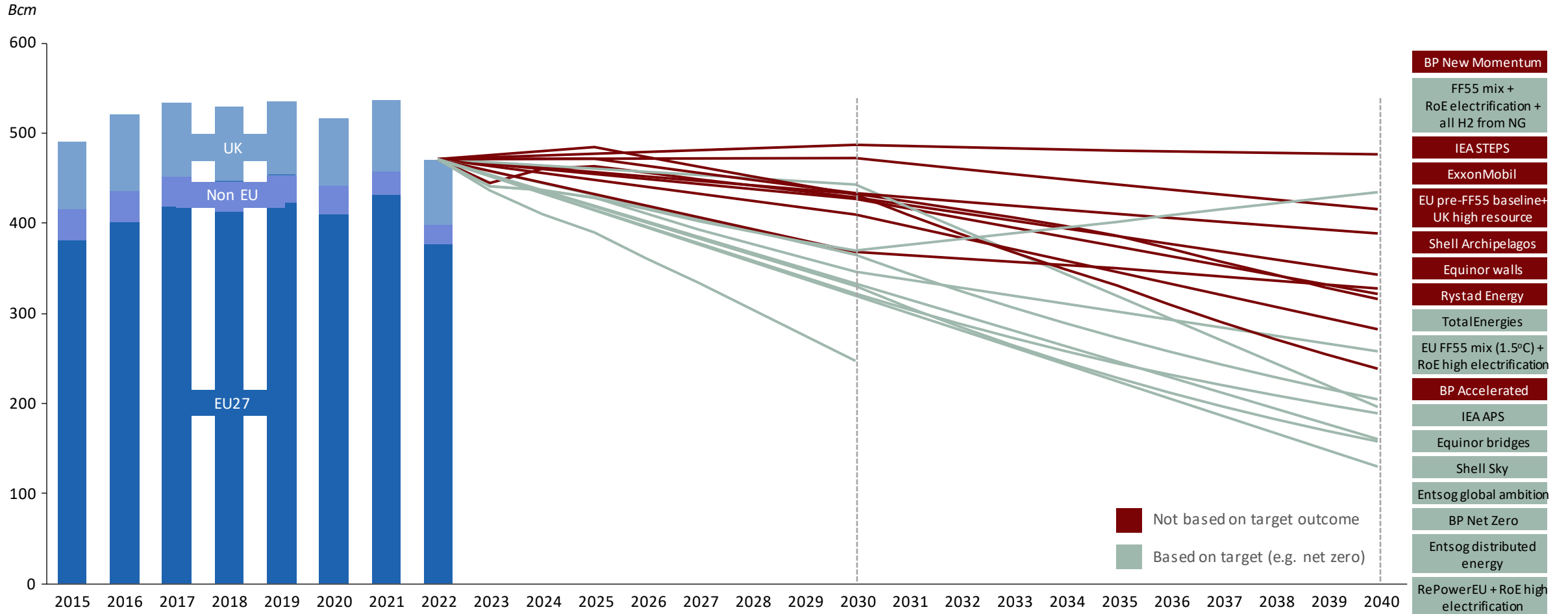
European demand outlook by scenario



Countries included in the scope are: EU, UK, Norway, Albania, Moldova, Montenegro, North Macedonia, Serbia, Switzerland, Ukraine
 IEA, Equinor and TotalEnergies uses relevant growth rate for outlook – geographic coverage is not exactly 1 to 1 with historical data points
 Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy, IEA, Equinor, TotalEnergies

Scenarios not based on target outcome indicate higher gas demand

European demand outlook by scenario



Countries included in the scope are: EU, UK, Norway, Albania, Moldova, Montenegro, North Macedonia, Serbia, Switzerland, Ukraine

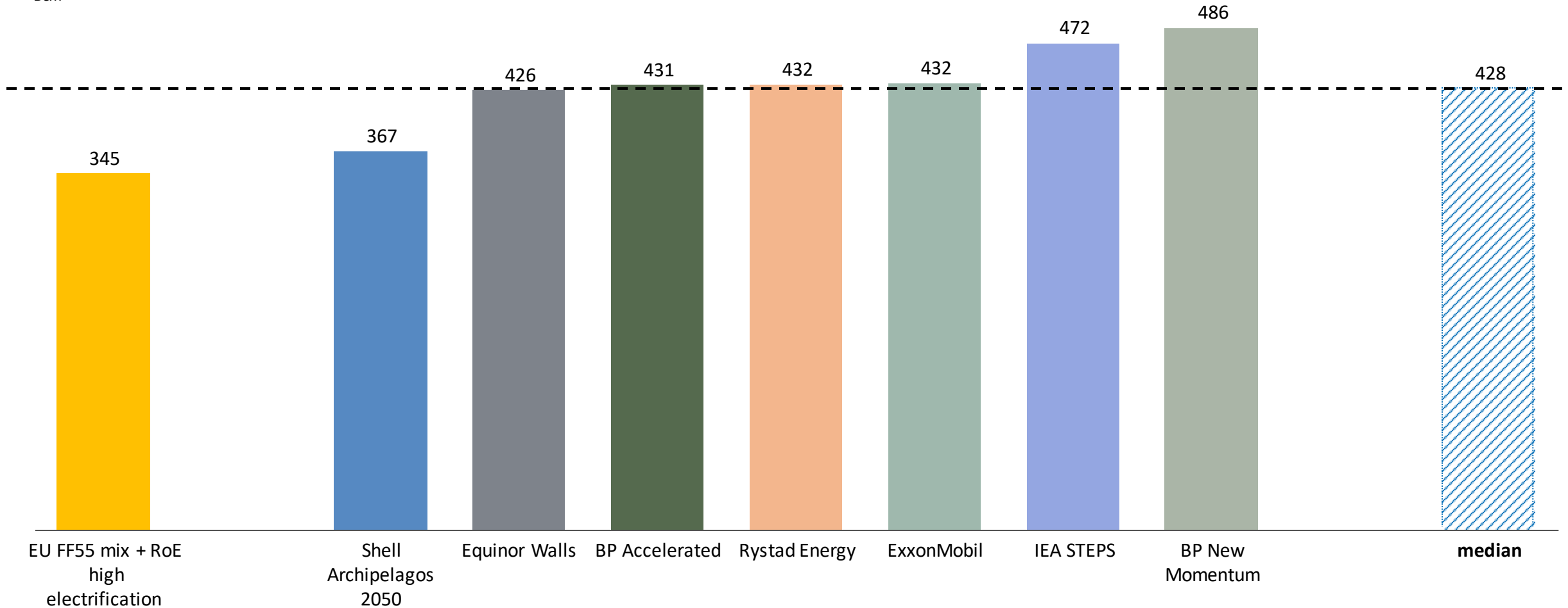
IEA, Equinor and TotalEnergies uses relevant growth rate for outlook – geographic coverage is not exactly 1 to 1 with historical data points

Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy, IEA, Equinor, TotalEnergies

median view aligned with the average of scenarios not based on target outcome

European demand outlook in 2030 by scenario

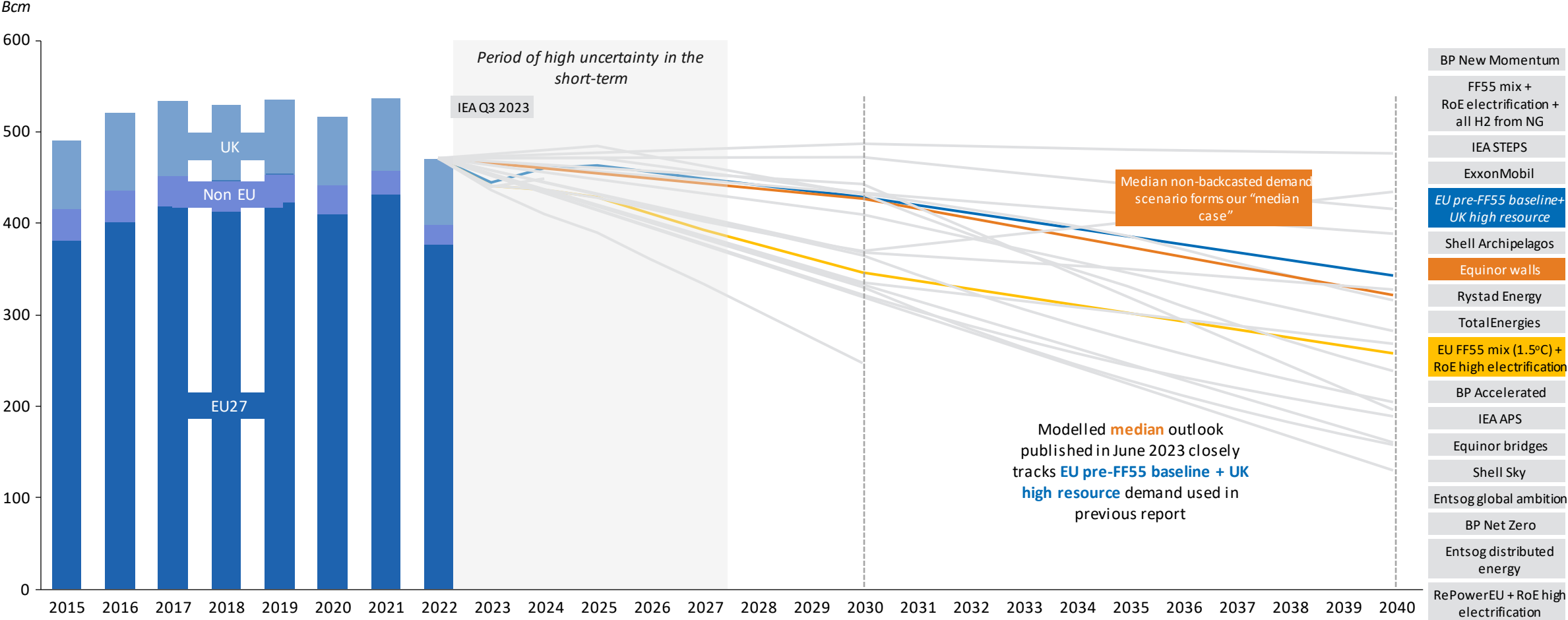
Bcm



Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy, IEA, Equinor, TotalEnergies

Median demand from non-target backcasted outlooks closely tracks EU's pre-FF55 outlook

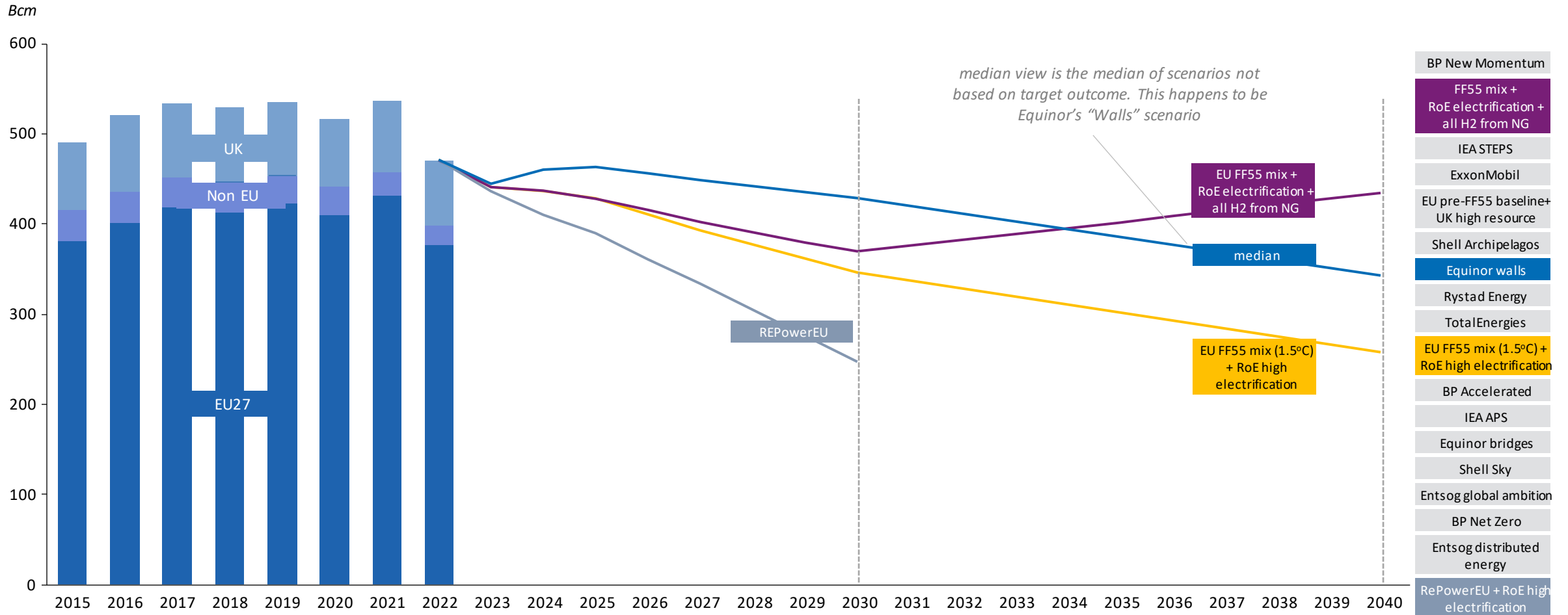
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A set of scenarios will be used to contextualize the European supply options

European demand outlook by scenario



Countries included in the scope are: EU, UK, Norway, Albania, Moldova, Montenegro, North Macedonia, Serbia, Switzerland, Ukraine

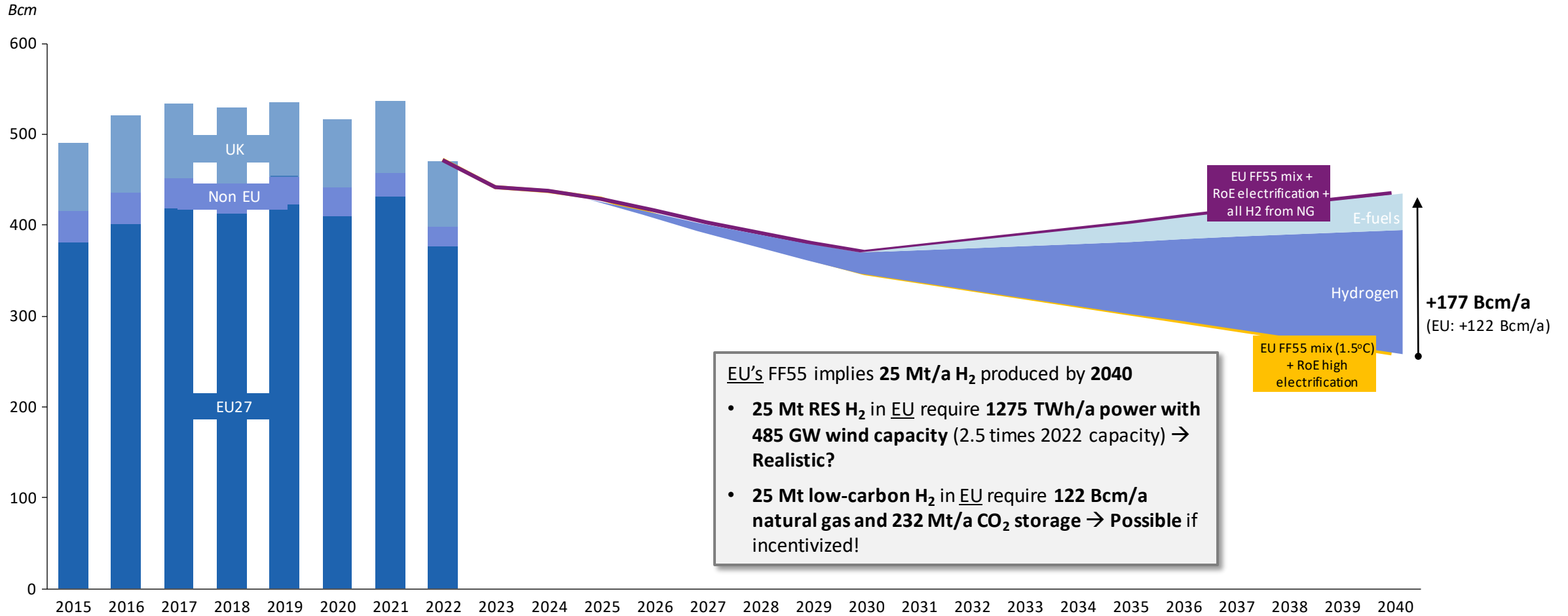
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Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy, IEA, Equinor, TotalEnergies

Sensitivity scenario: EU FF55 scenario with H₂ & e-fuels produced with natural gas / CCS

→ Increases demand for natural gas, CO₂ capture and storage

European demand outlook by scenario



* Final energy output is converted on energy-equivalence basis, whilst natural gas feedstock requirements include the efficiency differences between technologies for each low-carbon gas
Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy, IEA, Equinor, TotalEnergies

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Appendix

Limited changes to the supply stack's overall resources

- However, shift away from domestic resources in favor of African and LNG imports

Step	Full resource potential 2023-2040 BCM	Comment
Previous report excluding uncontracted LNG	7327	<ul style="list-style-type: none"> Uncontracted LNG excluded as it effectively is a goalseeked number to match demand and therefore less relevant
Domestic changes	-25	<ul style="list-style-type: none"> Overall relatively unchanged Big movement of resources from contingent to reserves as a result of numerous FID Indicates that the domestic industry has responded to the call for more resources
Special domestic increment	-414	<ul style="list-style-type: none"> Big downgrade primarily caused by Groningen no longer assumed to be part of the possible supply stack Barentspipe potential also downgraded as a function of updated numbers published by Gassco
Russia	-167	<ul style="list-style-type: none"> Downgrade explained by new assumption of existing flow until 2025, no more Ukraine transit from 2025 onwards and no supply after 2027
Piped gas	201	<ul style="list-style-type: none"> Big upgrade from more North African gas following new discoveries in Algeria and projects offshore Libya Also implies more competitive supply from North Africa as new resources have relatively low cost Caspian Sea potential relatively unchanged
LNG contracts and short term flexible	143	<ul style="list-style-type: none"> Half the upgrade from additional long term contracts signed since the previous report Second half from a higher possible share of short term LNG by extending time line one year to 2028
Current report	7064	<ul style="list-style-type: none"> Almost the same resource base, but significant shift from domestic resources market share to external resources

Note: Contracted LNG volumes as of end of October 2023;
Source: Rystad Energy analysis

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Full resource potential estimate for 2023-2040 is 155 bcm lower than previous report

Gas source	Increment group	Timing	Full resource potential 2023-2040 BCM*	Previous report full resource potential 2023-2040 BCM*	Delta	Comment on delta
Domestic	Base	Both	2174	1891	283	<ul style="list-style-type: none"> Domestic resources connected to the European demand via pipeline Significant portion of increment contingent moved to the base, incl. Romania's Neptune and assets in the NCS Includes all domestic resources not yet sanctioned for development Smaller increment as a result of projects being developed Exploration expected to yield limited potential given the mature nature of the domestic hydrocarbon basins Some of 2022 increment exploration projects have advanced and currently serve as increment contingent
	Increment contingent	Long term	391	646	-255	
	Increment exploration		96	150	-54	
Special domestic increment	Troll max	Short term	33	33	0	<ul style="list-style-type: none"> Short term potential in maximizing the Troll field output according to 2021 levels No material change since previous report Volume equivalent impact of increasing energy content in gas export Larger uptake as a result of extended timeline and increased asset base (NO) Official communication indicates curtailed production from October 2023. Option to reopen under emergency circumstances but aiming for full shutdown by 2024. Connects resources in the Barents Sea to the existing Norwegian pipeline network Recent plan revision has resulted in reduced volumes European shale resources are vast but economical extraction and permit process are key bottlenecks Small downward revision
	Higher GCV		72	18	54	
	Groningen	Long term	0	364	-364	
	Barents pipe		69	144	-74	
	European shale		425	455	-30	
Russia	Russian piped gas	Short term	92	259	-167	
Piped gas	Europe piped gas imports	Both	692	523	169	<ul style="list-style-type: none"> Revised imports assumptions based on cessation of imports via Ukraine in 2024 and Turkstream in 2027 Expected minimum imports from North Africa (Algeria and Libya) and Azerbaijan Larger volumes expected from Algeria and Libya due to new discoveries Potential increase in Algerian exports should gas be marketed instead of reinjected Uptake expected due to a forecast boost in Algerian gas production (new discoveries) Potential rerouting of Turkey's share of TANAP gas from Azerbaijan Re-route slightly shifted in time, no major changes Long term expansions of the TANAP/TAP infrastructure A firmer plan in place for TAP/TANAP expansion, capped by TAP capacity
	Algeria exports	Short term	678	599	78	
	TANAP re-route	Both	86	89	-3	
	TANAP/TAP expansion		344	387	-43	
LNG	Contracted LNG	Both	1227	797	430	<ul style="list-style-type: none"> All known LNG contracts with Europe as destination Significant upside due to a cessation large increase in LNG imports in 2022 Maximum potential spot and US LNG FOB imports The market will be shared with Asia and 100% market share is therefore unlikely The global pool of expected long term LNG production to meet global LNG demand Europe will be able to capture a market share of this vast potential
	Spot/FOB LNG	Short term	685	973	-288	
	Uncontracted LNG	Long term	6731	6946	-216	

Note: Contracted LNG volumes as of end of October 2023; *Full resource potential is based on tangible resources that are already producing or under development.

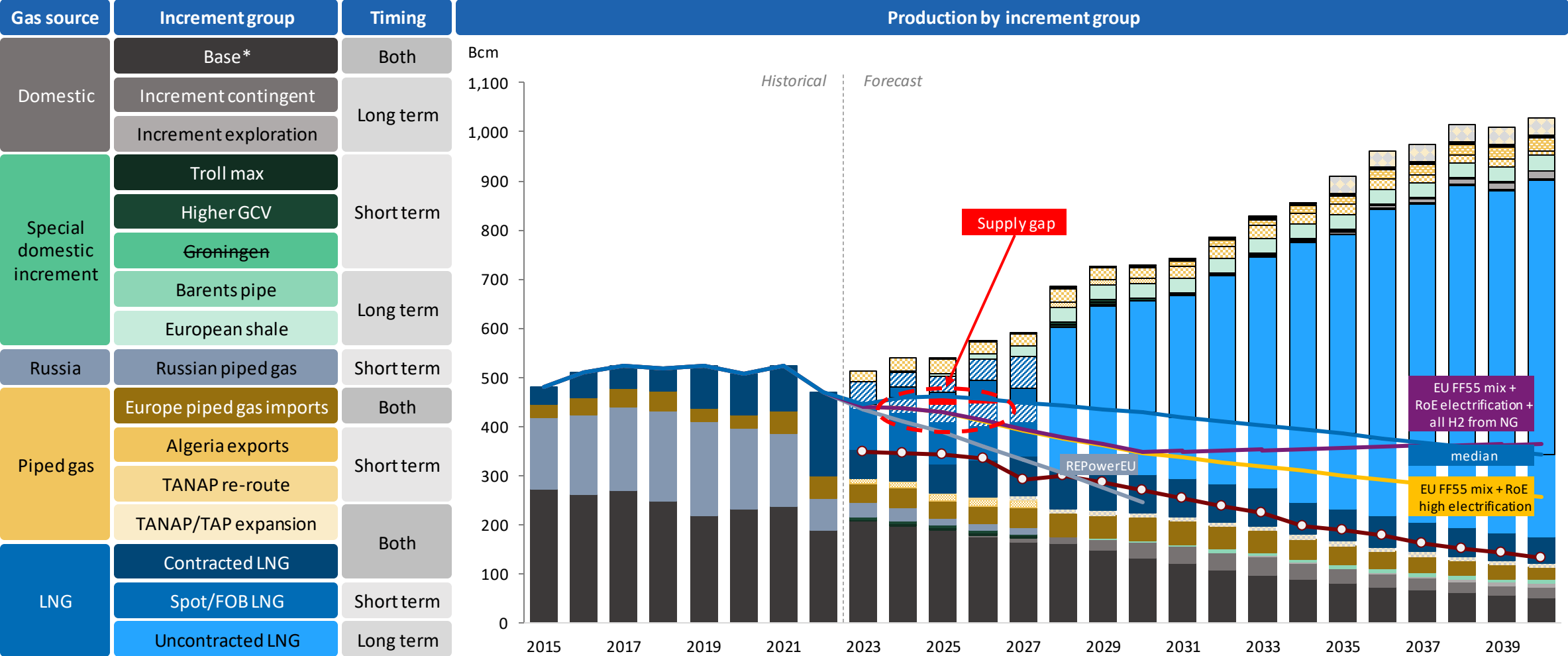
Source: Rystad Energy research and analysis

Increment groups within the supply stack are ranked by earliest availability and cost of supply

Timing	Increment group	Indicative combined political and economic cost of supply EUR/MWh	Cost increase	Comment
Both	Base	Low	Short term	Lowest cost of supply
	Europe piped gas imports			Base cost of supply from Algeria, Libya and Azerbaijan
	Contracted LNG			Contracted gas
Short term	TANAP/TAP short term expansion	Medium		Planned pipe expansion project that will boost piped Azeri gas to Europe
	Algeria sustained until 2030 at 2021			Behavior observed in 2021 hence reasonable cost of supply
	Troll max			Maximum utilization of the Troll field
	TR pass-through (re-route 10-40%)	High		Possible reroute as a function of high prices and greater Turkish LNG import capacity
	Higher GCV			Behavior observed in 2022's at high gas prices - higher gross calorific content of gas
	Spot/FOB LNG	130		Ceiling of what market share of spot LNG will be acquired by Europe (40USD/MMBtu)
	Grøningen	No longer considered available		Recent announcements indicated shutdown in late 2023.
	Algeria 75% marketed	Too high	Too expensive to be considered, demand will decline regardless	
	TR pass-through (re-route 70%)		Too expensive to be considered, demand will decline regardless	
Long term	Increment contingent	Lower	Long term	Contingent resources around Europe competitive vs long term LNG
	Increment exploration			Exploration efforts competitive vs long term LNG
	Barents pipe			Possible pipe expansion project that may be competitive with long term LNG
	Uncontracted LNG	30		Long term LNG expected to cost ~9 USD/MMBtu with vast low-cost gas from the US
	European shale	Too high		European shale gas resources, considered too politically challenging to be monetized
	TR pass-through (re-route 100%)			Considered too high-cost vs long term LNG
	TANAP/TAP long term expansion			Considered too high-cost vs long term LNG
	Algeria sustained until 2040 at 2021			Considered too high-cost vs long term LNG

Source : Rystad Energy research and analysis

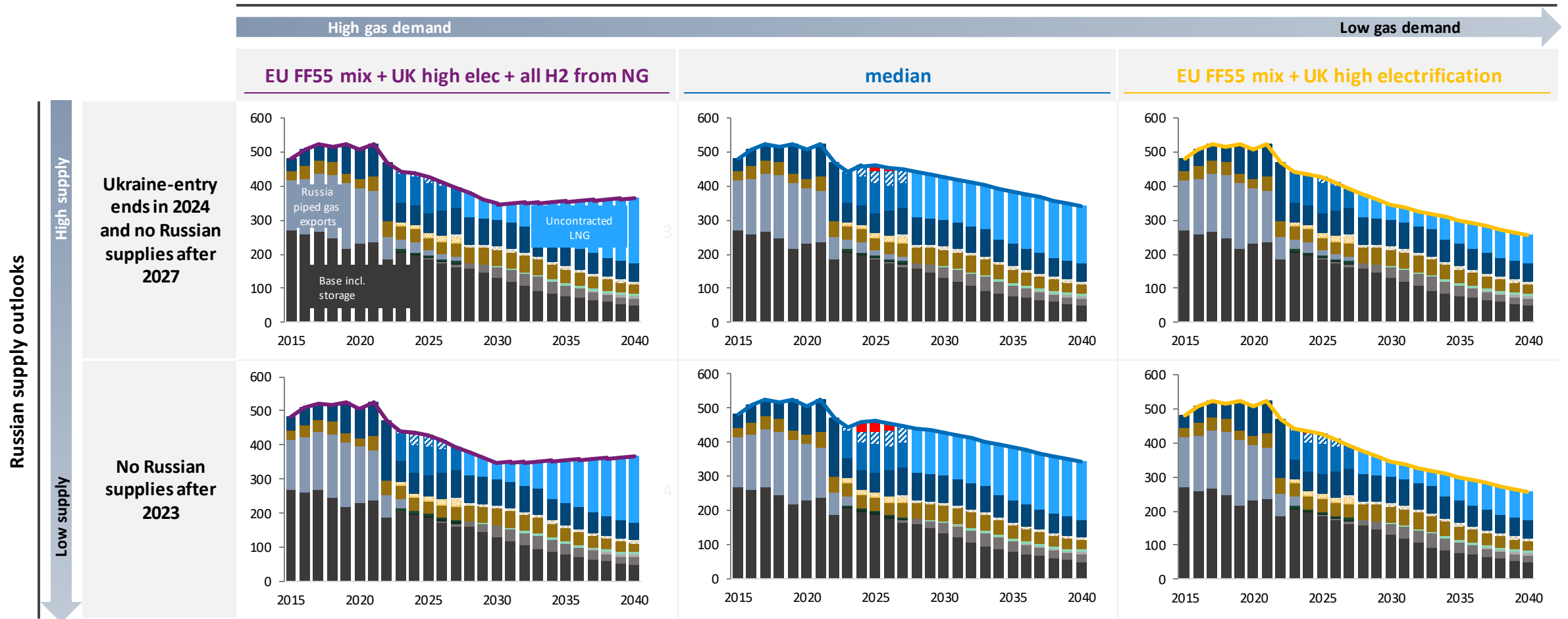
Supply gap between 0 to 20 bcm in the short term but LNG continues to play key role



Note: Contracted LNG volumes as of end of October 2023; *Base increment group includes storage. **Supply line for previous report includes all increments except spot/FOB LNG and uncontracted LNG.
 Source: Rystad Energy research and analysis, GasMarketCube, European Commission, UK BEIS

All scenario permutations indicate high reliance on LNG, supply gap in short-term is likely

Gas demand assumption (bcm)



Note: Contracted LNG volumes as of end of October 2023; Countries included in the scope are: EU, UK, Norway, Albania, Moldova, Montenegro, North Macedonia, Serbia, Switzerland, Ukraine

Source: Rystad Energy research and analysis

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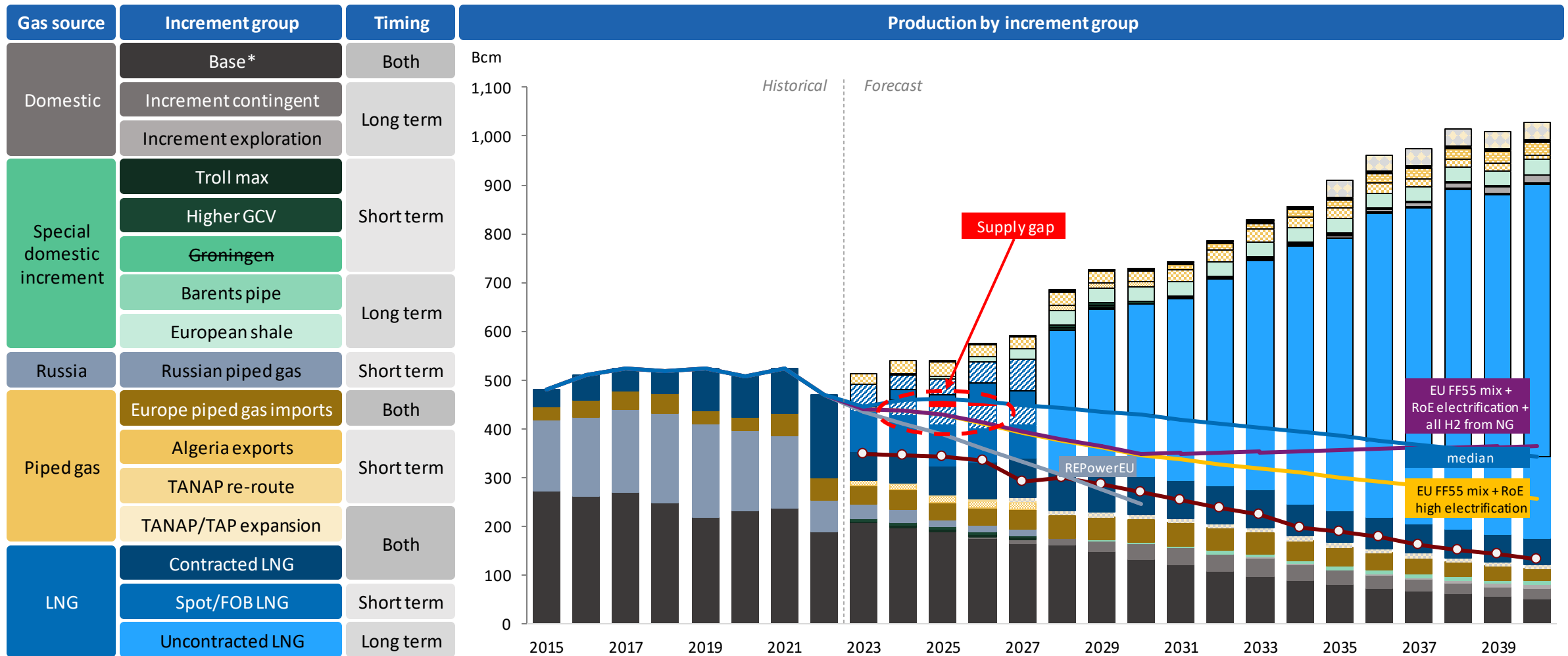
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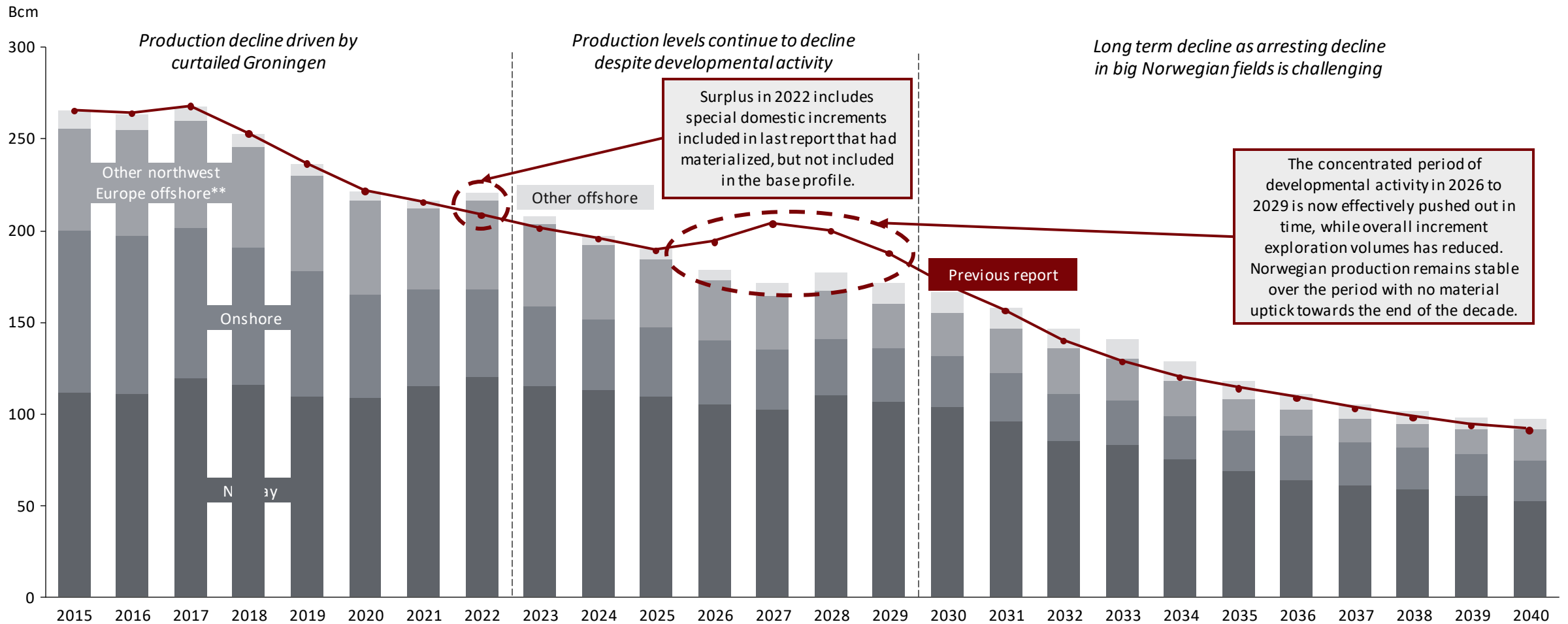
Supply gap between 0 to 15 bcm in the short term but LNG continues to play key role



Note: Contracted LNG volumes as of end of October 2023; *Base increment group includes storage. **Supply line for previous report includes all increments except spot/FOB LNG and uncontracted LNG.
 Source: Rystad Energy research and analysis, GasMarketCube, European Commission, UK BEIS

Significant domestic resources are available despite declining production trend

Overview of European domestic production*



*Does not include storage as in supply stack. **Other northwest Europe countries include Denmark, Ireland, the Netherlands and the United Kingdom.

Source: Rystad Energy research and analysis, GasMarketCube

Actual domestic production in 2022 called on special domestic increments, adding to base profile

Materialized domestic production in 2022

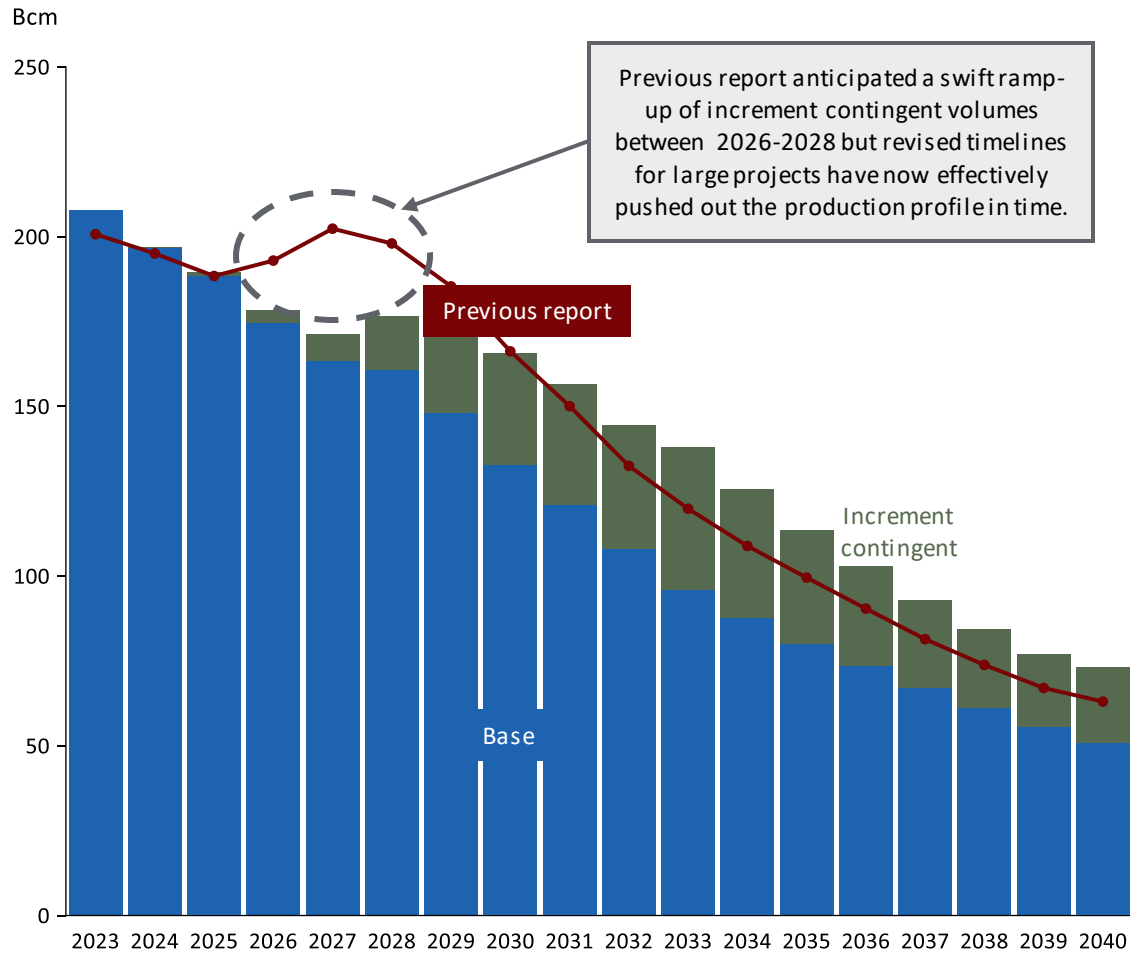
Bcm

Gas source	Increment group	Expected 2022 production (bcm)	Comment on expected and actual 2022 production
Domestic	Base	208	<ul style="list-style-type: none"> Lowest cost of supply domestic resources. Some new assets added and adjustment in production profiles.
	Increment contingent	0	<ul style="list-style-type: none"> Only a small amount of resources to be sanctioned for development in 2022. Changes in assets included and production profile adjustments.
Special domestic increment	Troll max	0	<ul style="list-style-type: none"> Option to increase the Troll field's output. Troll produced 2.4 bcm more gas than expected in the base increment of 2022.
	Higher GCV	6	<ul style="list-style-type: none"> Higher gross calorific value of some domestic assets. Cannot accurately estimate impact of higher energy content.
	(Groningen)	18	<ul style="list-style-type: none"> Official ramp-down of Groningen production may be halted under emergency circumstances. Production at Groningen was 1.7 bcm higher than predicted in the previous report base.
Short term domestic + special domestic increment		233	<ul style="list-style-type: none"> Europe's maximum domestic resource potential in 2022 was 233 bcm. All materialized special domestic increments have now been reflected domestic production in 2022.
Short term domestic + special domestic increment (excluding Groningen)		214	<ul style="list-style-type: none"> Communication on ramp-down of Groningen's production has changed since publication of previous report.
Actual 2022 production (bcm)		221	<ul style="list-style-type: none"> Special domestic increments, new assets and adjusted profiles added 12.7 bcm to Europe's expected base gas production in 2022.

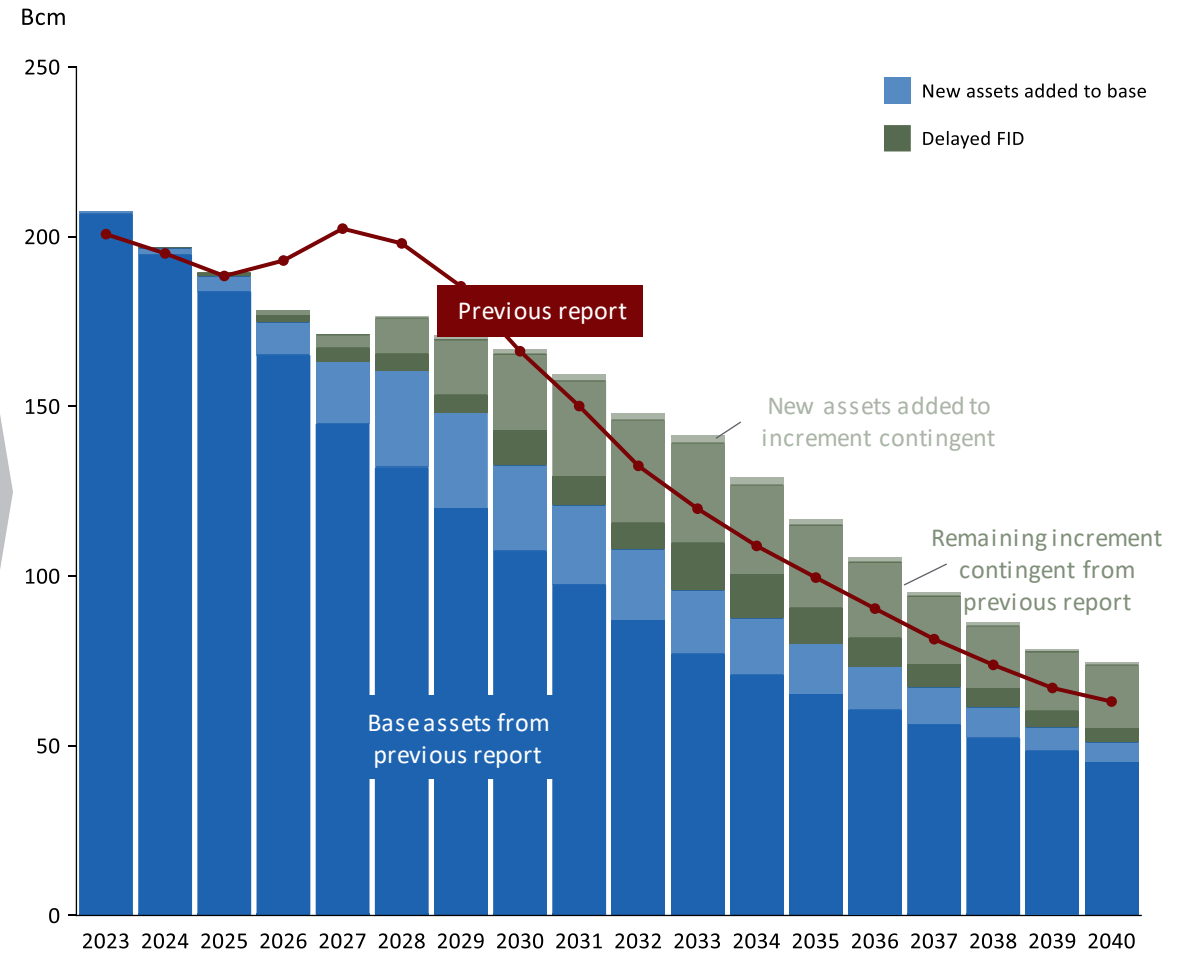
Source: Rystad Energy research and analysis, GasMarketCube

260 bcm of resources added to domestic base since previous report

Domestic production 2023-2040, split by increment group



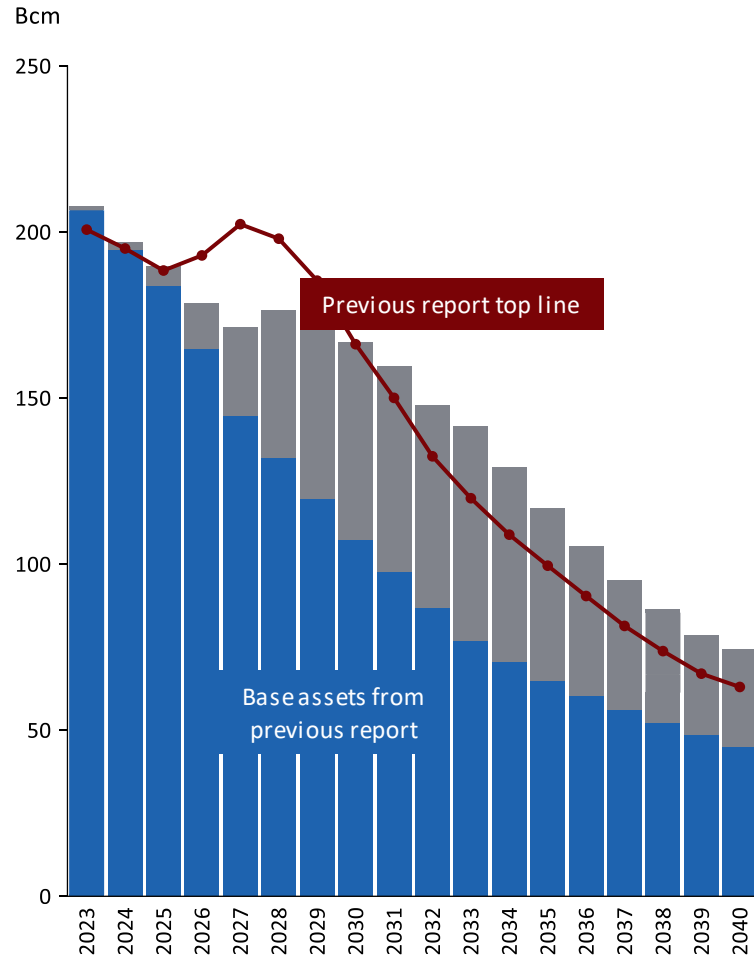
Domestic production 2023-2040, split by change from previous report



Source: Rystad Energy research and analysis

Norwegian projects form 9 of top 10 biggest resources in domestic base in both reports

Domestic production 2023-2040



Full resource potential of top 10 projects, 2023-2040

Project	2022 estimate	2023 estimate	Delta
1 Troll, NO	561	561	-0.0
2 Oseberg, NO	81	79	-2.3
3 Ormen Lange, NO	52	52	0.0
4 Gullfaks, NO	48	47	-1.3
5 Shebelinka, UA	29	44	14.9
6 Skarv, NO	38	36	-1.9
7 Visund, NO	32	32	-0.1
8 Aasta Hansteen, NO	32	29	-2.9
9 Aasgard FPSO, NO	25	27	2.0
10 Tyrihans, NO	28	27	-1.5

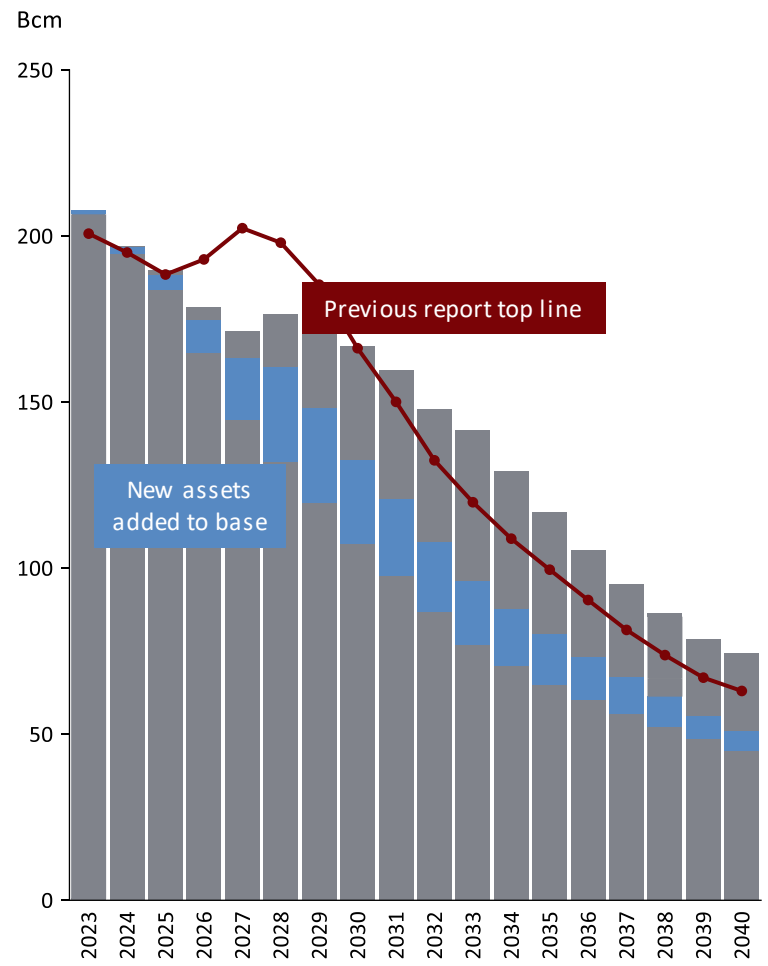
Map view of top 10 projects



Source : Rystad Energy research and analysis, UCube

Neptune Deep project in Romania adds 80 bcm resource potential to domestic base

Domestic production 2023-2040



Full resource potential of top 10 projects, 2023-2040

Project	2022 estimate	2023 estimate	Delta
1 Neptun Deep, RO	65	81	16.3
2 Ormen Lange subsea compression, NO	33	33	-0.0
3 Krafla/Askja (Yggdrasil), NO	17	21	4.0
4 Irpa (Asterix), NO	20	20	-0.2
5 Dvalin, NO	12	13	0.9
6 Fenris (King Lear), NO	11	13	1.2
7 Halten East, NO	9	9	-0.1
8 Orn, NO	7	8	1.3
9 Jackdaw, GB	8	8	0.1
10 North of Alvhelm (Yggdrasil), NO	4	6	2.1

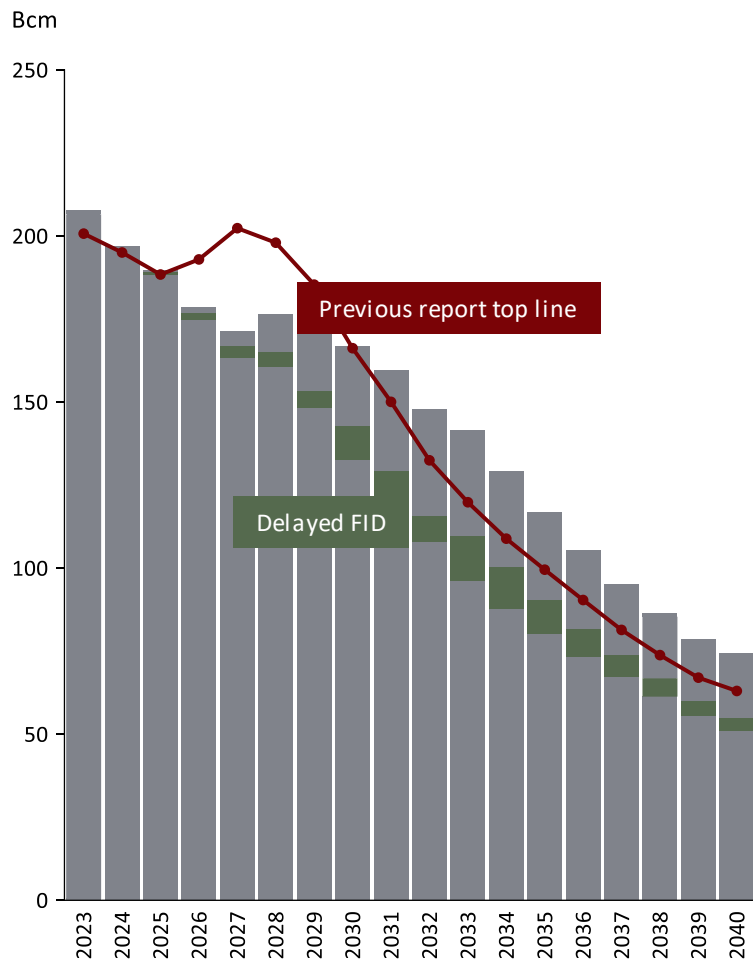
Map view of top 10 projects



Source : Rystad Energy research and analysis, UCube

Some projects with expected approvals in 2022/2023 face delays, including Linnorm in Norway

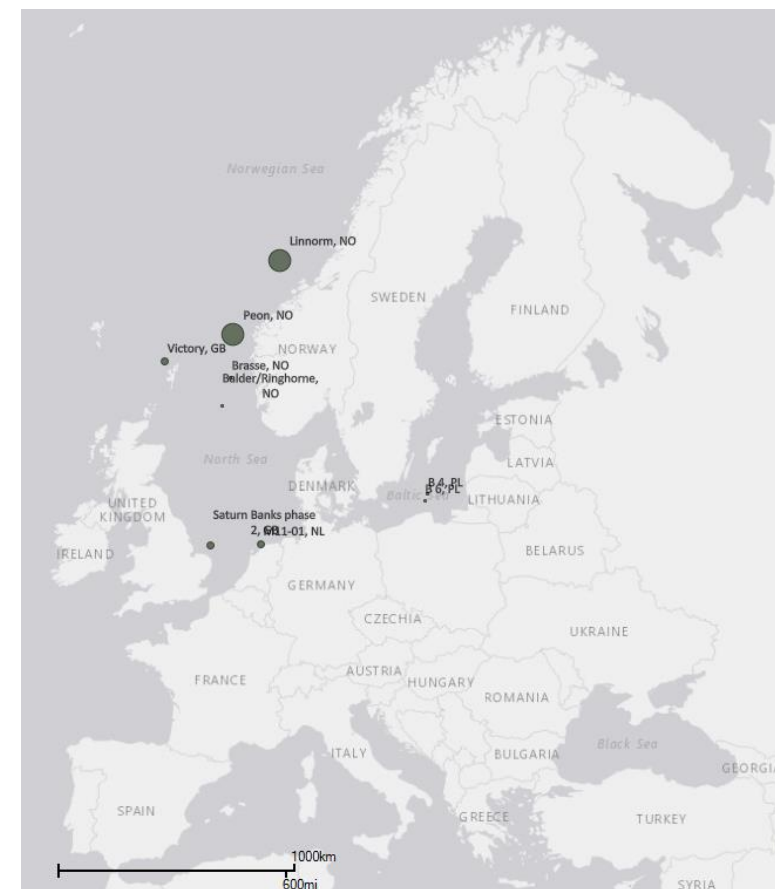
Domestic production 2023-2040



Full resource potential of top 10 projects, 2023-2040

Project	2022 estimate	2023 estimate	Delta
1 Peon, NO	27	26	-1.2
2 Linnorm, NO	30	24	-6.3
3 Fulla, NO	8	7	-0.5
4 Saturn Banks phase 2, GB	6	5	-0.6
5 Victory, GB	4	4	0.1
6 M11-01, NL	4	4	-0.0
7 Balder/Ringhorne, NO	2	2	-0.0
8 B 6, PL	2	2	-0.1
9 B 4, PL	2	2	-0.1
10 Brasse, NO	1	1	0.1

Map view of top 10 projects

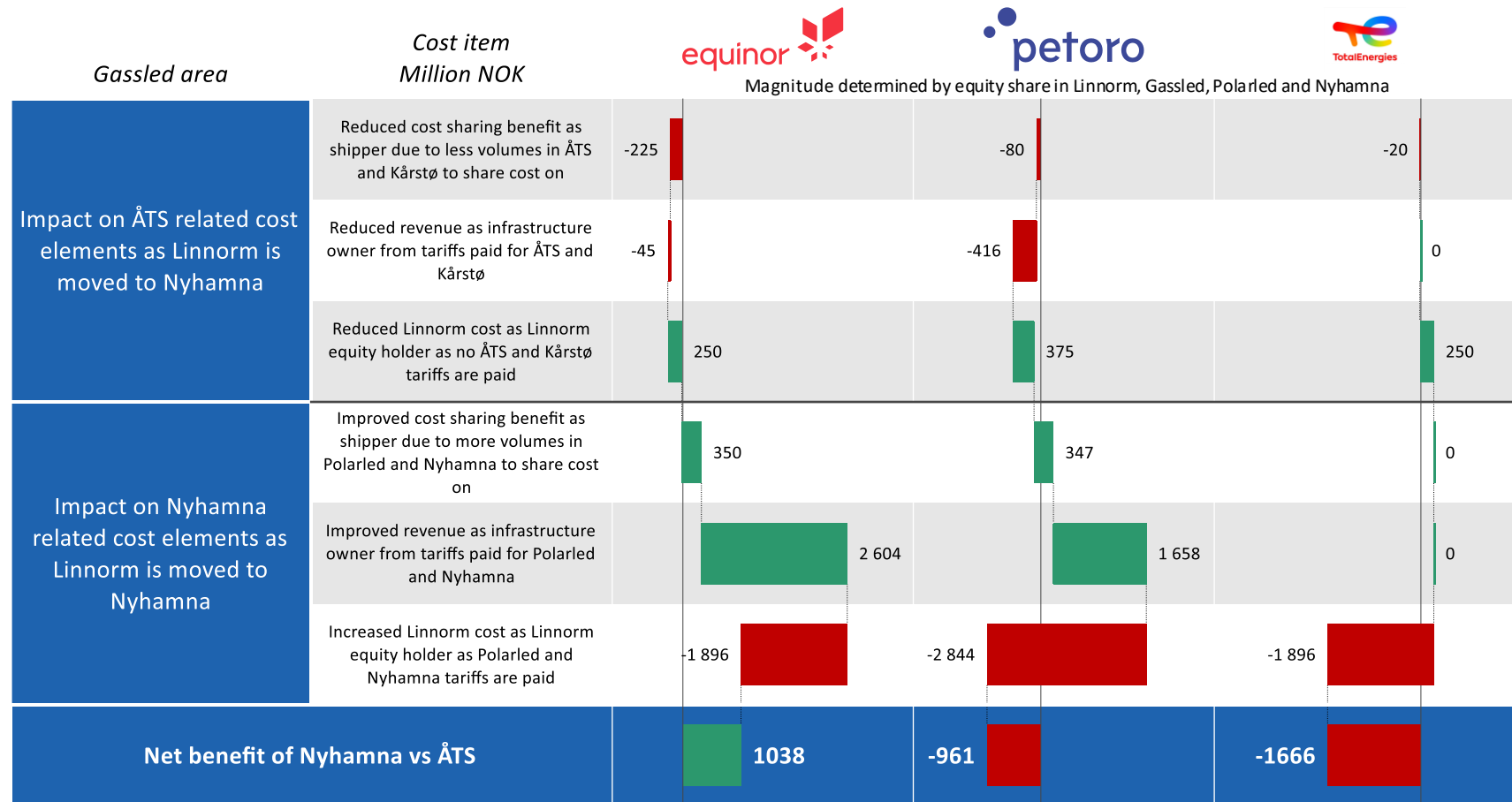


Source : Rystad Energy research and analysis, UCube

Misalignment in the Linnorm JV likely why the project did not meet the 2022 tax relief deadline

Cost-benefit analysis of Nyhamna vs ÅTS for JV*

million NOK

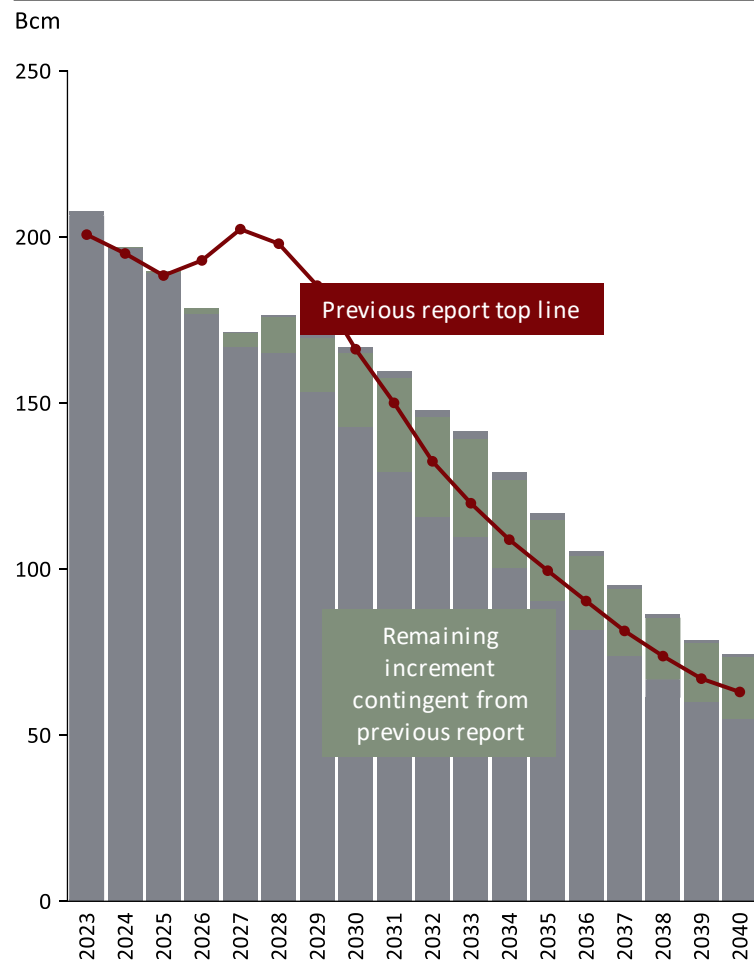


- The Linnorm partners have conflicting incentives for Linnorm volumes to go via ÅTS and Nyhamna (Polarled), based on synergies with infrastructure ownerships and other equity volumes.
- **Equinor** should prefer volumes in **Nyhamna** driven by high ownership in Polarled (37%) and Nyhamna (30%). The increased revenue from Polarled and Nyhamna K-elements more than offset Equinor’s associated costs for Linnorm.
- **Petoro** is better off with volumes through **ÅTS**. Nyhamna costs associated with the 30% interest in Linnorm are not offset through cost-sharing benefits and the infrastructure interests in Polarled (12%) and Nyhamna (26%). Petoro will also benefit from ÅTS selection through the 47% interest in Gassled.
- **Total** does not own any relevant infrastructure and has no other volumes in the Polarled/Nyhamna axis. Hence, Total should prefer **ÅTS** for Linnorm based on the gas transportation economics.
- The calculations consider expected equity volumes from 2025-2040, 2021 tariffs as reported by Gassco, and Linnorm resources of 30 billion SM3.

* The figures are given in million NOK and are cumulative over the period (no time discounting).
Source : Gassco; NPD; Rystad Energy research and analysis

Majority of increment contingent made up of same assets from previous report

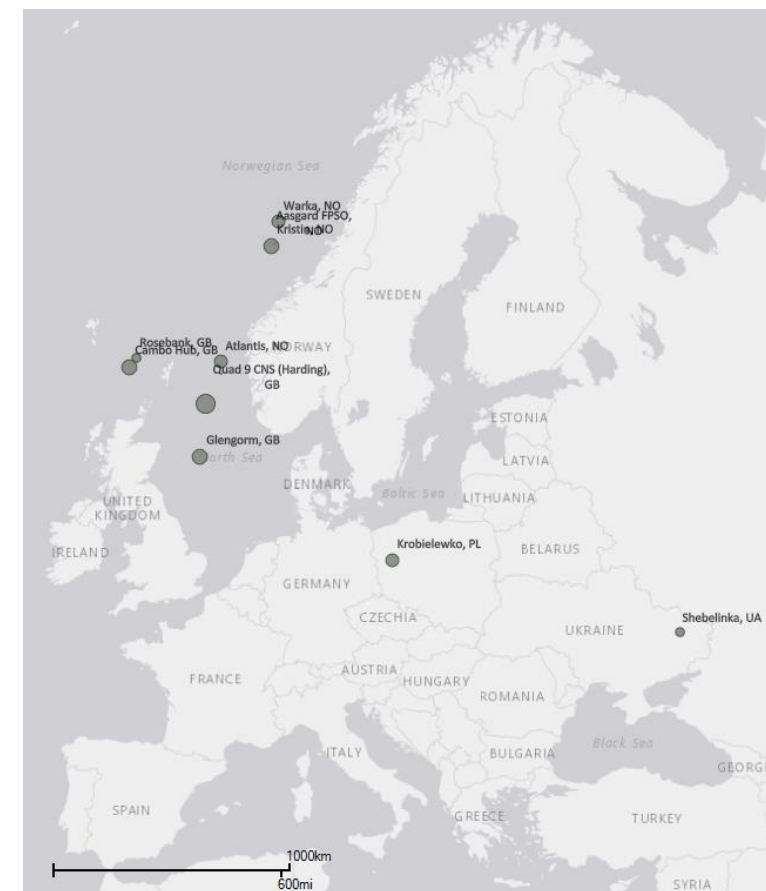
Domestic production 2023-2040



Full resource potential of top 10 projects, 2023-2040

Project	2022 estimate	2023 estimate	Delta
1 Quad 9 CNS (Harding), GB	21	20	-1.0
2 Lavrans Phase 2, NO	15	13	-1.9
3 Cambo Hub, GB	12	12	-0.2
4 Glengorm, GB	13	11	-1.3
5 Krobielewko, PL	11	10	-0.5
6 Atlantis, NO	9	10	0.2
7 Warka, NO	13	9	-4.2
8 Bergknapp, NO	7	7	0.4
9 Shebelinka, UA	7	7	-0.2
10 Rosebank, GB	8	6	-1.2

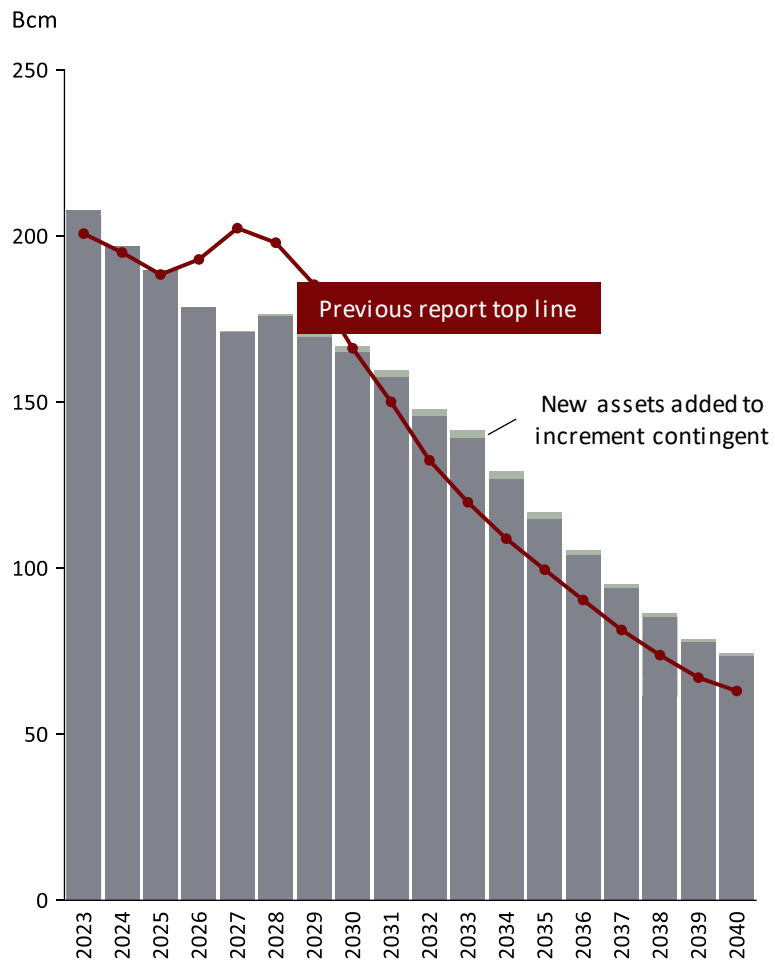
Map view of top 10 projects



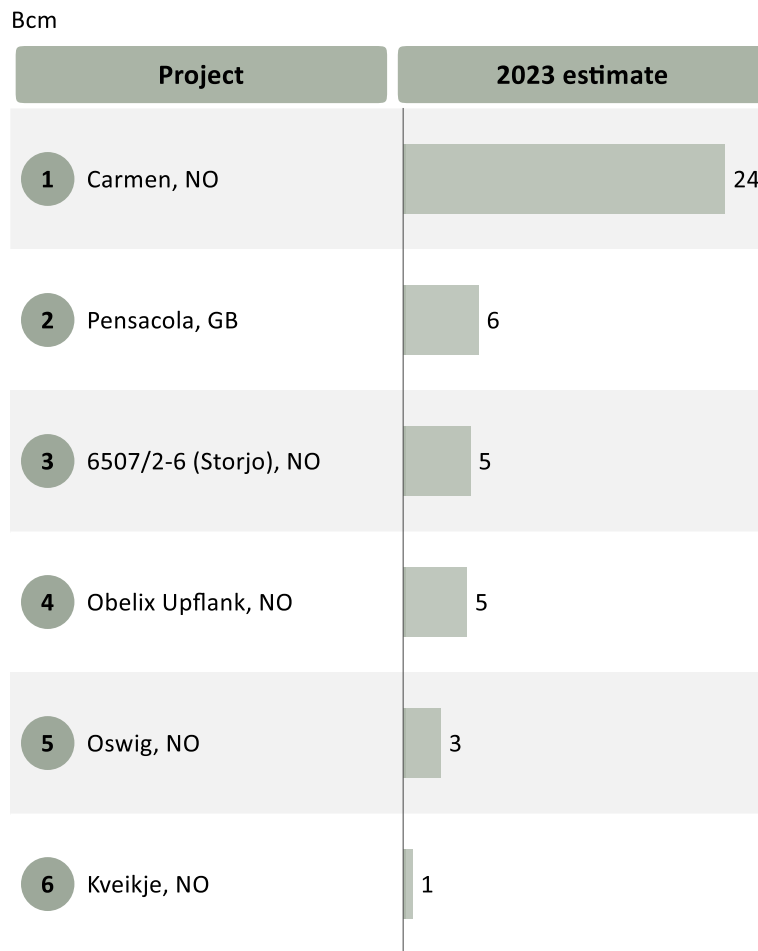
Source : Rystad Energy research and analysis, UCube

5 out of 6 new developments added to increment contingent since previous report are in Norway

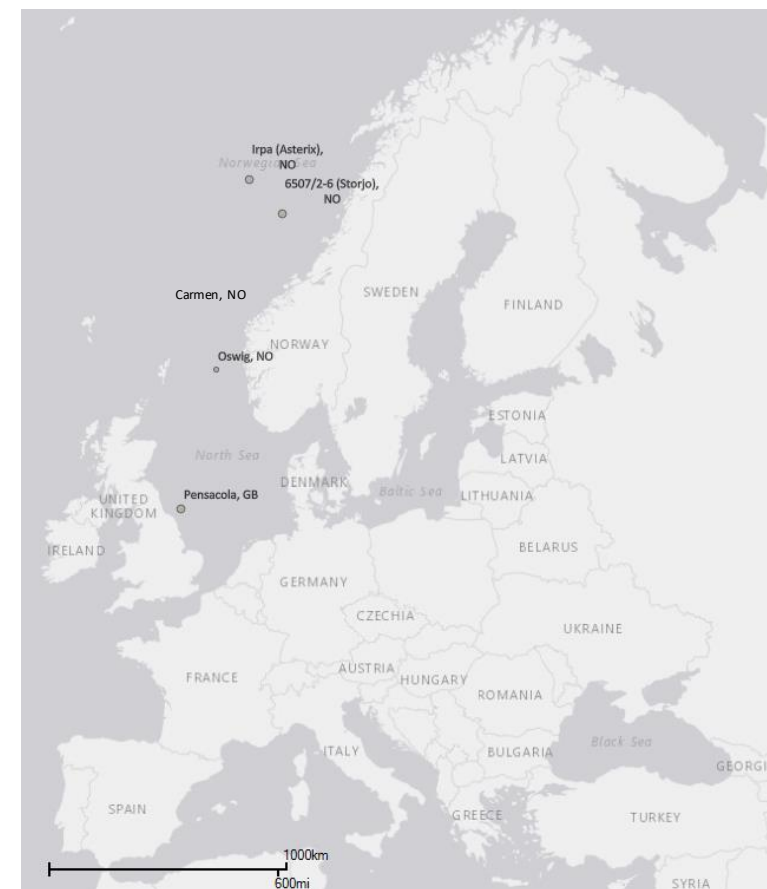
Domestic production 2023-2040



Full resource potential of top 10 projects, 2023-2040



Map view of top 10 projects



Source: Rystad Energy research and analysis, UCube

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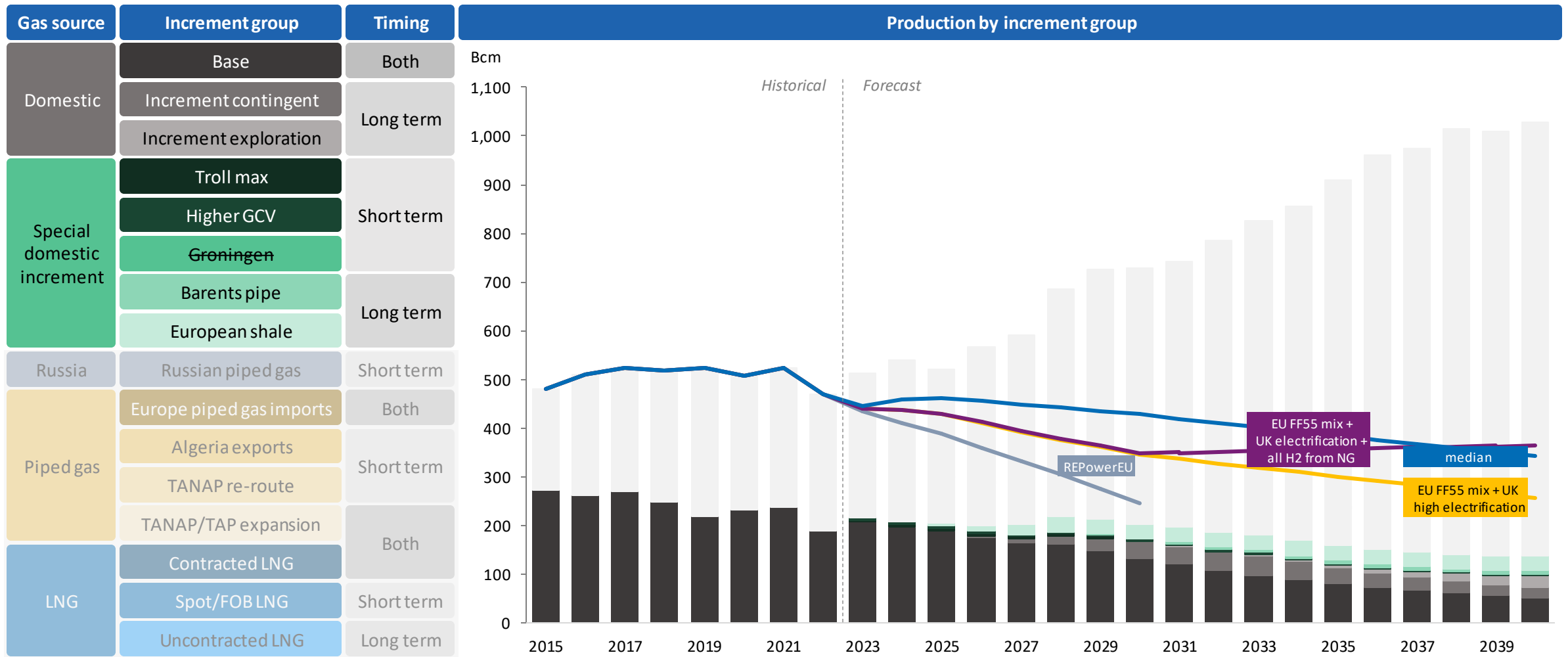
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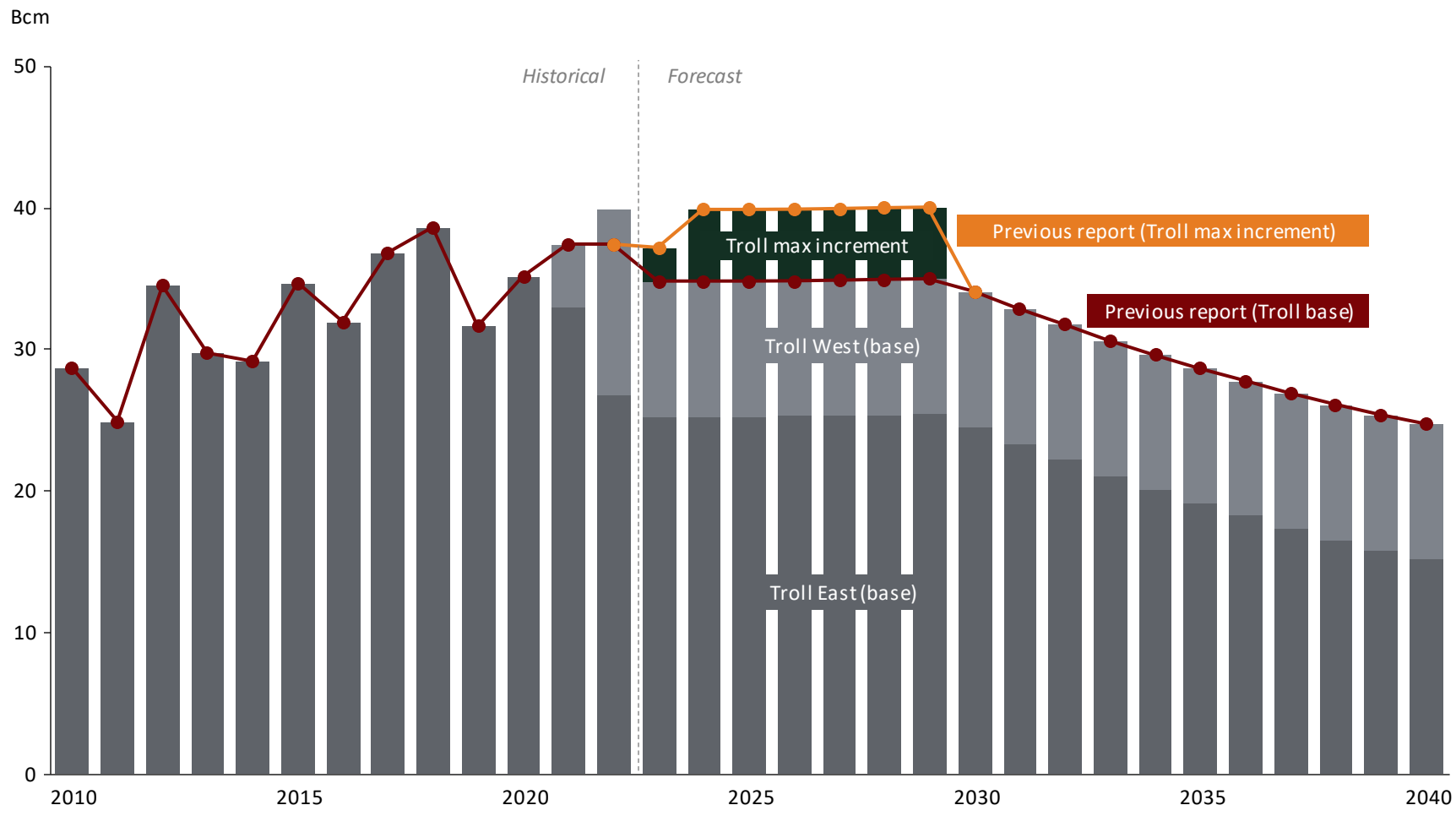
Special domestic increment shrinks significantly with cessation of Groningen volumes



Note: Contracted LNG volumes as of end of October 2023;
 Source: Rystad Energy research and analysis, GasMarketCube, European Commission, UK BEIS

5 bcm/year increment from maintaining Troll at elevated gas offtake levels

Gas production at Troll

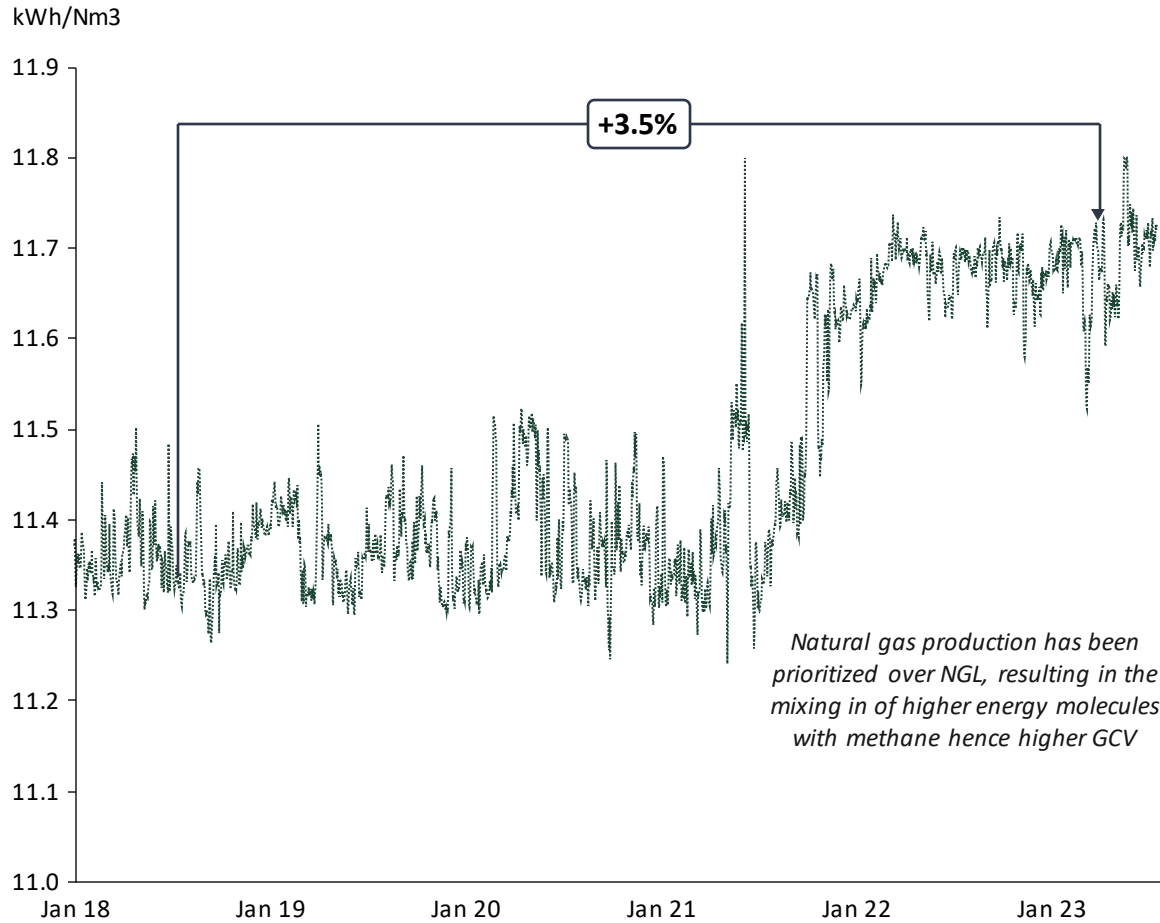


- Troll is the largest gas producing field in the North Sea, producing at 40 bcm in 2021.
- Gas production at Troll may be curtailed in favor of pressure support for oil production.
- Bypassing maintenance and producing at the field's full potential is unsustainable but the increment could add 5 bcm annually.

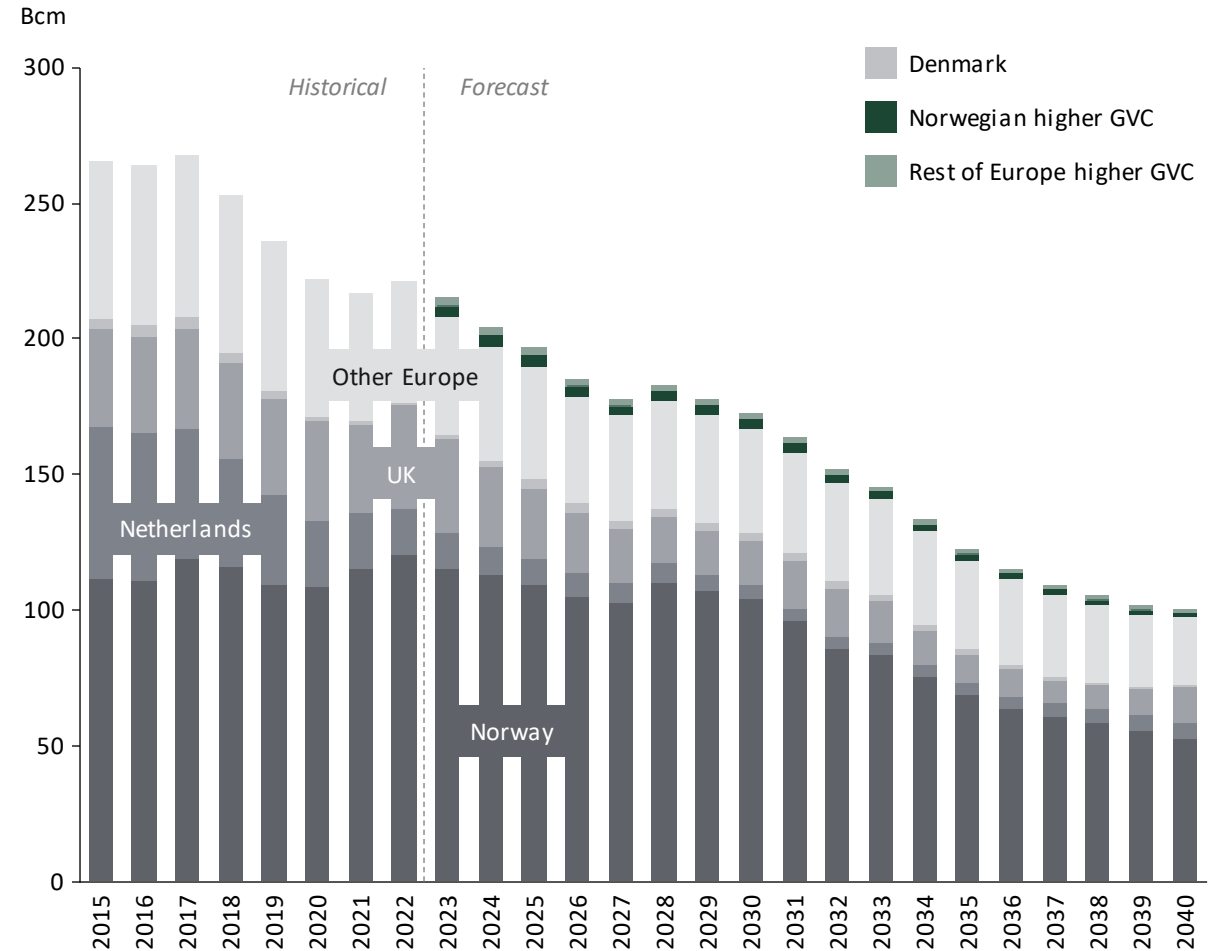
Source : Rystad Energy research and analysis, Rystad Energy Gas Market Cube

Higher energy content equivalent to 3.5% volume increase in Norwegian deliveries to Germany

Gross calorific value (GCV) of Norwegian Gas Delivered to Dornum, Germany



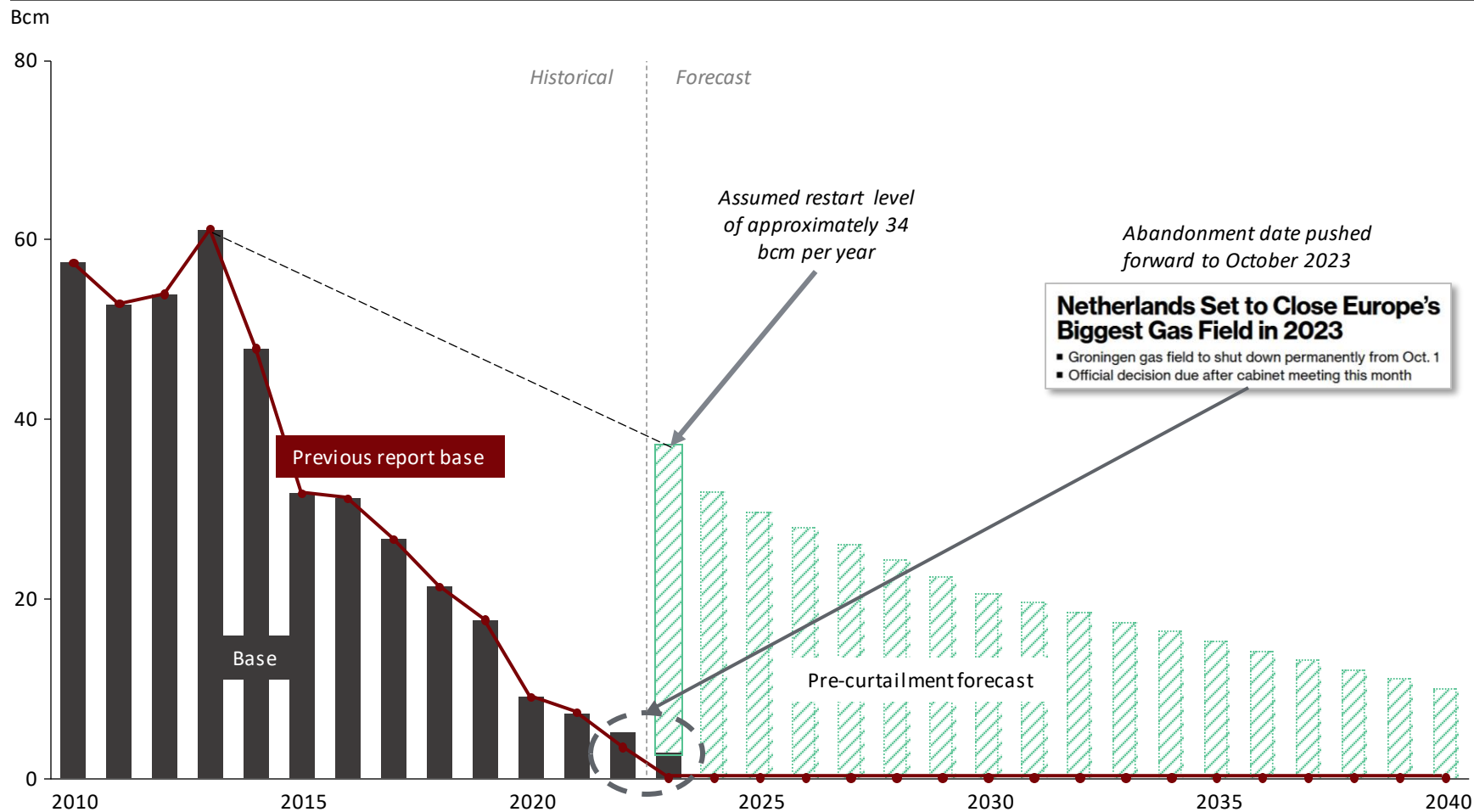
European gas production



Source: Rystad Energy research and analysis, GasMarketCube, ENTSOG

Netherlands' Groningen to shutdown permanently from October 2023

Gas production at Groningen

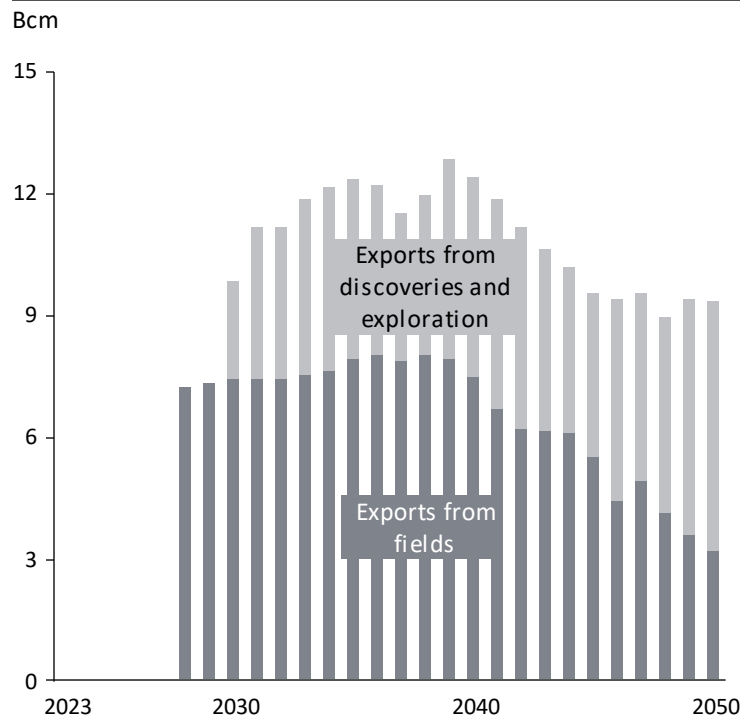


- Earthquakes as a result of production at the Groningen in the Netherlands led to the Dutch government's decision to curtail production on the field.
- Current plans would see production wind down in 2022 with cease of production in October 2023.
- Rystad's view before the curtailment would have seen production continue throughout the 2030s and into the 2040s, but these volumes are no longer considered available.

Source : Rystad Energy research and analysis, GasMarketCube, NAM, Bloomberg

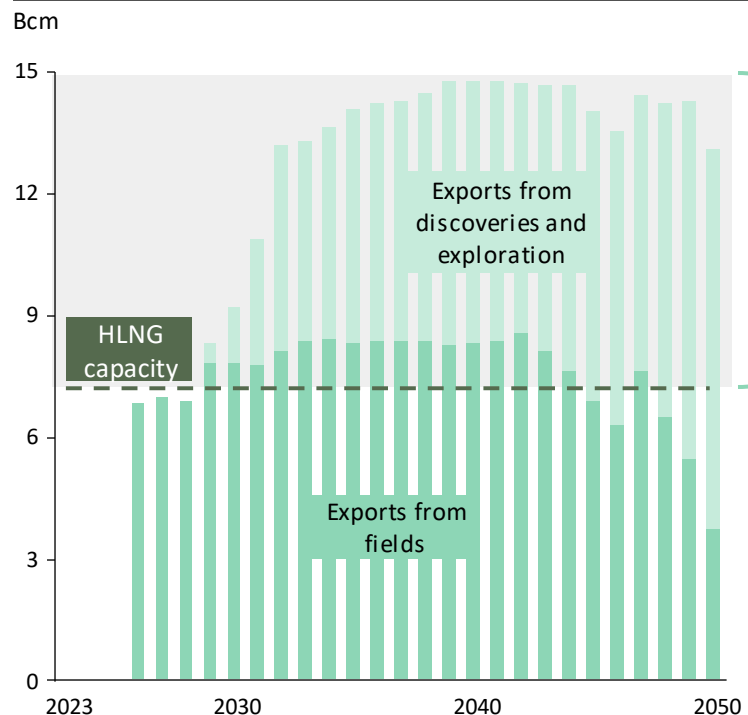
Latest Gassco report indicates significant downward revision of Barents pipe potential

Barents Sea piped gas export potential (2020 report)



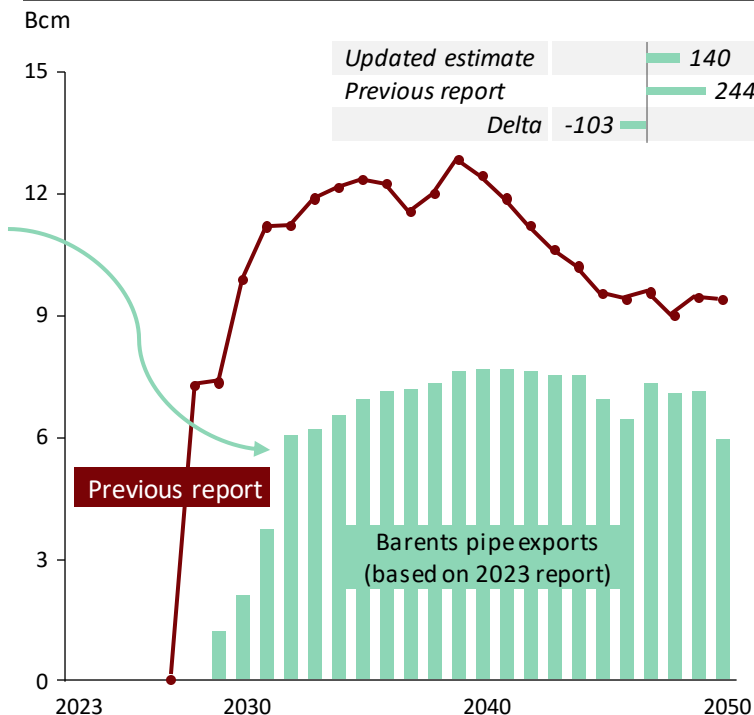
- Based on Gassco report released January 2020 on gas export solutions from the Barents Sea.
- The Norwegian Petroleum Directorate estimates that most of the remaining exploration potential on the Norwegian Continental Shelf to be in the Barents Sea.

Barents Sea export potential (2023 report)



- The latest Gassco report from April 2023 indicated large resource potential in the southern Barents Sea of approximately 80bcm.
- The dashed line represents the capacity of the Hammerfest facility (HLNG). Any additional volumes requires new infrastructure to be exported.

Barents Sea piped gas export potential (2023 report)

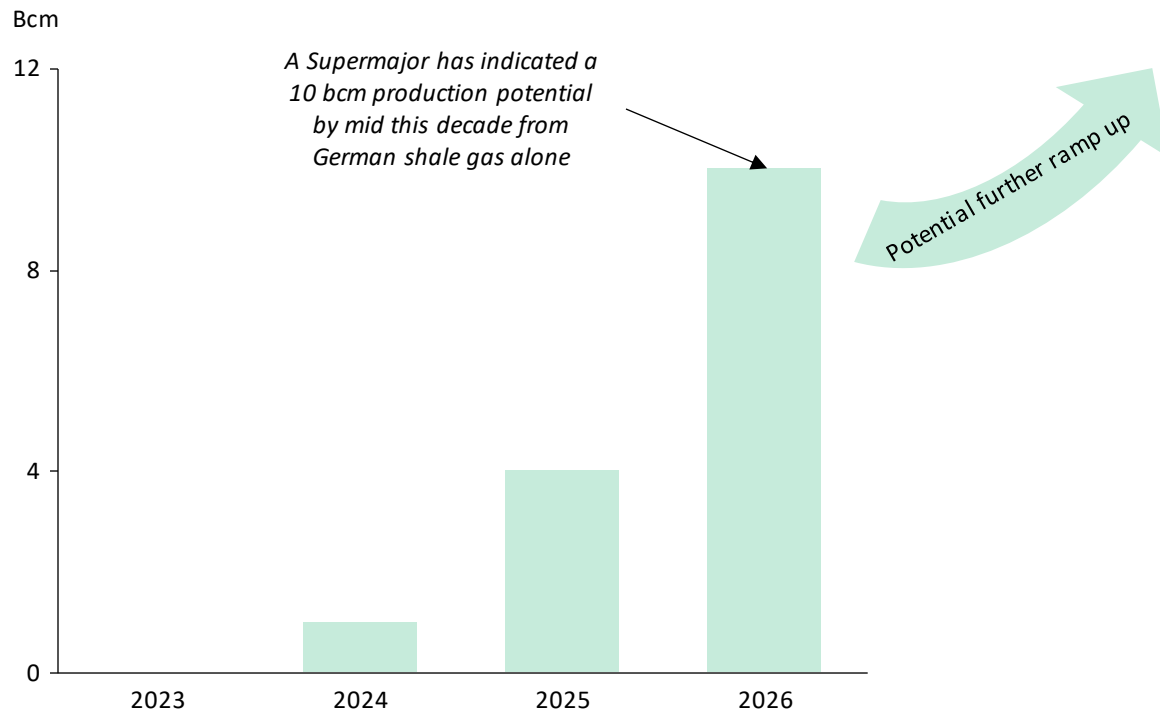


- Compared to the previous report, the latest estimates of potential exports via a new Barents pipeline is significantly lower, despite large resource potential.
- However, the Barents Pipe may still contribute around 140 bcm of gas up to 2050.

Source : Rystad Energy research and analysis, Gassco

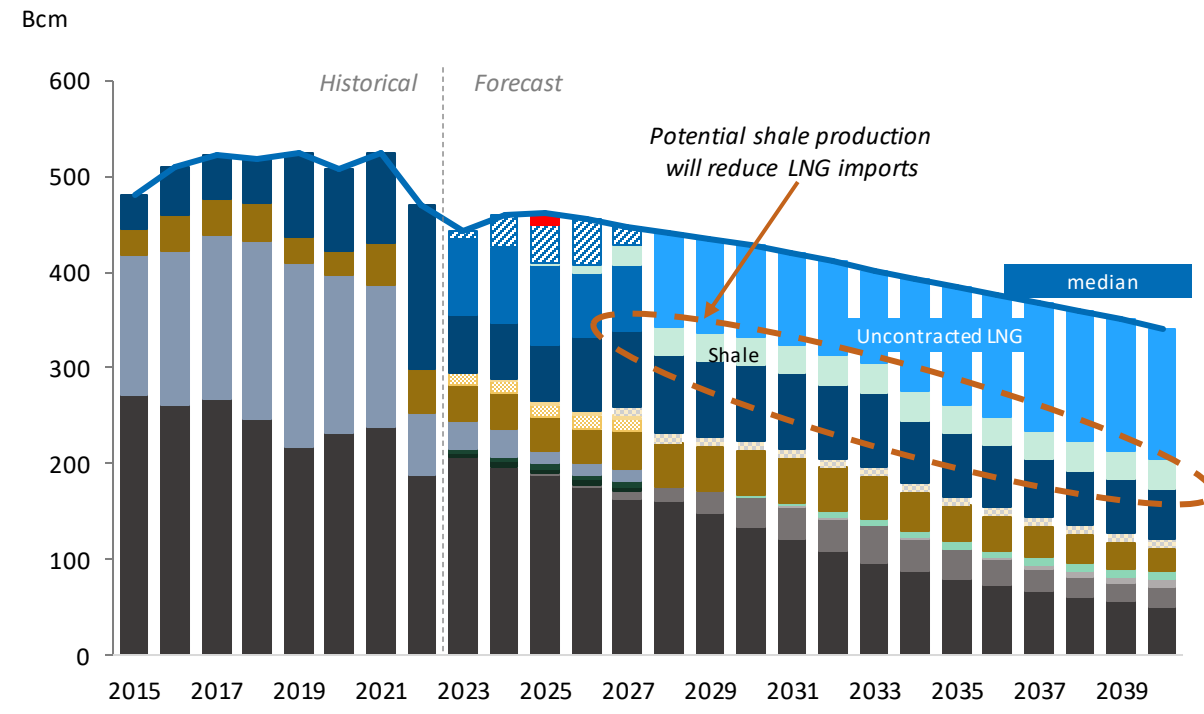
Vast shale resources may take pressure off LNG imports but economic potential is uncertain

Possible European shale gas production



- A Supermajor has indicated that permit process permitting, the potential German shale production can reach 10 bcm by the middle of this decade.
- European shale resources are vast, but economical extraction and permit process are the key bottlenecks to convert resources in the ground to useable energy.
- Further ramp up is likely possible, but no indication is given on maximum potential.

Impact on European supply potential



- Placing shale production into the wider context reveals that any production until 2027 will reduce, but not eliminate the burden on demand reduction to reach balance.
- From 2028 onwards, any shale production (in the chart assumed to ramp up towards 30 bcm per year) will reduce required LNG imports.
- This assumes that shale is more competitive than the long run marginal cost of LNG.

Note: Contracted LNG volumes as of end of October 2023;
Source: Rystad Energy research and analysis

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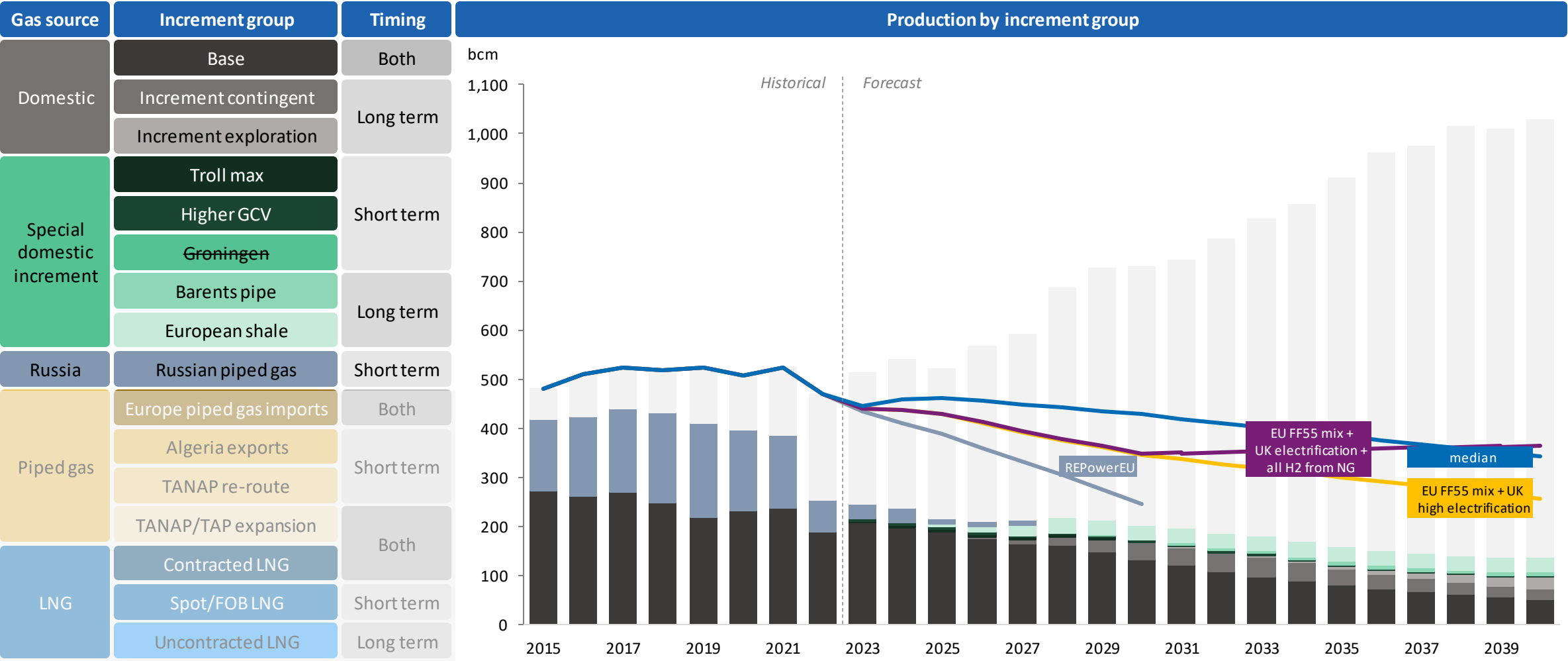
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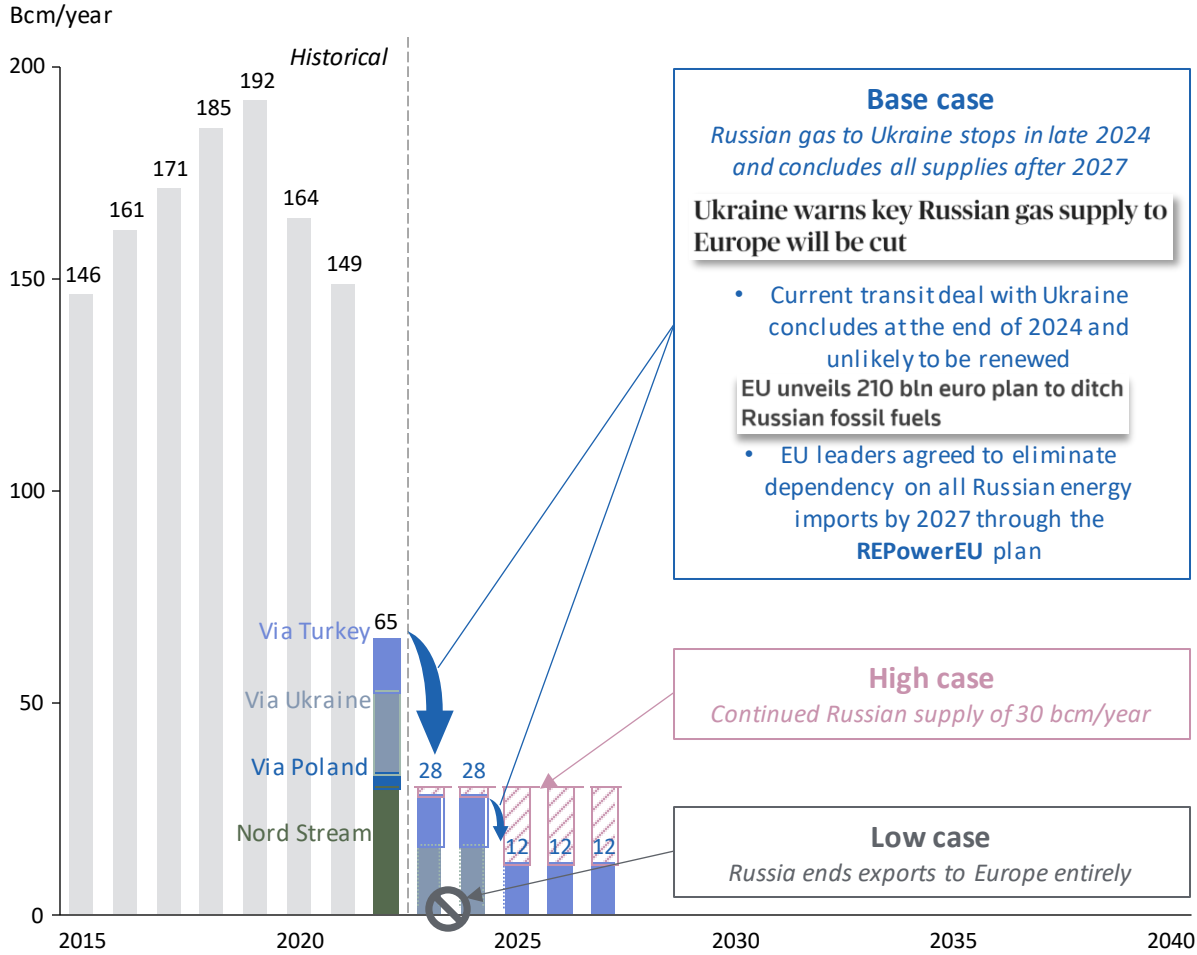
Russian piped gas via Ukraine assumed to cease in 2024 and Turkstream to conclude in 2027



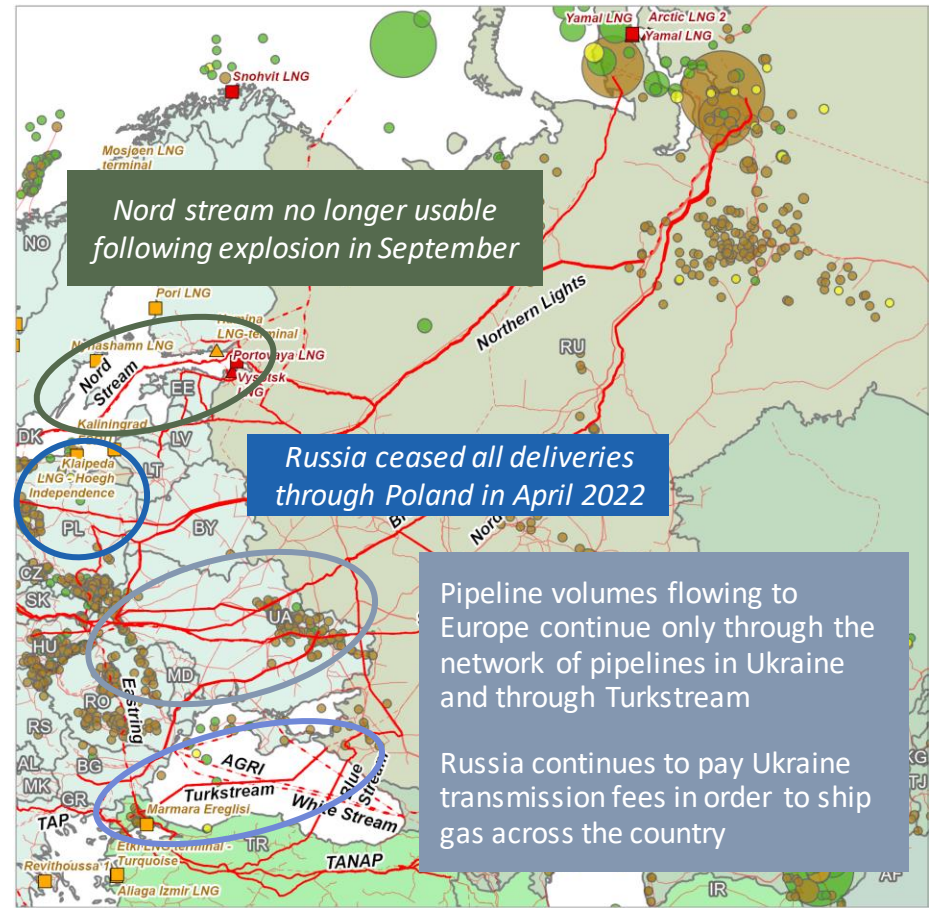
Note: Contracted LNG volumes as of end of October 2023;
 Source: Rystad Energy research and analysis, GasMarketCube, European Commission, UK BEIS

Short-term Russian pipeline deliveries to Europe between 0 to 30 bcm per year

Russian pipeline supplies to Europe by entry country



Russian pipeline supply routes to Europe



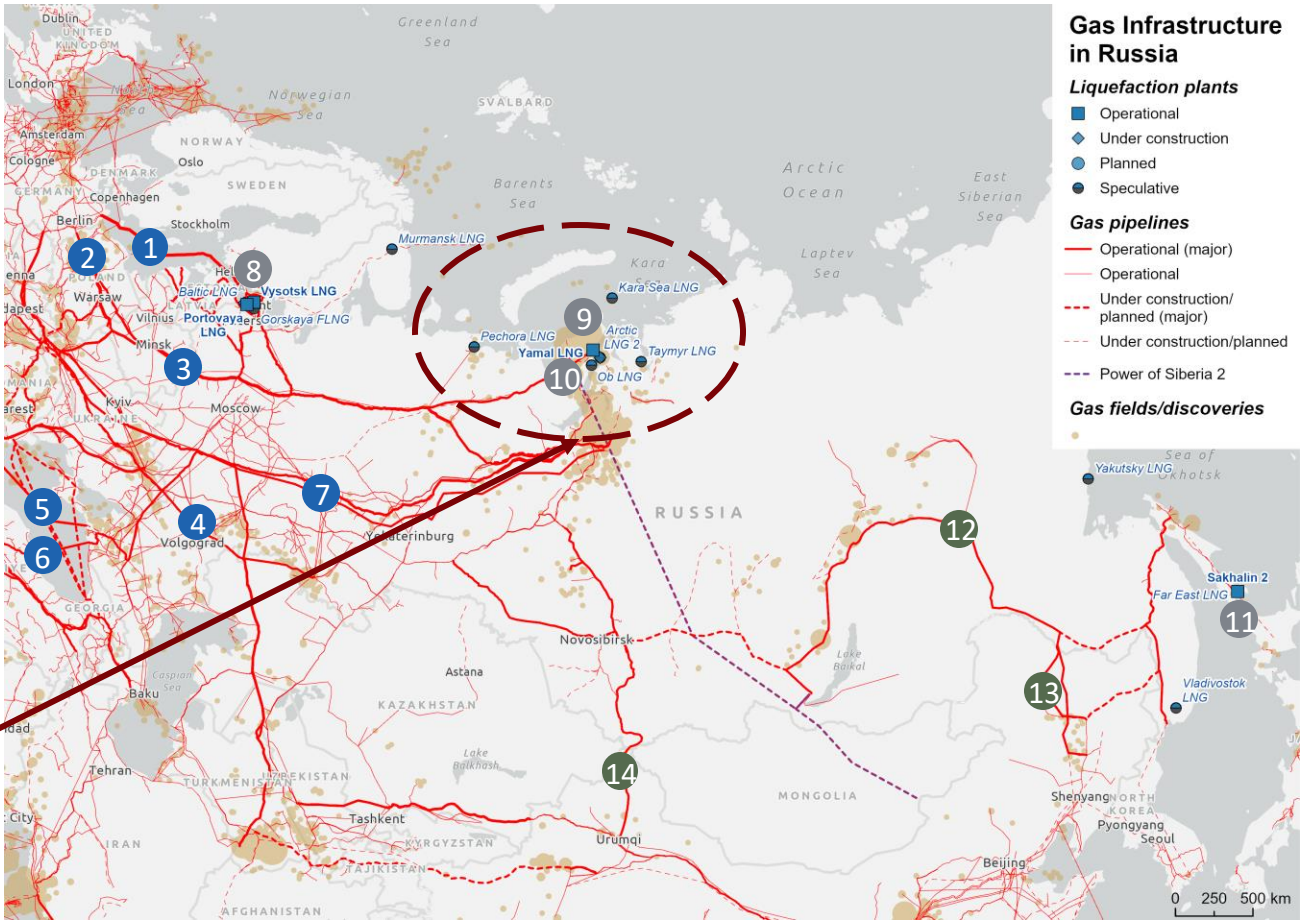
Source : Rystad Energy research and analysis, Politico, Reuters

Russia's gas exports network focuses primarily on Europe with big new investments required to target the Chinese market

Russian export pipeline network and LNG terminals**

No.	Name	Capacity (bcm/year)
1	Nordstream (sabotaged)*	55
2	Nordstream2 (cancelled)*	55
3	Yamal	32.9
4	Soyuz	31.5
5	Turk Stream	31.5
6	Blue Stream	16
7	Brotherhood	100

- Vast natural gas reserves located in the **Yamal Peninsula**, currently only connected via pipeline to Europe.
- Supply to China/Asia will be possible when/if **Power of Siberia II** is completed.
- This can displace Chinese reference LNG demand and reduce the additional LNG call, but is not implemented.



No.	Name	Capacity (bcm/year)
8	Baltic LNG (under construction)	17.9
9	Arctic LNG (under construction)	27.3
10	Yamal LNG	22.8
11	Sakhalin 2 LNG	13.5

No.	Name	Capacity (bcm/year)
12	Power of Siberia	38
13	Power of Siberia (expansion)	6
14	Power of Siberia II (planned)	50

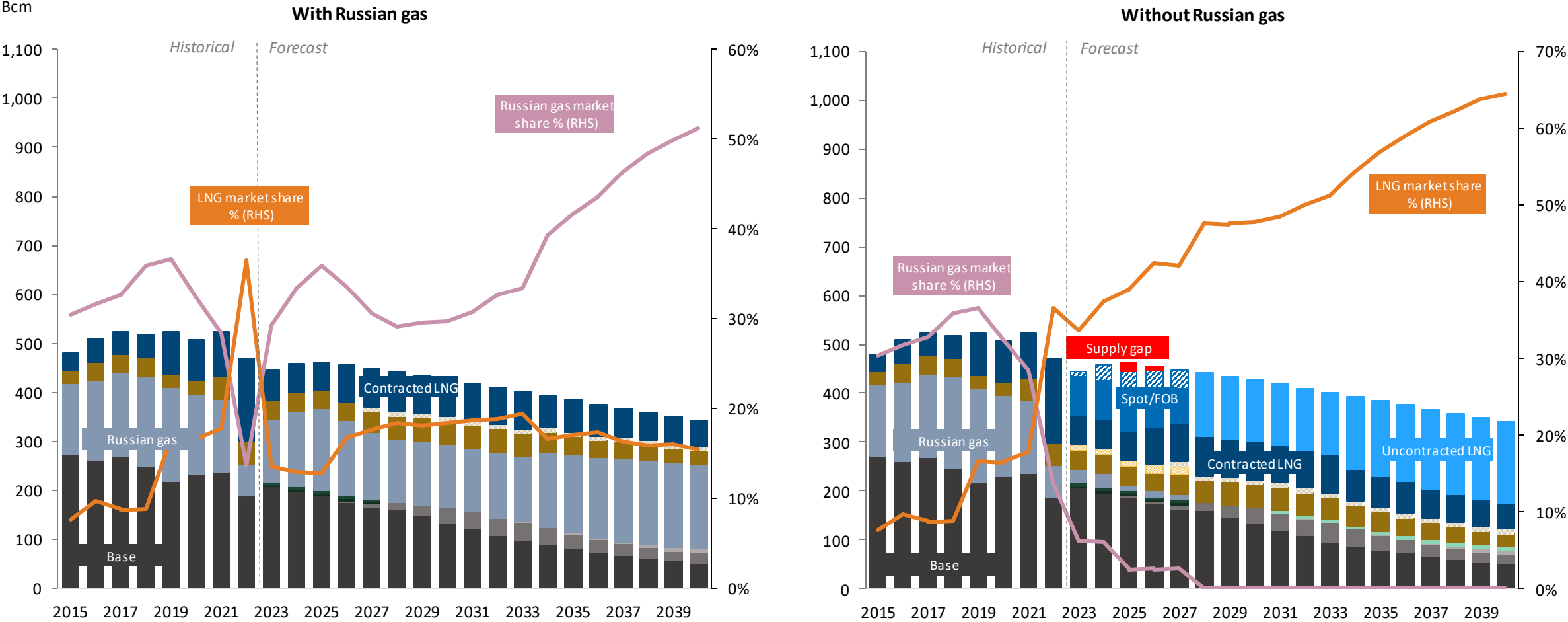
Legend

Red line	Europe pipeline
Green line	Asia pipeline
Blue dot	LNG terminal

*Only larger assets presented on the map. Other pipelines include: Imatra to Finland (7.1 bcm), Varska to Estonia (1 bcm). Other terminals include: Vysotsk LNG (1.4 bcm), Yamal (1.2 bcm), Portovaya LNG (2.1 bcm), Obsky LNG (6.9 bcm)
 Source: Rystad Energy research and analysis

From a lowest cost perspective Russian supply should have grown its market share in lieu of LNG

European supply with and without Russian gas

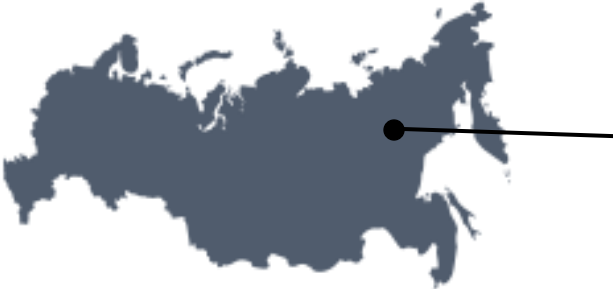


Note: Contracted LNG volumes as of end of October 2023;
Source: Rystad Energy research and analysis

Russia’s ambitions to develop Siberian gas face greater uncertainty

Case study: Russian LNG buildout

Yakutia LNG to commence in 2027



Name	Yakutia LNG
Capacity	17.7 mcm/yr (planned)
Operator	Globaltec
Construction start	2023
Completion	2027
Supplier	Russia
Target	Far east China

Algeria has a higher gross production of natural gas than Norway, however much of it is not marketed due to reinjection, flaring and other losses.

Norway and Azerbaijan see comparatively fewer losses to these processes, allowing for marketable gas rates of 83% and 58% for 2021 respectively.

Gas reinjection occurs when fields are producing more oil, the tight spreads between oil and gas prices may prompt gas production to be prioritized.

Source : Rystad Energy research & analysis, GasMarketCube, Upstream

Russia to focus on LNG with gas assets reshuffle

Russian authorities are considering increasing the country’s LNG exports to help counter the expected loss of supplies to Europe via onshore and offshore pipelines.

The plans involve increasing government control over the development of gas resources, leaving them with more direct stakes in major gas assets, rather than handing them to giants such as Gazprom.

Unexplored or undeveloped assets held by state-controlled Gazprom and other companies will be returned to government control, who aim to auction any returned assets to operators that can ensure faster development of the acreage.

Russia’s largest independent gas producer Novatek has renewed its push to persuade authorities to give it control of these assets, given it has patented its own liquefaction process, Arctic Cascade.

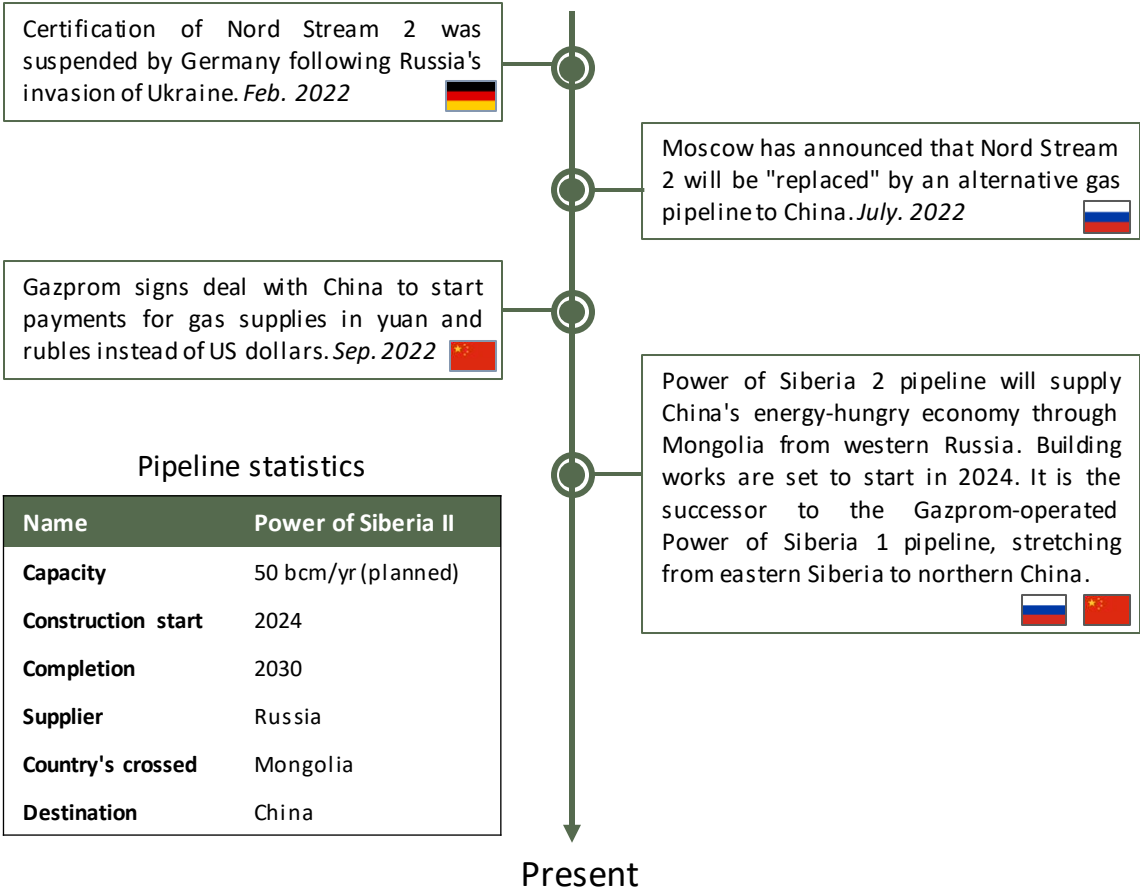
Arctic cascade, is based primarily on Russian-manufactured equipment, thus no reliance on the west.

Novatek is also leading Russian industry efforts to foster the country’s LNG export capacity, pushing the sector to develop internationally competitive technology and manufacturing standards.



Power of Siberia II is agreed between Russia and China with construction start potentially in 2024

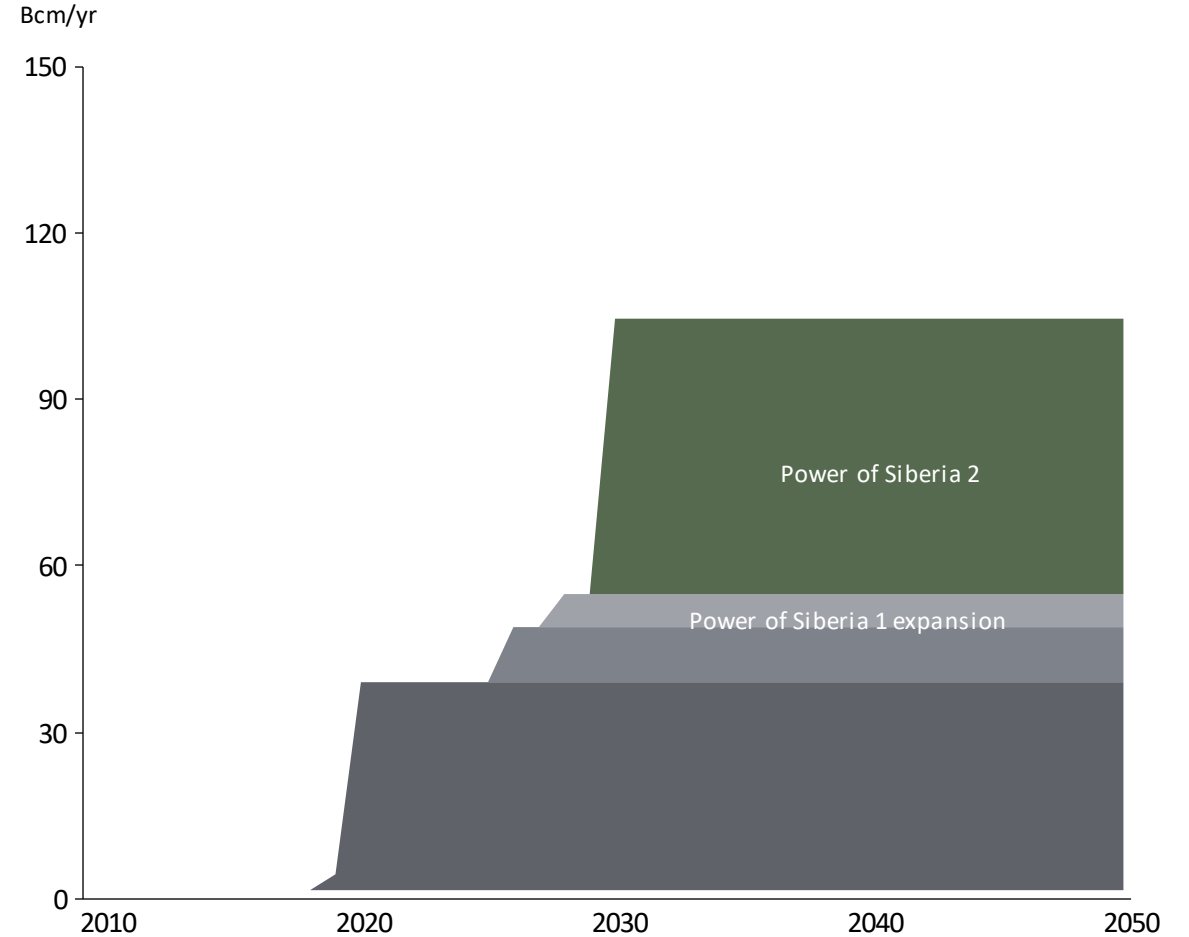
Case study: Russian gas pipelines to China



Pipeline statistics

Name	Power of Siberia II
Capacity	50 bcm/yr (planned)
Construction start	2024
Completion	2030
Supplier	Russia
Country's crossed	Mongolia
Destination	China

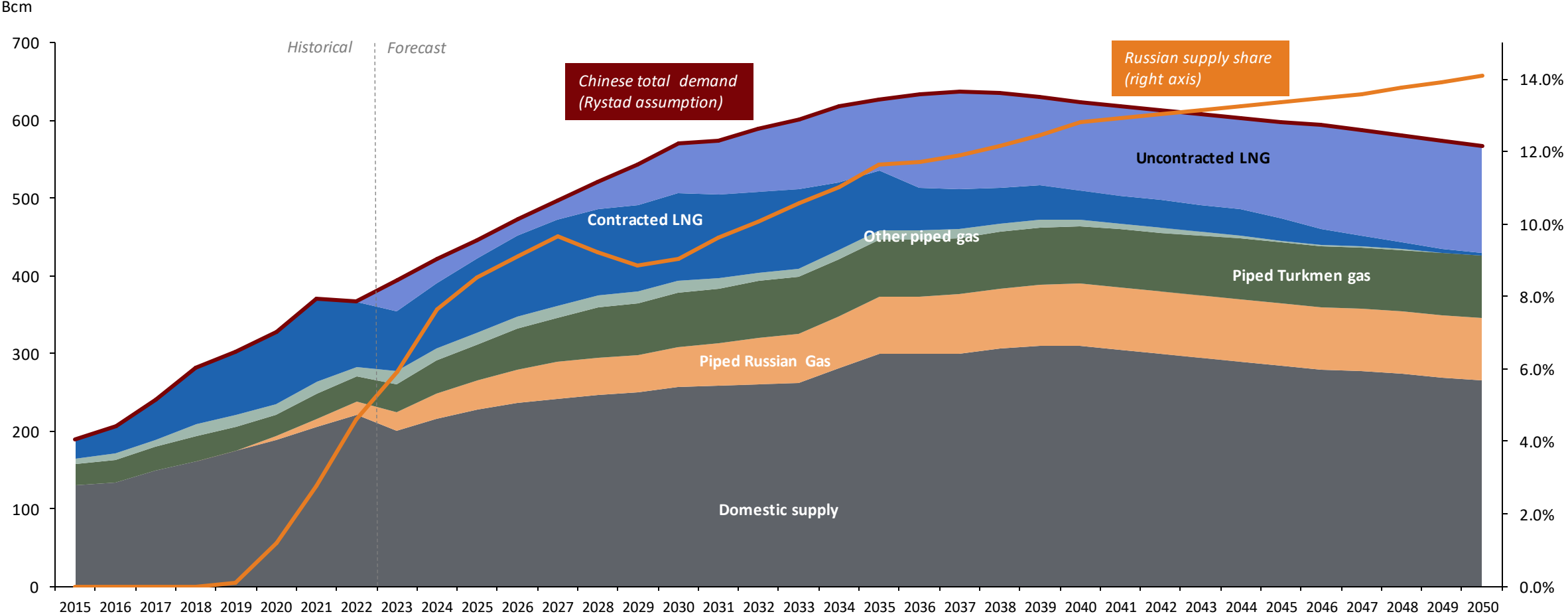
Russian pipelines leading to China



Source: Rystad Energy research & analysis, GasMarketCube

Russian gas not expected to increase over 15% market share in China

China's gas supply and demand analysis



Source: Rystad Energy research and analysis; GasMarketCube

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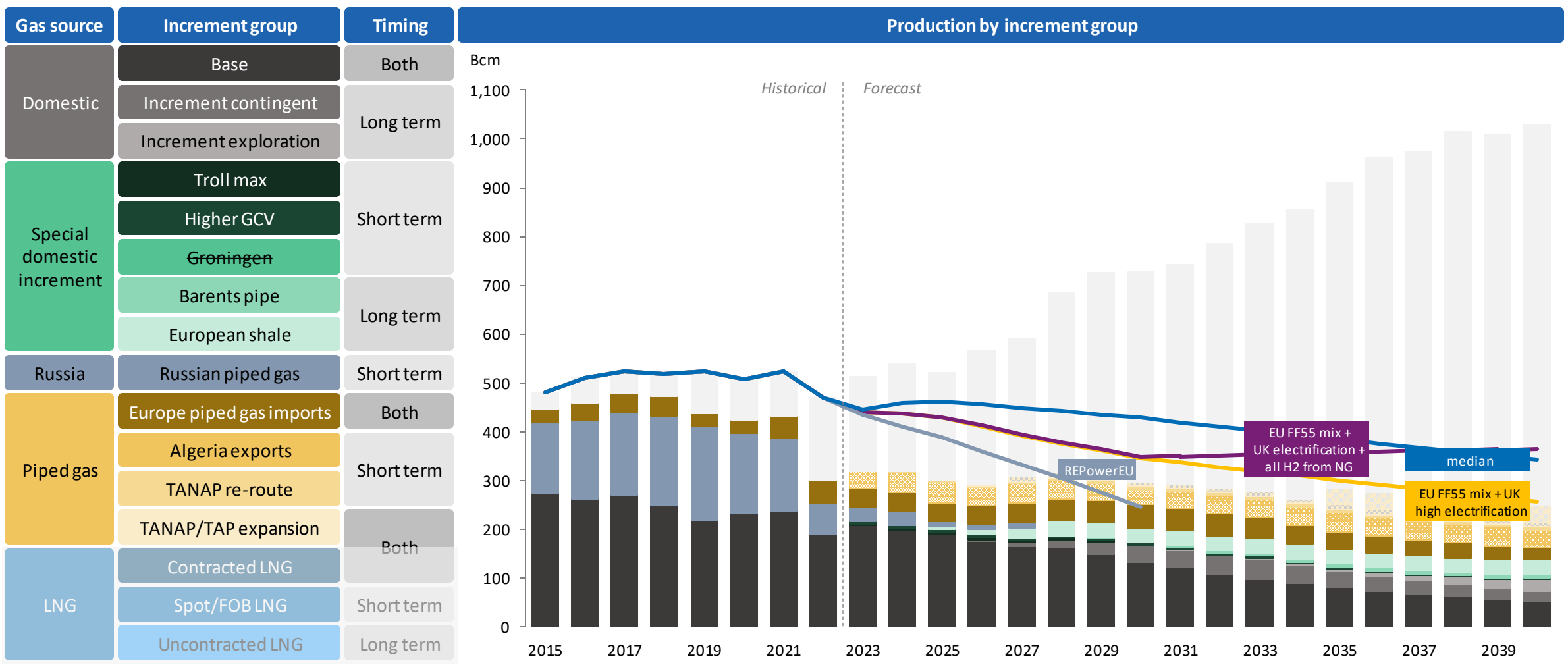
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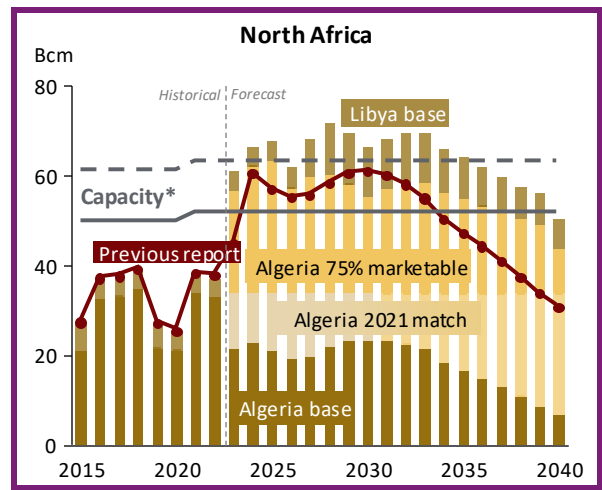
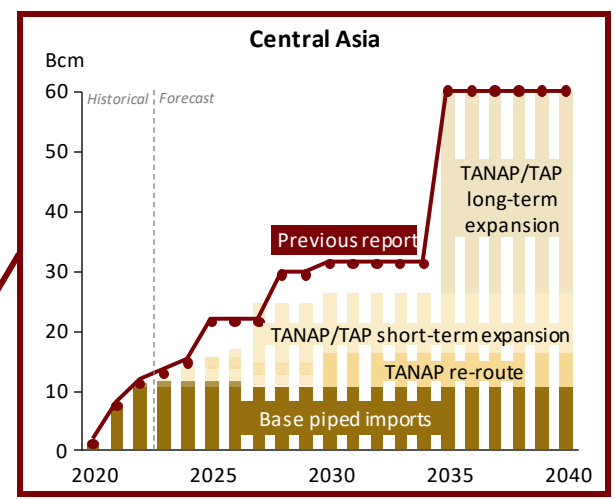
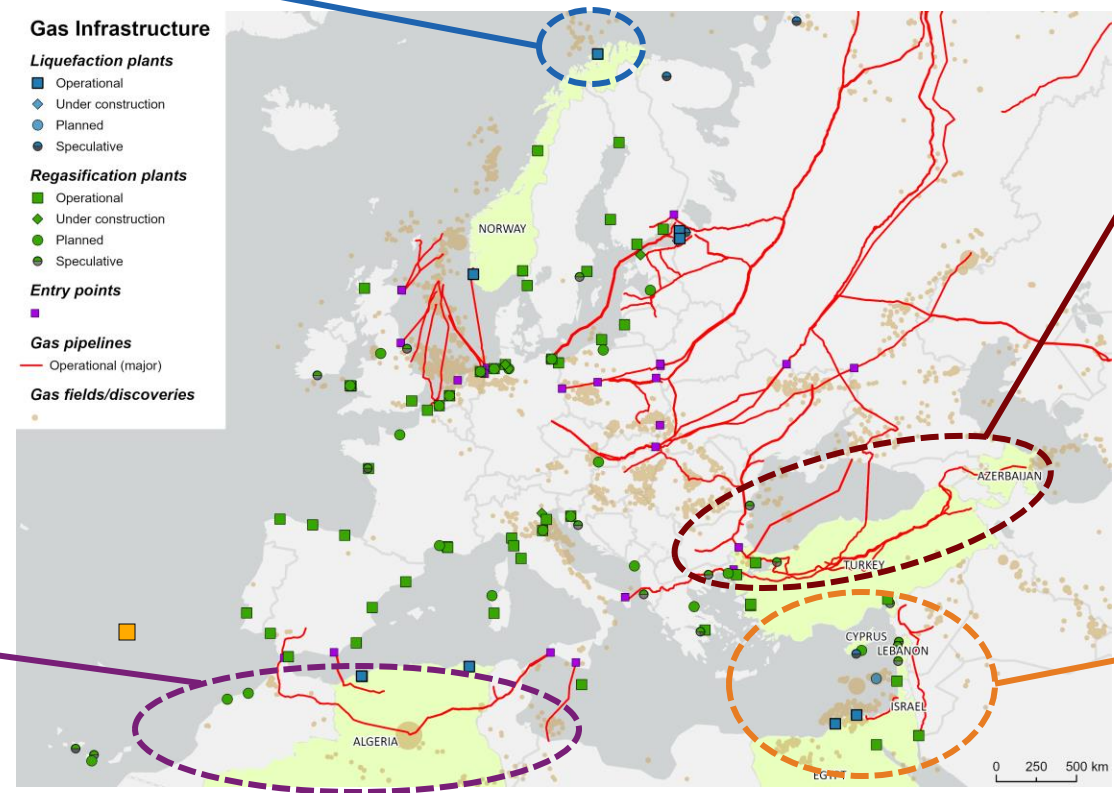
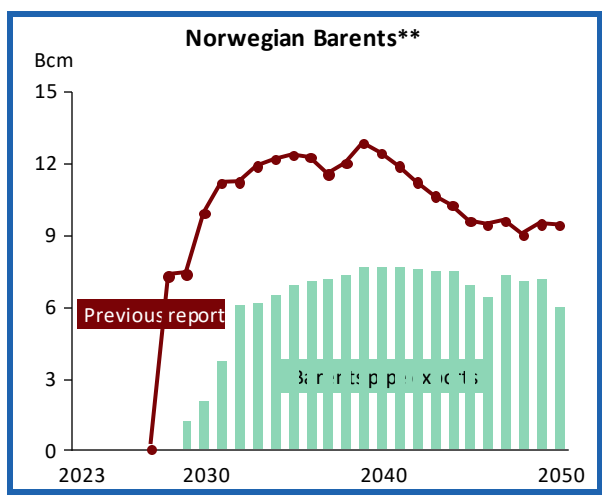
Appendix

Algeria supply and increased volumes from TANAP can offer boost to European market



Note: Contracted LNG volumes as of end of October 2023;
 Source: Rystad Energy research and analysis, GasMarketCube, European Commission, UK BEIS

Infrastructure expansions around Europe's periphery can help increase supply of piped gas



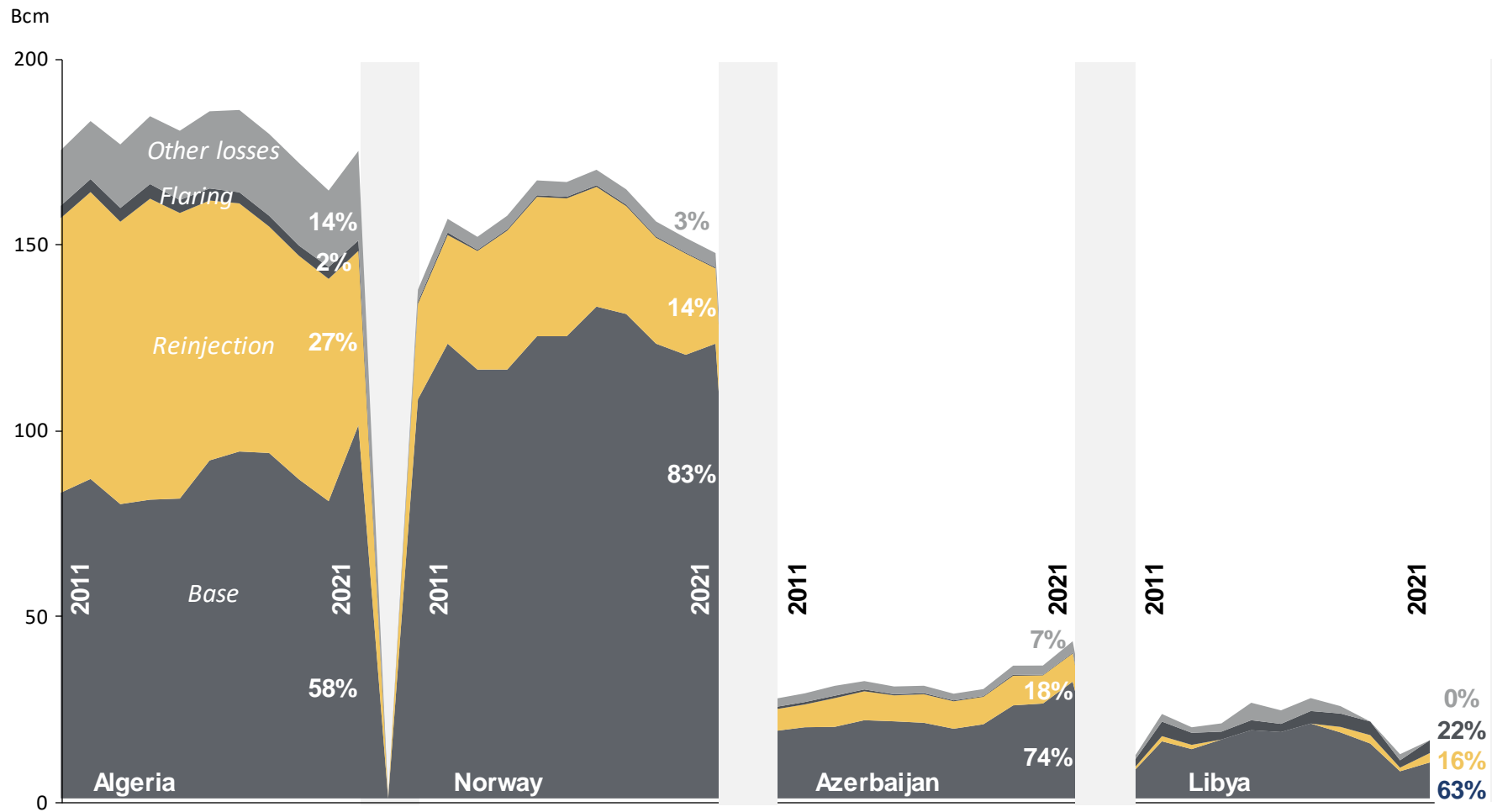
Eastern Mediterranean (no change in sentiment since previous report)

Rystad's assumption remains that Eastern Mediterranean resources will be dedicated to local consumption and allocated to potential LNG exports from Egypt. While there has been a few new discoveries, they are not of any significant size and will likely form part of the LNG pool in any case. A pipeline to Europe is considered unlikely given the geopolitics, difficult topography and insufficient Cypriot resources for a standalone export solution towards Europe.

*Solid line indicates capacity given by Medgaz pipeline, Transmed pipeline and Greenstream pipeline. Dashed line includes GME pipeline in addition. **See domestic increments for additional details
 Source: Rystad Energy research and analysis

Algeria reinjects far more gas than other potential European suppliers

Gross Natural Gas Production*



- Algeria has a higher gross production of natural gas than Norway, however much of it is not marketed due to reinjection, flaring and other losses.
- Norway and Azerbaijan see comparatively fewer losses to these processes, allowing for marketable gas rates of 83% and 58% for 2021 respectively.
- Gas reinjection occurs when fields are producing more oil, the right spreads between oil and gas prices may prompt gas production to be prioritized.

* Percentages shown for 2021
 Source : Rystad Energy Gas Market Cube, Rystad Energy research and analysis, GECF

Hassi R'Mel new discovery to boost Algerian exports by 5.5 bcm per year

Algeria gas output increase due to new discoveries

Algeria's Sonatrach Targets 'Rapid New Output': Exclusive Mees Interview With CEO Toufik Hakkar

6 Jan 2023 | Issue: 66 / 1 | By: Aydin Calik

MEES speaks to Sonatrach CEO Toufik Hakkar where he lays down his firm's plans for 2023 and beyond with gas output increases at the top of the agenda.

Hassi R'mel: les travaux d'évaluation et de développement du réservoir "LD2" connaissent une progression notable

Algeria's Oil Output Falls Back Below 1mn b/d As Focus Switches To Maxing Gas Exports

26 May 2023 | Issue: 66 / 21 | By: James Cockayne

Algeria's crude output is falling in line with the country's Opec+ commitments. This dovetails with a need to cut gas reinjection to meet ambitious gas export targets.

Algeria unveils six new hydrocarbon discoveries as Ukraine war spurs upstream sector

State-owned Sonatrach said the finds are spread across four geological basins

UPDATE 1-Algerian gas discovery boosts reserves, Sonatrach says

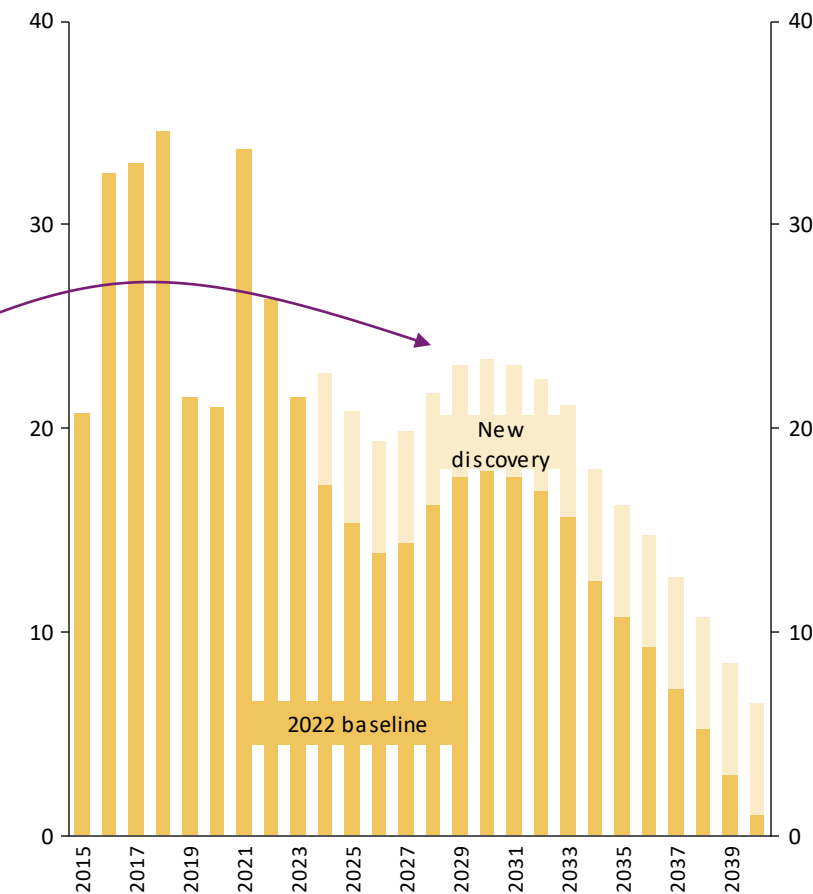
Algeria gas discovery profile

Bcm



Algeria gas production

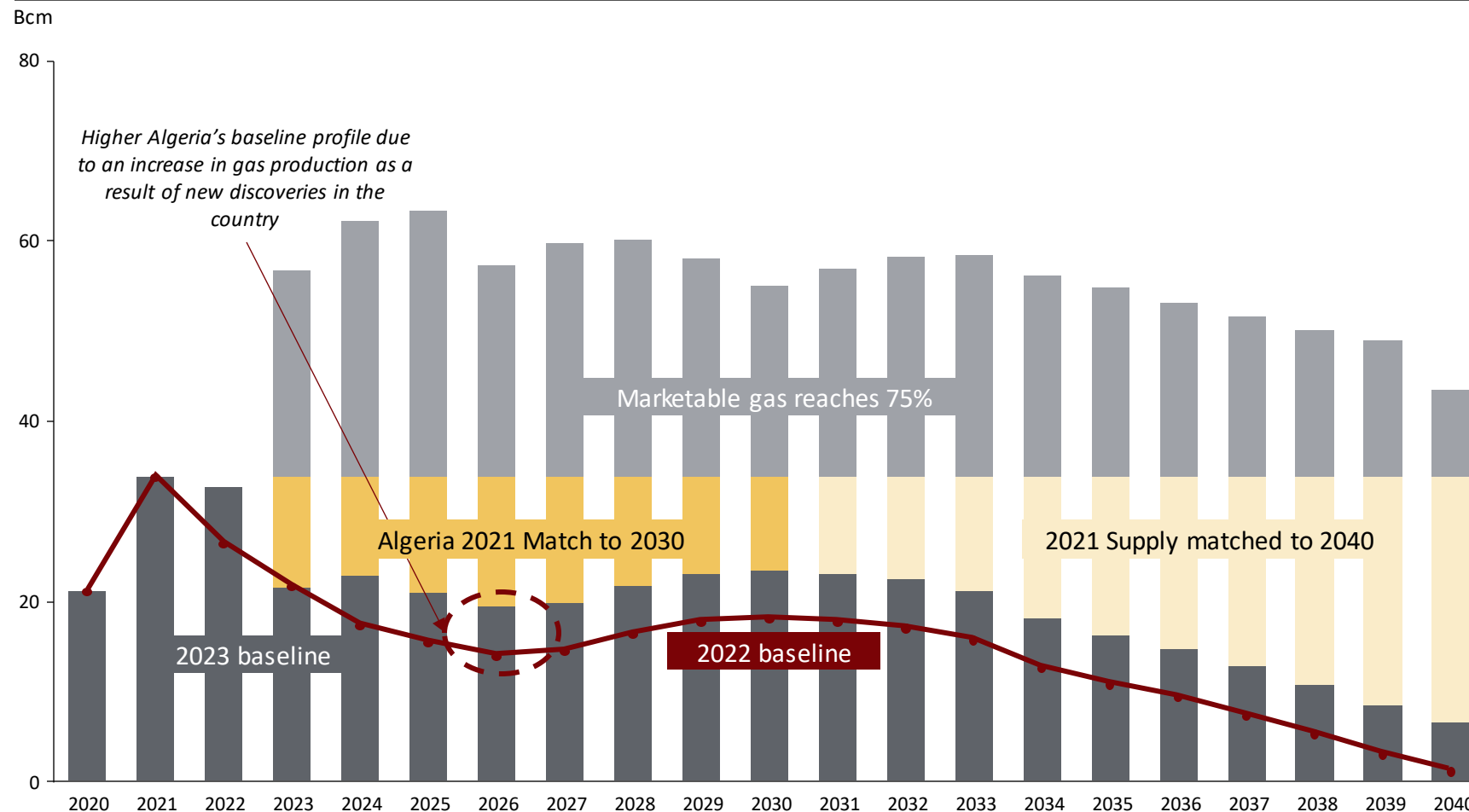
Bcm



Source : Rystad Energy research and analysis; MEES; TotalEnergies; Reuters; Upstream; APS.DZ

Algeria’s pipeline exports have been uplifted as a result of new production assets coming online

Algeria natural gas pipeline exports



- Rystad has revised up its outlook for pipeline exports to Europe from Algeria compared to a year ago
- This has been driven in large part due to new discoveries near its largest gas field, Hassi R’Mel, and the signing of new energy agreements with Italy, the largest recipient of Algerian piped gas
- Algerian oil and gas fields are very mature and, as such, must reinject large quantities of gas in order to maintain reservoir pressure
- Algeria has historically prioritized oil production over gas but, with recent OPEC+ production curtailments, a shift towards more gas production is taking place
- Due to a higher baseline, 75% marketable gas increment tracks higher than in last year’s report

Source : Rystad Energy Gas Market Cube, Rystad Energy research and analysis, GECF

Eni's development of the Bahr Es Salam A&E fields will add up to 7.3 bcm per year

Libya gas output increase due to new discoveries

Italy's Eni signs \$8bn gas deal with Libya amid energy crunch

The energy agreement, signed during Italian PM Meloni's visit to Tripoli, seeks to boost Libya's gas output through new offshore gas fields.

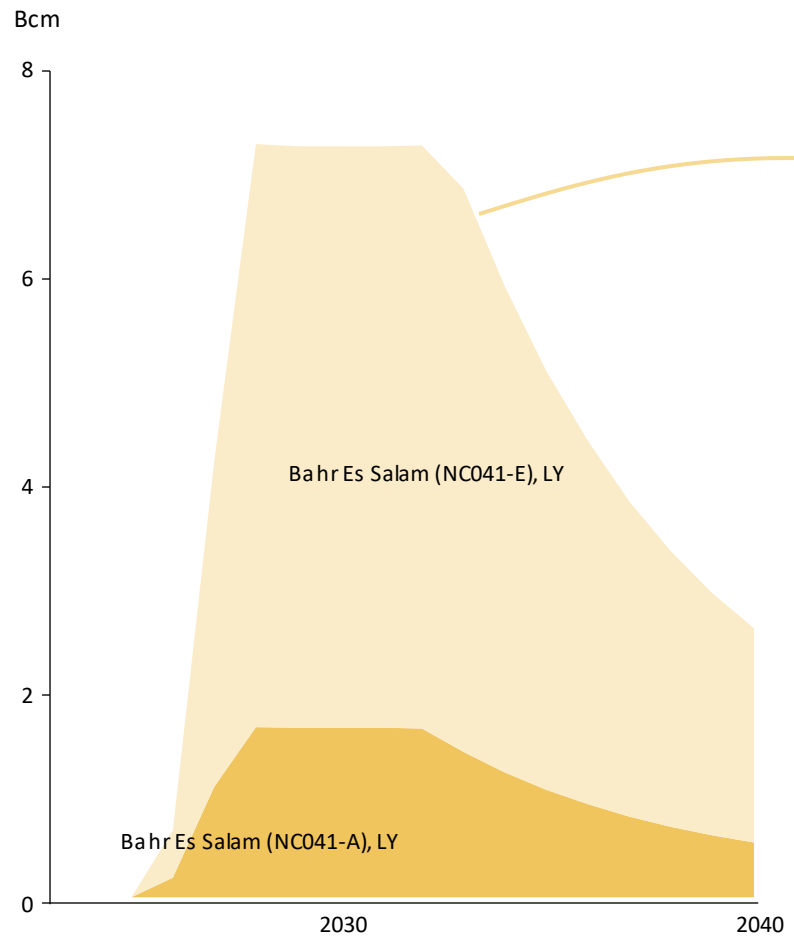


SUMMARY
The first major upstream project in Libya since around 200 will involve developing two offshore gas fields, with production scheduled to start in 2026. [Gas in Transition, Volume 3, Issue 2]

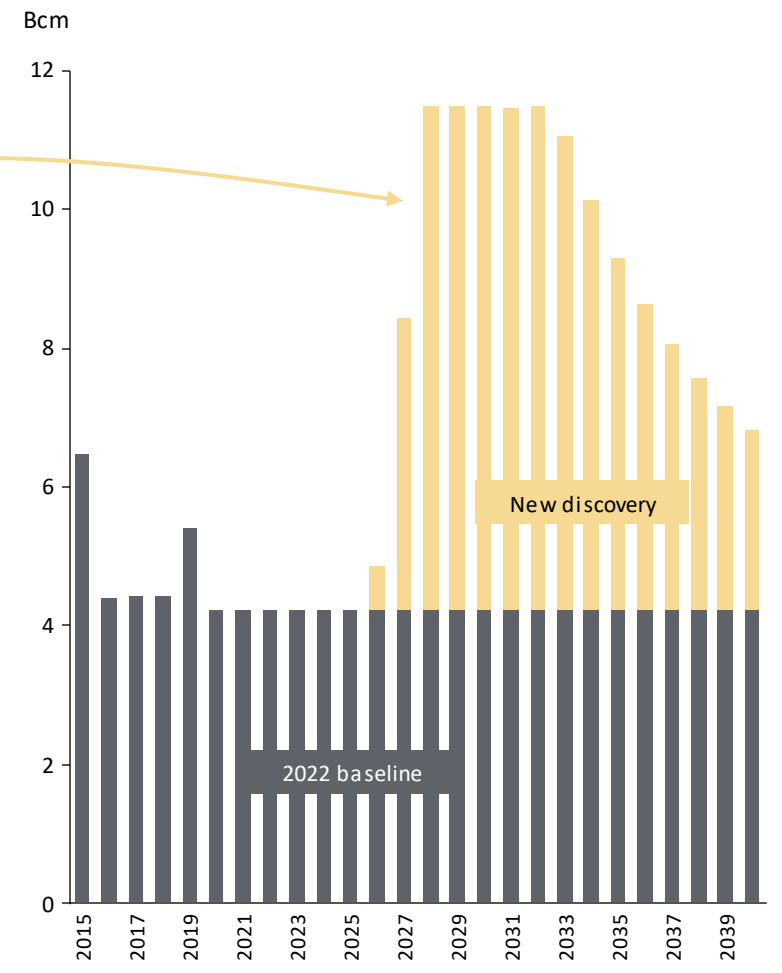


Libya's NOC, Eni sign agreement to develop two plots with 6 trillion cubic feet of gas reserves

Libya gas discovery profile



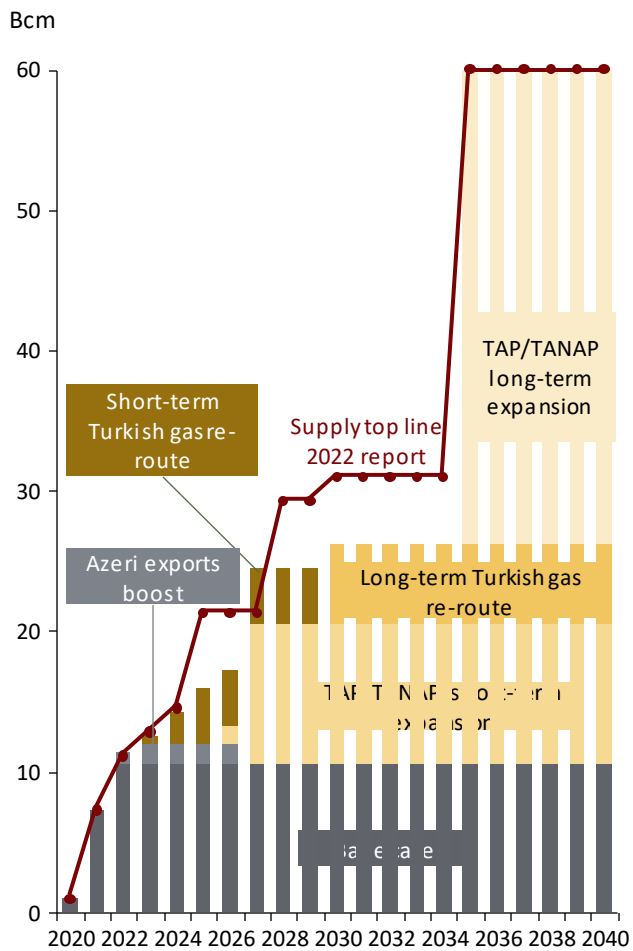
Libya gas production



Source : Rystad Energy research and analysis; Al Jazeera; Natural Gas World; S&P Global

Central Asian gas exports are currently seen as one of the key supply routes of gas to Europe, with volumes increasing since 2022

Potential of the Central Asian gas exports to Europe via TANAP



	Key characteristics	Increment	2022 study	Commentary
Base case	<ul style="list-style-type: none"> TANAP's capacity stands at 16.2bcm, with European deliveries at 10.5bcm and Turkish deliveries at 5.7bcm Azeri exports to Europe maintained and capped at 10.5bcm as per agreed nominal capacity 	N/A	N/A	No change compared to the 2022 report, with European deliveries at 10.5bcm and Turkish deliveries at 5.7bcm
Base case: Azeri exports boost	<ul style="list-style-type: none"> Azeri gas exports has increased from 19bcm in 2021 to 22.6bcm in 2022 and it is further expected to grow in 2023 Europe's exports is expected to increase to at least 11.6bcm in 2023 from 11.3bcm in 2022 	2023: 1.5bcm	N/A	Azerbaijan has boosted its deliveries both to Turkey and Europe in 2022, with a further increase planned for 2023
TAP/TANAP short-term expansion	<ul style="list-style-type: none"> In July 2022, the EU and Azerbaijan signed a MoU on an energy partnership, which includes doubling TAP capacity to over 20bcm by 2027 (TANAP capacity expansion to 31bcm) After the completion of the first capacity bidding phase, 1.2bcm extra capacity has been allocated from 2026. The next bidding phase is expected later this year 	2026: 11.7bcm* 2027: 20bcm	2025: 23bcm 2028: 31bcm	As a result of a strategic partnership between the EU and Azerbaijan, TAP is expected to expanded by 2027. With more material plans in place, the outlook has been updated, resulting in slightly lower uptake than previously stated.
Short-term Turkish gas re-route	<ul style="list-style-type: none"> Azeri gas to Turkey to gradually re-route to supply the European market The re-route option is constrained by Turkish demand and its likelihood to be supplied from other sources, e.g., Iran 	2023: 10% 2024: 40% 2025: 70%	2022: 10% 2023: 40% 2024: 70%	The possibility of short-term Turkish gas re-route has been upheld, with a delay of one year compared to the 2022 iteration, subject to Turkish demand.
Long-term Turkish gas re-route	<ul style="list-style-type: none"> As a result of Turkish domestic gas production increase, full re-route is feasible from 2030 	2030: 100% (5.7bcm)	2030: 100% (5.7bcm)	No change with regards to long-term Turkish gas re-route, which is seen as a possibility from 2030
TAP/TANAP long-term expansion	<ul style="list-style-type: none"> With the planned TANAP expansion, the capacity could increase up to 60bcm (2035). This expansion would require construction of additional compressor stations additional gas sources to be involved, such as Turkmenistan or Iran It is assumed all new capacity will be dedicated to supply Europe 	2035: 60bcm	2035: 60bcm	TAP/TANAP long-term expansion up to 60bcm in 2035 has remained unchanged. This option, however, would require significant investments in infrastructure and alternative supply sources, such as Turkmenistan.

*Additional capacity can be higher subject the next bidding phase later in 2023
Source: Rystad Energy research and analysis

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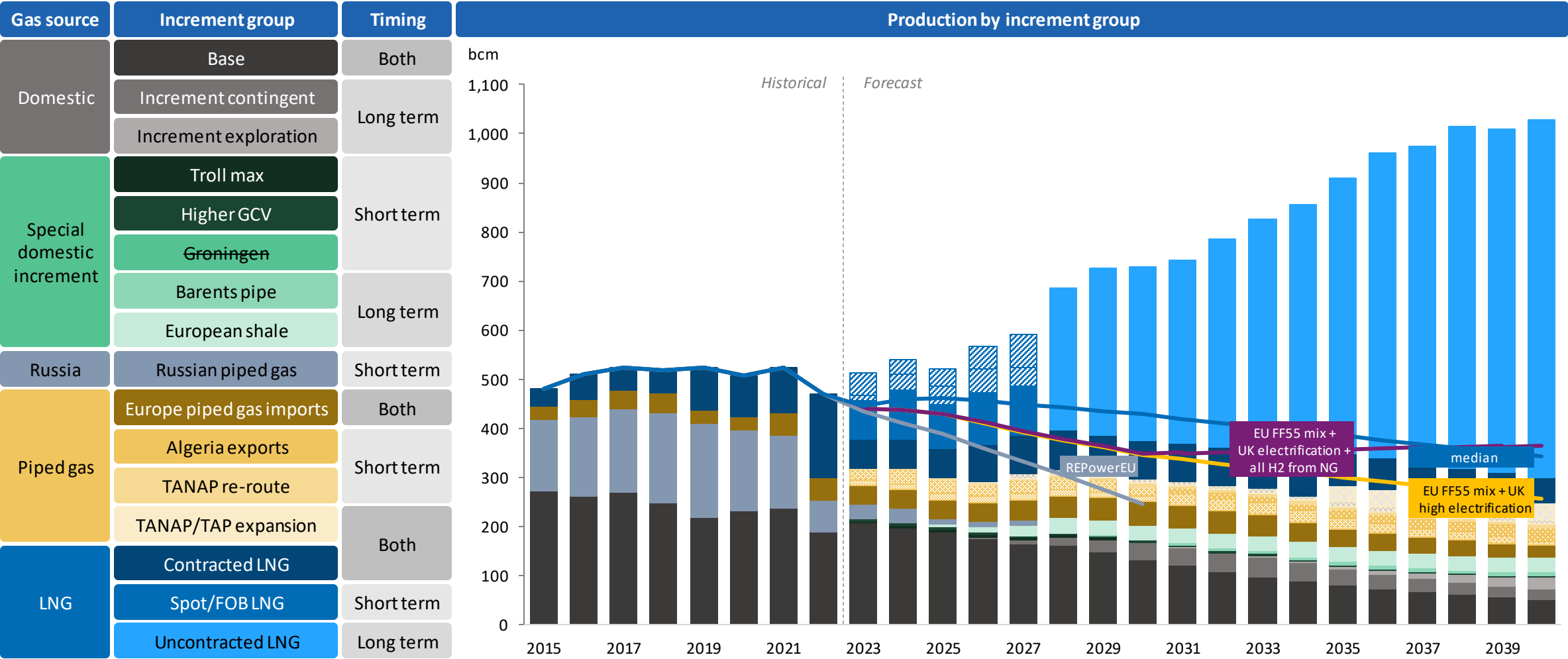
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More long-term LNG contracts have been secured since last report, reflecting uptick towards 2040



Note: Contracted LNG volumes as of end of October 2023;
 Source: Rystad Energy research and analysis, GasMarketCube, European Commission, UK BEIS

LNG supply methodology have separate approaches for short- and long-term supply to reflect market readiness to supply additional LNG volumes

Short-term supply outlook

Methodology and approach: The short-term outlook (2023-2027) focuses on the achievable LNG market share to be captured by Europe in competition with other regions, particularly Asia from a fixed set of liquefaction capacity determined by prior investment decisions.

Step	Description
1 Historical LNG imports	<ul style="list-style-type: none"> Europe's LNG imports has surged to unprecedented levels since the Russian invasion on Ukraine Reduced volumes of Russian gas supply to Europe have been largely substituted by LNG, causing a surge in gas prices in Europe and worldwide Since the war outbreak, Europe has accounted for around 30% of global LNG imports on an annual basis
2 Maximum LNG imports	<ul style="list-style-type: none"> Post war outbreak imports level has been used as a ceiling for European capture of available LNG volumes on a global market Available volumes have been calculated based on a monthly maximum imports share, which corresponds to around 30% of aspects global annual LNG imports
3 Supply by type	<ul style="list-style-type: none"> Potential available LNG supply has been broken down by type: contracted, FOB and short-term spot Contracted volumes are based on known long-term contracts; FOB volumes that can head to Europe; the remainder is allocated to short-term spot.

Long-term supply outlook

Methodology and approach: In the long-term (from 2028 onwards), it is assumed that the market will be able to address demand needs by sufficient existing and future investment in LNG infrastructure, including midstream.

Step	Description
1 Reference demand	<ul style="list-style-type: none"> Reference case derived from governmental projections/targets for LNG demand in Asia and in Europe This reference includes a view on global balances outside Europe to determine what the call on LNG is
2 Potential supply	<ul style="list-style-type: none"> Identification of currently operating and upcoming LNG producing assets, taking into account its competitiveness and non-technical aspects (such as sanctions) A deep dive on US capability to supply the extra volumes to the market due to its substantial capacity to fulfill global demand
3 Supply permutations	<ul style="list-style-type: none"> Possible supply scenarios, with sensitivity of the scale of US production and supply of RoW speculative projects, including Iranian and Russia LNG In higher US LNG production, the supply gap is expected to be covered by incremental US supply
4 Europe rebalancing implications	<ul style="list-style-type: none"> With the knowledge from previous steps it will be possible to understand how global LNG will be able to balance the European gas market The expected cost of supply for this incremental LNG will be used to understand long term gas price implications in Europe Regas capacity in Europe and the required signals to trigger the incremental liquefaction capacity will be crucial to realize the call on incremental global LNG

Source : Rystad Energy research and analysis

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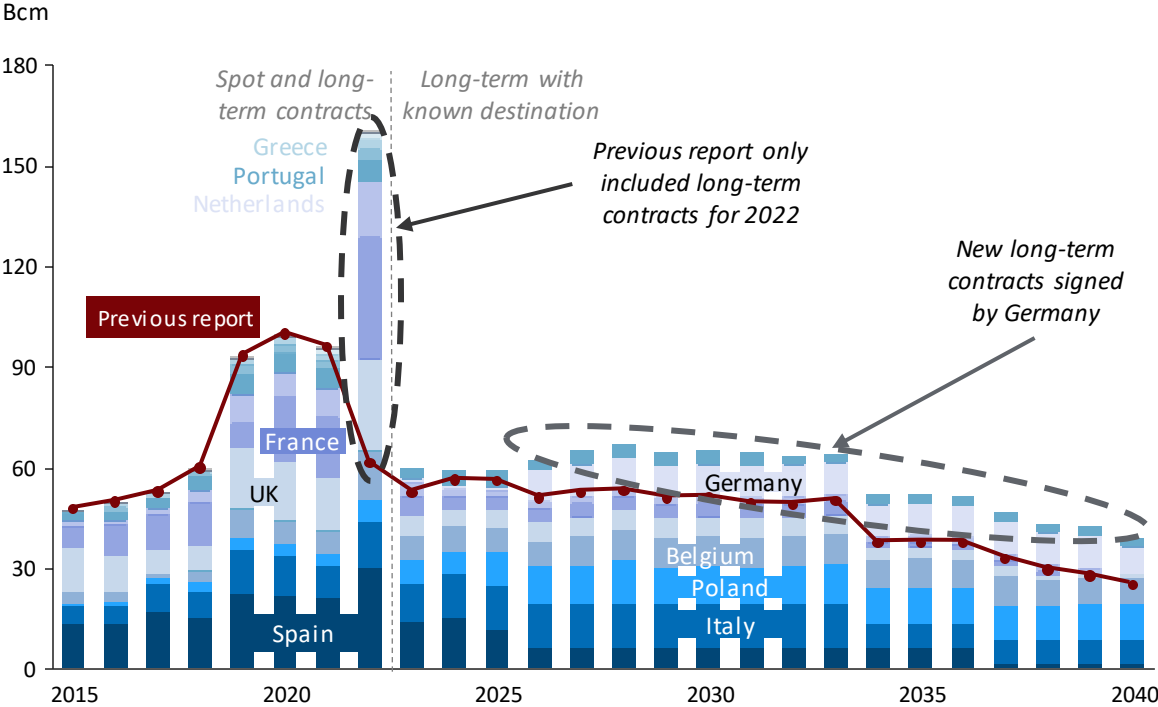
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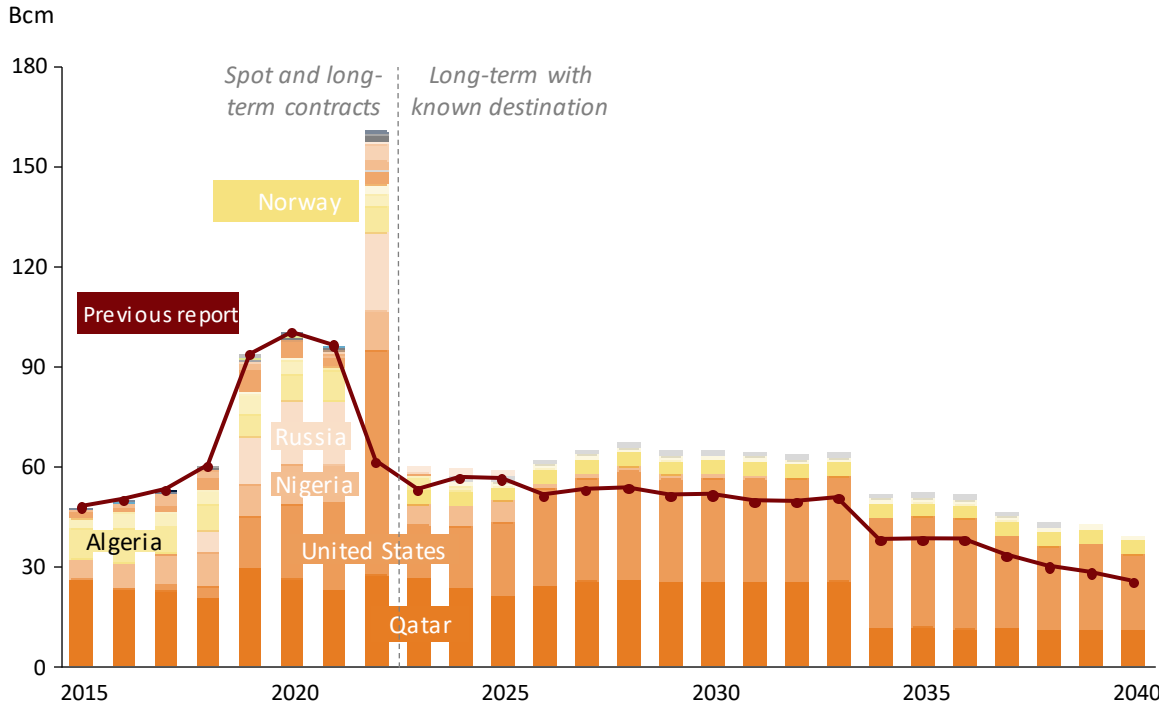
Contracted LNG is primarily sourced from Qatar and the United States

Contracted LNG imports to Europe, split by importing country



- Long term contracts are primarily related Spain, Italy, Poland and Belgium, with Poland being particularly active in the LNG market to secure long-term supply.
- The spike in imports from 2019 was driven by high spot deliveries, particularly in 2022 with the reduction of Russian piped gas.
- European countries have also signed more long-term contracts in response.

Contracted LNG imports to Europe, split by exporting countries



- Qatar and the United States are the primary LNG suppliers to Europe.
- In 2019 and 2020, the spot cargoes used Europe as a buyer of last resort due to global oversupply.
- This situation changed dramatically in 2021 when spot cargoes directed to Europe to meet demand instead, as the continent recovered from COVID and Russian supplies began to decline.

Source : Rystad Energy research and analyses; Rystad Energy GasMarketCube

10 new contracts signed since Russia's invasion of Ukraine between 15-20 years duration

LNG contracts to Europe signed 2022-2023

Signed date	From country	To country	Seller	Buyer	Volume (Mtpa)	Contract start date	Duration (years)	Contract Term
2023-07-11	United States	United Kingdom	Delfin LNG	Centrica	1.0	2026-06-01	15	FOB
2023-06-22	United States	Germany	Venture Global LNG	SEFE	2.3	2026-07-01	20	FOB
2023-04-24	United States	United Kingdom	Delfin LNG	Hartree Partners	0.6	2026-06-01	20	FOB
2023-01-25	United States	Poland	Sempra	PKN ORLEN	1.0	2028-12-15	20	FOB
2022-12-20	United States	Portugal	NextDecade	Galp Energia	1.0	2027-10-15	20	FOB
2022-11-29	Qatar	Germany	QatarEnergy	ConocoPhillips	2.0	2026-01-01	15	DES
2022-10-06	United States	Germany	Venture Global LNG	EnBW	1.0	2026-07-01	20	FOB
2022-10-06	United States	Germany	Venture Global LNG	EnBW	1.0	2026-07-01	20	FOB
2022-04-21	Angola	Italy	Angola LNG	Eni	1.1	2024-01-01	20	FOB
2022-04-21	Congo	Italy	Congo Republic	Eni	3.0	2023-10-01	20	FOB

Source : Rystad Energy research and analysis, LNG Trade Tracker Dashboard

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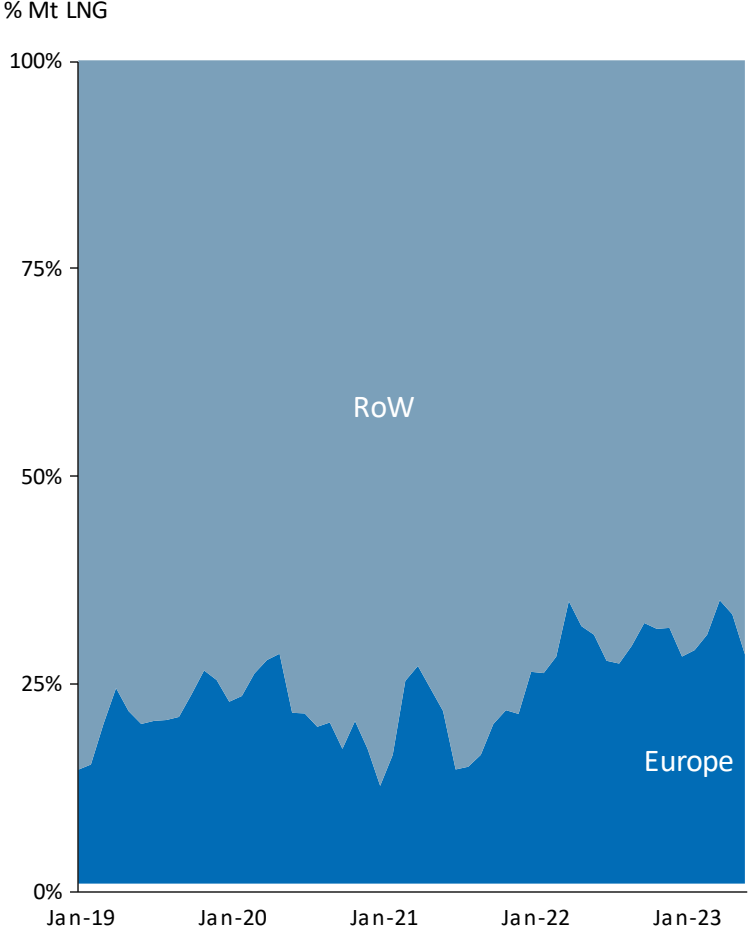
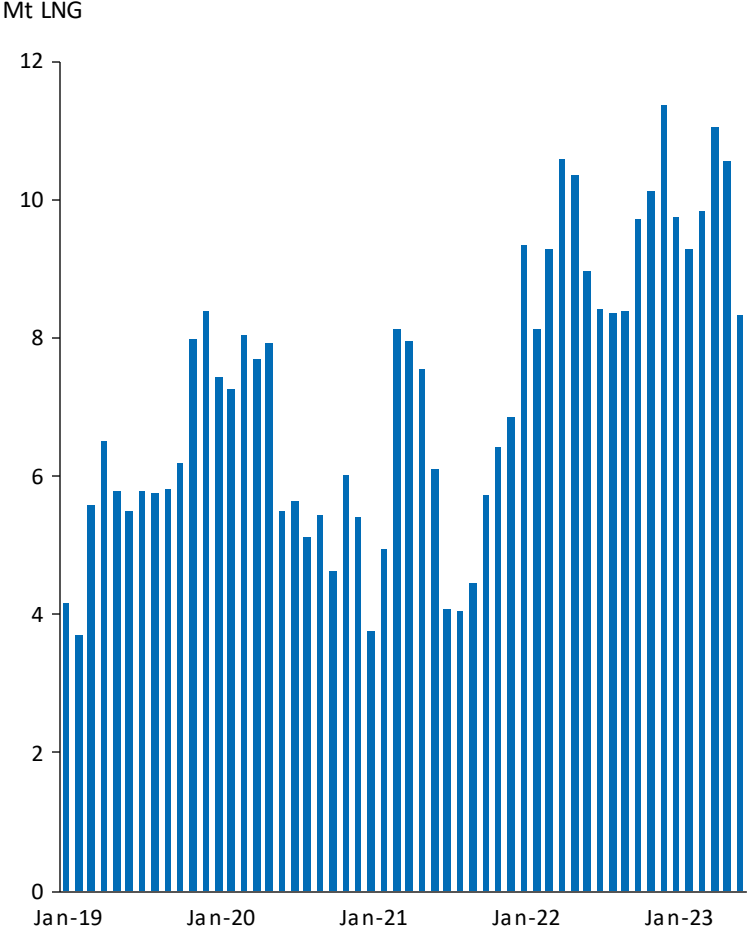
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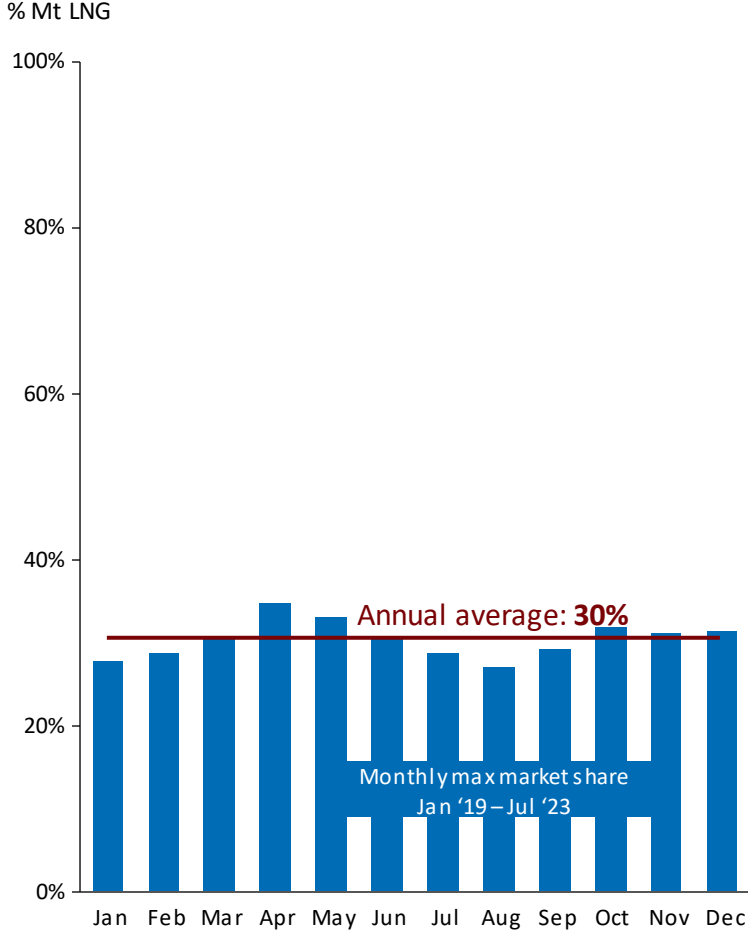
Appendix

Europe's short-term LNG has been capped at historical max market share of 30% pa

Europe's LNG imports have surged since Russia's invasion, ... increasing Europe's capture of available LNG volumes...



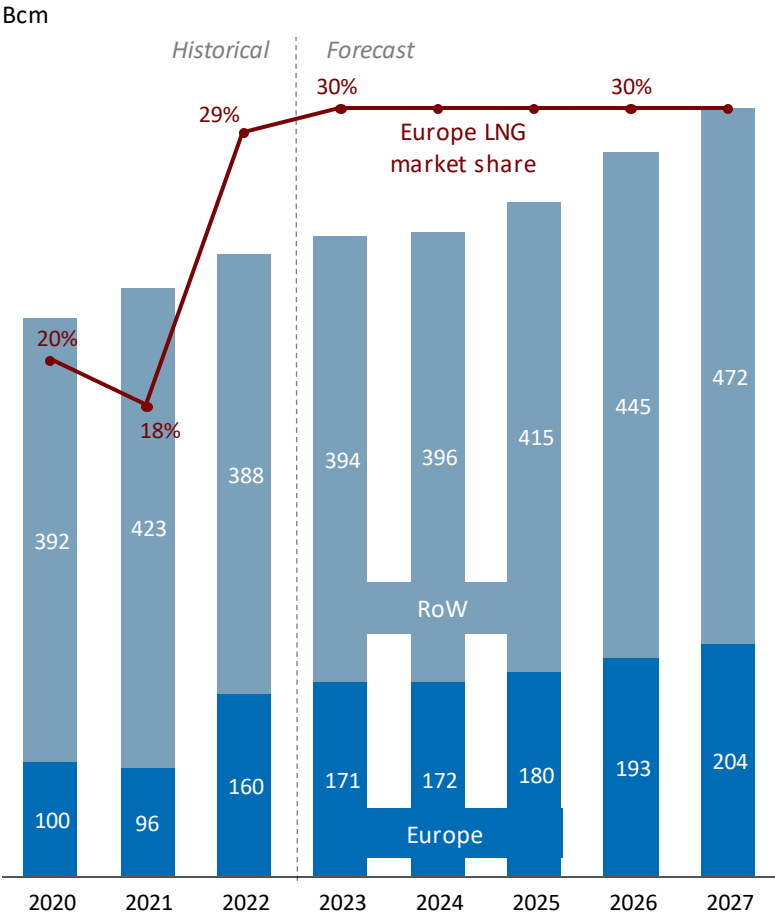
... and setting a market share cap in the short-term



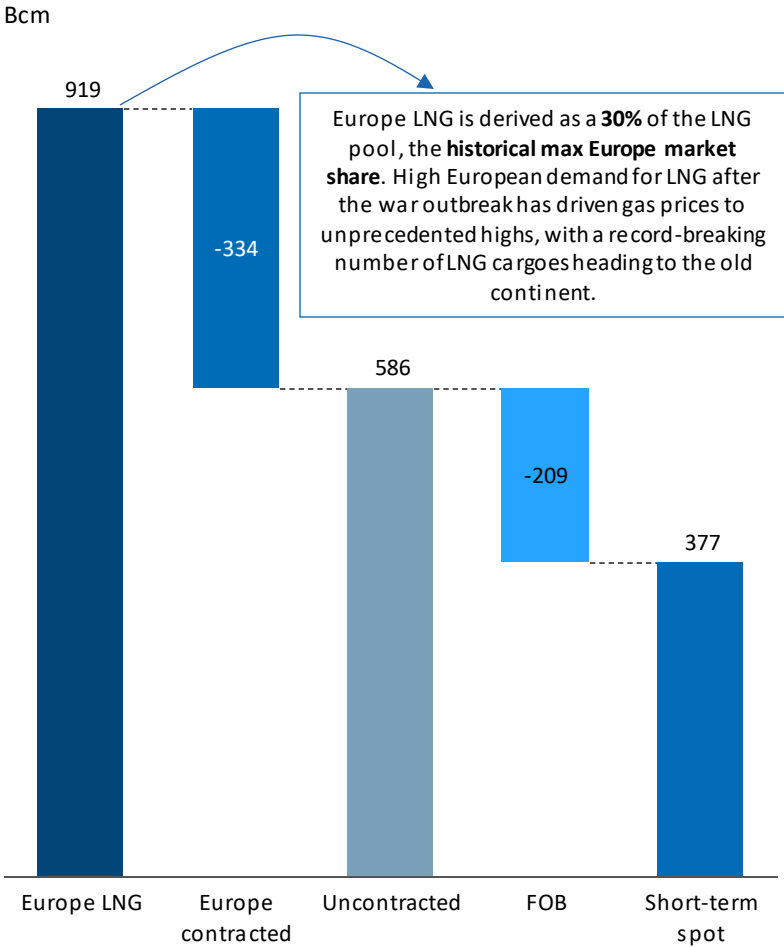
Source: Rystad Energy research and analysis; LNG Trade Tracker

Short-term spot is derived based on available LNG, contracted LNG and FOB

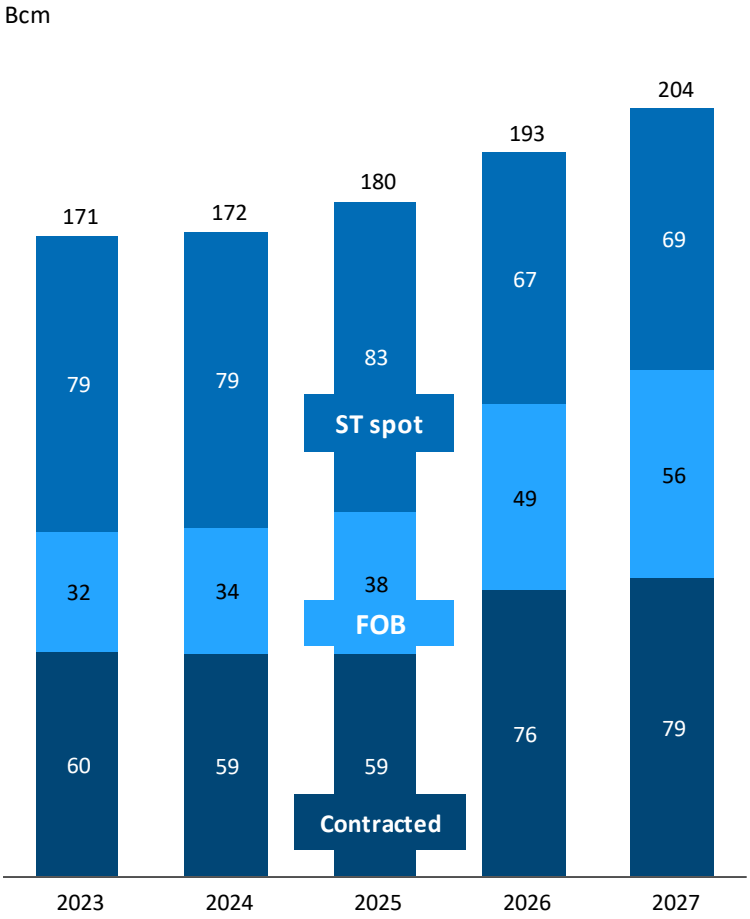
LNG imports, 2020-2027



Cumulative short-term LNG supply to Europe, 2023-27



Competitive LNG to Europe, 2023-27



Note: Contracted LNG volumes as of end of October 2023;
 Source: Rystad Energy research and analysis; GasMarketCube, LNG Trade Tracker

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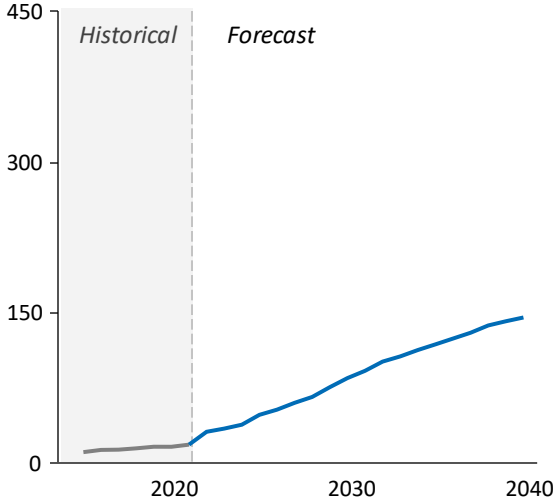
Asia and Europe are driving up LNG demand as gas demand rise while domestic supplies dwindle

Regional LNG demand

Bcm

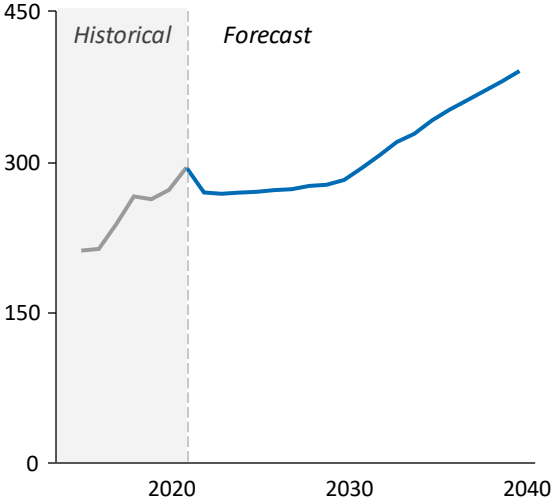
Indonesia, Thailand and Vietnam

LNG volumes required to meet gas demand set out government reports as references cases.



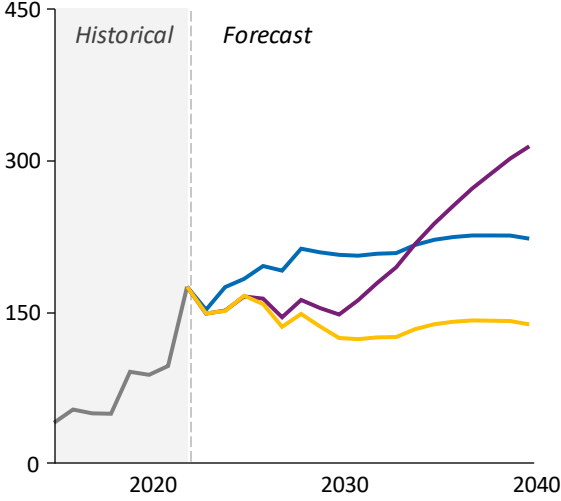
Other APEC

Reference scenario from APEC Energy Demand and Supply Outlook 2022 is used. Excludes LNG volumes from Indonesia, Thailand and Vietnam.



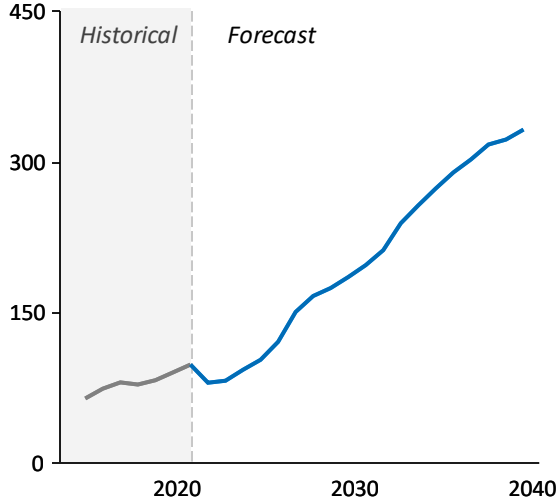
Europe

- median case:** Equinor walls
- High case:** EU Fit-for-55 mix + UK high electrification + all H2 from NG
- Low case:** EU Fit-for-55 mix + UK high electrification



Rest of the World

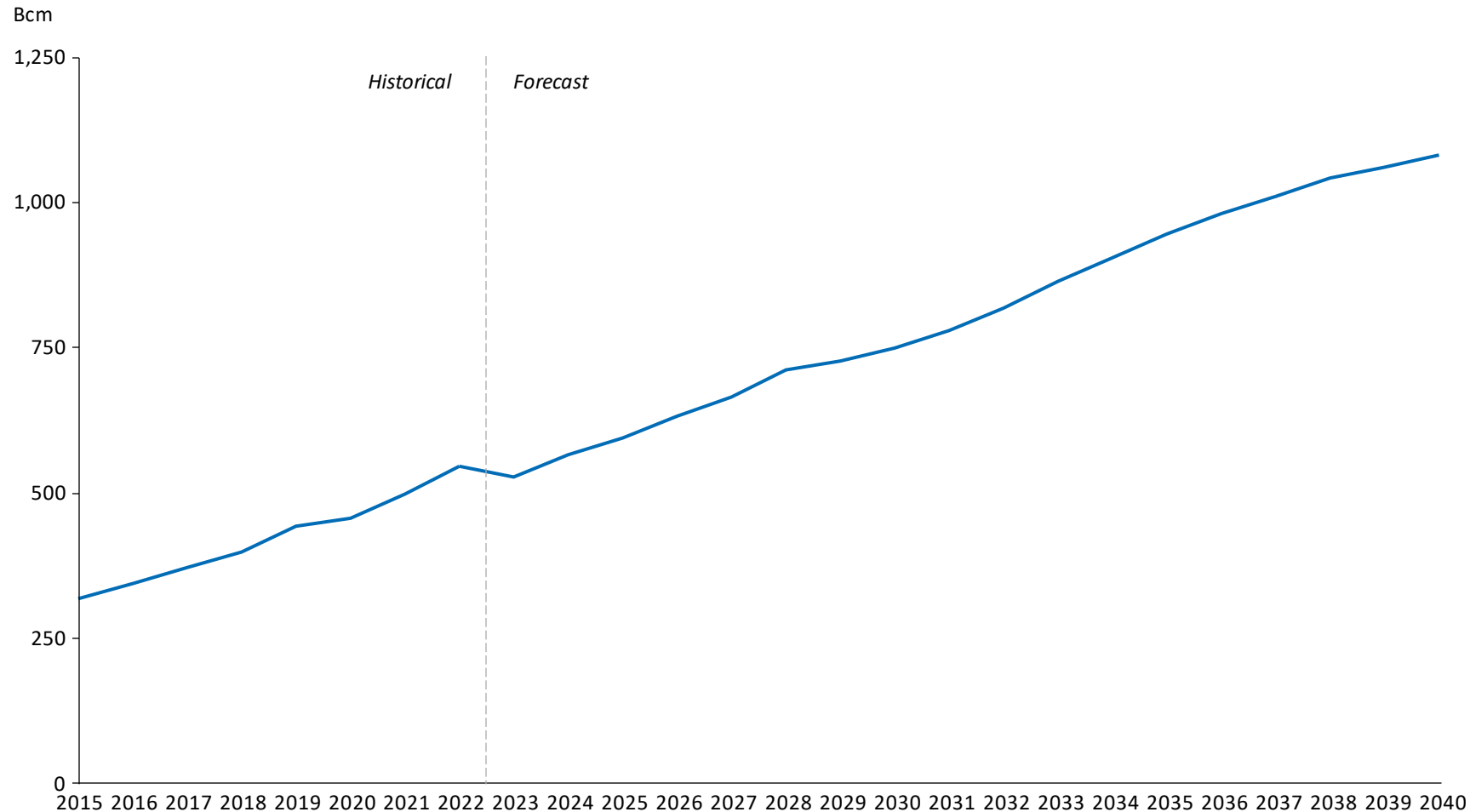
Rystad Energy 2.2 degree scenario to reflect the trajectory for the rest of the world.



Source : Rystad Energy research and analysis; Rystad Energy GasMarketCube; APEC Supply and Demand Outlook 2022

Global LNG demand expected to double towards 2040

Implied global demand for LNG based on reference case

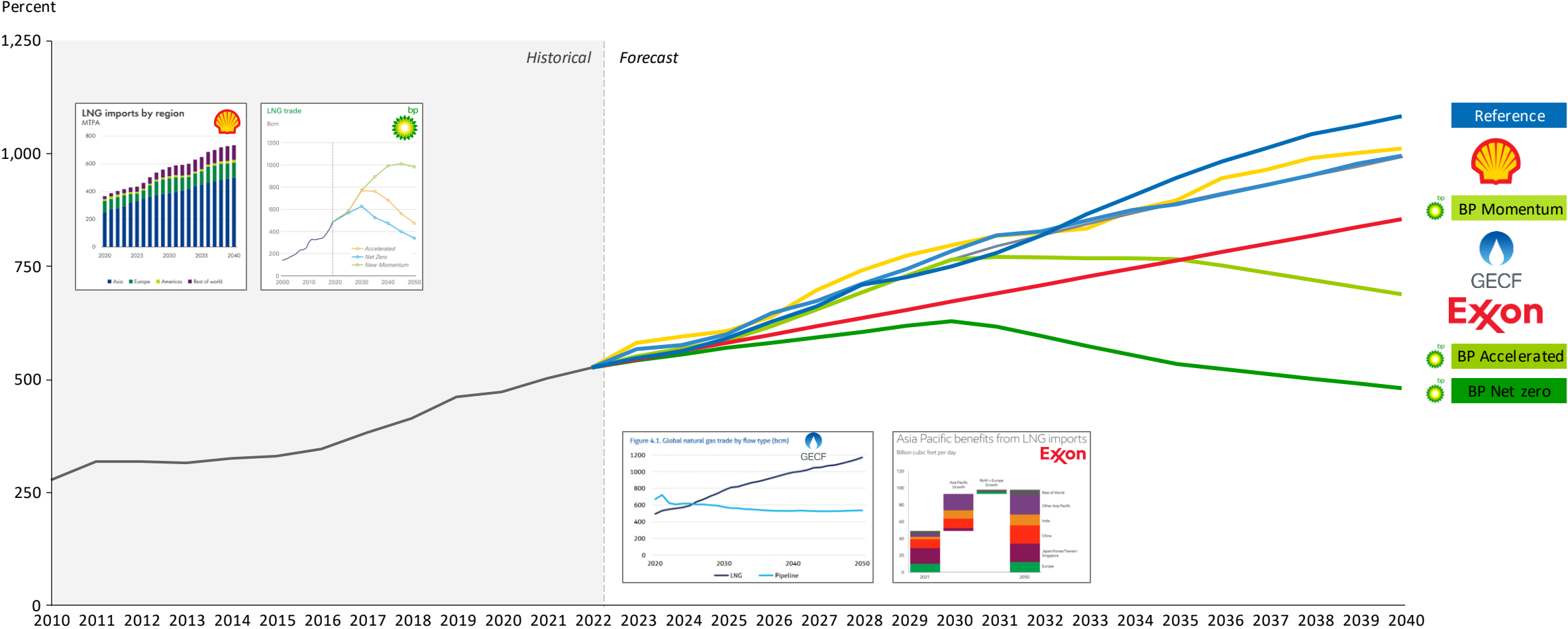


- The reference scenario takes selected non-backcasted demand for various regions.
- Europe LNG demand is based on the **median** scenario and implied call on LNG based on the competitive supply stack.
- Gas demand is expected to remain high until 2040 with widespread adoption of coal-to-gas switching in the rest of the world despite declining European gas demand.
- The topline global demand for LNG may reduce if countries can maximize gas production from domestic resources.

Source: Rystad Energy research and analysis, GasMarketCube, APEC Supply and Demand Outlook 2022

Reference is in the upper bound of LNG outlooks indicating government targets may be aggressive

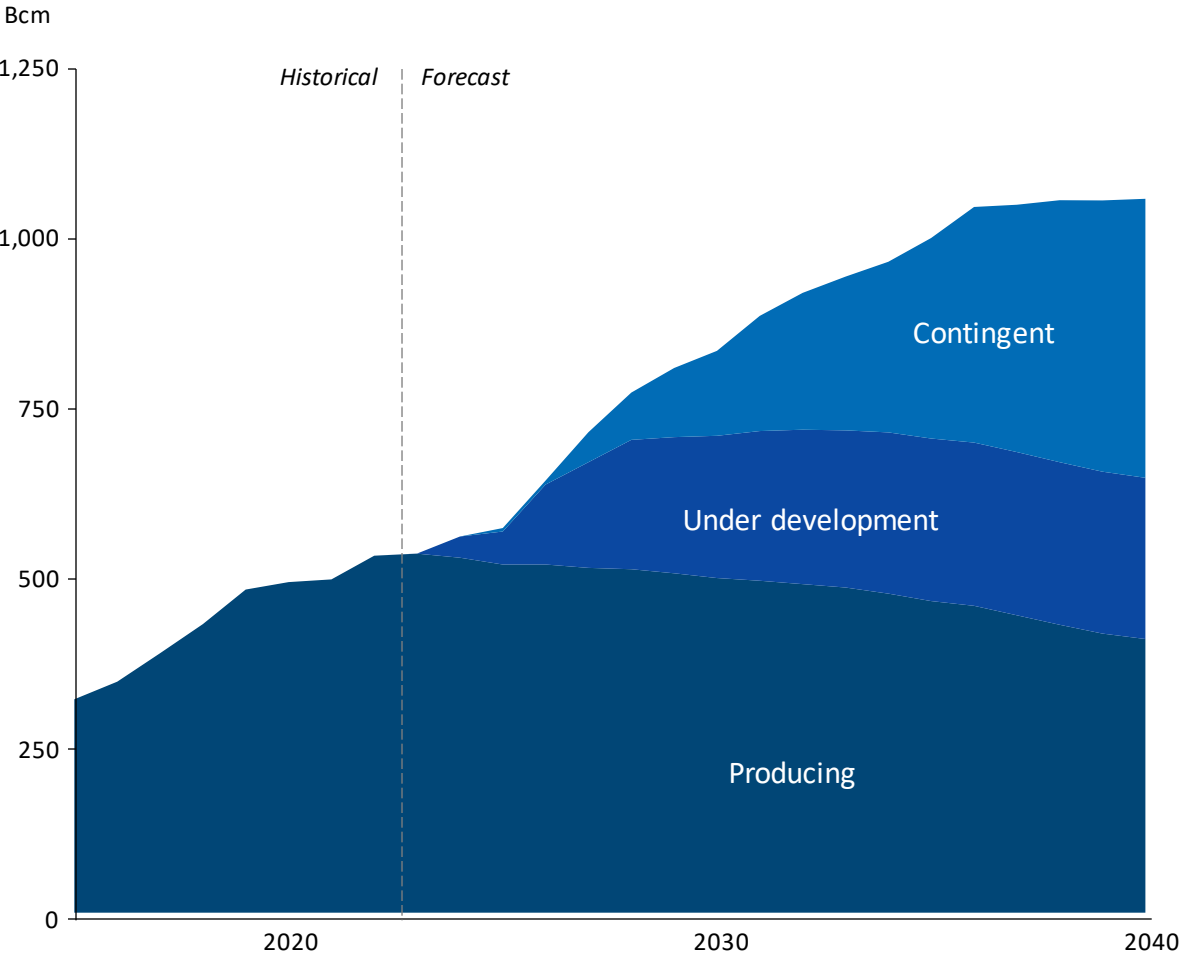
Implied demand for LNG forecasted by different sources



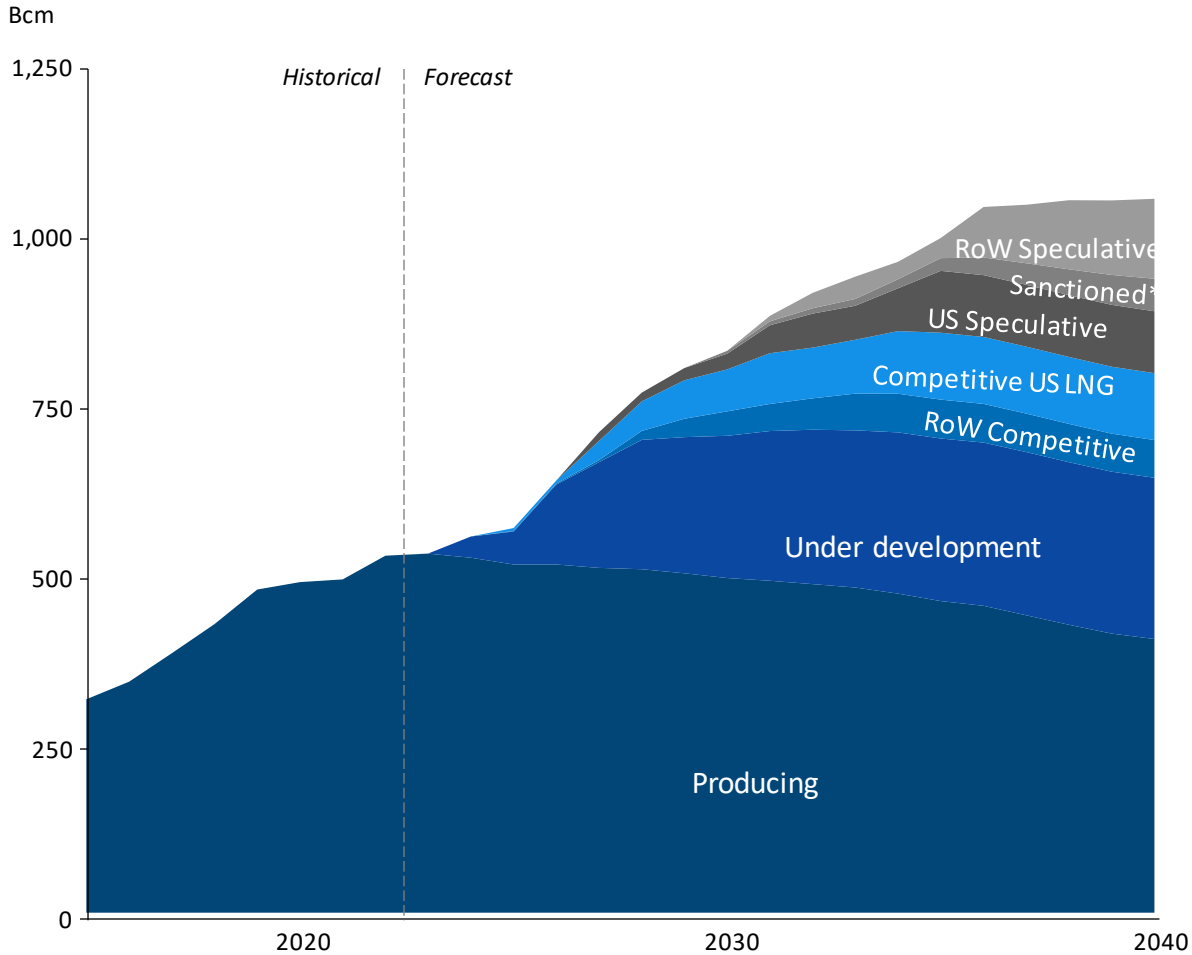
Source : Rystad Energy research and analysis, EnergyScenarioCube, Shell 2023 Energy Outlook, ExxonMobil 2023 Energy Outlook, BP 2023 Energy Outlook

The contingent supply wedge includes projects governed by non-technical uncertainties

LNG production by life cycle category



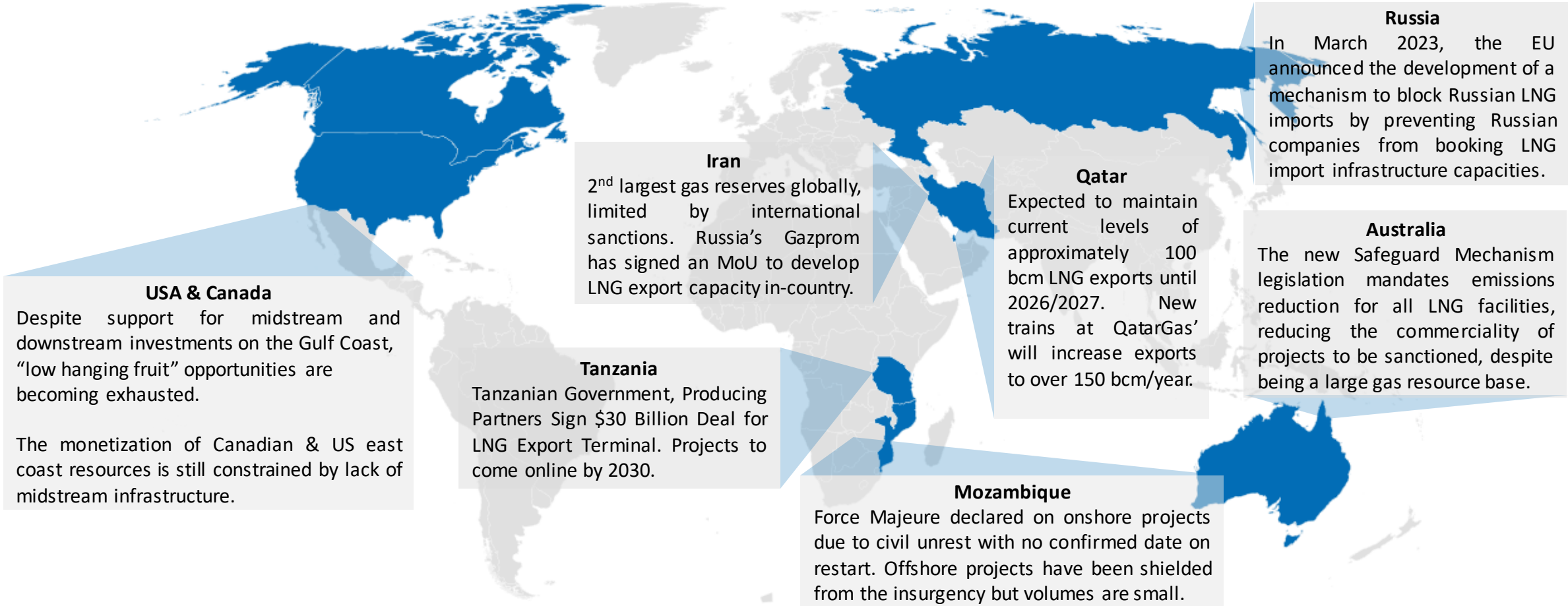
LNG production by life cycle, contingent split on competitiveness



*LNG from Russia and Iran
Source: Rystad Energy research and analysis, UCube

Available gas resources globally sit in the hands of few, key decision makers

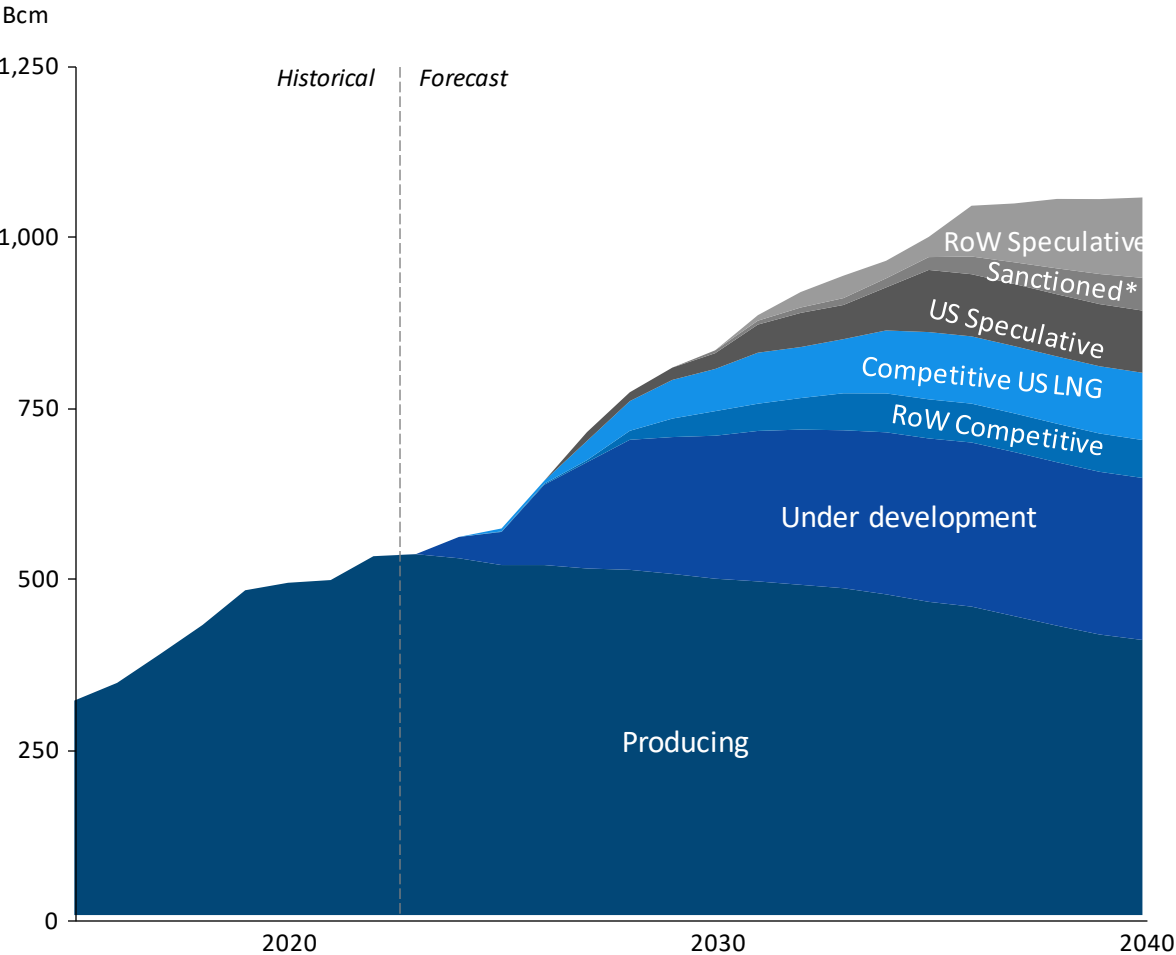
Regional LNG supply potential to Europe



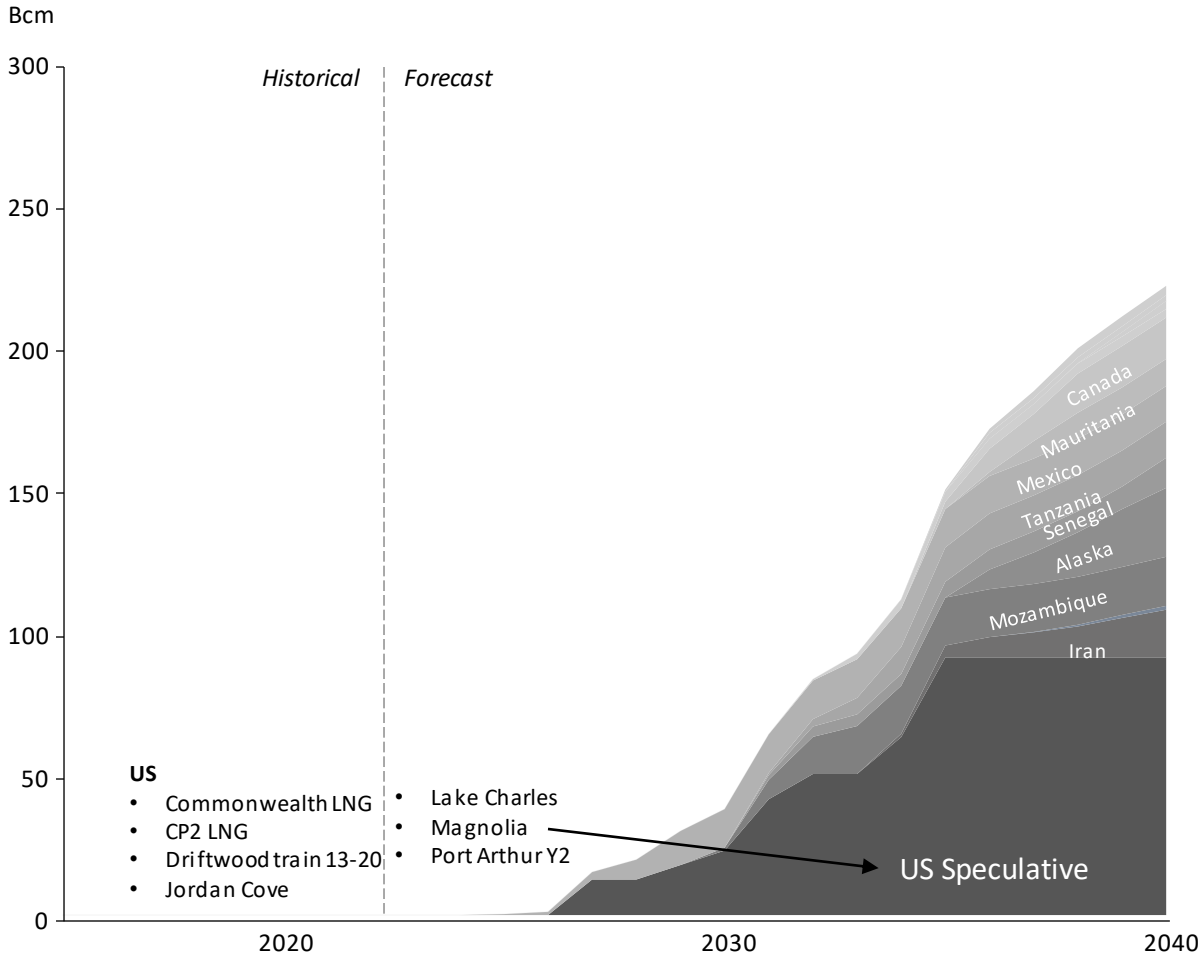
Source: Rystad Energy research and analysis

Certain US facilities, remote and politically difficult LNG projects deemed speculative

Competitive supply categories

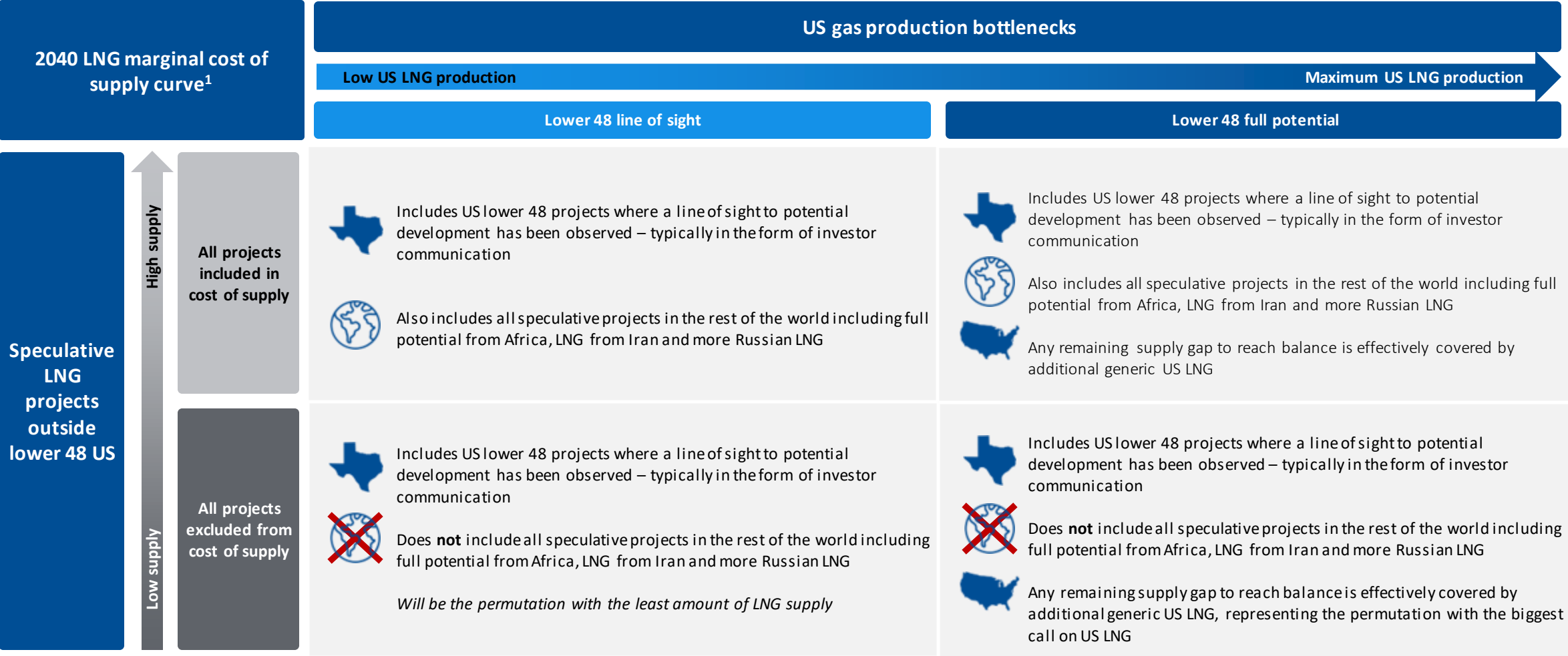


Speculative LNG project grouped on country



Note: *LNG from Russia and Iran
Source: Rystad Energy research and analysis, UCube

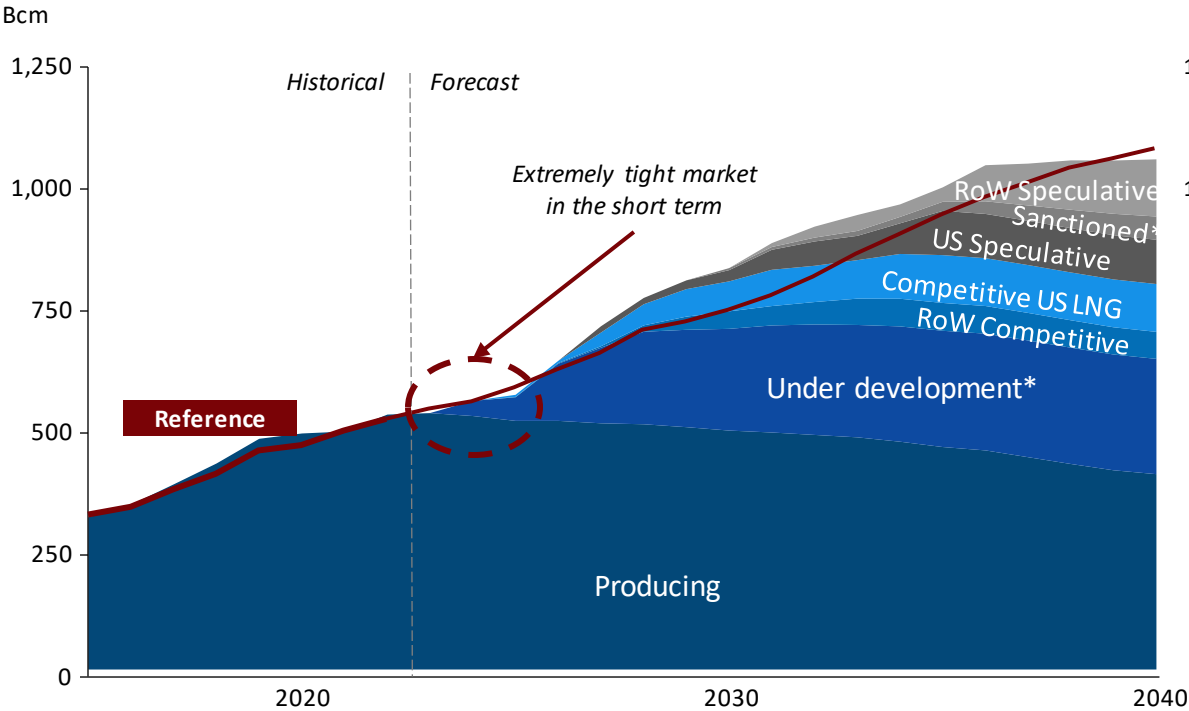
Potential LNG supply permutations defined by RoW speculative projects and US potential



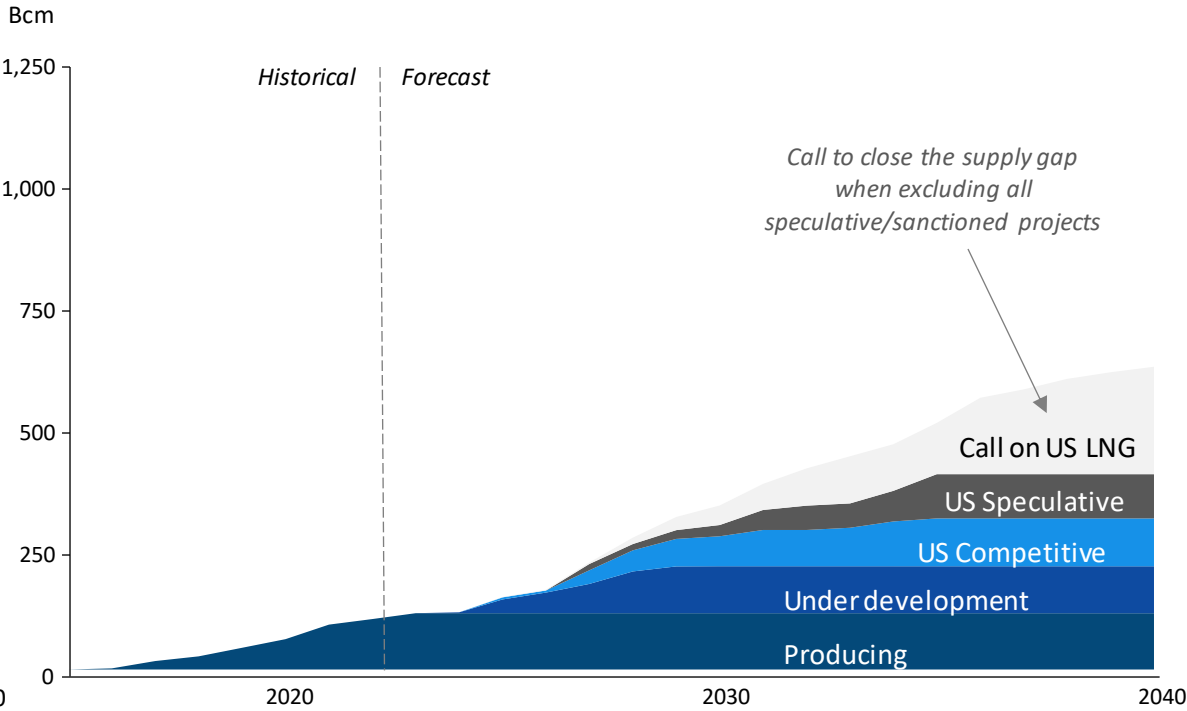
Source : Rystad Energy research and analysis

Isolating the theoretical maximum call on US LNG yields over 300 Bcm by 2040

Resources required to meet maximum call on US gas production



Isolated US LNG outlook, maximum call on US LNG



- In order to meet Reference case demand, global LNG market may have to rely on the maximum output of all regions, including those from speculative projects and sanctioned countries.
- Under current production projections supply shortage is possible from 2037 onwards in reference demand case.
- The market is also extremely tight in the short term, relying on all projects under development to come online on time to meet demand.

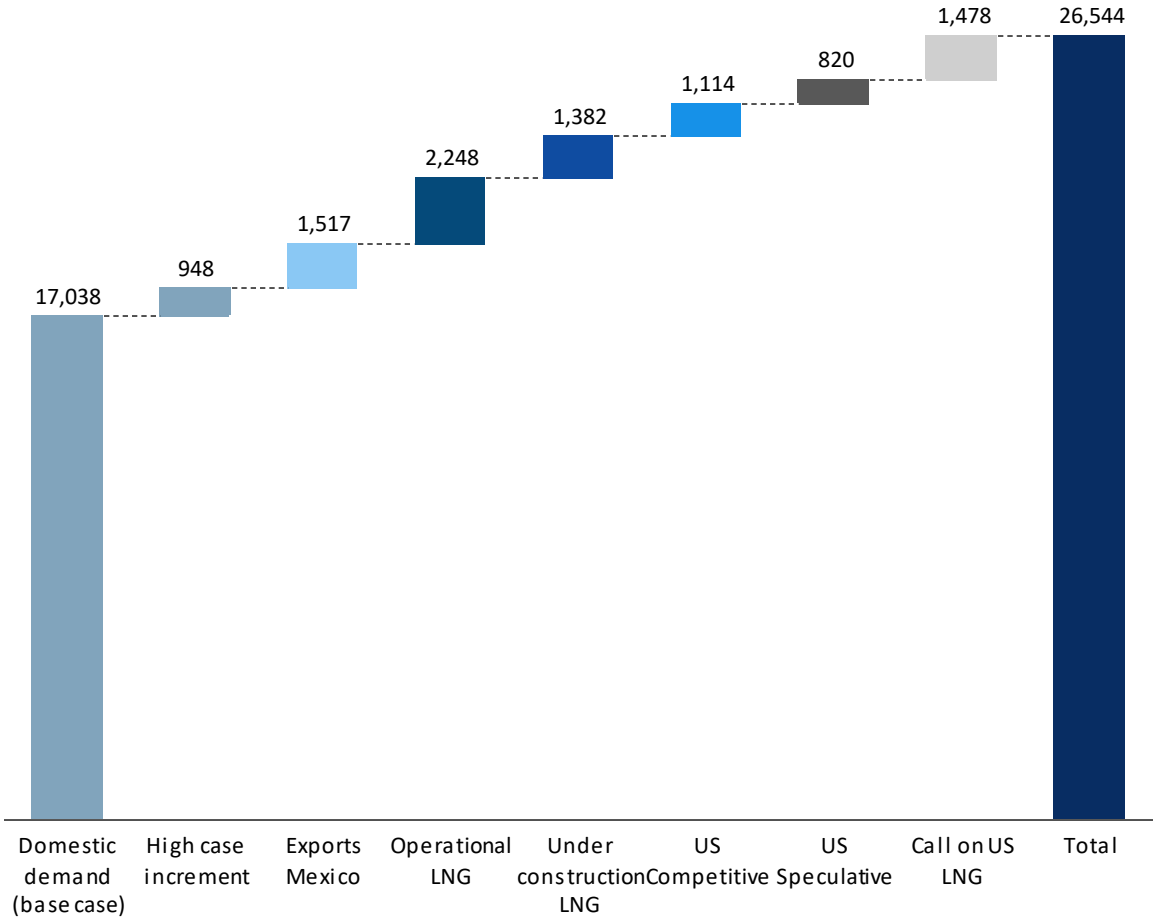
- Call on US LNG represents the maximum US volumes required to close the supply gap under the reference demand scenario, when excluding all speculative projects (RoW competitive, sanctioned, RoW speculative).
- The US has a remarkable capacity to fulfill the remaining global demand for LNG, thereby setting a cap on global LNG prices. Other major gas-exporting nations can also supply competitive volumes.

*Including all ex-US under development LNG; **LNG from Russia and Iran
Source: Rystad Energy research and analysis, UCube

US resources are burdened with all LNG growth to see if LNG markets have an effective price ceiling

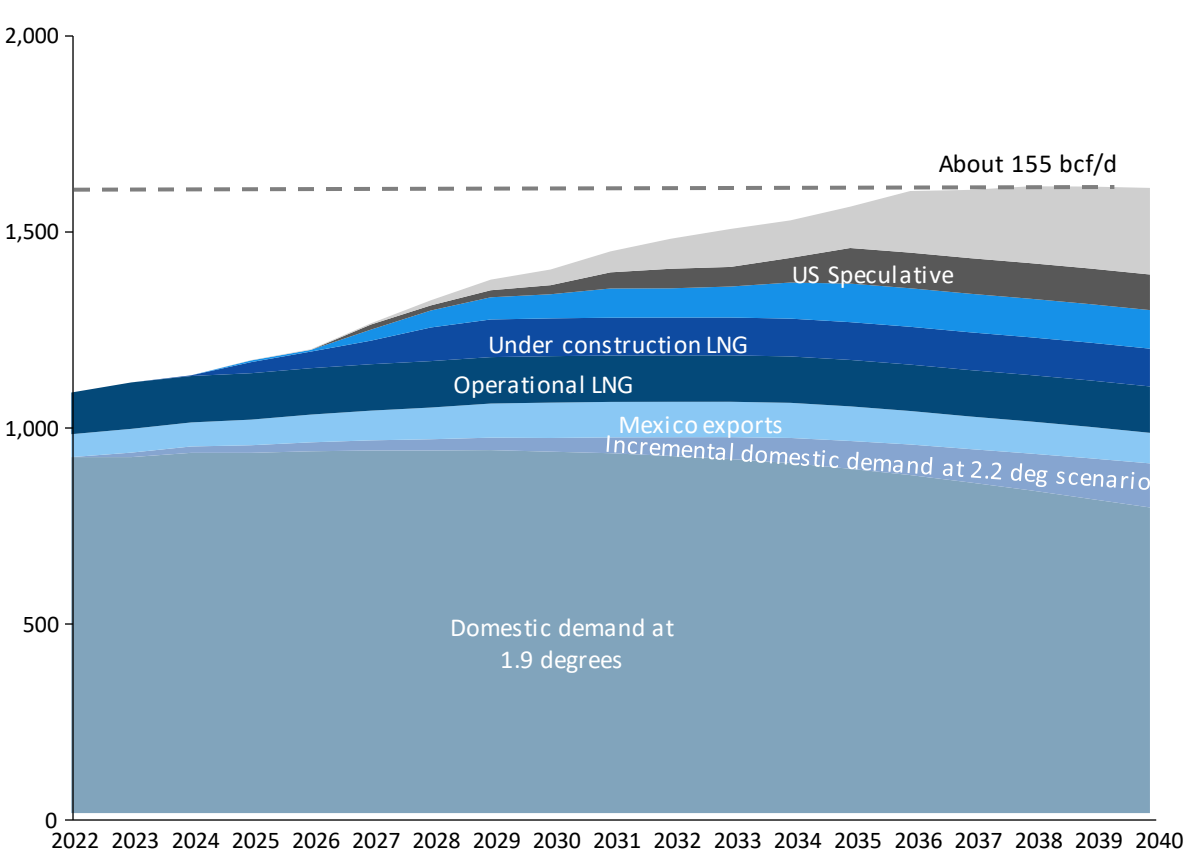
Resources required to meet max call on US gas production 2022-2040

Bcm (cumulative)



Production profile*

Bcm



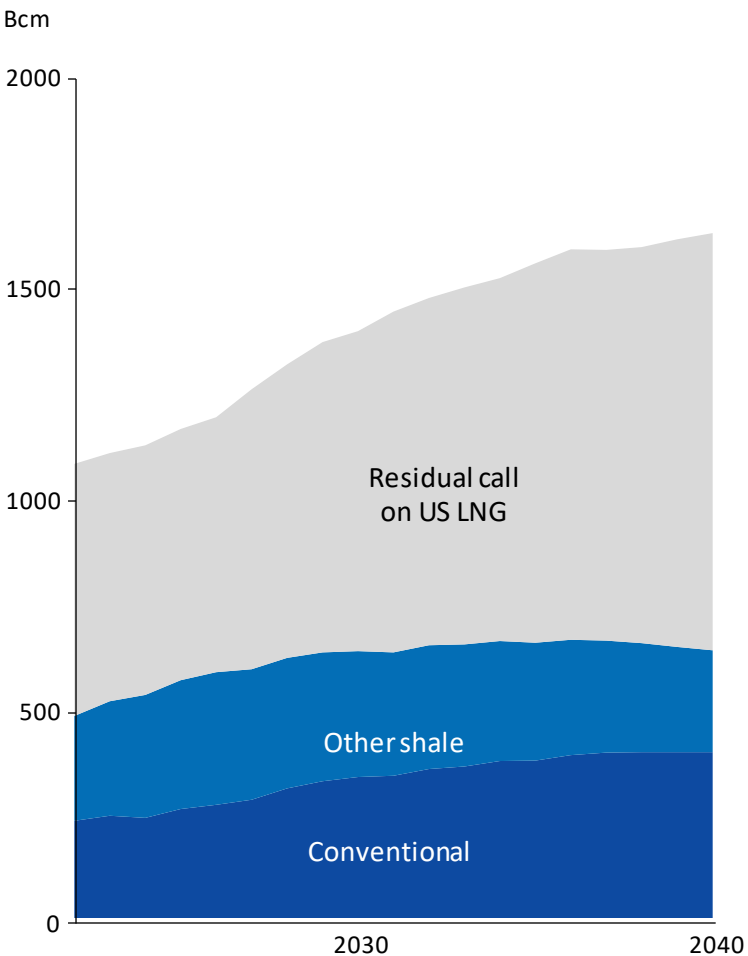
*The Production profile follows the median scenario
 Source : Rystad Energy research and analysis, Rystad Energy GasMarketCube

Abundant low-cost US resources can meet all demand variations with reasonable activity

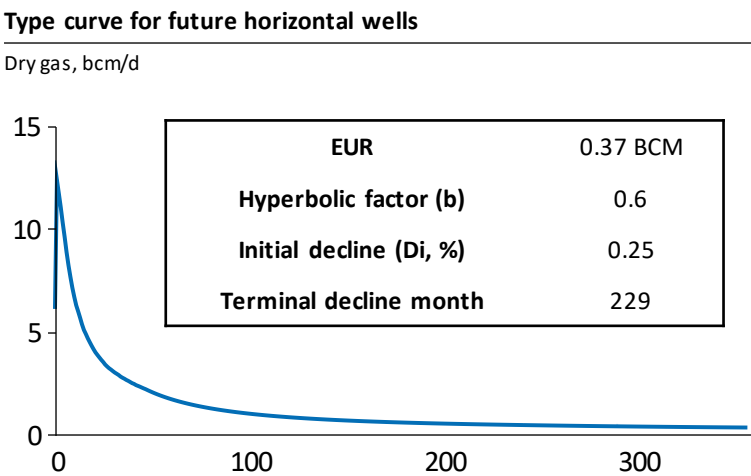
Resource potential, split by shale play

Basin	Remaining wells*	BCM per well	Remaining resources (bcm)
Appalachia	90,000	0.41	36,119
Haynesville	25,000	0.36	8,499
Eagle Ford (dry gas)	20,000	0.24	4,759
Woodford (dry gas)	8,000	0.31	2,323
Other shale	n/a	n/a	11,298
Conventional gas	n/a	n/a	3,745
Sum supply	143,000	0.37	66,743
Maximum demand (2022 - 2050)			44,416

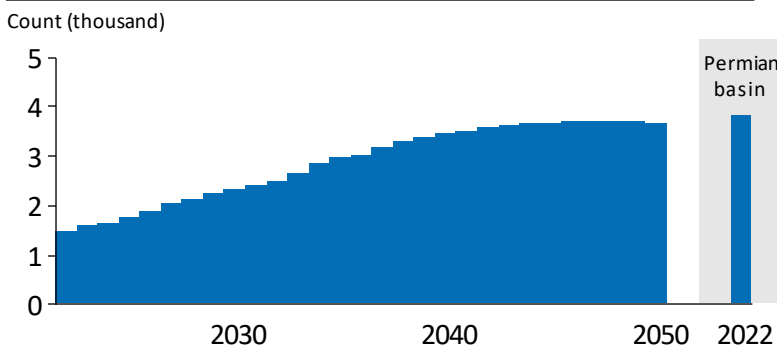
Maximum gas production, split by resource type



Implied activity



Required well count for maximum call on gas shale plays

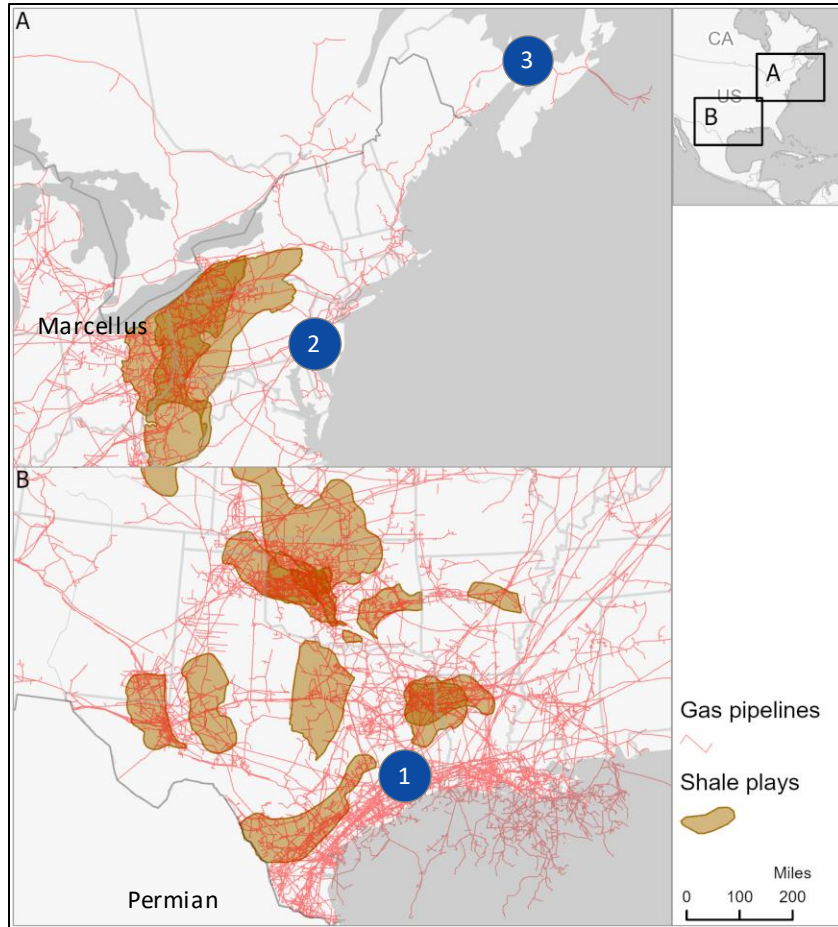


About 3,700 wells per year at an inventory of 143,000 = **39 years of inventory** to maintain max required annual production

* At 0.11 USD/MCM or 3.8 USD/MMBtu
Source: Rystad Energy research and analysis, Rystad Energy UCube, EQT

North American midstream investments can help displacement of Russian gas

North American LNG exports capability



North American LNG exports

- 1 • US LNG exports to Europe are mainly concentrated in the Gulf Coast, specifically Texas and Louisiana
- 1 • Extensive midstream and downstream investments have led to the development of numerous LNG terminals
- 2 • Monetizing US East Coast resources is possible, but there are limited downstream investments due to insufficient midstream infrastructure.
- 3 • Canadian export potential remains largely untapped, with only a few projects progressing towards realization. The TC Canadian Mainline pipeline is currently underutilized.

Challenge

- Lack of North America midstream infrastructure hinders the region's ability to displace Russian gas in Europe through increased liquefaction capacity.
- Challenges with pipeline permitting impede the monetization of inland upstream gas resources in the form of LNG exports to Europe.

Recent updates

- US Gulf Coast is set to undergo boom in LNG project sanctioning. Leading projects poised for FID include Lake Charles, Rio Grande and Port Arthur.
- Freeport LNG was temporarily suspended in the second half of 2022 but exports have since resumed.
- No recent news on developments from east coast
- Canada's first export terminal, LNG Canada is 85% complete.
- Repsol scraps plan for Saint John terminal as insufficient infrastructure means gas must be shipped across the country, pushing costs too high.

Recent updates

- Constraints in midstream infrastructure still limit North America's export potential, as long-term demand uncertainty discourage large investments.

Source : Rystad Energy research and analysis

Full US potential required to meet global demand by 2040 regardless of RoW speculative projects

2040 LNG marginal cost of supply curve*

US gas production bottlenecks

Low US LNG production → Maximum US LNG production

Lower 48 line of sight

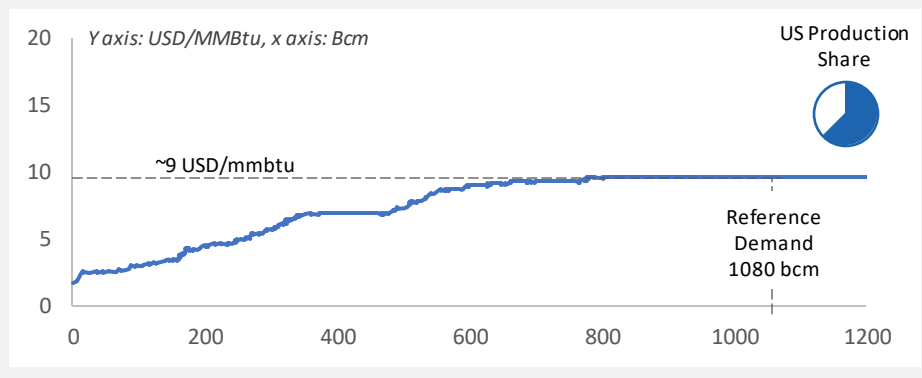
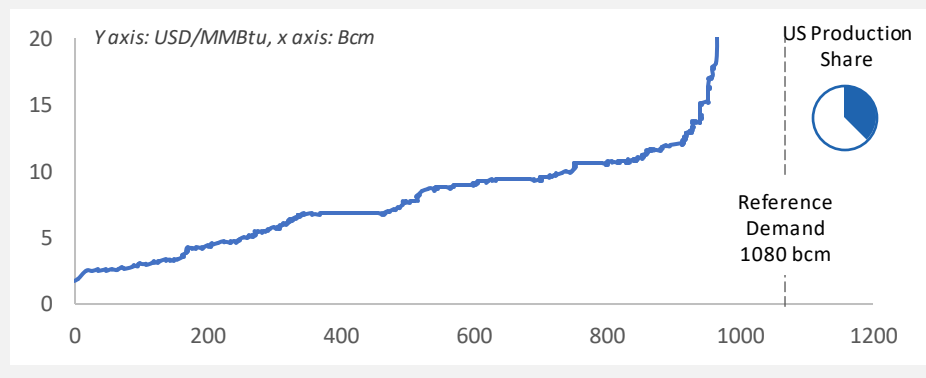
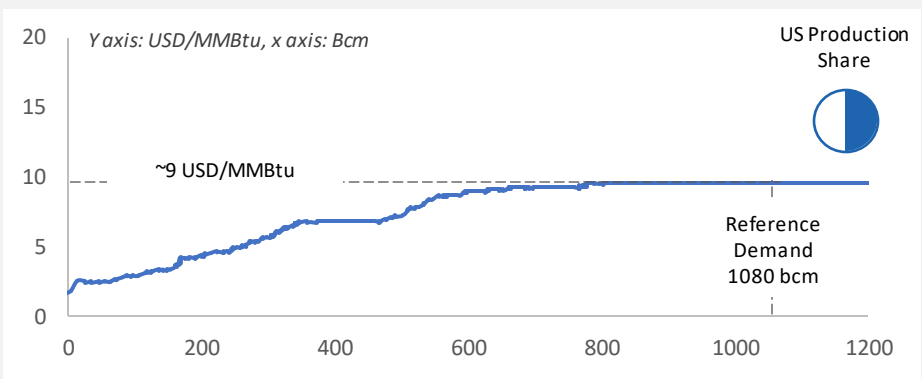
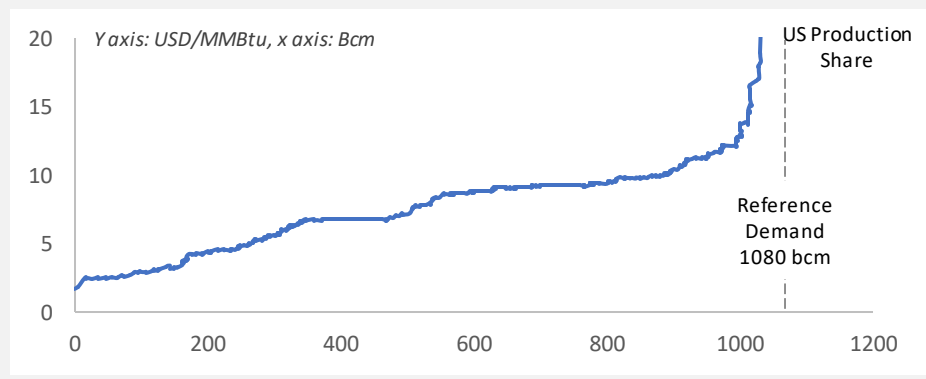
Lower 48 full potential

Speculative LNG projects outside lower 48 US

High supply ↑
Low supply ↓

All projects included in cost of supply

All projects excluded from cost of supply

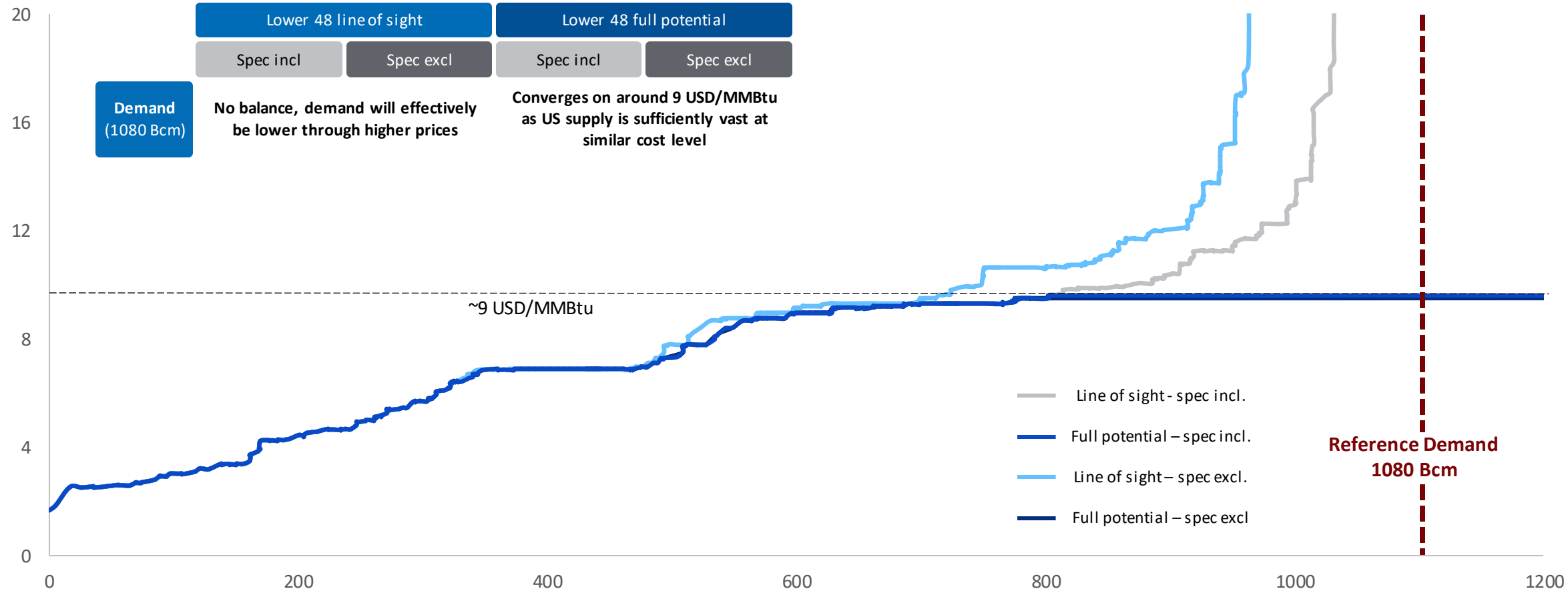


*2040 is used to showcase expected development of long-term LNG cost of supply
Source: Rystad Energy research and analysis

Permutations are converging on cost curves as US LNG represents such a long and flat area

Cost of supply build-up in 2040 for various LNG supply permutations

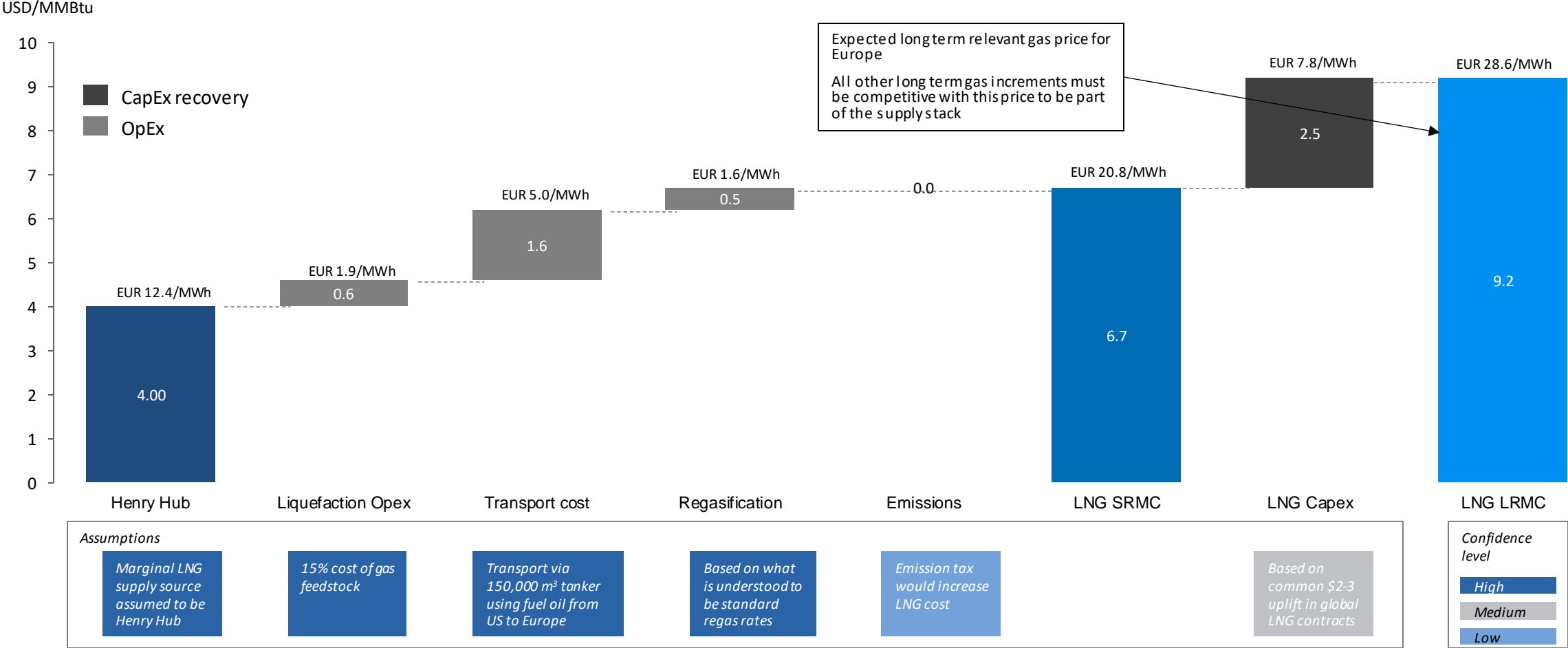
Y-axis: USD/MMBtu; x-axis: Bcm



Source: Rystad Energy research and analysis

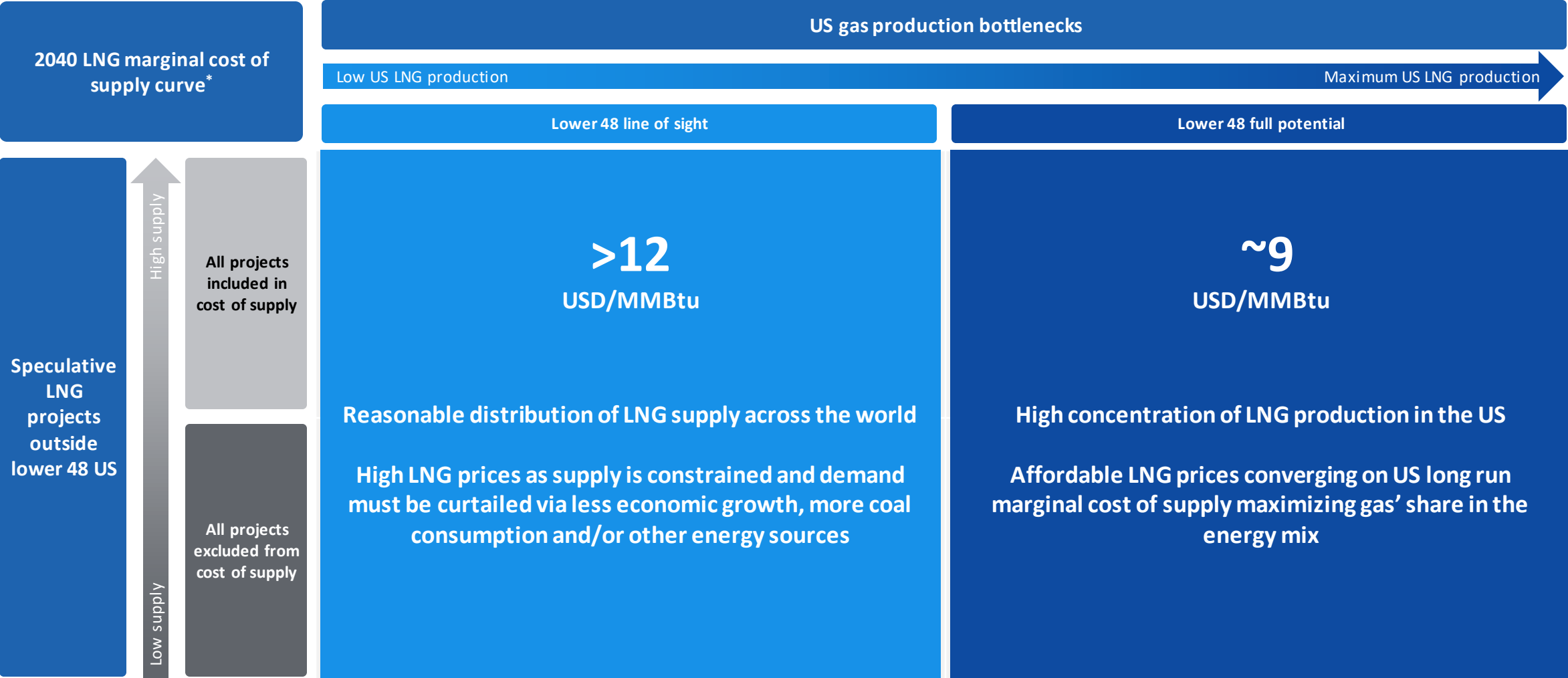
US long run marginal cost of supply setting global gas prices (equal to pre-crisis expectations)

LNG price forecast buildup based on long term Henry Hub assumption



Note: Numbers may not add up due to rounding
Source: Rystad Energy research and analysis; ANGEA report 2023

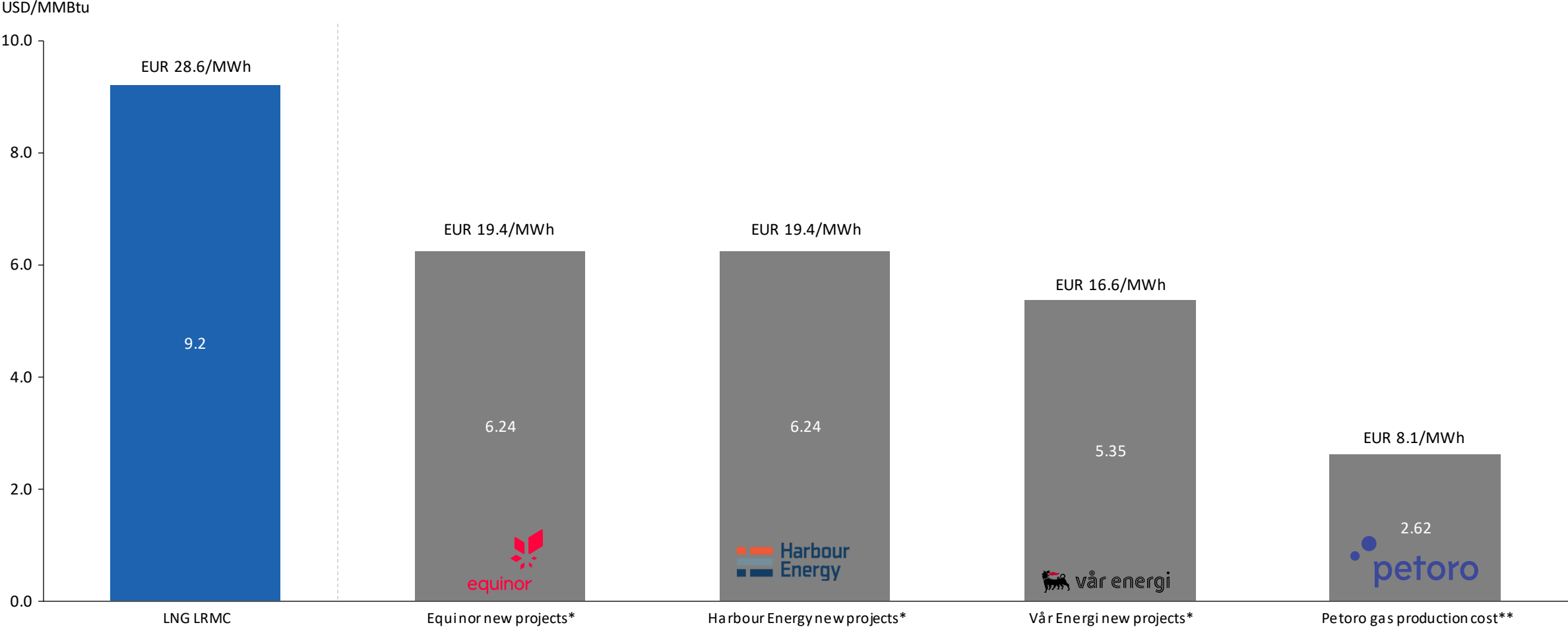
The full global LNG supply potential needed for affordable prices under projected demand levels



*2040 is used to showcase expected development of long-term LNG cost of supply
Source: Rystad Energy research and analysis

Domestic resources typically outcompete uncontracted long-term LNG

Natural gas supply cost comparison



* Figures converted from USD/bbl at 35 USD/bbl and 30 USD/bbl ** As assumes all 2022 production cost less expenses for gas purchases, storage and administration divided only on 2022 sales gas production
 Source : Rystad Energy research and analysis; Harbour Energy a n nual report, Equinor CMD 2023, Vår Energi a n nual report 2022, Petoro a n nual report 2022

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 - Contracted LNG
 - Short-term LNG
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- Balance

- Short-term Monte Carlo simulation model
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Appendix

Key conclusion from last year report has been further bolstered by new infrastructure additions

Infrastructure component	Capacity change versus previous report BCM	Comment
 <p>Regas</p>	70	<ul style="list-style-type: none"> By far the greatest addition of new capacity with 70 bcm higher capacity across various projects compared to previous report 35 bcm of capacity have begun operations since last year's report in Germany, Netherlands and Finland Adds flexibility and enhances security as LNG cargoes can be rerouted unlike piped gas
 <p>Interconnectors</p>	10.6	<ul style="list-style-type: none"> Baltic pipe the biggest addition compared to last year report - helps bring Norwegian gas to Denmark and Poland Helps bring more export diversification of North Sea gas, but does not imply more molecules can overall be exported Also a smaller project between Hungary and Romania completed to enhance capacity
 <p>Storage</p>	1.3	<ul style="list-style-type: none"> Minor change in overall storage capacity compared to regas and interconnectors Storage, similar to other infrastructure, not necessarily constrained by capacity but rather available molecules

Key conclusions from 2022 report still valid


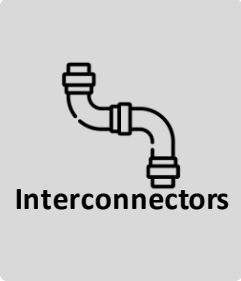

European gas infrastructure capacity can handle a full displacement of Russian gas*

Insufficient gas commodity to serve all demand is raising questions on regional gas distribution and supply security

*Despite overall infrastructure ability to tackle Russian gas displacement in Europe, some regions (in particular CEE and SEE) have been historically dependent on East to West flows and still need infrastructure investments to improve security of supply.
 Source: Rystad Energy research and analysis, GasMarketCube, GIE AGSI

Limited investments to address bottlenecks, increase supply options and system resilience

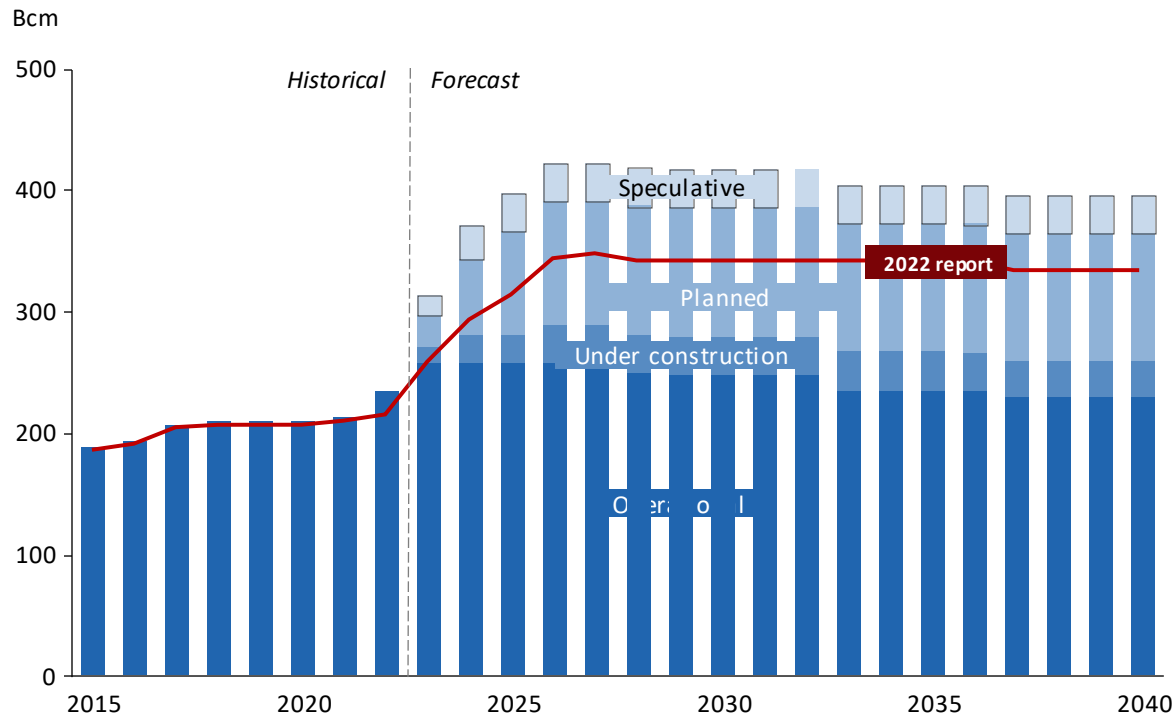
Developments in key infrastructure bottlenecks in regional gas balances

Bottleneck area	Detail	Developments since previous report	Assessment
 <p>LNG regasification terminals</p>	<p>New LNG regas terminals and related transmission system connections required to replace Russian supplies and increase system resilience</p>	<ul style="list-style-type: none"> 35 bcm/year of LNG regasification capacity came online in Finland, Germany and the Netherlands <p>First FSRU intended for use at Lubmin LNG terminal arrives in Germany</p> <p>New Dutch terminal boosts EU drive to cut reliance on Russian gas</p>	<p>Newly added capacities are concentrated in north and central Europe. Some planned terminals in other regions are facing delays.</p>
 <p>Interconnectors</p>	<p>Some interconnector expansions useful to improve connectivity between regions.</p> <p>France, Spain and Portugal agree to build Barcelona-Marseille gas pipeline</p> <p>Spain-France gas pipeline capacity increased and available, Spain says</p> <p>Italian LNG infrastructure has weakened the case for Spain-Italy gas pipeline, Snam says</p>	<ul style="list-style-type: none"> Spain, Portugal and France announced a new deal to build an underwater hydrogen pipeline between Barcelona and Marseille, but may transport gas in the short-term Spain and Italy in talks on a gas interconnector between the Barcelona terminal and Livorno - interest has weakened because of regas capacity buildup in Italy Capacity increases in Romania-Hungary, Poland-Slovakia, Greece-Bulgaria and Lithuania-Latvia as well as Baltic Pipe from the North Sea European countries have been optimizing interconnectors capacity as well as intra-regional connectors 	<p>Infrastructure projects are underway across the continent to address bottlenecks in the medium term</p> <p>Bolstering interconnections and regas will further ease bottlenecks reduce price spreads</p>
 <p>Storage</p>	<p>Storage capacity to manage seasonal demand swings</p>	<ul style="list-style-type: none"> Only marginal changes observes on storage capacity Discussions in regional settings around geographical distribution of storage capacity as it is currently highly concentrated in North and Central Europe No storage on the British Isles for example has been raised as a point of concern, but can be alleviated with more flexible trading options using regas capacity and pipelines to shift gas around Ukraine storage if used would help with further supply security as periods with surplus can be better exploited 	<p>Storage is sufficient on a continental level but there are still discussions on regional level regarding what should be sufficient capacity</p> <p>Deploying Ukraine storage will help with energy security</p>

Source : Rystad Energy research and analysis, Entso-g, Offshore Energy, Financial Times, Reuters, Upstream Online, BBC

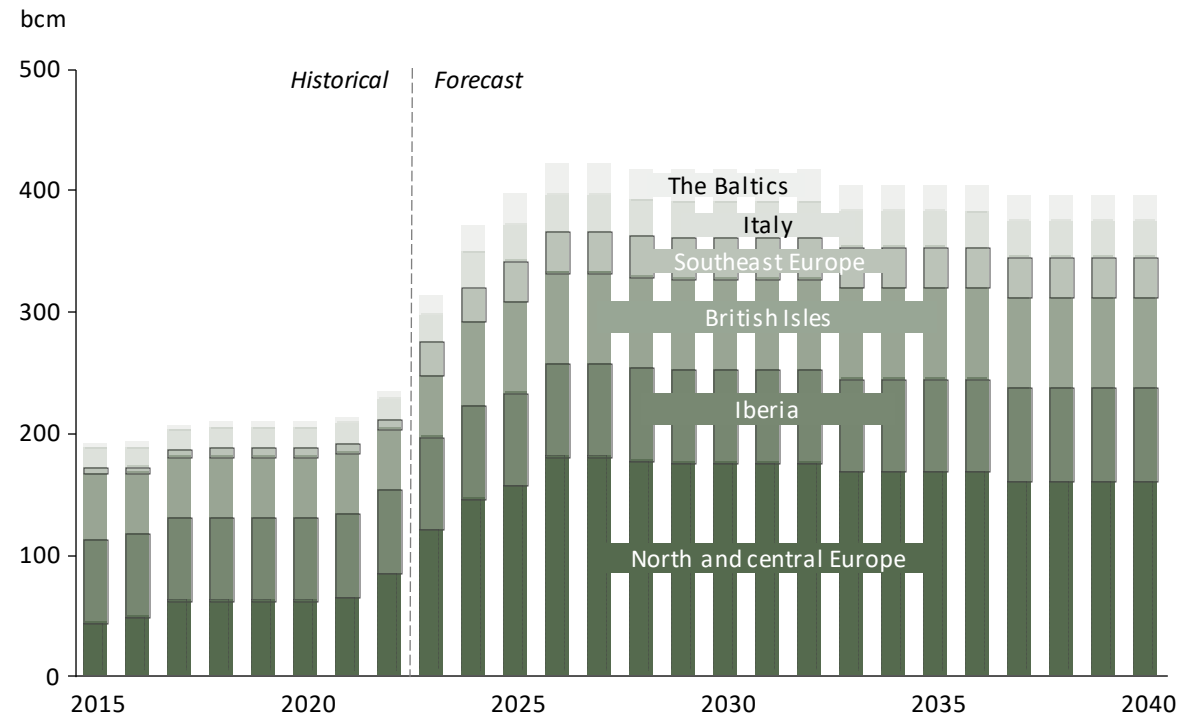
Europe LNG regas/import capacity can grow by 130 Bcm to 364 Bcm/year by 2040

European LNG regasification capacity by status



- In 2022, European regasification capacity was 234 Bcm and is expected to grow to 364 Bcm by 2040, if all the planned projects go ahead.
- Fast-deploying FSRU units can help expand capacity rapidly.

European LNG regasification capacity by region



- In 2022, north and central Europe accounted for 36% of the market, followed closely by Iberia.
- In the forecast period, regasification is expected to rapidly grow at 13% CAGR until 2027. Much of the capacity additions is driven by new regasification facilities in north and central Europe.

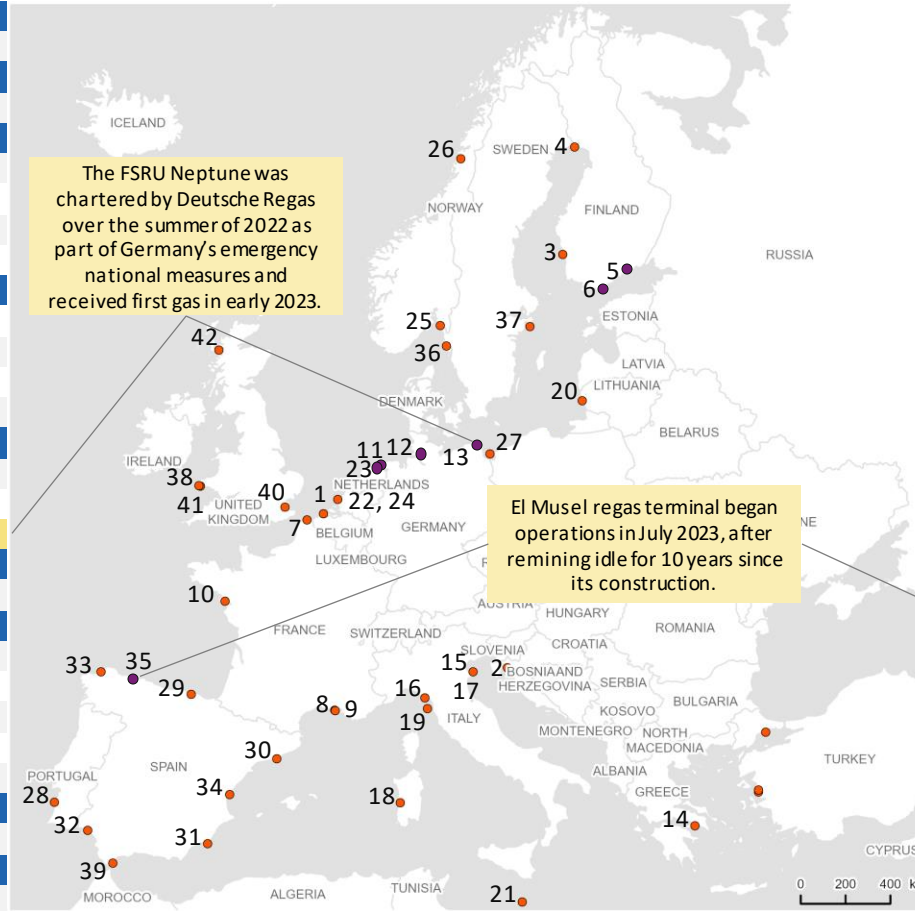
Source : Rystad Energy research & analysis, Rystad energy GasMarketCube

8 regasification terminals added in the past year but capacity still unevenly spread

European operational LNG regasification capacity, 2023

Bcm

Country	Bcm	No.
Belgium		
Zeebrugge 1	9.24	1
Croatia		
Krk LNG terminal 1	2.98	2
Finland		
Pori LNG	0.21	3
Tornio Manga LNG	0.56	4
Hamina LNG-terminal	0.168	5
Inkoo FSRU (Exemplar)	5.15	6
France		
Dunkerque LNG	13.4	7
Fos Cavaou 1	8.4	8
Fos Tonkin	1.54	9
Montoir-de-Bretagne 1	11.2	1
Germany		0
Wilhelmshaven FSRU 1	7.71	1
Elbehafen LNG Terminal	5.15	1
Lubmin FSRU 1 (Neptune)	5.35	1
Greece		3
Revithoussa 1&2	6.9	1
Italy		4
Adriatic LNG	9.27	1
Panigaglia LNG	3.61	5
Ravenna LNG	0.98	6
HIGAS LNG terminal	0.28	7
Toscana - Toscana FSRU	3.78	8
Lithuania		9
Klaipeda LNG - Hoegh Independence	4.2	2
Malta		0
Electrogas Malta	0.56	2



From previous report (orange circle) Newly operational terminals (purple circle)

Country	Bcm	No.
Netherlands		
Gate (Rotterdam)	12.3	22
Eemshaven FSRU	8.23	23
Gate (Rotterdam) expansion 1	4.12	24
Norway		
Fredrikstad LNG terminal	0.14	25
Mosjøen LNG terminal	0.56	26
Poland		
Swinoujscie Phase 1	5.15	27
Portugal		
Sines LNG Terminal	8.12	28
Spain		
Bahía de Bizkaia Gas (Bilbao LNG)	7.14	29
Barcelona LNG	17.6	30
Cartagena	12	31
Huelva	12	32
Mugardos LNG	3.64	33
Sagunto	8.96	34
El Musel	8	35
Sweden		
Lysekil LNG	0.28	36
Nynäshamn LNG	0.56	37
United Kingdom		
Dragon LNG	7.84	38
Gibraltar LNG	0.056	39
Grain LNG 1,2&3	21	40
South Hook LNG 1	21.8	41
Mowi LNG terminal	0.308	42

Source: Rystad Energy research and analysis, GasMarketCube

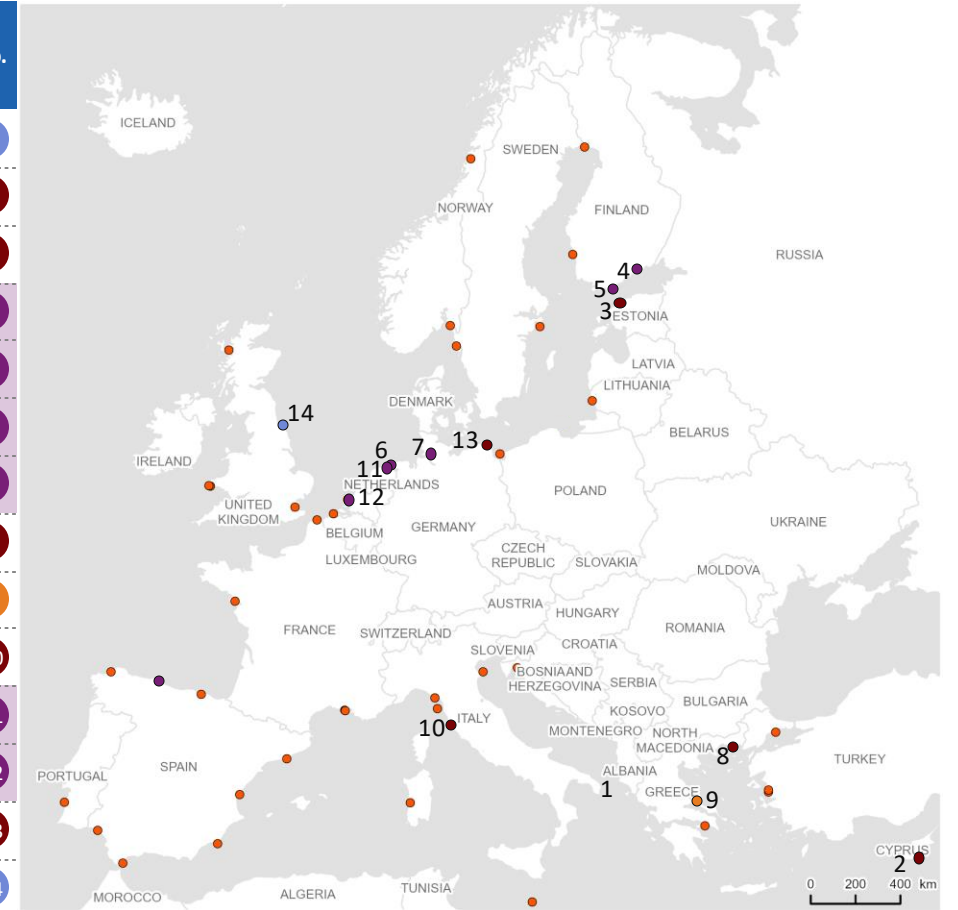
6 out of 14 projects starting up in 2022 and 2023 from previous report now operational

Expected European LNG regasification capacity in 2022 and 2023 from previous report

Bcm

Country	Plant name	Capacity (Bcm)	Previous report start-	New start-up year	Previous report status	Comment	No.
Albania	Albania LNG terminal (Port of Vlorë)	3.5	2023	2023	Planned	FSRU Excelsior deployed to Germany instead with no alternative vessel arrangements.	1
Cyprus	Cyprus FSRU	0.8	2023	2023	Under Construction	FSRU vessel near completion but jetty construction facing severe delays.	2
Estonia	Paldiski LNG	5.2	2022	2023	Under Construction	Nearing completion.	3
Finland	Hamina LNG	0.2	2022	2022	Under Construction	Now operating since publication of the previous report.	4
Finland	Inkoo FSRU (Exemplar)	5.2	2023	2023	FID	Now operating since publication of the previous report.	5
Germany	Wilhelmshaven FSRU	7.7	2022	2022	Under Construction	Now operating since publication of the previous report.	6
Germany	Elbehafen LNG Terminal	5.2	2023	2023	Planned	Now operating since publication of the previous report.	7
Greece	Alexandroupolis LNG	5.7	2023	2023	Under Construction	Conversion works for FSRU kicked off in early 2023.	8
Greece	Argo FSRU	4.7	2023	2023	Planned	Awaiting FID.	9
Italy	Piombino FSRU (Golar Tundra)	5.2	2023	2023	Planned	FSRU test phase commenced in May 2023.	10
Netherlands	Eemshaven FSRU	8.2	2022	2022	Under Construction	Now operating since publication of the previous report.	11
Netherlands	Gate LNG terminal (LNG Rotterdam) expansion 1	4.1	2024	2022	FID	Now operating since publication of the previous report.	12
Poland	Swinoujscie	6.1	2022-2023	2023-2024	Under Construction	Ongoing.	13
United Kingdom	Teesside GasPort-Trafigura	7.7	2023	2024	Planned	Trafigura is looking to relaunch the terminal.	14

Operational Under construction Planned Speculative Existing terminals



Source: Rystad Energy research and analysis, GasMarketCube

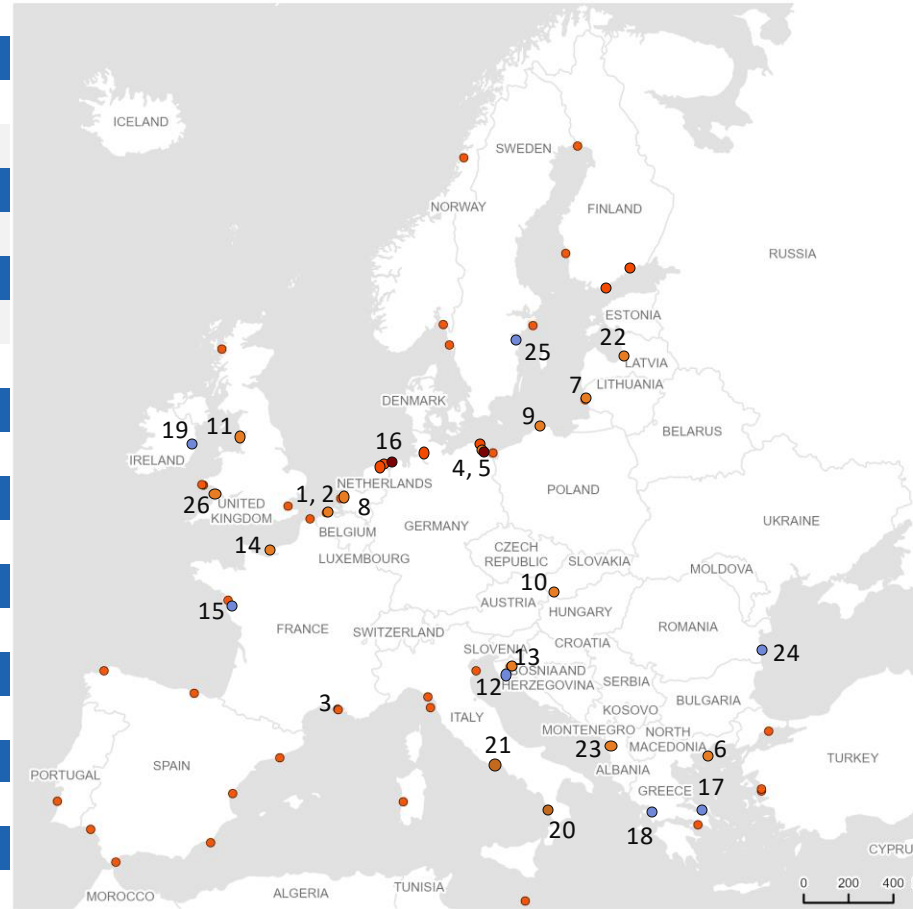
20 new regasification plants have been announced since previous report to rebalance supplies

Future LNG regasification capacity in Europe between 2022 and 2040

Bcm

Other upcoming regasification capacities from previous report

Country	Bcm	No.
Belgium		
Zeebrugge 2 Expansion Step 1	6.58	1
Zeebrugge 2 Expansion Step 2	1.82	2
France		
Fos Cavaou 2	8.68	3
Germany		
Stade LNG 1	7.72	4
Stade LNG 2	13.7	5
Greece		
Thrace INGS FSRU	5.66	6
Lithuania		
Klaipėdos Nafta FSRU 2	4.2	7
Netherlands		
Gate (Rotterdam) expansion 2	4.12	8
Poland		
Gaz-System Gdansk FSRU	4.48	9
Slovakia		
Bratislava LNG terminal	0.91	10
United Kingdom		
Port Meridian LNG	7	11



● Under construction ● Planned ● Speculative ● Existing terminals

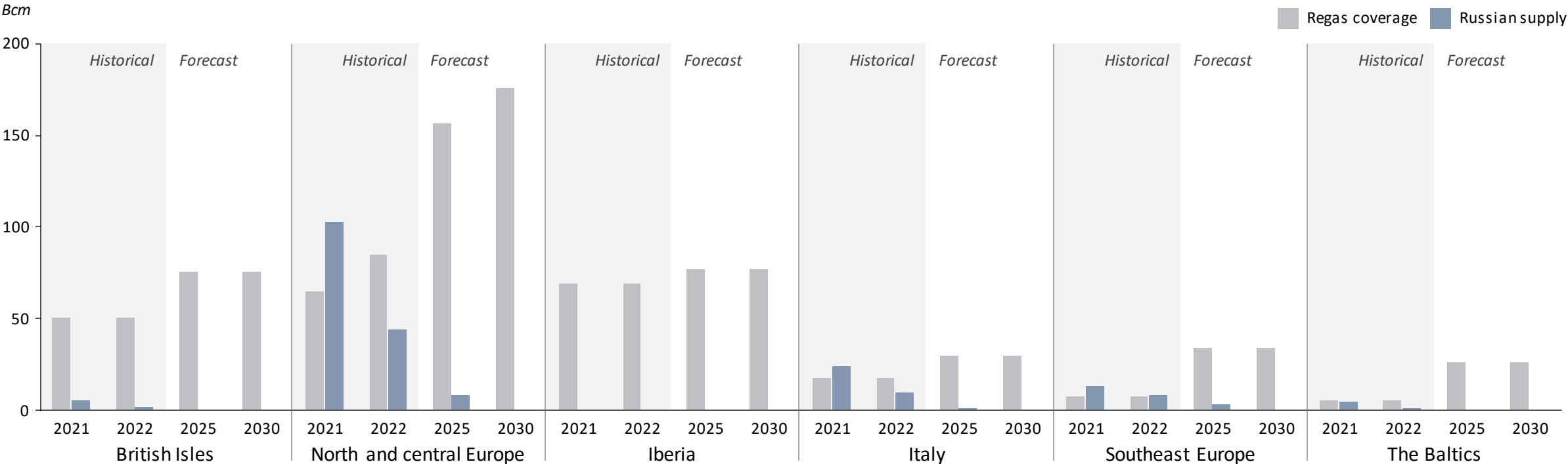
New regasification capacities since previous report

Country	Bcm	No.
Croatia		
Croatian LNG	3.36	12
Krk LNG terminal 2	3.29	13
France		
Le Havre FSRU	4.32	14
Montoir-de-Bretagne 2&3	6.63	15
Germany		
German LNG Terminal	8.24	16
Greece		
Aegean FSRU	3.08	17
Dioryga LNG Terminal	2.8	18
Ireland		
Predator LNG Ireland	4.2	19
Italy		
Portovesme FSRU (Golar Arctic)	2.1	20
Ravenna FSRU (BW Singapore)	5.15	21
Latvia		
Skulte LNG Terminal	6.38	22
Montenegro		
Bar LNG terminal	0.56	23
Romania		
Romania LNG (Constanta LNG)	7.42	24
Sweden		
Oxelösunds LNG	0.28	25
United Kingdom		
South Hook LNG 2	6.17	26

Source: Rystad Energy research and analysis, GasMarketCube

European areas will have higher flexibility with increased regasification capacity

Regas capacity vs Russian gas reliance in 2021, 2022, 2025 and 2030



- The chart above illustrates the comparison between regional regasification capacity and Russian gas imports in 2021, 2022, 2025 and 2030.
- According to announced and ongoing projects, regasification capacity is expected to increase for all regions, which will improve Europe’s flexibility as overall gas demand is expected to remain relatively flat towards 2030.
- As Europe phases out Russian piped gas from 2022, North and Central Europe and Germany in particular has rapidly accelerated the buildout of regasification capacity and will continue to do so up to 2030, while commitments by other regions are largely limited after 2023.

Source: Rystad Energy research and analysis, GasMarketCube

Regional balances based on country groupings that are relatively well-connected by infrastructure

Demand grouping	Country
British Isles	Ireland
	United Kingdom
North and Central Europe	Belgium
	Croatia
	Czech Republic
	Denmark
	Germany
	France
	Luxembourg
	Hungary
	Netherlands
	Austria
	Poland
	Slovakia
	Slovenia
	Sweden
	Norway
	Ukraine
	Switzerland
	Spain
	Portugal
	Italy
Bulgaria	
Greece	
Cyprus	
Malta	
Romania	
Montenegro	
North Macedonia	
Albania	
Serbia	
Moldova	
Southeast Europe	Bosnia and Herzegovina
	Estonia
	Latvia
	Lithuania
	Finland
The Baltics	

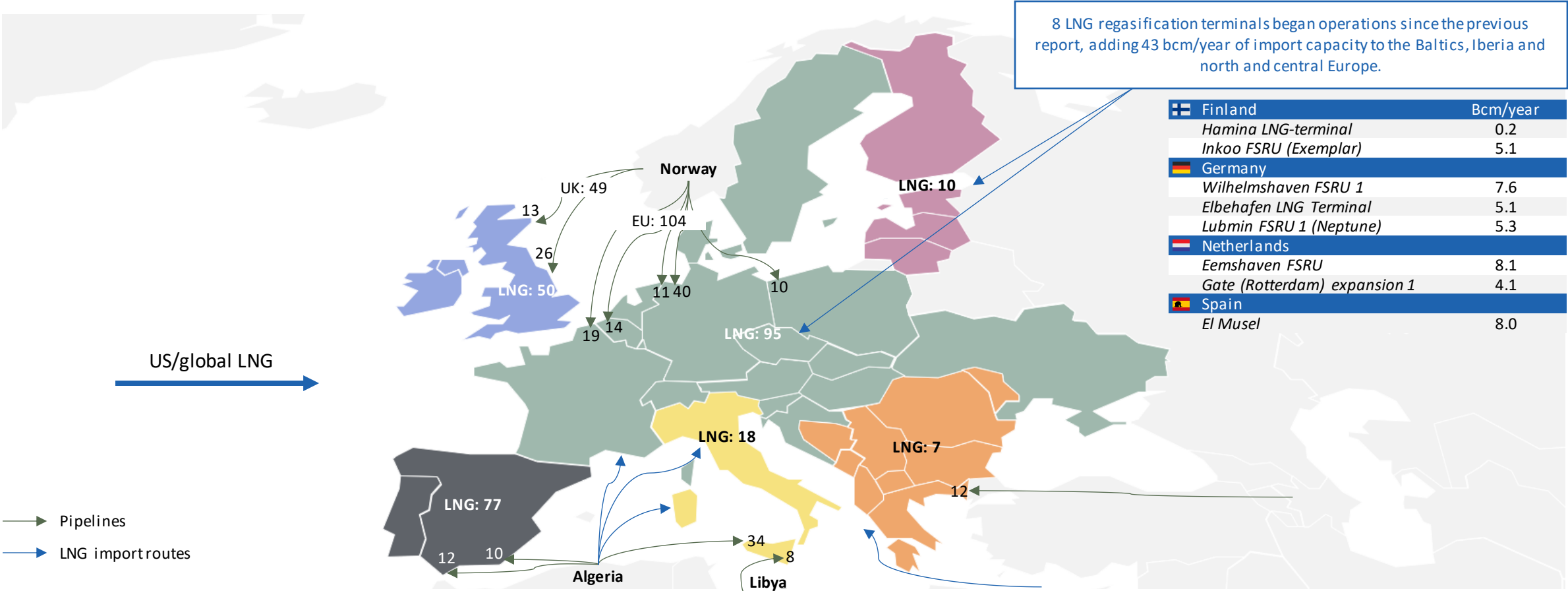


Source : Rystad Energy research and analysis

New regasification facilities add import capacities particularly in north and central Europe

LNG and non-Russian pipeline import capacities by region

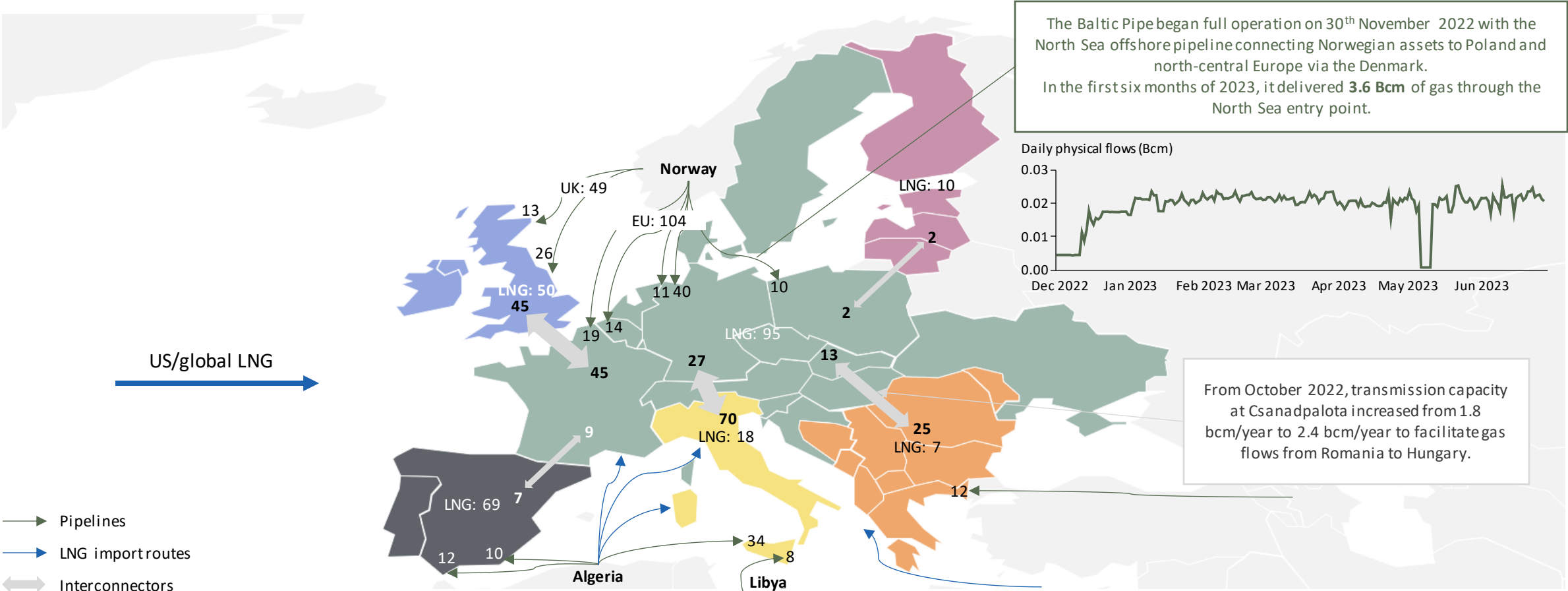
Bcm/year



Baltic pipe and new project in Southeast Europe have improved interconnector capacity

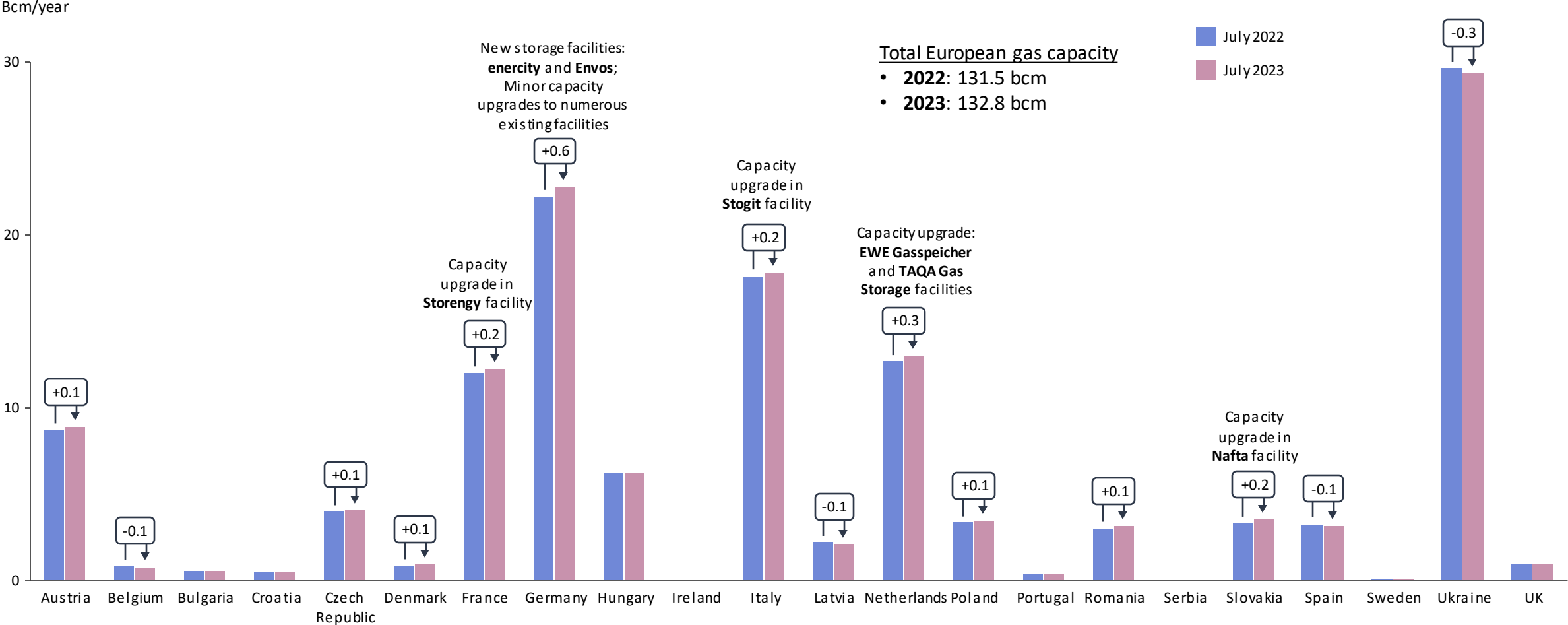
Regional interconnectors capacities

Bcm/year



European gas storage capacity has recorded a small increase of 10% pa between 2022 and 2023

Storage capacities*

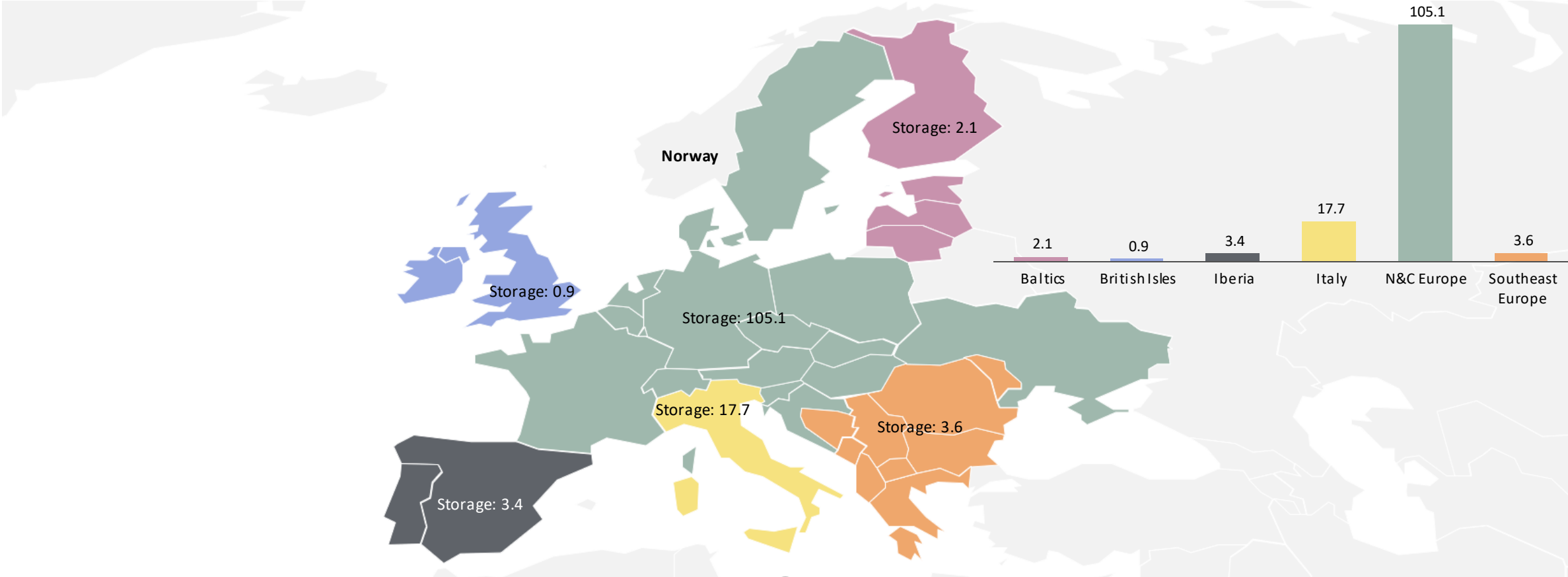


*as of 30th July 2022 and 30th July 2023
 Source: Rystad Energy research and analysis; GIE AGSI

N&C Europe and Italy have the largest available gas storage capacities

Storage capacities*

Bcm/year



*as of 30th July 2023
Source : Rystad Energy research and analysis; GIE AGSI

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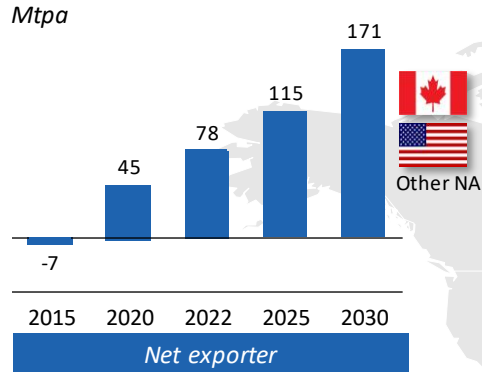
Appendix

Increasing competition between Europe and Asia for LNG volumes with US as marginal supplier

LNG supply and demand balance for key regions, 2010 to 2022*

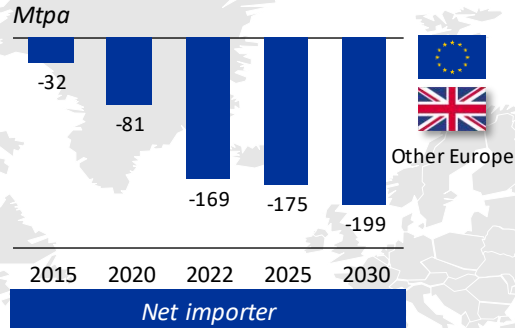
Tonnes of LNG per annum, millions

North America LNG balance



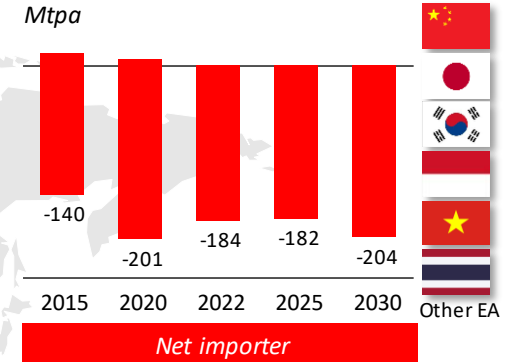
The US is well-positioned to serve both European and Asian markets. Spot cargoes are directed to their destinations based on favorable netback price.

Europe LNG balance



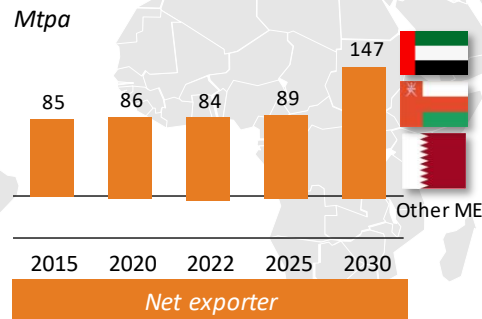
Europe and Asia are the largest LNG demand centers. If other supply regions, such as Australia, ME and East Africa, can boost LNG deliveries to Asia, more US LNG volumes may become available to Europe.

East Asia LNG balance

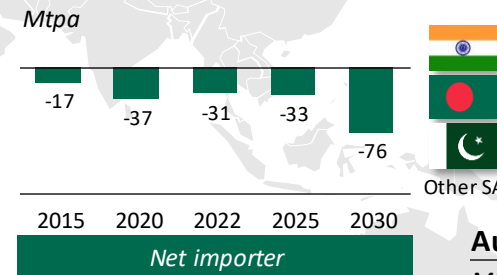


Growing economies in South Asia are set to transform the region into a key demand center for LNG.

Middle East LNG balance

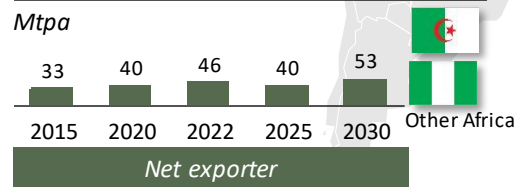


South Asia LNG balance

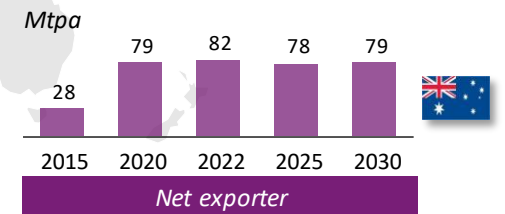


Africa, the Middle East and Australia are all key exporters but deliver smaller volumes than the US.

Africa LNG balance



Australia LNG balance



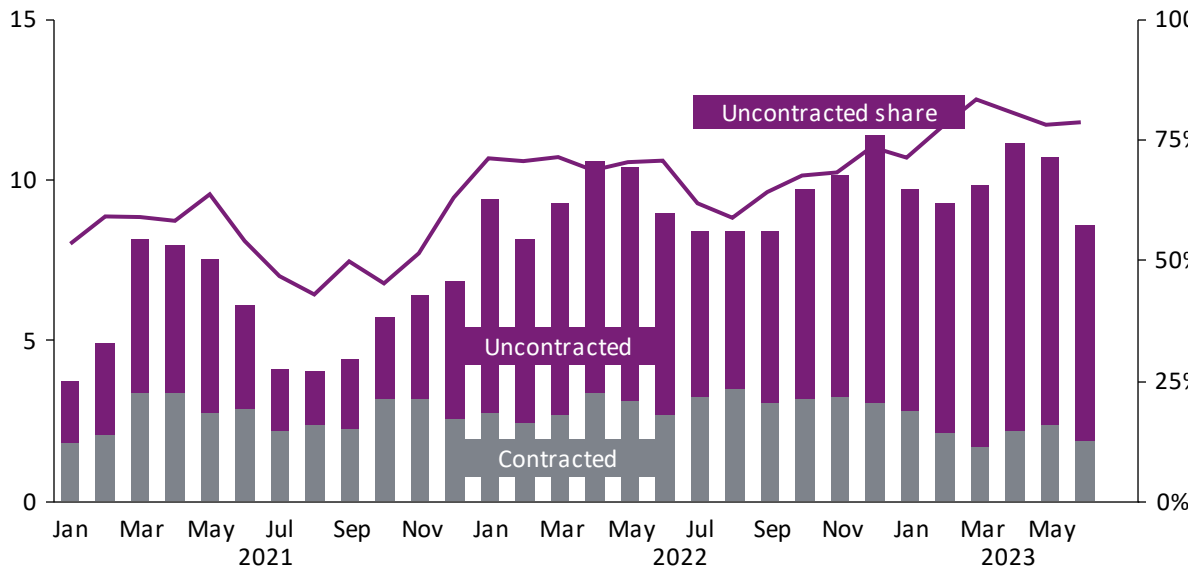
*Balance as a function of Supply less Demand. Negative balance indicates net imports, whereas a positive balance indicates net exports.

Source; Rystad Energy research and analysis, GasMarketCube, APEC Supply and Demand Outlook 2022

Europe unwilling to commit to long-term LNG contracts with decarbonization goals in mind

Monthly transported volume of LNG to Europe by contract type, 2022 to date

million tonnes (left); % (right)



- The majority of Europe's LNG is purchased through the spot market, where prices are typically higher than those negotiated under long-term contracts.
- In 2021, uncontracted volumes as a share of Europe's total LNG imports stood at 55%. This rose to 68% in 2022 following Russia's invasion of Ukraine.
- Being competitive on price, many LNG cargoes are drawn away from Asia as the market grows tighter.

Impact of EU's Fit for 55 on contracting decision



The EU's **Fit for 55 package** aims to cut emissions by 55% by 2030 and reach net zero by 2050, with goals to shift from natural gas to renewable and low-carbon gases.



Climate

- Entering long-term contracts signals future demand to gas producers, which is inconsistent with the EU's long-term climate goals and risks gas lock-in.
- A boom in low-carbon technologies may see LNG demand falling sooner than expected.



Timeline

- Difficult for European utilities to commit to medium- to long-term LNG contracts if the EU's communication on targets and commitment to timeline is unclear.
- Companies such as QatarEnergy typically offer long-term contracts of ~25 years with minimal destination flexibility, making it a major commitment for EU buyers.



Price

- The price of an LNG contract is higher when projects have a shorter timeframe to earn back investment costs.
- Pre-FID projects may also take ~5 to 6 years before they begin to deliver volumes to Europe. By then, other fuels e.g. green hydrogen may be more competitive.



The EU's view of gas as a transition fuel is ultimately incompatible with signing long-term deals with LNG producers. However, the glut of upcoming regasification capacities is incompatible with this view, heightening the risk of stranded assets.

Source: Rystad Energy research and analysis, LNG Trade Tracker Dashboard

Commercial innovation in LNG contracting may offer more flexible options for Europe

	Long-term contracts	VS	Short-term spot purchases
Security of supply	✓ More reliable source of supply for set duration		✗ Risk of demand destruction if supply falls short, especially with high Asia demand
Pricing terms	✓ More predictable, typically cheaper		✗ Subject to market volatility, expensive under a tight market
Flexibility	✗ Long-term LNG demand is uncertain given Europe's decarbonization goals		✓ Limited commitment in the medium- to long-term hence minimal volume risk

Flexible contracts- the ideal 'middle ground' for Europe

- Expiring legacy contracts with existing LNG producers:**
- LNG may be recontracted for shorter durations without obligation to underwrite capital expenditure
 - Not always possible at fields with resource depletion
- Portfolio players and trading houses:**
- Secure volumes from different regions and resell to end users at a margin
 - Typically overcontract to hold a net long position and may release volumes over time

Commercial innovation in LNG contracting:

- New types of contracts with more flexibility

Uniper chief says flexible duration LNG contracts key for Europe

Qatar Offers Looser LNG Contract Terms to Entice Asian Buyers

Examples of flexible LNG contracts

Seasonal contracts:
A contract for delivery during the winter months when gas demand tends to peak, signed at a premium to an agreed benchmark.

Options contracts:
A right to buy pre-agreed volumes when required by paying an option premium.

Greek utility clinches winter LNG deal with TotalEnergies

In September 2022, the Greek utility company DEPA Commercial signed a seasonal options contract with TotalEnergies.

The deal was agreed for a right to buy 2 LNG cargoes per month for a five-month period during the winter.











































DEPA can pay a cancellation fee if its gas demand is already met, without taking on excess volume risk.

The price of the cargoes is also pre-agreed to avoid high volatility.

Source : Rystad Energy research and analysis, Center on Global Energy Policy at Columbia University, Reuters, Bloomberg

Recent contracted volumes of US LNG deals increase probability of future projects

US LNG export capacity agreements

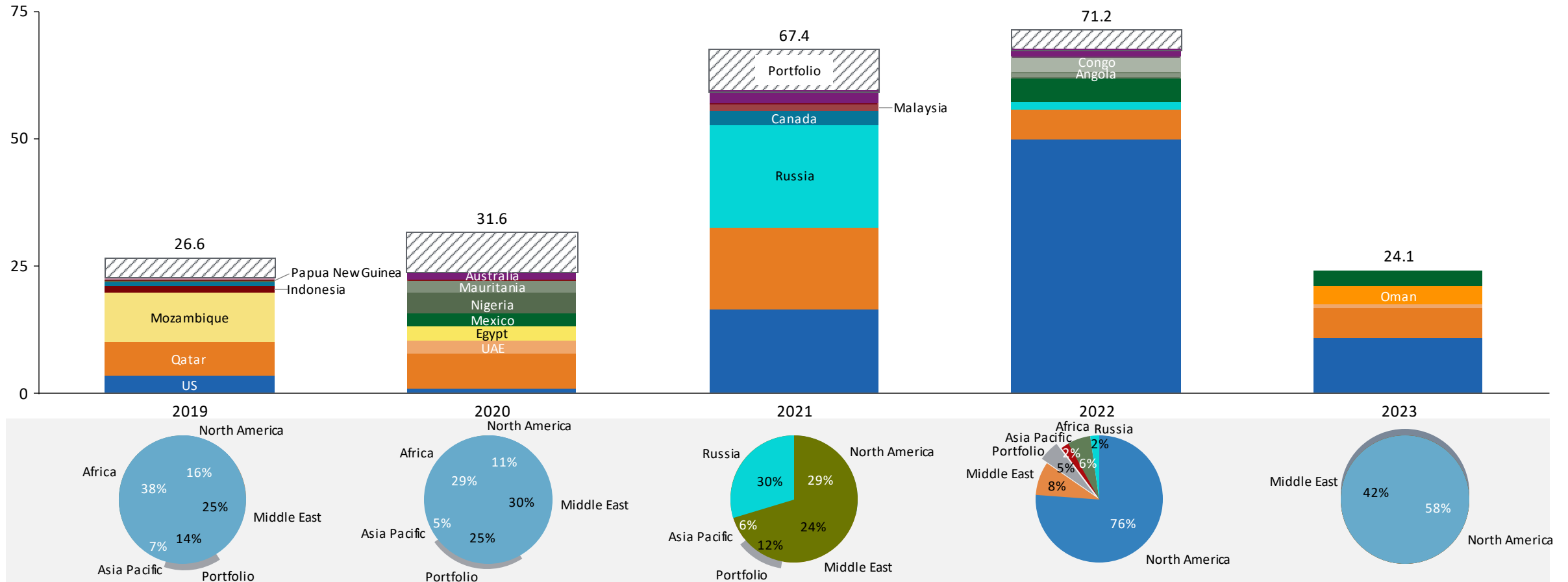
Signed Date	To Country	Seller	Buyer	Volume (Mtpa)	Contract Start Date	Duration (years)	Contract Term
6/26/2023		 Cheniere Energy	 ENN	0.9	7/1/2026	3.5	FOB
6/26/2023		 Cheniere Energy	 ENN	1.8	1/1/2030	20	FOB
6/22/2023		 Venture Global LNG	 SEFE	2.3	7/1/2026	20	FOB
6/21/2023	Portfolio	 Cheniere Energy	 Equinor	0.9	1/1/2027	18	FOB
6/21/2023	Portfolio	 Cheniere Energy	 Equinor	0.9	1/1/2030	15	FOB
5/16/2023	Portfolio	 Cheniere Energy	 Korea Southern Power	0.1	1/1/2024	3	DES
5/16/2023	Portfolio	 Cheniere Energy	 Korea Southern Power	0.4	1/1/2027	20	DES
4/28/2023		 Venture Global LNG	 JERA	1.0	1/1/2027	20	FOB
4/24/2023		 LNG Allies	 Hartree Partners	0.6	6/1/2026	20	FOB
3/1/2023	Portfolio	 Venture Global LNG	 Excelerate Energy	0.7	1/1/2027	20	FOB
2/23/2023		 Venture Global LNG	 China Gas Holdings	1.0	1/1/2027	20	FOB
2/23/2023		 Venture Global LNG	 China Gas Holdings	1.0	1/1/2027	20	FOB
1/25/2023		 Sempra	 PKN ORLEN	1.0	12/15/2028	20	FOB
1/19/2023		 NextDecade	 Itochu Corp.	1.0	10/15/2027	15	FOB
12/28/2022	Portfolio	 Sempra	 RWE	2.3	7/1/2027	15	FOB
12/26/2022		 Venture Global LNG	 INPEX	1.0	7/1/2026	20	FOB

Source : Rystad Energy Research & analysis, Rystad Energy LNG Trade Tracker Dashboard

Significant recent increase in LNG volumes contracted

LNG SPA contracts concluded, 2019-2023 to date*

Million tonnes of LNG per annum



*up to July 1, 2023

Source: Rystad Energy research and analysis, LNG Trade Tracker dashboard

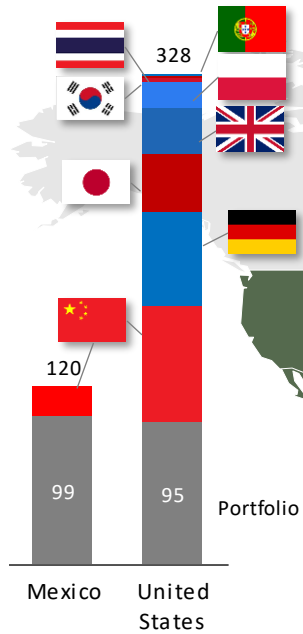
Europe secured only half of the LNG volumes secured by Asia since the invasion

LNG contracts* concluded in 2022&2023

Bcm (aggregated volumes by 2040)

N. America contract destination

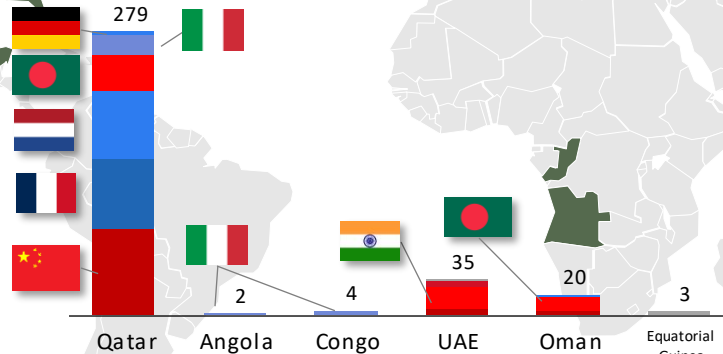
Bcm



Avg. Duration (Years)	23	19
Contract Term	FOB	FOB
Price Indexation	Waha Hub	Henry Hub

Middle East/Africa contract destination

Bcm

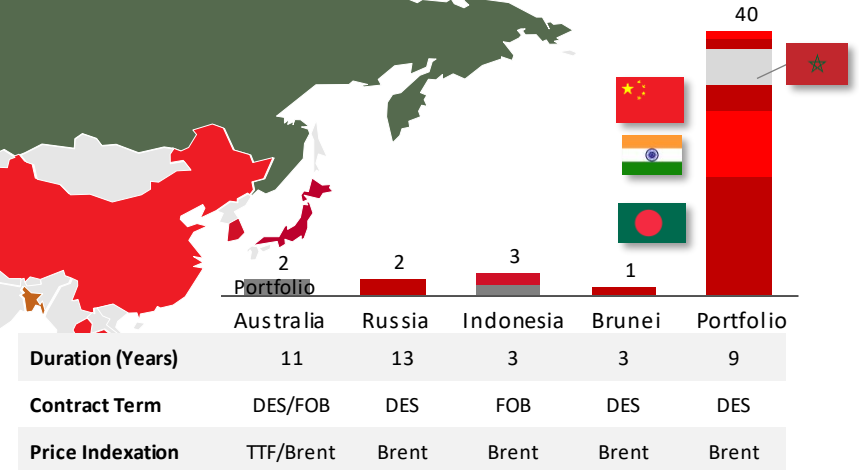


Avg. Duration (Years)	21	20	20	2.59	3.5	5
Contract Term	DES	FOB	FOB	FOB	DES	FOB
Price Indexation	TTF/Brent	Brent	Brent	Brent	Brent	TTF

17 contracts
Europe
324 Bcm
(231 Mt)

RoW contract destination

Bcm



Duration (Years)	11	13	3	3	9
Contract Term	DES/FOB	DES	FOB	DES	DES
Price Indexation	TTF/Brent	Brent	Brent	Brent	Brent

48 contracts
Asia
613 Bcm
(438 Mt)

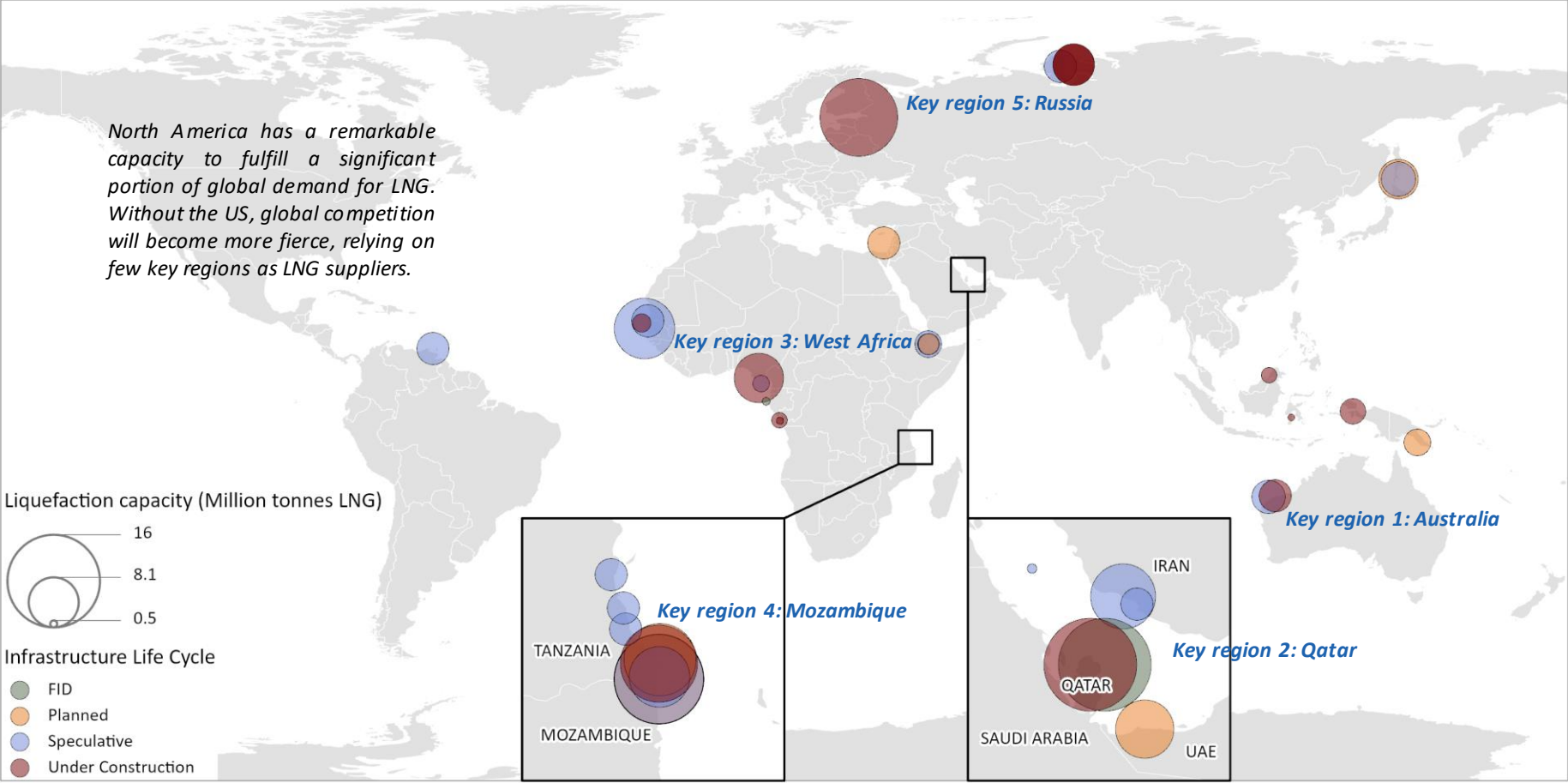
*Only includes SPA signed in 2022 and up to 31st October 2023, MoUs and HoAs are excluded

Source: Rystad Energy research and analysis, GasMarketCube

Global competition for LNG intense without US acting as swing producer

Map view of global upcoming liquefaction capacities by life cycle category (excluding North America)

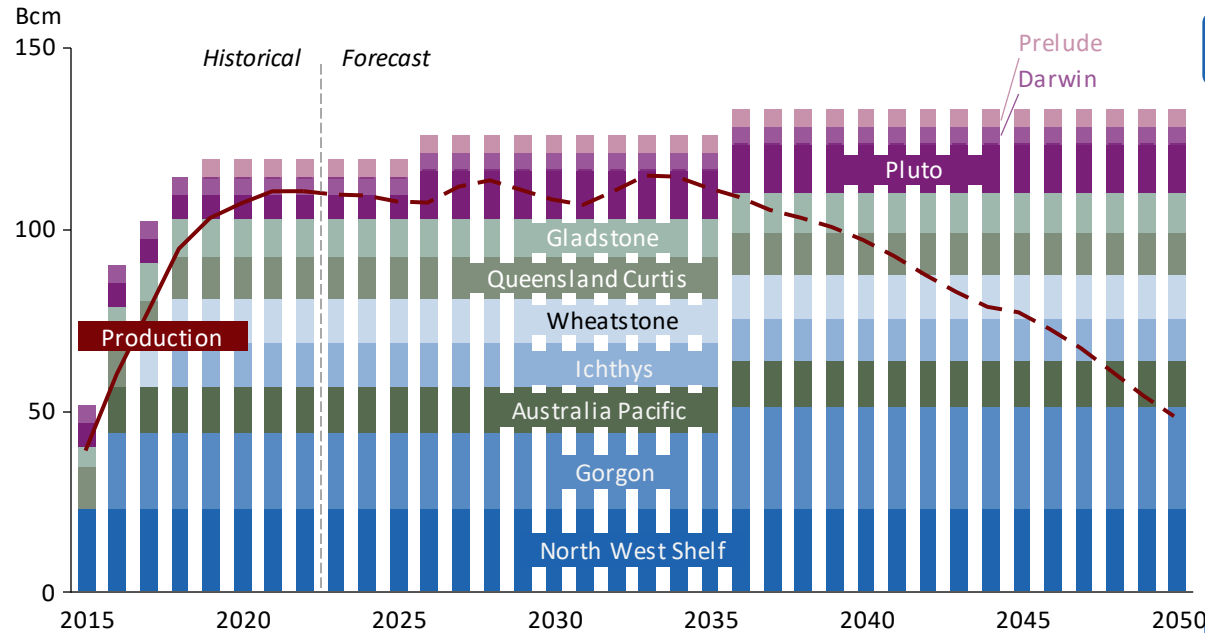
Million tonnes



Source : Rystad Energy research and analysis

Australia's emissions legislation risks commerciality of LNG projects, incentivizing decarbonization

Australia LNG production outlook and liquefaction capacity by plant, 2015-2050



- Expansions of the Gorgon and Pluto projects will add modest liquefaction capacities to Australia.
- The 2022 monthly average for Australia's LNG exports was at 9.4 bcm. Exports to Japan made up the largest share at 38%, followed by China at 28%.
- Japan has a stake in the Barossa development, which links gas from the Timor Sea to Darwin and is lobbying for special treatment under the new Safeguard Mechanism to ensure security of supply.

Impact of recent legislation on Australia's LNG exports

Safeguard Mechanism (Crediting) Amendment Act 2022

- Takes effect from 1st July 2023.
- Reduce emission limits for high-emitting industries to achieve net-zero by 2050.
- All LNG facilities are included under the new legislation and must reduce net emissions by **4.9%** per year to 2030, either directly or by surrendering offsets.
- Potential reduction in the commerciality of existing projects and risk the viability of projects to be sanctioned.

Australia resists Japan's lobbying for NT gas export project to be given special treatment

Australia passes tougher emissions reduction law that hits gas investments

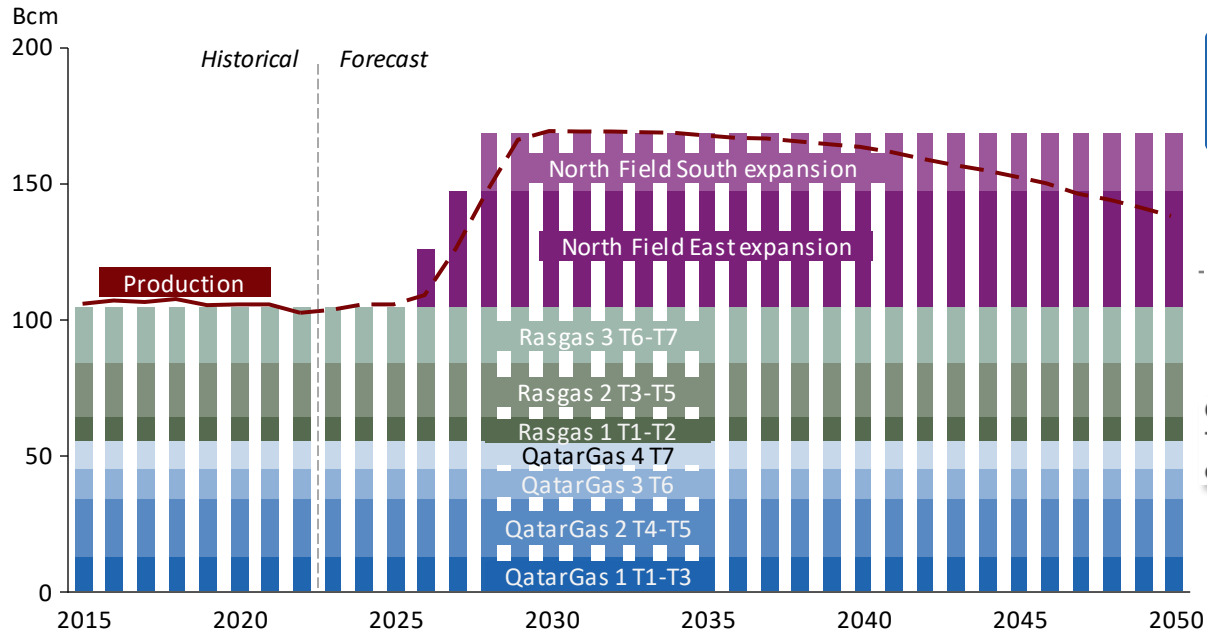
Electrifying Queensland's LNG export operations

- Revised Safeguard Mechanism legislation resurfaced talks to electrify the Gladstone, Australia Pacific and Queensland Curtis LNG facilities.
- Potentially cut emissions by 45% and save 71 petajoules of natural gas per year, which could be exported or used domestically.
- Savings could exceed US\$115 million per year with significant upsides.

Source : Rystad Energy research and analysis, GasMarketCube, The Guardian, Reuters

Qatar strengthening position as global LNG supplier with NFE and NFS expansions

Qatar LNG production outlook and liquefaction capacity by project, 2015-2050



- Qatar has emerged as a key player in the market, since announcing its strategic focus towards LNG in 2017.
- Two major expansion projects will increase the nation's capacity to approximately 125 bcm with the NFE project and near 170 bcm by 2030 with NFS.
- As a result, Qatar is expected to contribute around \$24 billion in contract awards up to 2025.

Upcoming Qatari liquefaction projects

Liquefaction project	FID year	Start-up year	Status	Capacity (Bcm)	Cost of supply DES to Asia (USD/MMBtu)
NFE expansion	2021	2026-2027	Under construction	42.4	4.3
NFS expansion	2023	2028	International partners confirmed	21.2	5.6

QatarEnergy signs deal with TotalEnergies for North Field South expansion

Qatar to supply Germany with LNG as EU seeks secure energy options

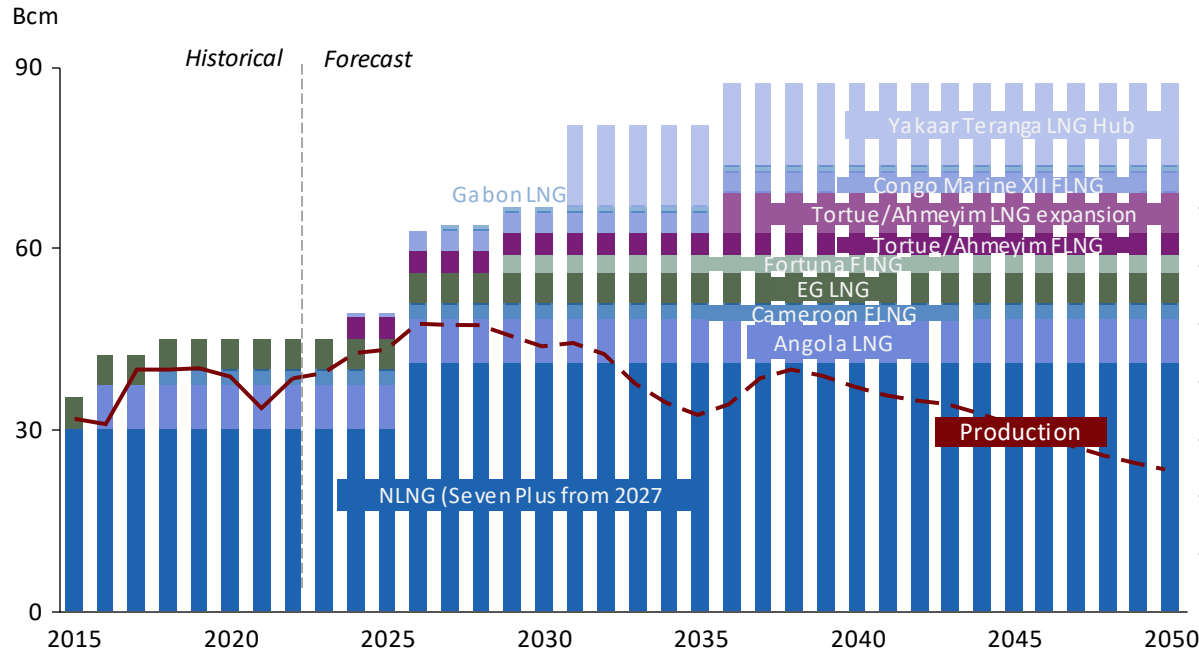
Compared to recent LNG project approvals, NFE brings the highest LNG capacity at the lowest breakeven price

- State-owned QatarEnergy holds 75% ownership of NFS and agreed to a deal with TotalEnergies for 9.375% effective ownership, booking an LNG entitlement volume of 1.5 Mtpa by 2030.
- QatarEnergy is in talks with both European and Asian buyers.
 - “ Half of our production normally goes East and half goes West, this equation may be the same or may be 60% to 40% according to market needs, it is a supply and demand issue ”
 - Saad al-Kaabi, President and CEO of QatarEnergy
- In November 2022, Germany signed an SPA for 2 Mtpa of LNG for at least 15 years starting from 2026. Other contracts include SPAs to China and Bangladesh.

Source: Rystad Energy research and analysis, GasMarketCube, Reuters, Financial Times

West Africa eager to add large capacities into the 2030s but projects may not deliver full ambition


West Africa LNG production outlook and liquefaction capacity by plant, 2015-2050




Upcoming West African liquefaction projects

Liquefaction project	Country	FID year	Start-up year	Status	Capacity (Bcm)	Cost of supply DES to Asia (USD/MMBtu)
Greater Tortue Ahmeyim FLNG	Mauritania	2018	2024	Under construction	3.4	5.6
Marine XII FLNG	Congo	2022	2024	Under construction	0.8	11.3
NLNG Seven Plus	Nigeria	2019	2026	Under construction	10.9	10.4
Marine XII FLNG Phase 2	Congo	2022	2026	Under construction	2.7	8.2
Gabon LNG	Gabon	2023	2027	FID	0.95	11.3
Fortuna FLNG	Equatorial Guinea	2023	2027	Speculative	3	22.4
Yakaar Teranga LNG Hub	Senegal	2026	2031	Speculative	13.6	8.3
Bir Allah LNG Hub	Mauritania	2032	2036	Speculative	6.8	7.9

- West Africa has traditionally been the continent's main source of crude oil while the east is more gas-prone, but it is increasingly also becoming an export hub for LNG.
- Upcoming projects in Nigeria, Mauritania and Senegal will add approximately 35 bcm of liquefaction capacities to the region into the 2030s.
- Smaller-scale projects and expansions in Congo, Equatorial Guinea and Gabon are expected to come online sooner.



- Plans for the large LNG hub in Senegal-Mauritania has seen delays and capacity reductions following the Covid-19 pandemic
- The growing Islamic insurgency in Mali also raises security concerns.



- Nigeria's T7 project was sanctioned with export capacity exceeding domestic resources.
- Daily utilization of NLNG's name plate capacity averaged only 65% in May 2023.

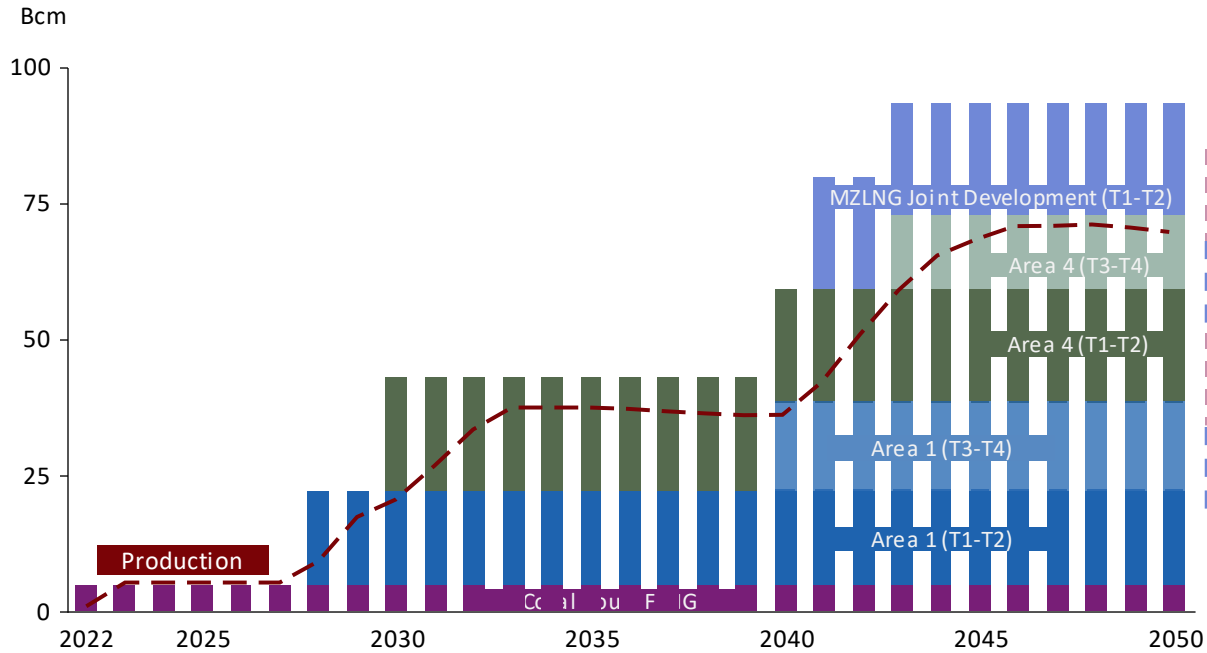


- Eni launched Congo's first liquefaction project in April 2023, as part of their energy supply procurement diversification strategy.
- Congo-Brazzaville is set to become a key LNG exporter in the region.

Source: Rystad Energy research and analysis, GasMarketCube

Offshore LNG production looks promising in Mozambique but onshore plants remain at standstill

Mozambique LNG production outlook and liquefaction capacity by project, 2015-2050



Upcoming Mozambique liquefaction projects

Liquefaction project	FID year	Start-up year	Status	Capacity (Bcm)	Cost of supply DES to Asia (USD/MMBtu)
Area 1 LNG (T1-T2)	2019	2028	Under construction	17.5	5.5
Area 4 LNG (T1-T2)	2026	2030	Planned	20.7	6.9
Area 1 LNG (T3-T4)	2035	2040	Planned	16.3	6.0
Area 4 LNG (T3-T4)	2038	2043	Speculative	13.6	6.4
MZLNG Joint Development (T1-T2)	2036	2041	Speculative	20.4	5.1

- TotalEnergies' declared force majeure on its Area 1 (T1-T2) project in 2021 after civilians in a nearby town were attacked by rebels linked to Islamic State.
- The Coral South project operated by Eni shipped its first LNG cargo in November 2022, being shielded from the insurgency as an offshore project.
- In April 2023, Eni expressed interest in building a second FLNG platform to replicate the Coral South project.

TotalEnergies
TotalEnergies prepares for Mozambique LNG restart

- In May 2023, TotalEnergies announced that it will begin to implement an action plan to prepare for the project's restart although no date has been confirmed.
- Armed conflict has continued, albeit taking place away from the project site.

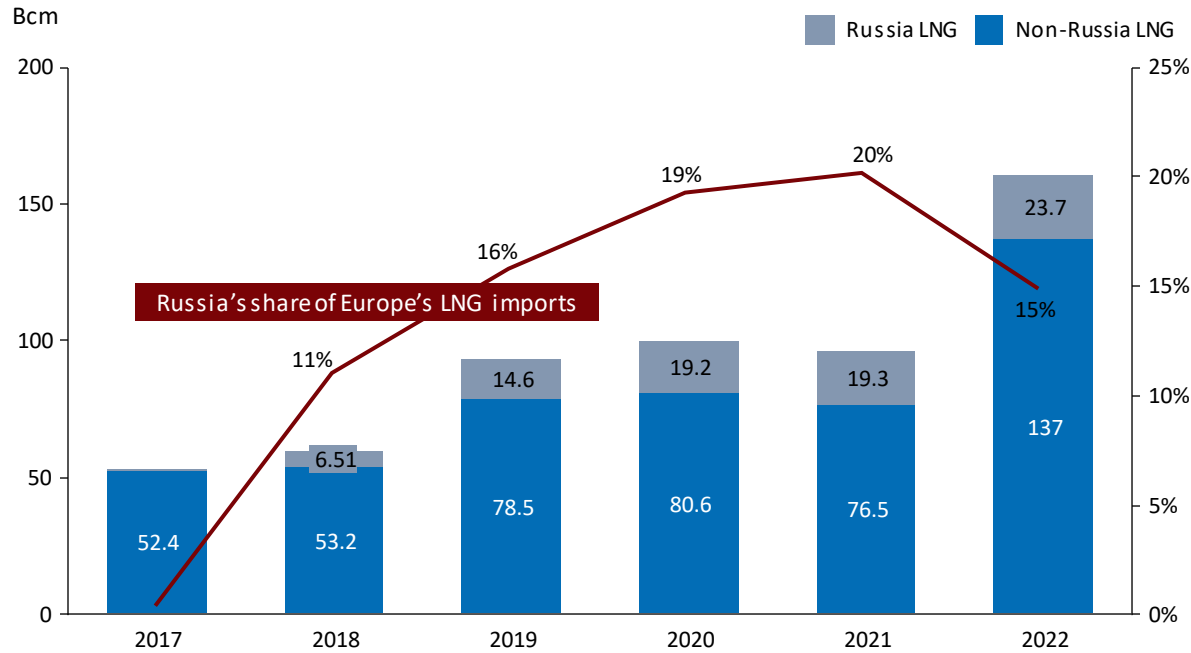
ExxonMobil
ExxonMobil fires up fresh bid battle for transformed LNG project in Mozambique

- The Rouvuma LNG (Area 4) facility has been placed on hold since the insurgency.
- ExxonMobil is now considering modular fabrication concept for the plant which will boost capacity by 3.3 bcm.
- Galp is however looking to divest its stake.

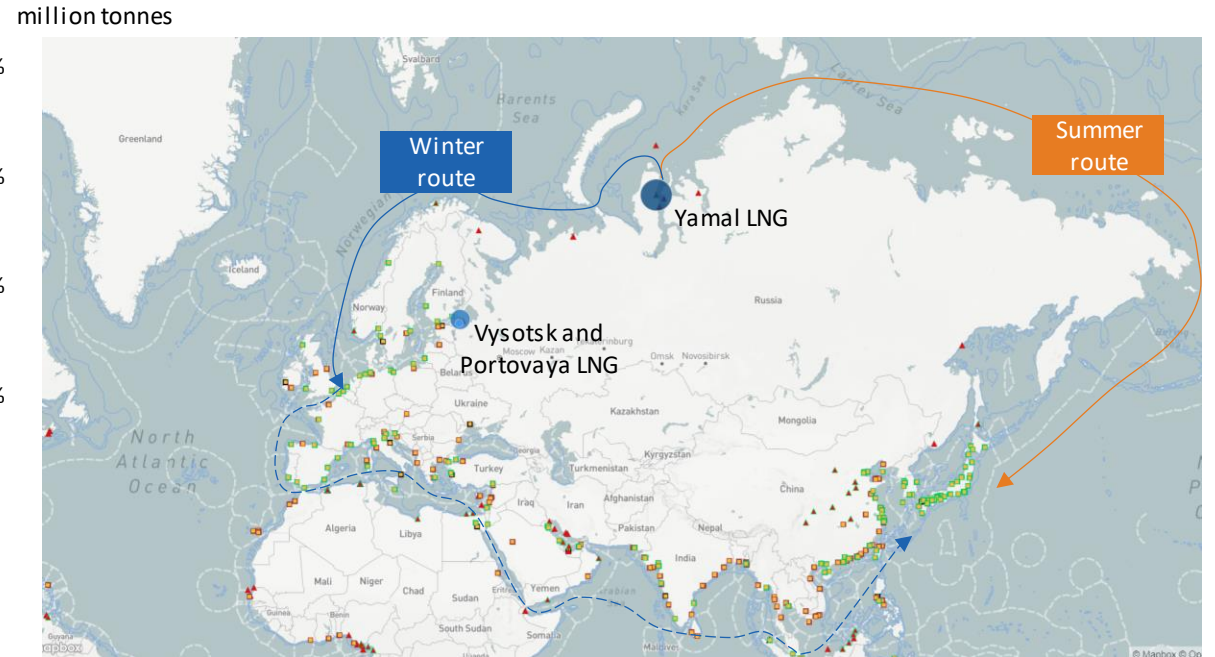
Source: Rystad Energy research and analysis, GasMarketCube, Reuters, Upstream Online

No ban on Russian LNG so far, but redirected cargoes from Yamal LNG to Asia likely to be costly

Europe's LNG imports, split by Russian and non-Russia origin



Map view of Russian LNG export plants to Europe



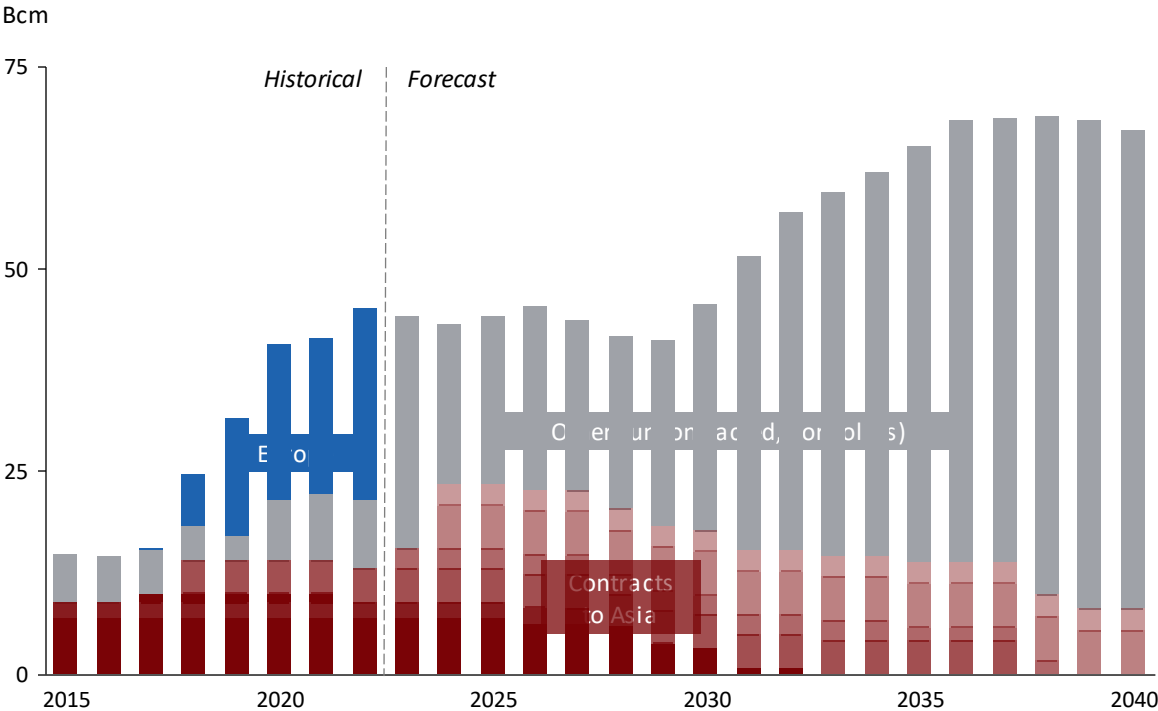
- Europe's Russian LNG imports in 2022 was at 23.7 bcm, 23% higher than in 2021.
- Even though the share of Russian LNG dropped from 20% to 15%, this was driven by much greater imports of non-Russian LNG following the cessation of pipeline volumes. There are no restrictions on Russian LNG imports in Europe so far.
- Europe made up 55% of Russia's LNG exports in 2022, followed by China and Japan.

- Much of the European LNG demand is served by facilities at Yamal. In 2022, it exported 27 Mt of LNG.
- In summer, cargoes redirected away from Europe may be shipped via the Arctic Circle to Asia instead. However, during winter, LNG carriers have to take a longer route via the Suez Canal. This also entails trans-shipment via European terminals in Belgium and France.

Source: Rystad Energy research and analysis, LNG Trade Tracker

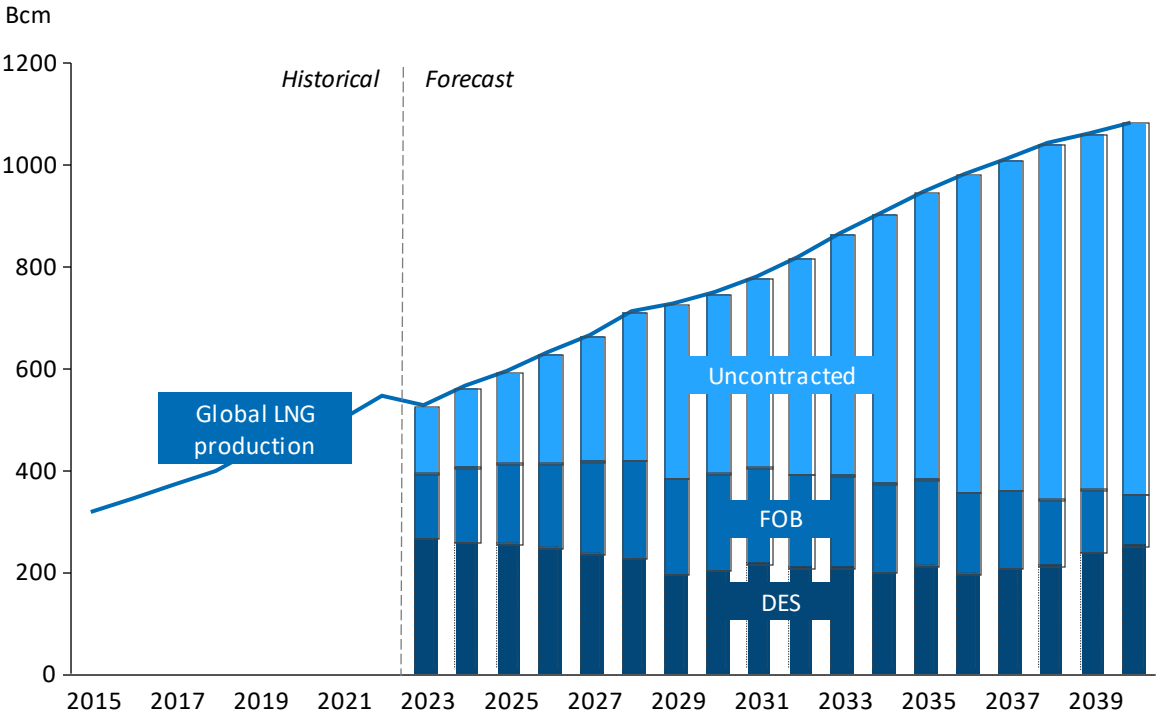
Uncertain future for Russian LNG to Europe highlights need for alternative long-term contracts

Russian LNG exports, split by destination



- The future of Russia’s LNG exports remains uncertain, particularly with regards to the large volumes from Yamal LNG that is currently contracted to Europe-based portfolio players.
- 5.44 bcm of LNG currently signed to Total will expire in 2031. Additionally, 5.984 bcm is contracted to portfolios held by Shell, Total and Naturgy with an end date in 2037.
- It is uncertain whether these volumes may be redirected to Asia, given the complexities associated with shipping in the winter.

Global LNG production, split by contract type



- The global LNG market is increasing in volumes and liquidity up to 2040 – this presents an opportunity for Europe to secure supplies.
- Spot LNG markets remain far less liquid than the seaborne crude market, primarily because there are smaller volumes involved.
- LNG producers still express a preference for long-term contracts to underwrite high capex projects, while LNG is generally sold at a lower price than crude.

Source : Rystad Energy research & analysis, Rystad Energy GasMarketCube

Report contents

Key messages

- Summary
- Key messages

Full report

- Demand
- Supply

 - Introduction to supply stack

 - Domestic production

 - Domestic increments

 - Russia supply

 - Piped gas imports

 - LNG increment

 - Contracted LNG

 - Short-term LNG

 - Long-term LNG

- Infrastructure

- LNG deep dive

- Balance

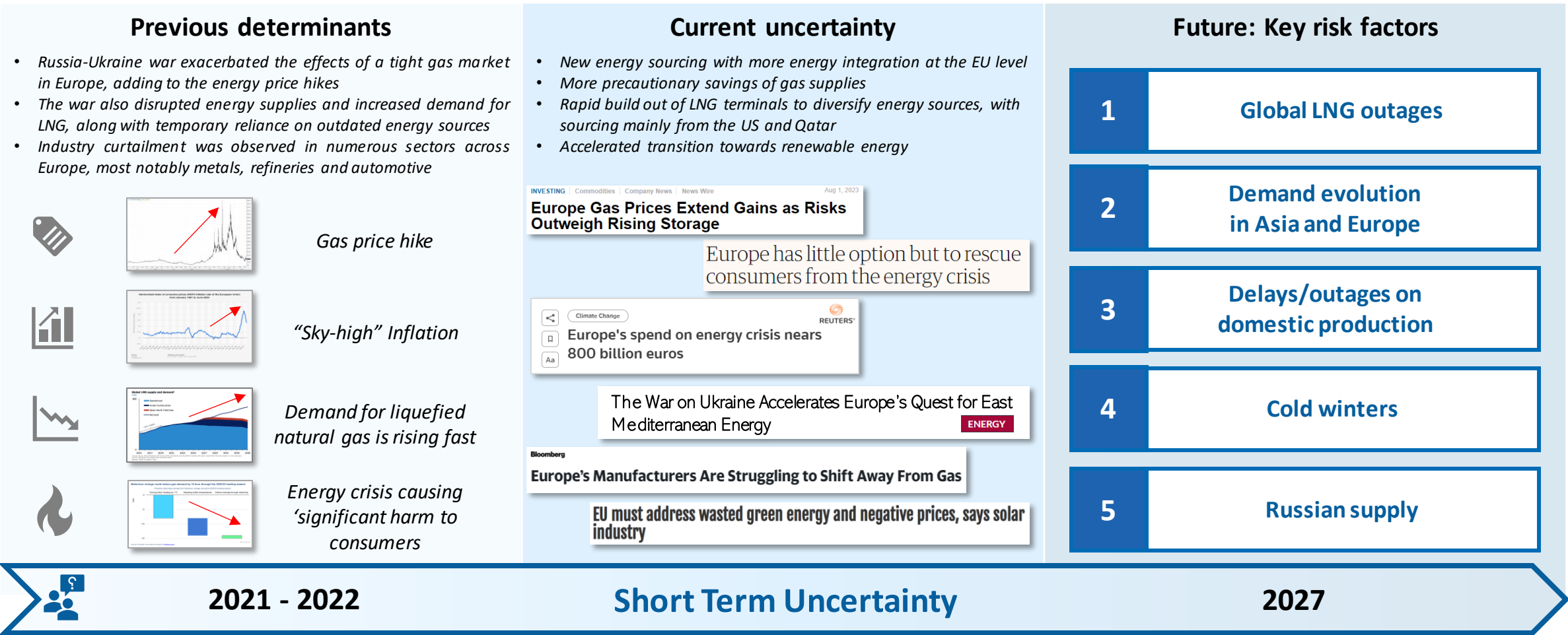
 - Short-term Monte Carlo simulation model

 - Sensitivity analysis

Appendix

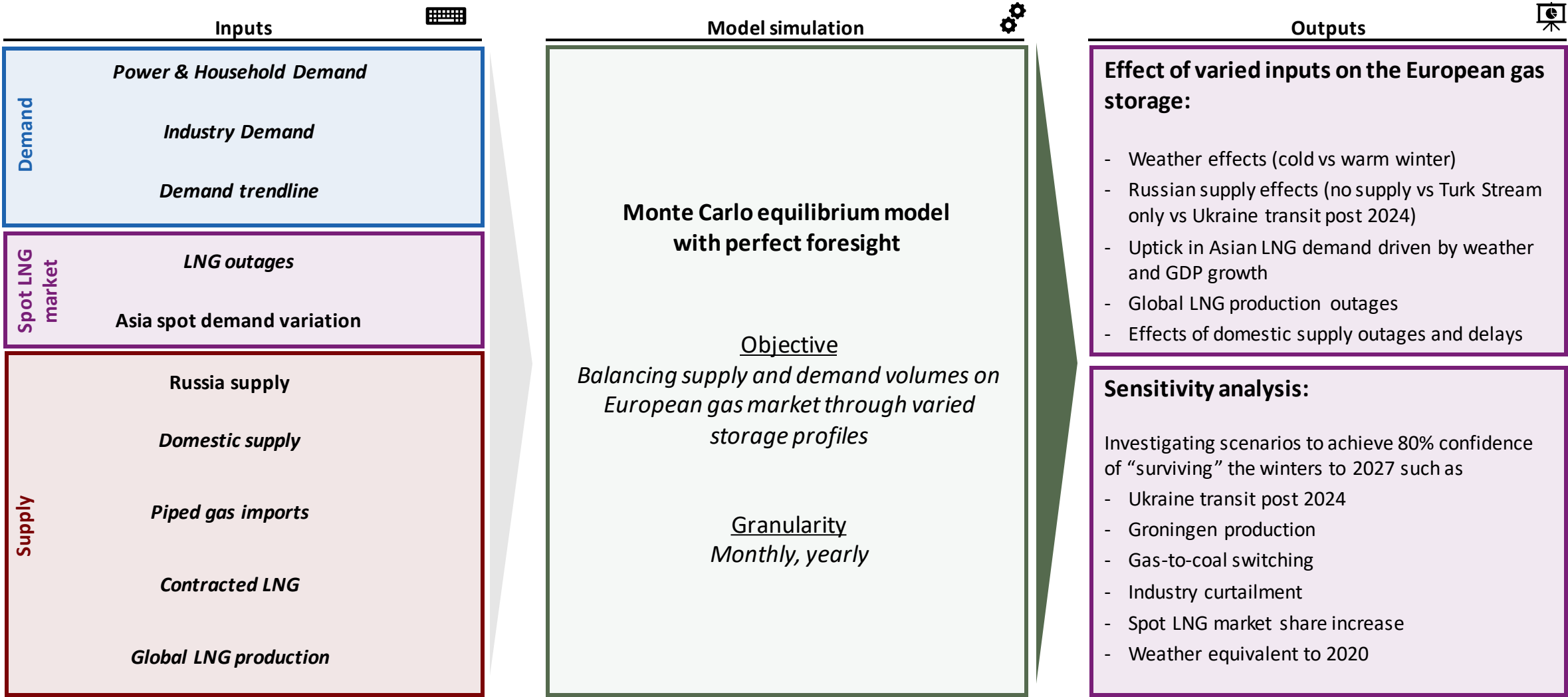
Europe's short-term energy security outlook requires sophisticated modelling to understand uncertainties and critical dependencies

Key elements impacting near-term uncertainty (2023 - 2027)



Source: Rystad Energy research and analysis

Monte Carlo simulation can examine the interaction between inputs and EU gas storage levels

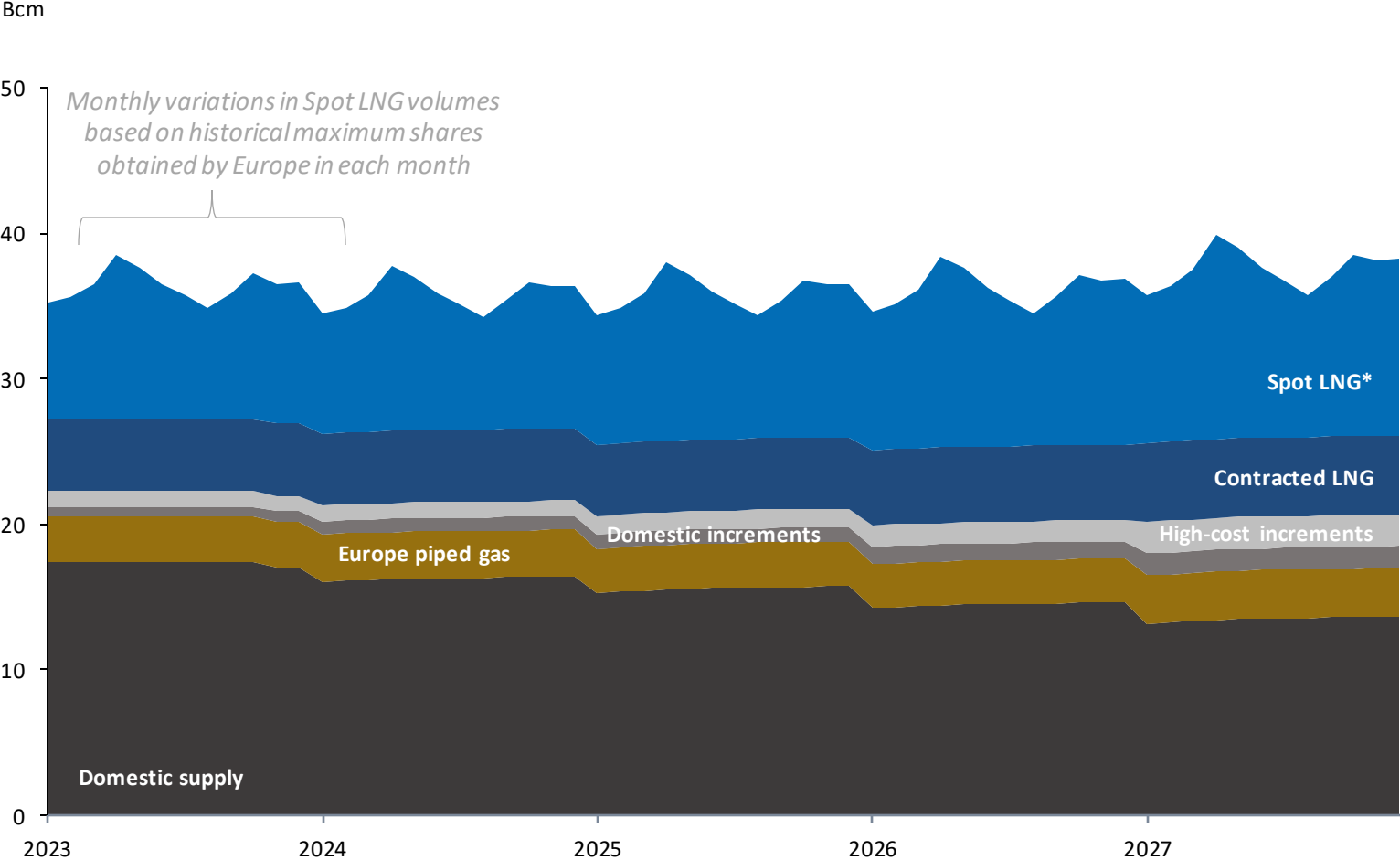


Source: Rystad Energy research and analysis

European supply stack remains a vital input into the model, with variation coming from scenarios with Russia, interruptions and delays in domestic production

Supply

Overview of fixed supply stack



* Spot LNG doesn't include effects of unplanned outages and Asian demand variation
Source: Rystad Energy research and analysis

Supply stack

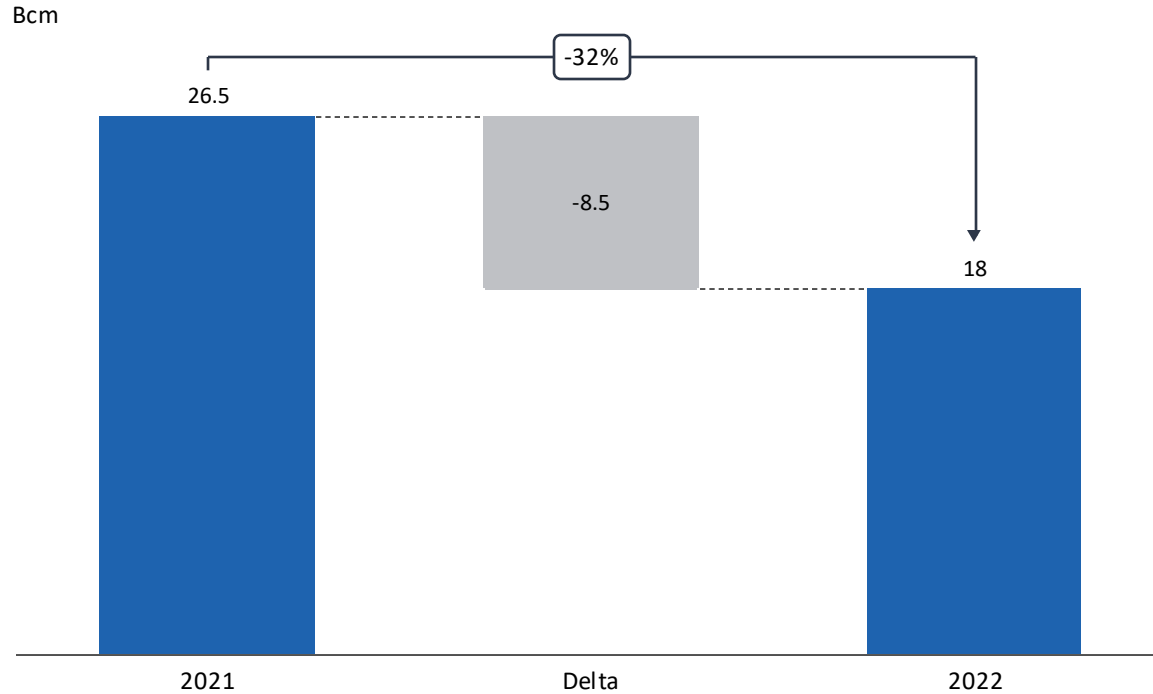
The European supply stack is a vital input in the model. Core domestic supply includes several uncertainties

Assumptions

- Domestic production and global LNG production assumes **probability of delays** on the rollout of planned assets/facilities and **probability of interruption** on existing assets based on historical data
- Europe is **willing to consistently pay high prices** to replicate maximum historical share of spot LNG market and add develop high-cost increment assets

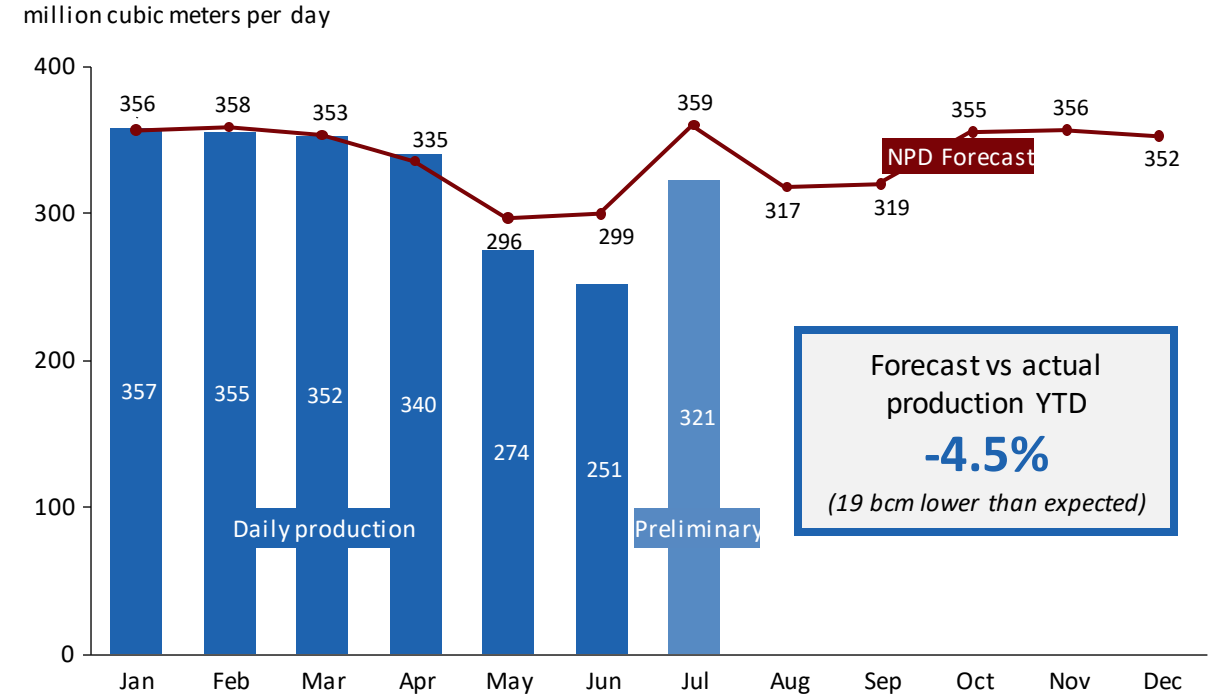
Expected production from producing fields can be impacted by reserve revisions and maintenance

Martin Linge gas reserves, 2021-2022



- Martin Linge is an Equinor operated field straddling the Norwegian/UK border that started production in 2021
- Reported reserves in 2021 were 26.5 bcm – this estimate was derived from knowledge before any production history
- Upon starting production and the wealth of information such an event feeds the reservoir model, the reserve base and production performance expectations were subsequently downgraded
- Such a downgrade event would typically occur within the first year of production

2023 daily gas production on the NCS

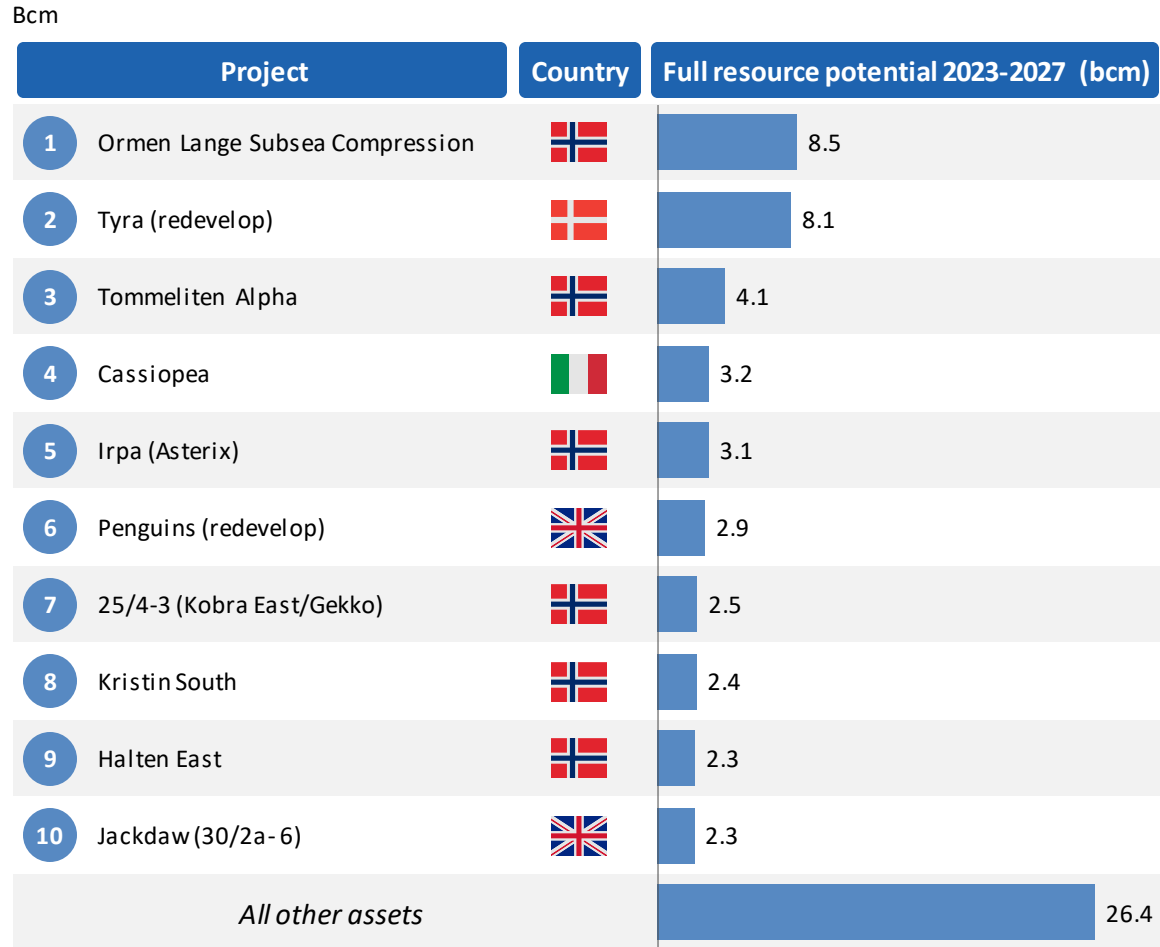


- All fields are subject to maintenance to maintain safety and overall maximize production efficiency
- Such maintenance efforts may however take more time than expected and there might be unforeseen events that causes shutdowns or production curtailments lower production versus expectations
- An example of such an event occurred for Norwegian production this summer when maintenance programs at Nyhamna for example went on for longer than expected

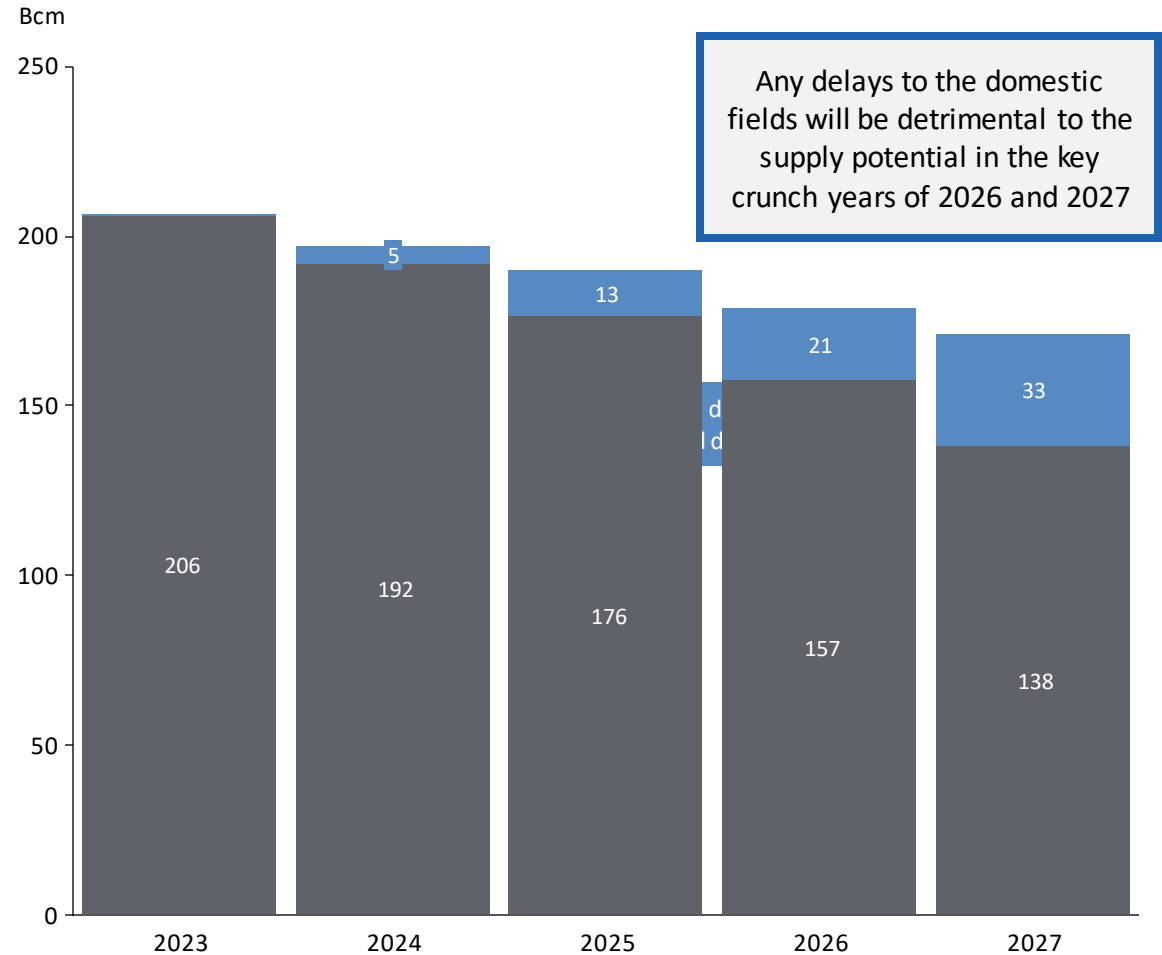
Source: Rystad Energy research and analysis, Rystad Energy Ucube, NPD

Supply security can ill afford delays to projects coming on-stream by 2027

Full resource potential of top 15 projects starting up in 2023-2027



Domestic production 2023-2027, split by life cycle category

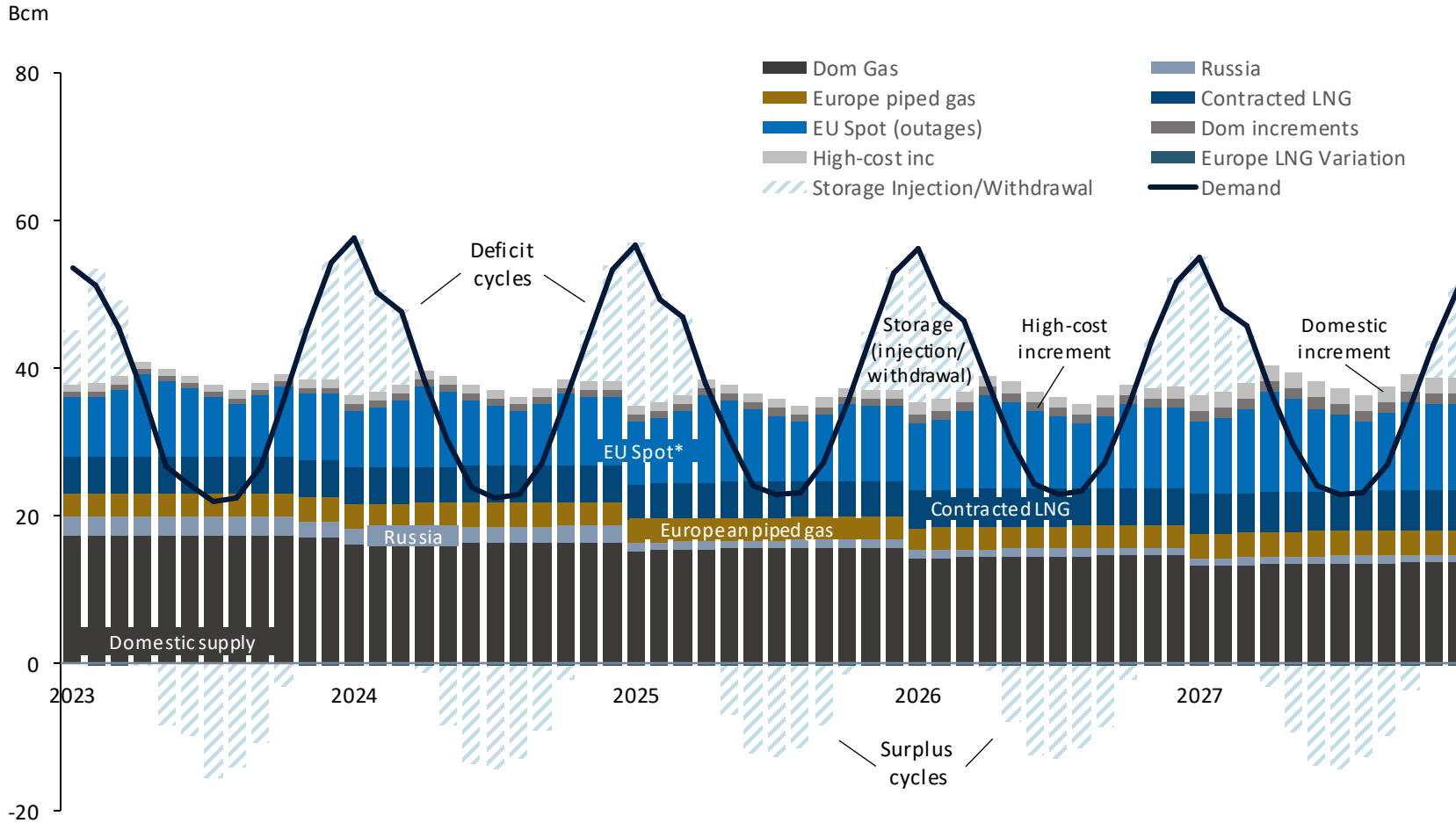


Rystad Energy research and analysis, Rystad Energy GasMarketCube, Rystad Energy Ucube,

Gas storage and spot market LNG level seasonal variation in European gas demand

Demand Supply

European - supply*/demand balance for a single iteration



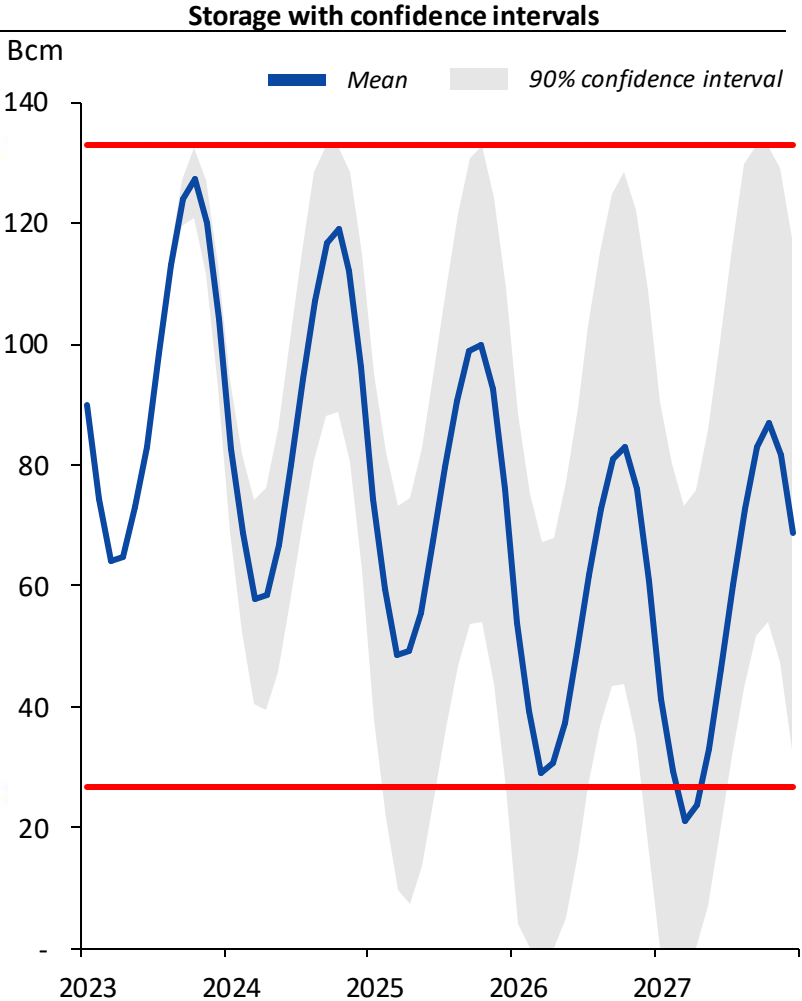
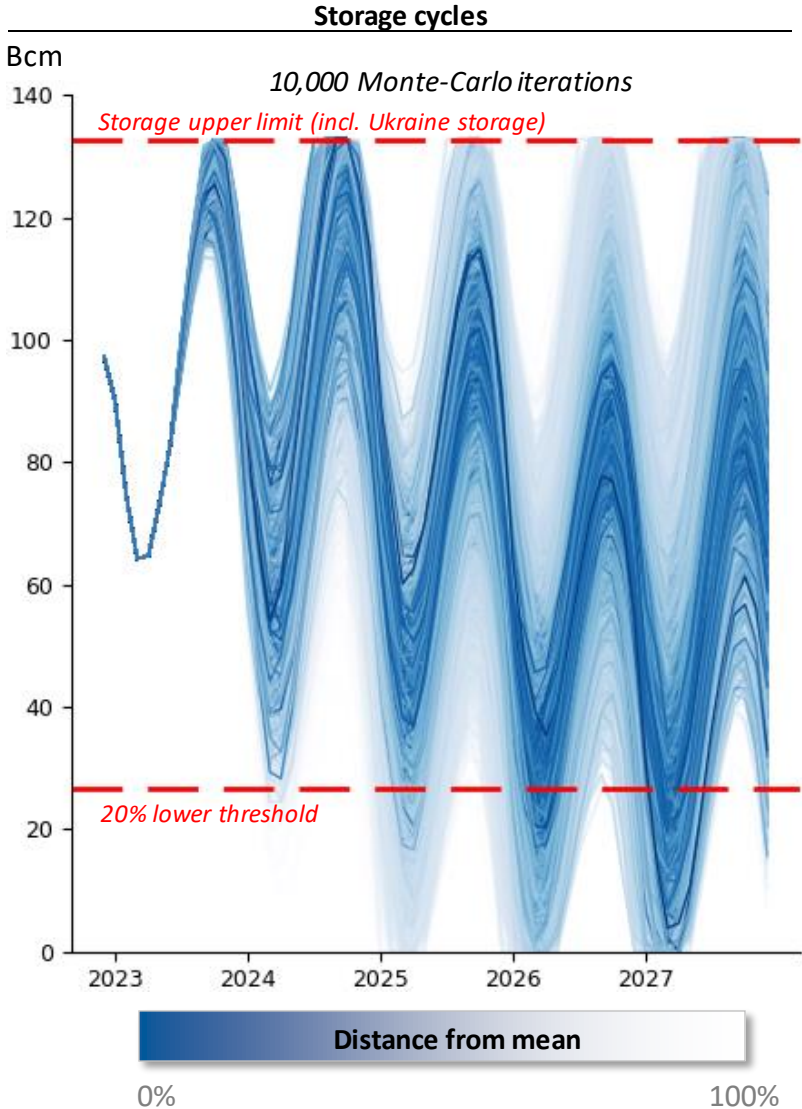
- Supply/Demand balances shown for a single iteration of equilibrium model.
- The months where supply exceeds demand are used to fill European storage. Once the technical storage limits are reached no more gas can be injected
- The deficit cycles lean on storage reserves to supply the missing volumes. When such volumes can't be provided the gas market becomes unbalanced, which may lead to demand curtailment

* Supply scenario: Russia: continue with the current capacity * EU Spot includes outages
 Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube

By stochastically modelling input variables, gas balances scenarios result in probabilistic storage outcomes

Model inputs	
Demand	Power & Household demand Based on historical HDD numbers
	Industry demand Based on historical PMI numbers
	Demand trendline Follows long-term median demand
Spot LNG market	LNG outages In-house data set
	Asia spot demand variation Based on historical HDD and GDP numbers
Supply	Russia supply Three scenarios include: current operations, Turk Stream only, and no supply
	Domestic supply In-house data set, variations based on historical project delays and production deviations
	Piped gas imports In-house data set
	Contracted LNG In-house data set
	Global LNG production In-house data set

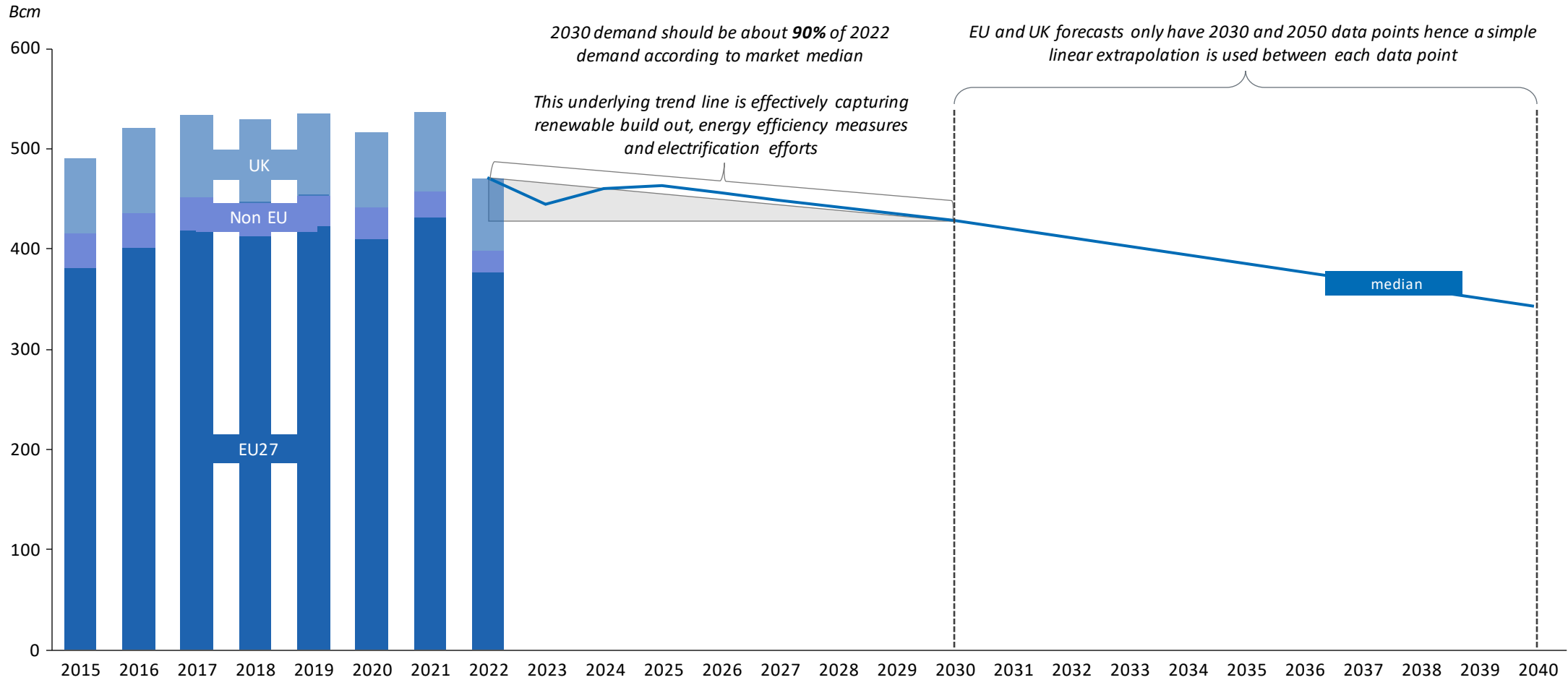
Source : Rystad Energy research and analysis, Eurostat



The 2030 point for reference demand acts as a trend line to be met under a mean scenario

Demand

European demand outlook by scenario



Countries included in the scope are: EU, UK, Norway, Albania, Moldova, Montenegro, North Macedonia, Serbia, Switzerland, Ukraine

IEA, Equinor and TotalEnergies uses relevant growth rate for outlook – geographic coverage is not exactly 1 to 1 with historical data points

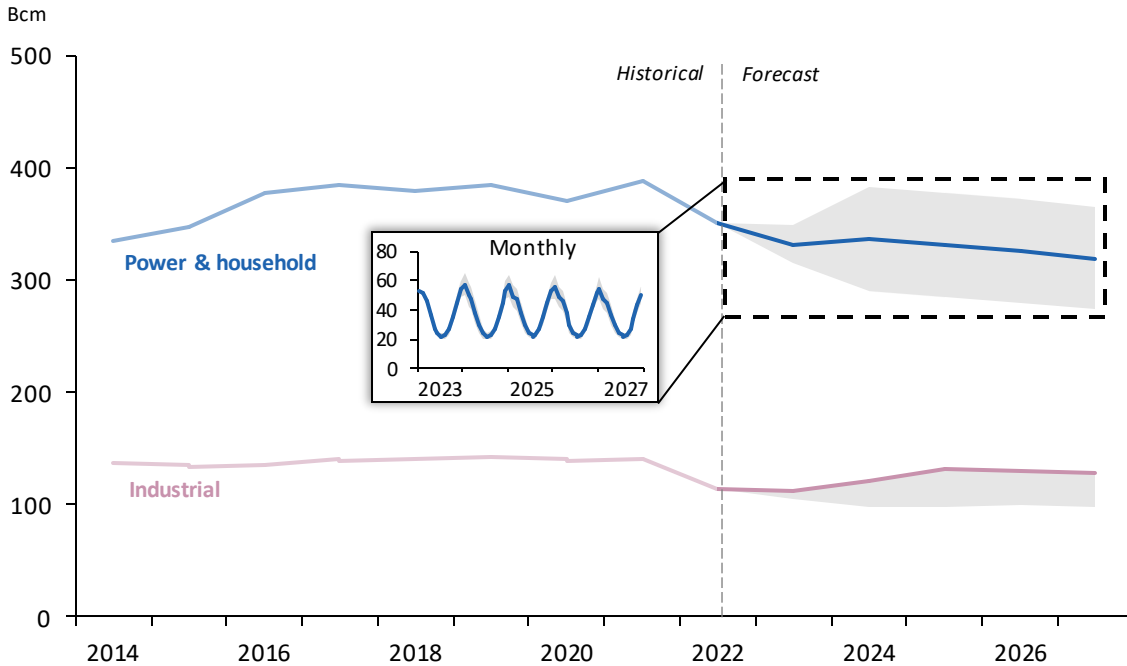
Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy, IEA, Equinor, TotalEnergies

Around the trend line uncertainties in weather and industry will create oscillations

Demand

European natural gas demand build up

Annual natural gas demand in Europe split by sector, 2014-2027



Power & household:

We assume power & household having lower demand moving forward due to structural changes in the power mix and electrification of household sector



Industrial:

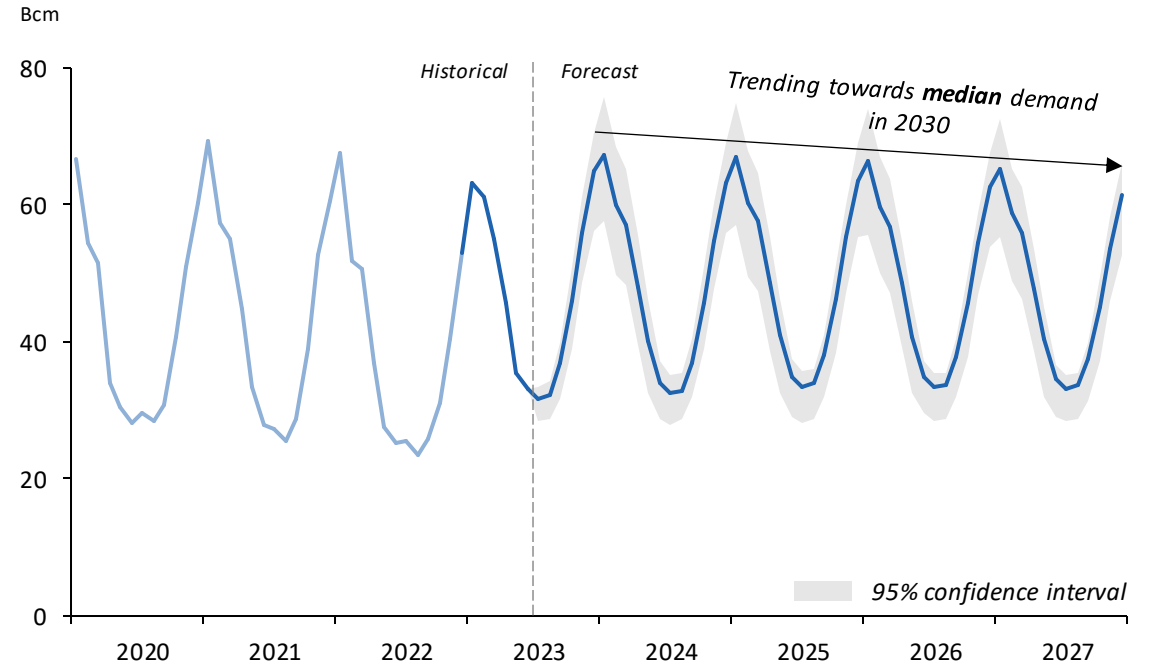
Industrial demand is expected to recover 88%* of the post-war losses over the next 2-year period. However, it will be impacted by efficiency gains and electrification in the coming years

*Includes a 3 bcm structural change in industrial demand derived from IEA assessment

Source: Rystad Energy research and analysis

Monthly demand cycles

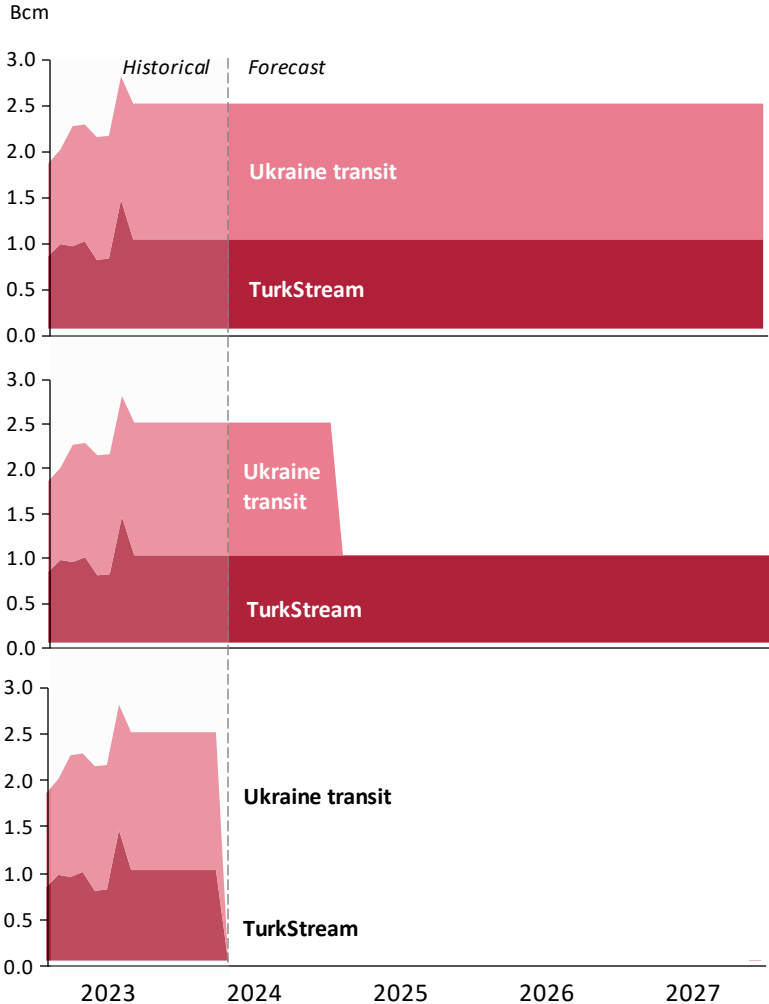
Monthly natural gas demand in Europe, 2020-2027



- Final distribution of European monthly demand is governed both by the weather variation and probabilistic outcome of industrial demand.
- The topline trend follows the median demand scenario
- There is higher variation of winter demand due to acute effect of cold temperatures on power & household consumption

Three supply scenarios reflect our view on the development of Russian exports in the near-term

Gas supplies to Europe



* Probability figures are estimates based on market intuition
 Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube

Supply

10% probability*



- Scenario 1: Continued supply of Russian gas at current volumes to 2027.

80% probability*



- Scenario 2: Contract for Russian exports via Ukraine doesn't get renewed post current expiration date at the end of 2024.

10% probability*

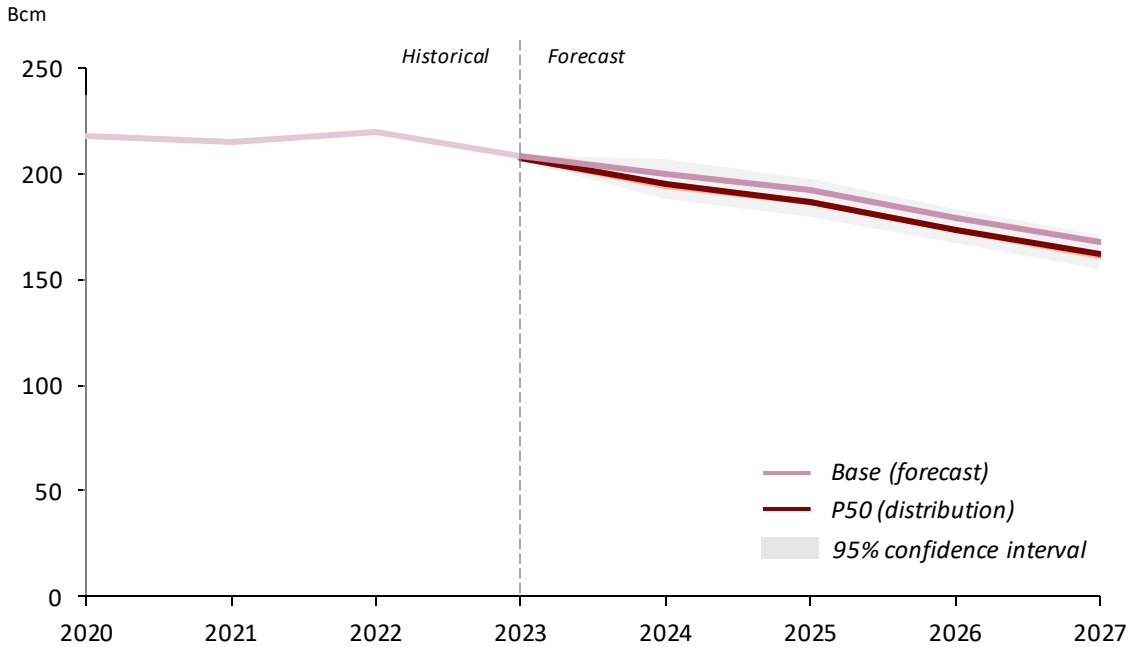


- Scenario 3: Complete shut-off of Russian gas supply to Europe from August 2023.

Uncertainty in domestic production results in 5bcm downgrade from forecasted numbers

European natural gas supply build up

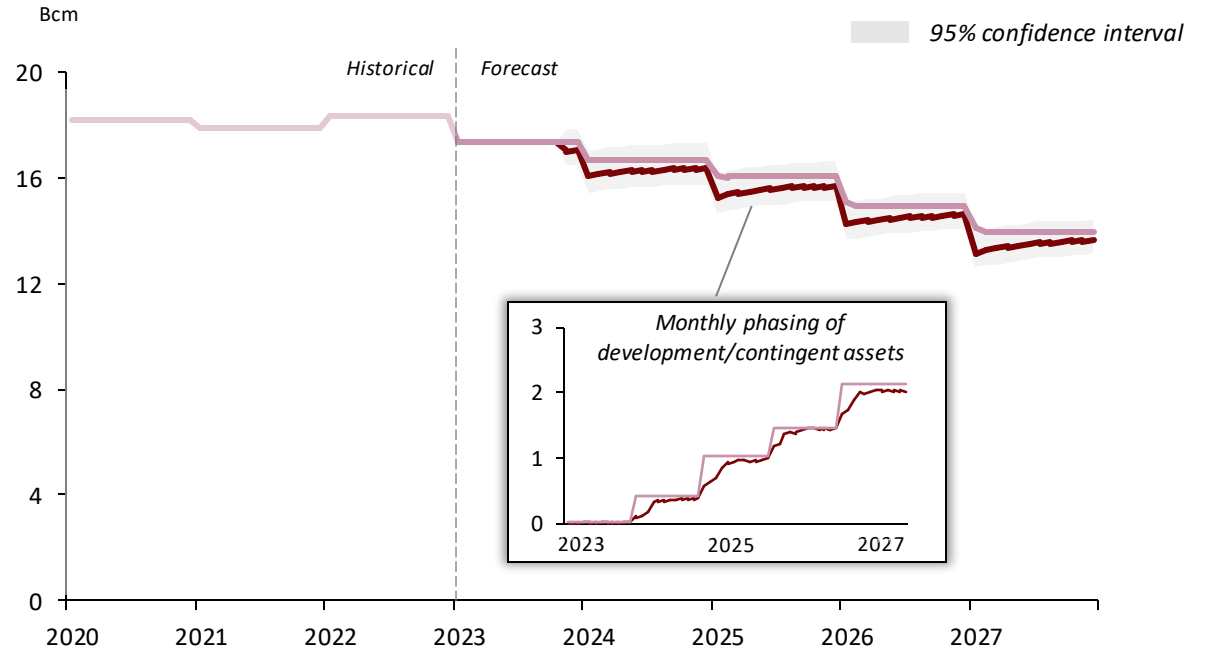
Annual natural gas domestic supply in Europe, 2020-2027



- Several uncertainties are examined for domestic supply (producing and under development assets): production deviation for all forecasts, plateau deviation for producing assets, which will hit plateau in 2023-2027 and delays on the rollout of under development assets.
- P50 of the distribution trails the forecasted numbers due to the skewed nature of historical observations

Monthly supply cycles

Monthly natural gas domestic supply in Europe, 2020-2027



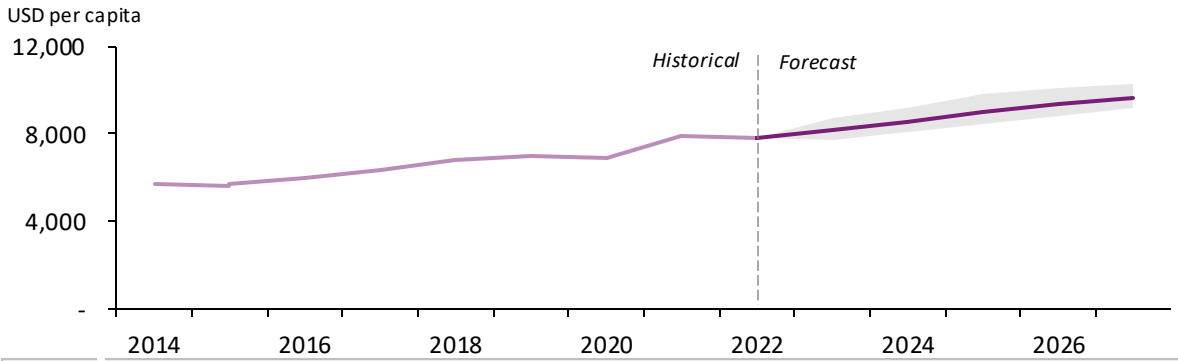
- Due to the skewness of production deviation, the mean of the distribution falls below the forecast.
- Phasing of under development assets (due to potential delays) push out the start-up of those fields, hence resulting in a varied intra-monthly profiles for production

Source : Rystad Energy research and analysis

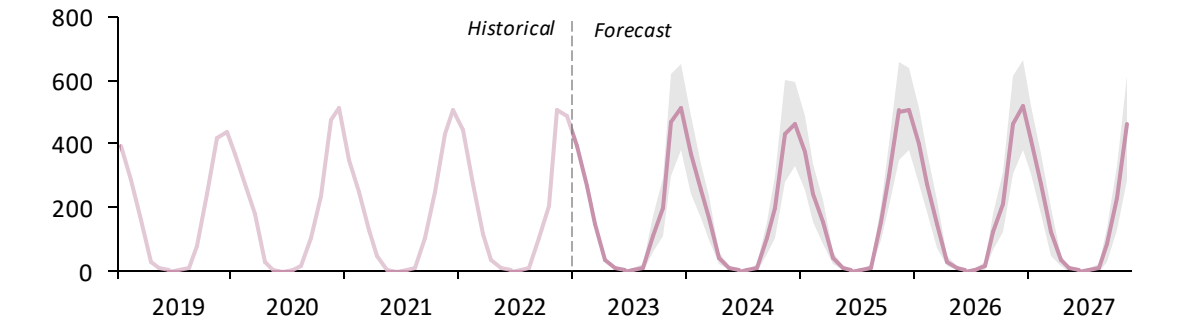
IMF expectations for strong economic recovery in Asia with upside for a faster GDP growth

Key drivers for Asian LNG demand variation

Average GDP per capita of selected Asian countries



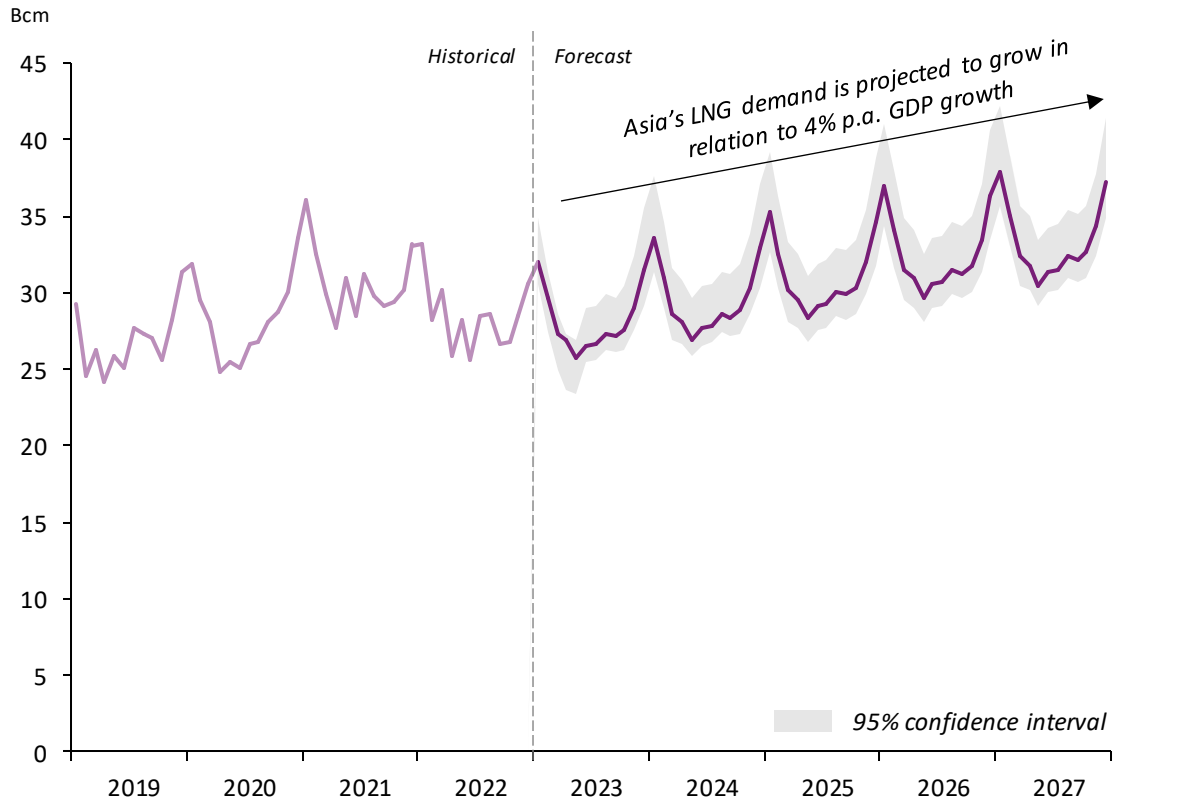
Asia GDP per capita*:
On average the Asian countries are set to grow 4% y/y**. The distribution reflects the uncertainty around the economic development with a higher wedge placed on the upside



NE Asia* HDD variation:**
North-East Asian countries historically have significant winter variation and large reliance on natural gas for heating demand

Monthly Asian LNG demand cycles

Asian spot LNG demand cycles, monthly

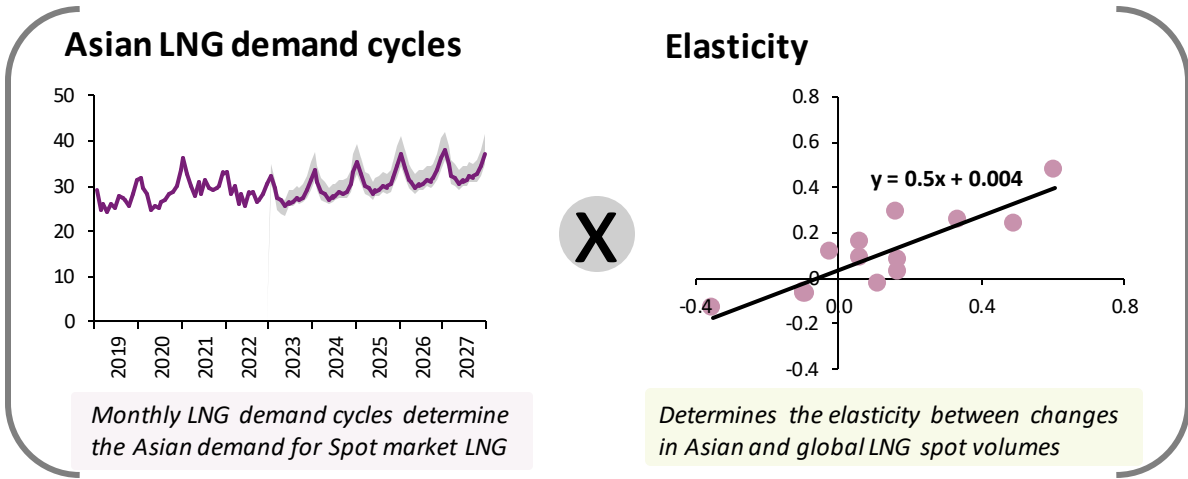


There is an increasing demand dynamic for spot LNG in Asia, primarily driven by economic growth. Based on historical observation there is also a higher upside to have stronger economic growth than forecasted, hence the distribution takes into a

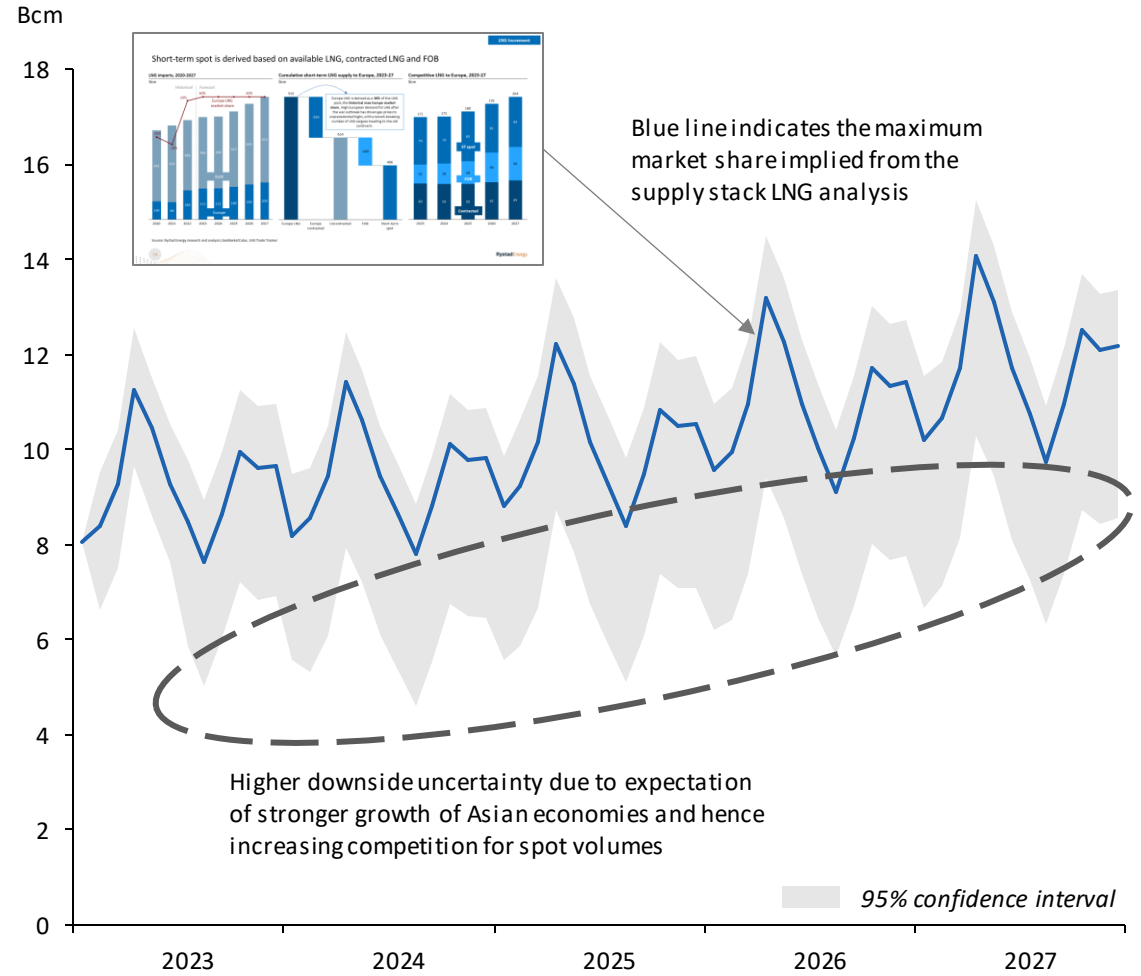
* Asia Selection: Indonesia, Philippines, Taiwan, Japan, South Korea, Malaysia, Brunei, Singapore, China, Vietnam, Cambodia, Thailand, Myanmar, Bangladesh, India, Pakistan ; **IMF population and GDP projections; ***NE Asia i includes China, Japan, South Korea
Source : Rystad Energy research and analysis, IMF

Europe's spot volumes assume maximum historical shares of LNG with uncertainty influences by Asian demand fluctuation

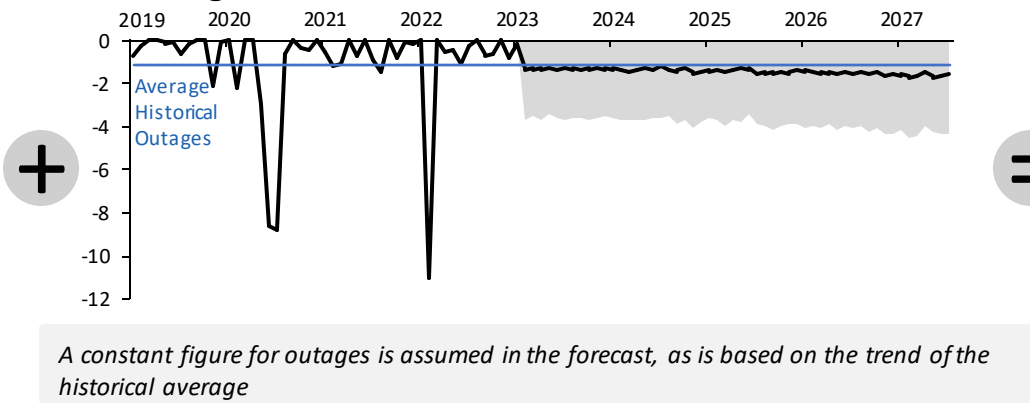
Spot LNG oscillation build-up



European spot LNG volumes



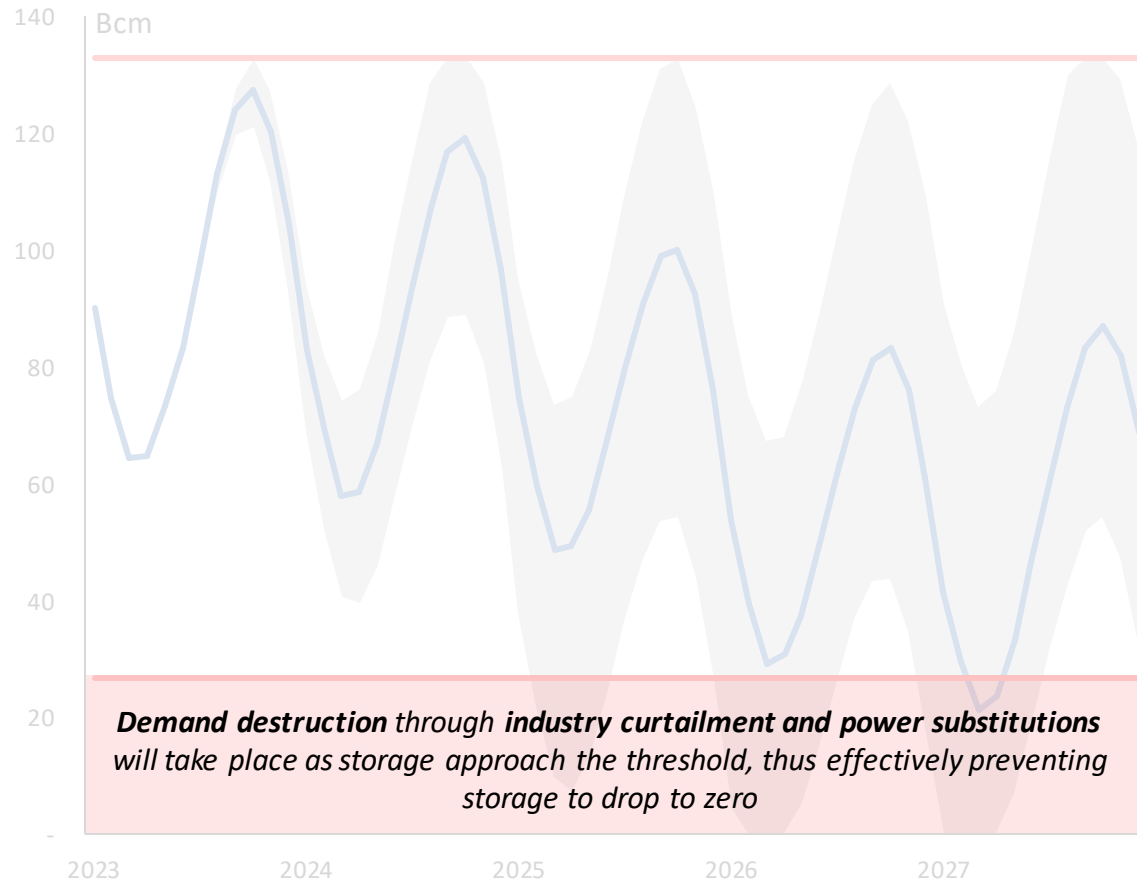
LNG Outages



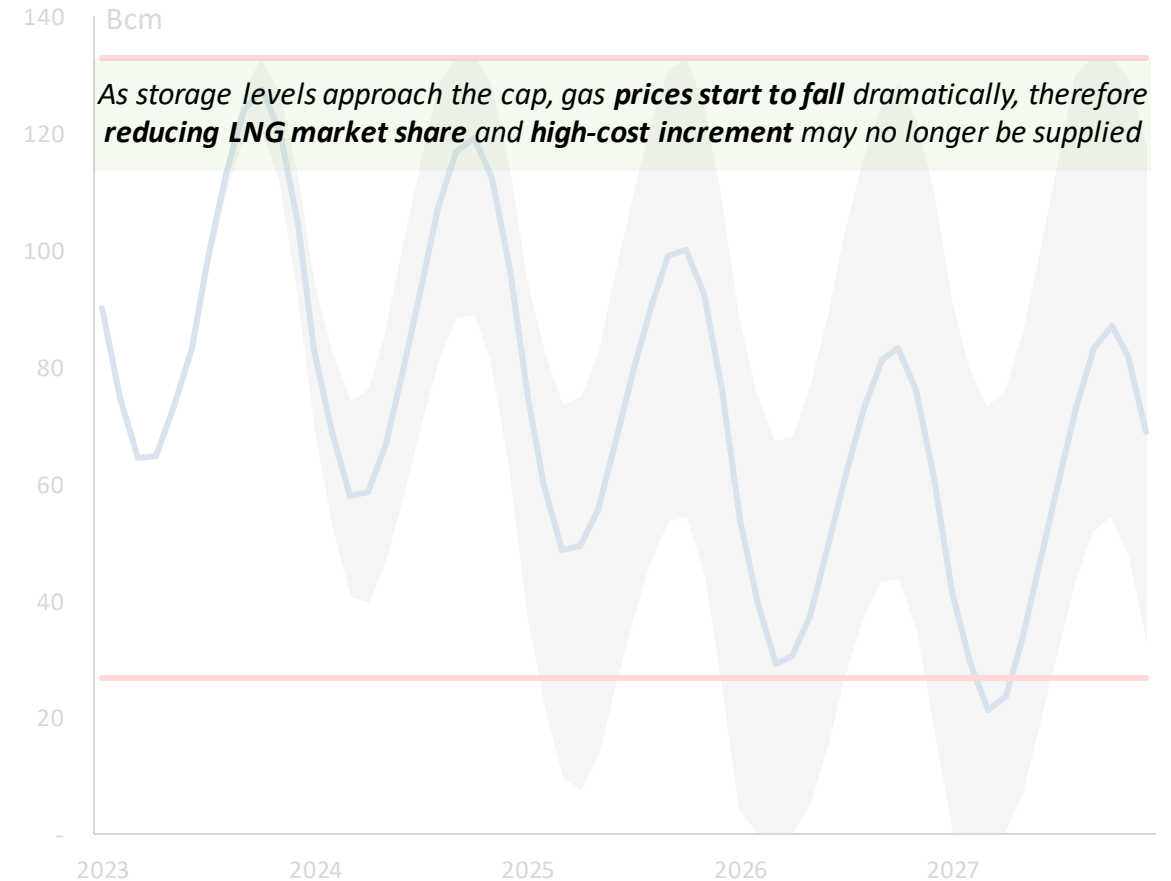
Source: Rystad Energy research and analysis

Storage unlikely to reach extremities as unmodelled gas price implications will counter-balance

Iterations with low storage levels likely to cause demand curtailment ...

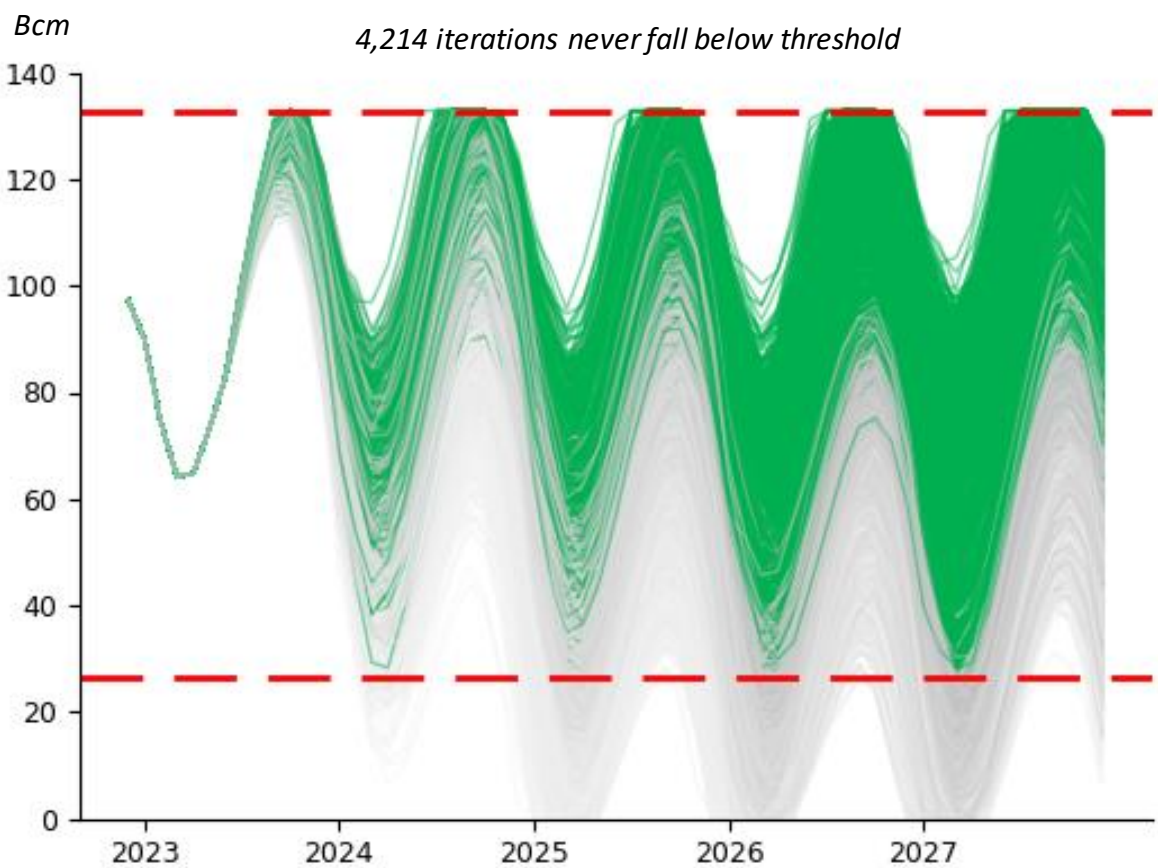
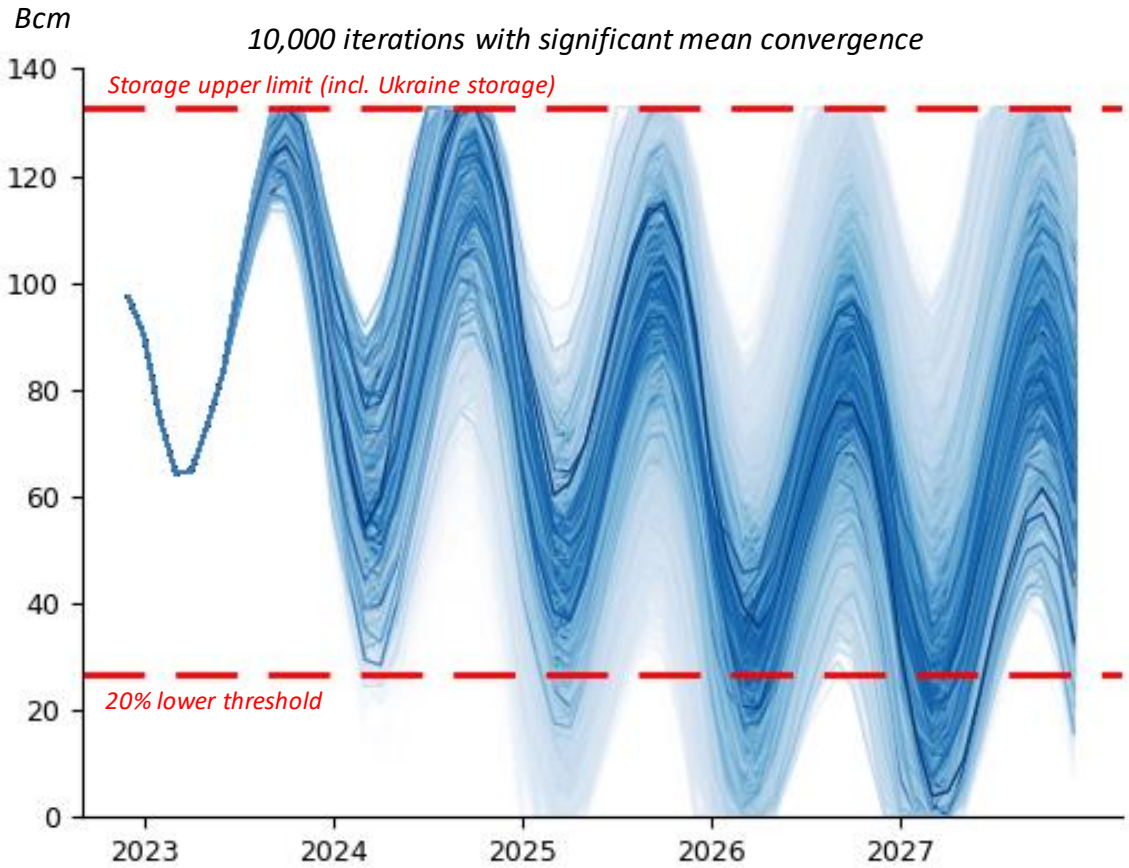


... whilst high storage will drop gas prices and remove the necessity of high-cost supply



Source: Rystad Energy research and analysis

Monte Carlo simulation highlights low likelihood of staying above 20% threshold

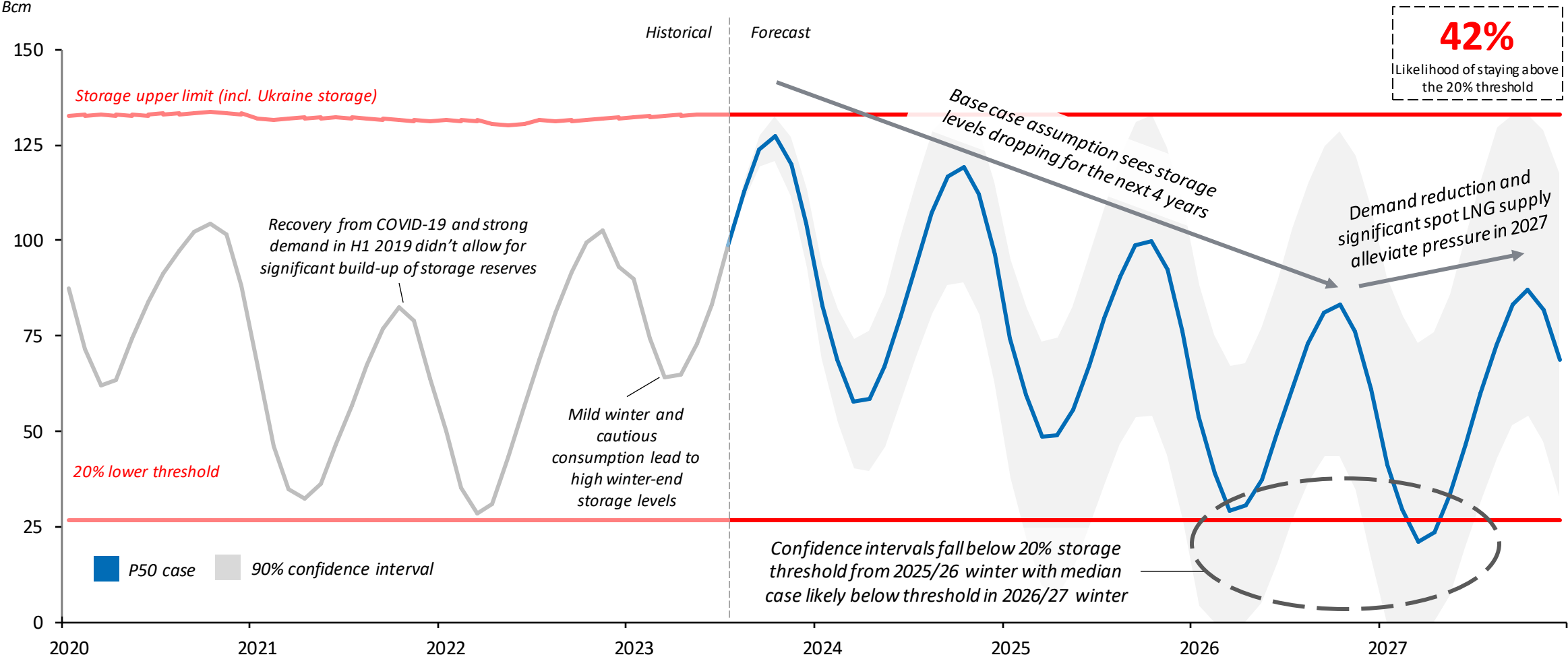


42% likelihood of staying above 20% threshold

Source : Rystad Energy research and analysis

Storage is coming off a mild 2023 winter, however increasing market tightness is likely to cause gas shortage by 2026

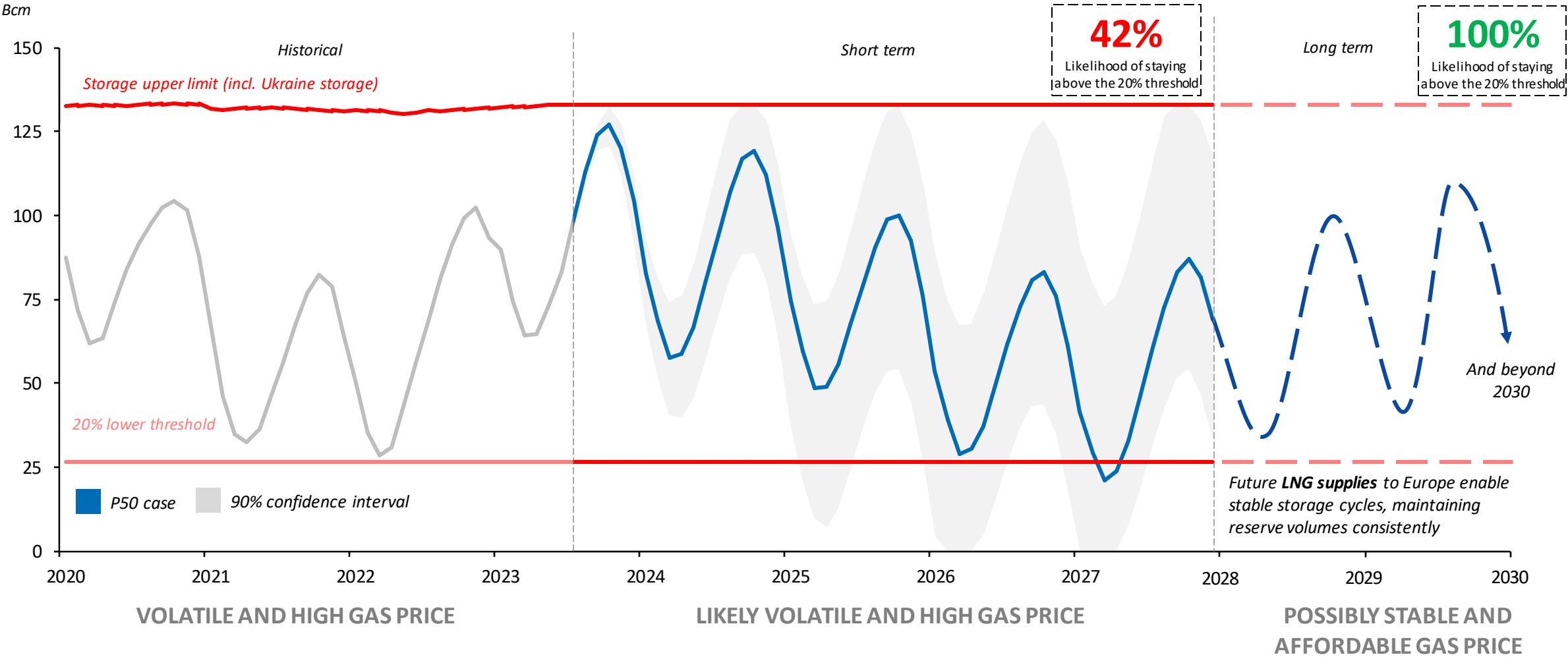
European Storage monthly profile, 2020-2027



Source: Rystad Energy research and analysis

LNG supplies in the long term will allow gas storage levels to remain within healthy boundaries

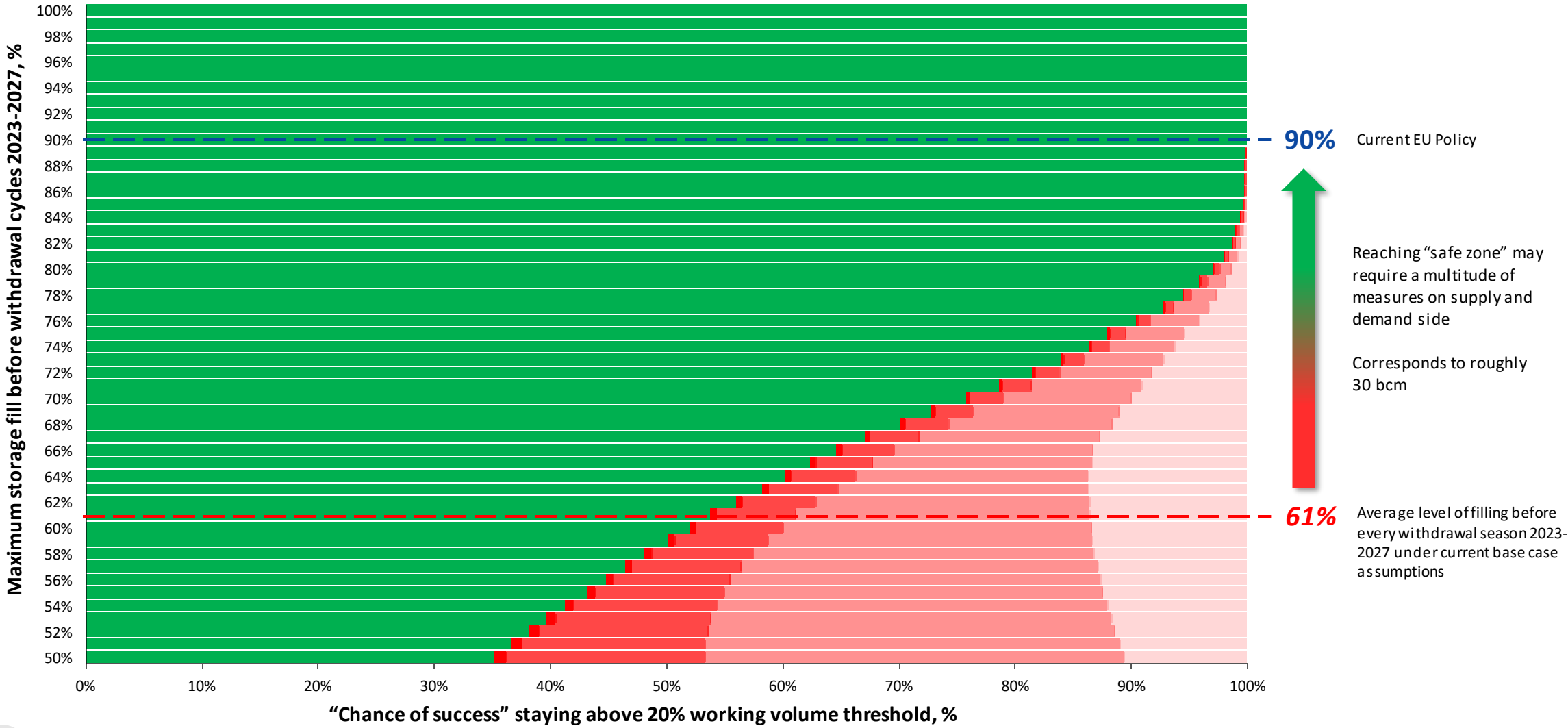
European Storage monthly profile, 2019-2030



Source: Rystad Energy research and analysis

Accounting for short term volatility indicates more supply is needed to meet storage levels

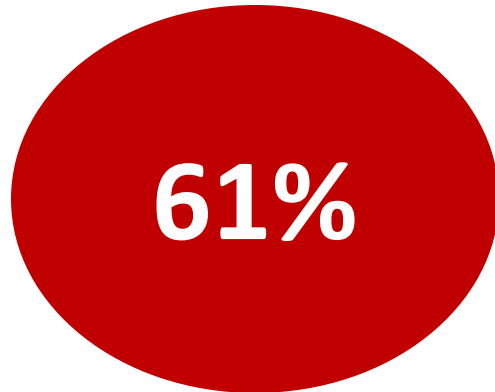
Success 2024 2025 2026 2027



Around 15% increase in flexible LNG market share above all time high market share required to meet storage requirements

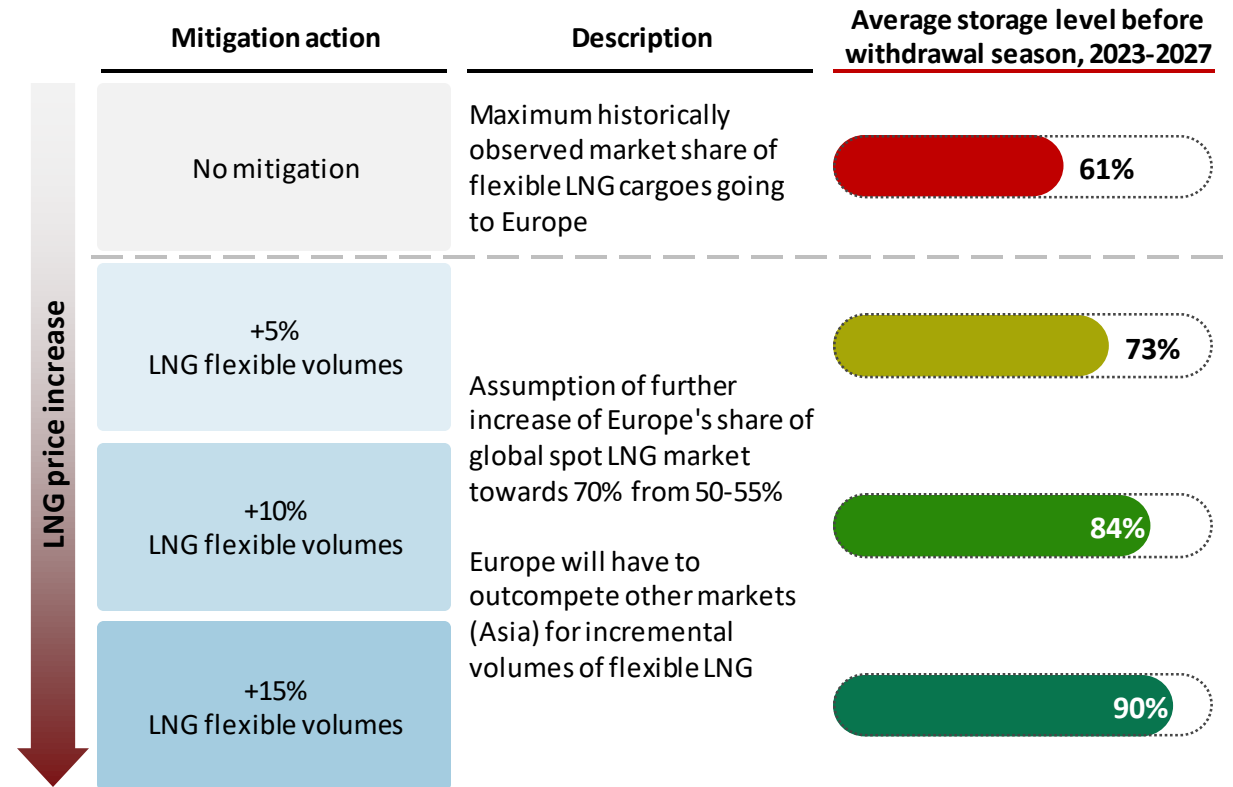
Base case average storage level

The combination and likelihood of different winter temperatures, industrial activity, Russian gas supply, LNG outages and more results in:



Average level of storage filling before each withdrawal season from 2023 to 2027

Potential mitigation through increase in flexible LNG volumes



- High prices risk demand response such as industrial curtailment or gas-to-coal switching
- Other negative economic implications are likely to follow, therefore creating feedback loop for gas demand

Source: Rystad Energy research and analysis

Report contents

Key messages

- Summary
- Key messages

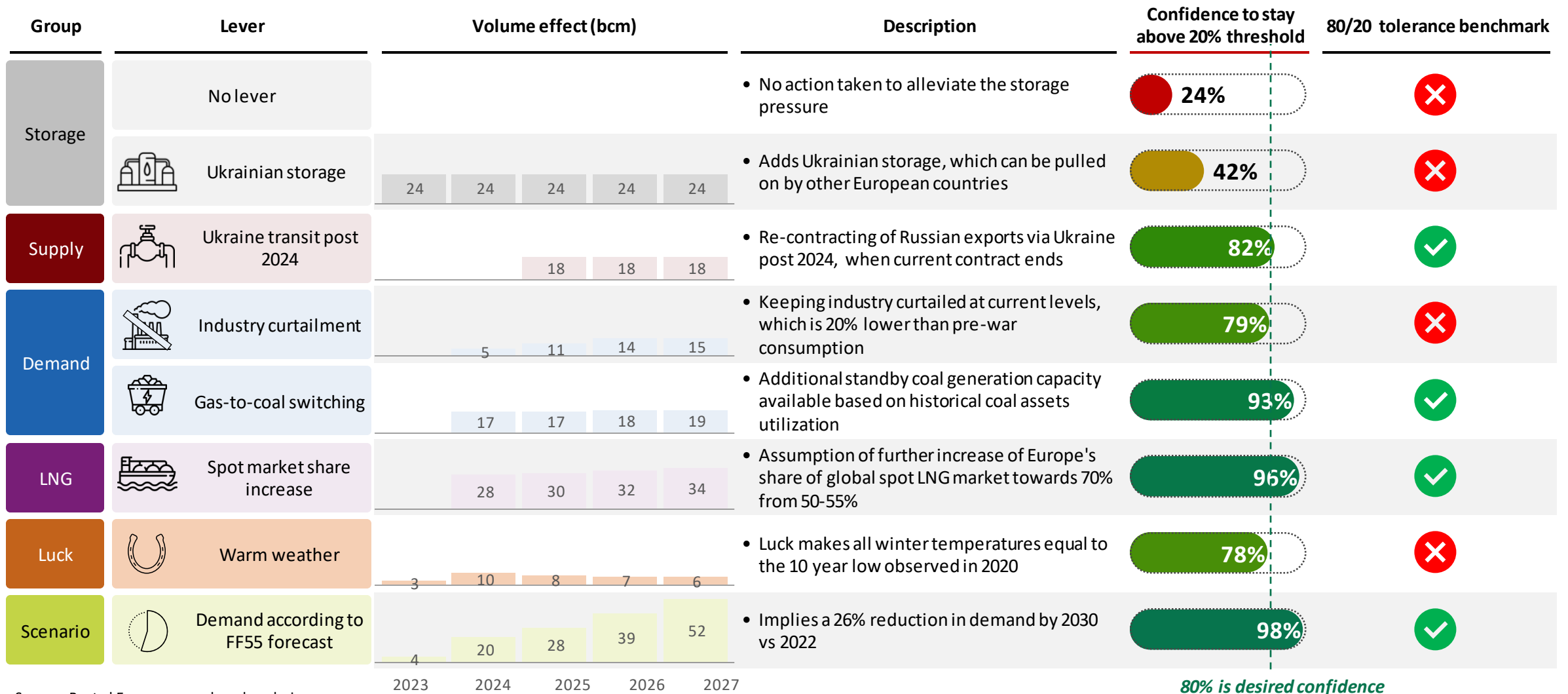
Full report

- Demand
- Supply

- Introduction to supply stack
- Domestic production
- Domestic increments
- Russia supply
- Piped gas imports
- LNG increment
 - Contracted LNG
 - Short-term LNG
 - Long-term LNG
- Infrastructure
- LNG deep dive
- Balance
- Short-term Monte Carlo simulation model
- Sensitivity analysis

Appendix

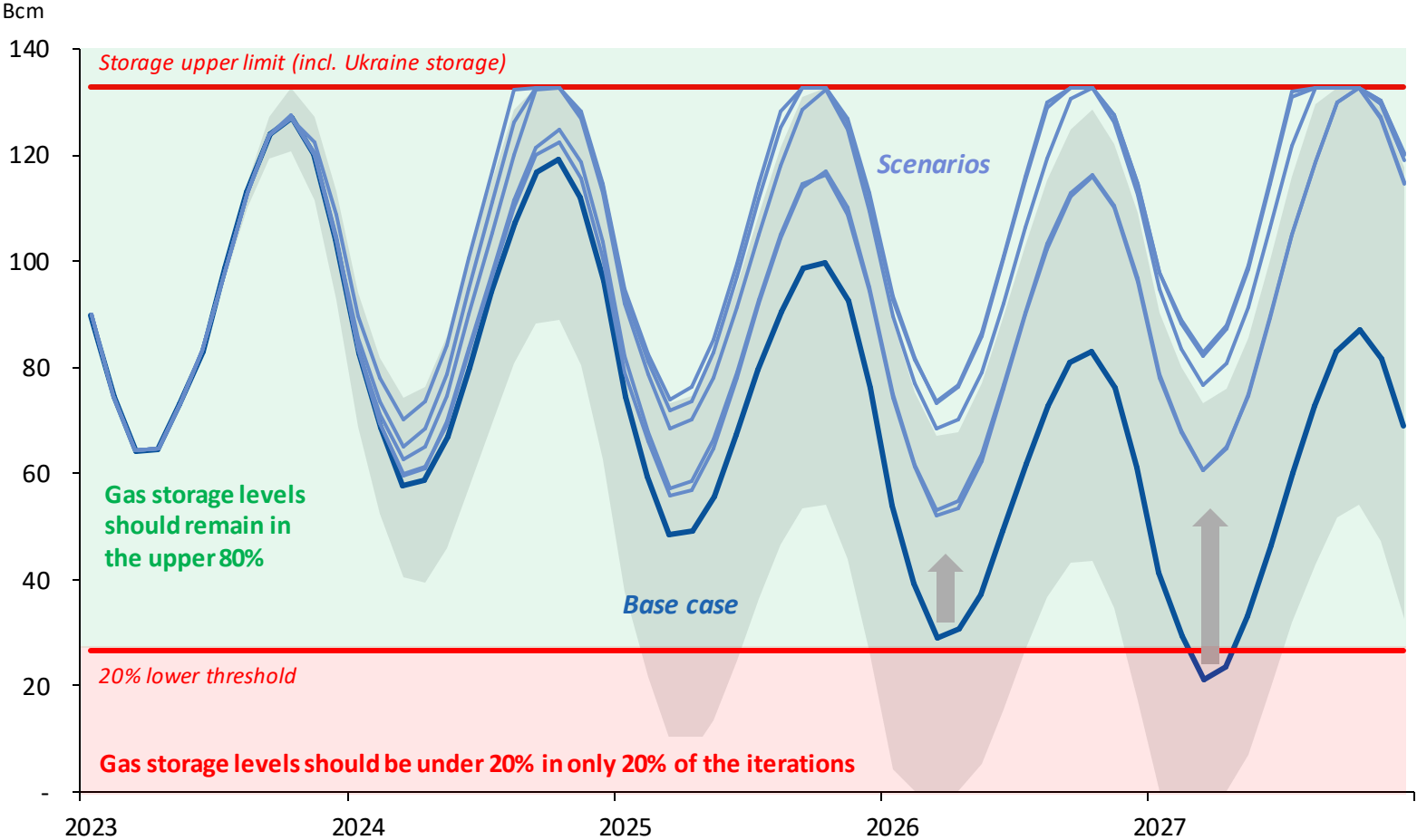
Different options available to Europe to increase confidence in gas storage availability



Source: Rystad Energy research and analysis

Low storage levels can trigger policy implementation to keep gas reserves above 20%

Schematic of storage cycles at a 80/20 benchmark



80/20 benchmark

An 80/20 confidence is used as a benchmark for a positive short-term storage outlook. This allows 20% tolerance on the storage levels to fall under the lower threshold, whilst 80% of outcomes ensure ample gas in storage to satisfy demand to 2027

Policies

Raising storage levels above 20% demands tough decisions, significant policies, and strong decision-making power due to resource allocation, infrastructure, and regulatory implications.

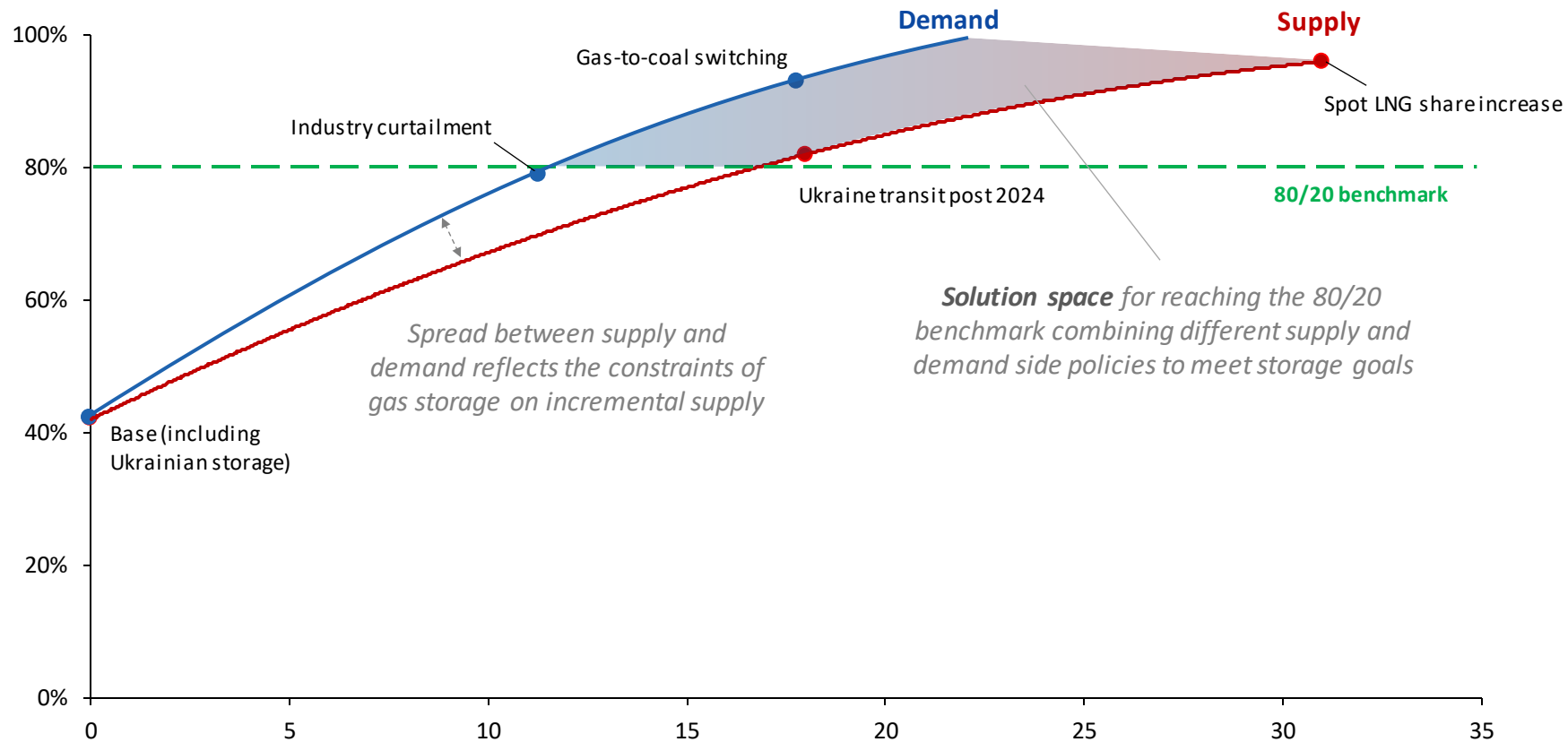
Several scenarios are chosen to test their ability to alleviate the pressure and bring confidence interval within the 80/20 benchmark

Source : Rystad Energy research and analysis

Europe may lean on a combination of solutions to guarantee 80% confidence

Impact of scenarios on % confidence staying above storage threshold

Confidence, % / annual average volume impact, bcm



- Only 42% of base case iterations do not fall below the critical 20% threshold for European gas storage
- There is a clear need for Europe to use different supply and demand levers to improve chances of avoiding critically low gas storage
- Many of the options available to policy-makers are insufficient on their own to provide high levels of confidence in sufficient gas storage volumes, or the required magnitude from that option is considered too drastic as to be politically unfeasible, such as industrial curtailments
- Combining different levers of supply and demand sets the solution space for improving gas storage confidence levels and moderates the action required on any given option

Source: Rystad Energy research and analysis

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Appendix

Several market developments have happened since data collection in July 2023

Market developments since July 2023

Change	Description	Implication
New discoveries	Significant Norway discoveries such as Carmen, Norma and Ost Frigg. Wittau Tief in Austria and smaller discoveries in UK sector	Increased domestic contingent resources, but likely only production after 2027
Project approvals	Eirin and Rosebank approved in Norway and UK, but marginal gas resources	Marginal reallocation of contingent resources to base
Domestic projects start-ups	Project start ups primarily in Norway such as Tommeliten Alpha, Kobra/Gekko as well as Seagull in UK	Less uncertainty related to supply timing
Storage changes	NAM, a JV between Shell and ExxonMobil, is planning on closing its Norg underground storage (capacity of around 5.4bcm) following the closure of the Groningen field.	Reduced flexibility of market balancing in an event of reduced supply and increased demand.
LNG contracts	Since July 2023, there have been a few large long-term LNG contracts signed by European buyers, mainly with Qatar but also from UAE and the US.	Smaller exposure to the spot market.

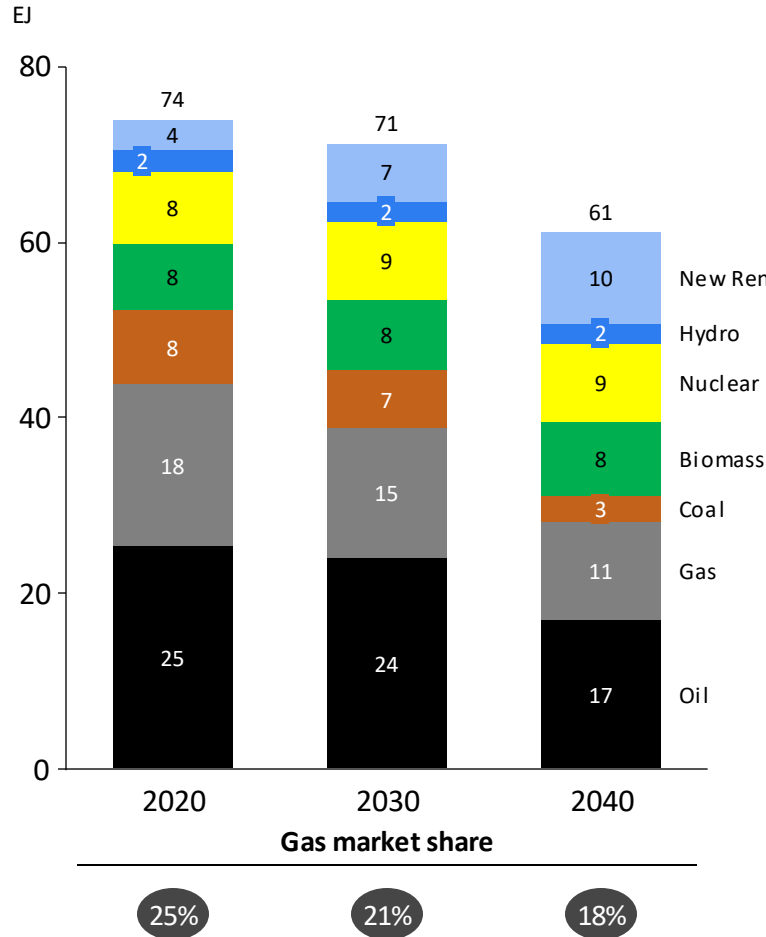
LNG contracts signed since 5th July 2023

Date	From Country	To Country	Volume (Mtpa)	Start year	End year
2023-10-26			0.588	2026	2028
2023-10-25	Portfolio		0.85	2026	2027
2023-10-25	Portfolio		1	2028	2040
2023-10-23			1	2026	2053
2023-10-20			0.25	2024	2027
2023-10-18			1.75	2026	2053
2023-10-18			1.75	2026	2053
2023-10-18			0.4	2024	2026
2023-10-17		Portfolio	0.6	2024	2028
2023-10-11			1.75	2026	2053
2023-10-11			1.75	2026	2053
2023-09-15	Portfolio		0.5	2024	2026
2023-09-08			0.9	2024	2028
2023-08-22			0.8	2026	2043
2023-08-17			0.9	2024	2028
2023-08-14			0.4	2026	2029
2023-08-03		Portfolio	2.2	2027	2047
2023-07-17	Portfolio		0.368	2024	2035
2023-07-17	Portfolio		0.8	2026	2035
2023-07-17			1.2	2026	2039
2023-07-11			1	2026	2041

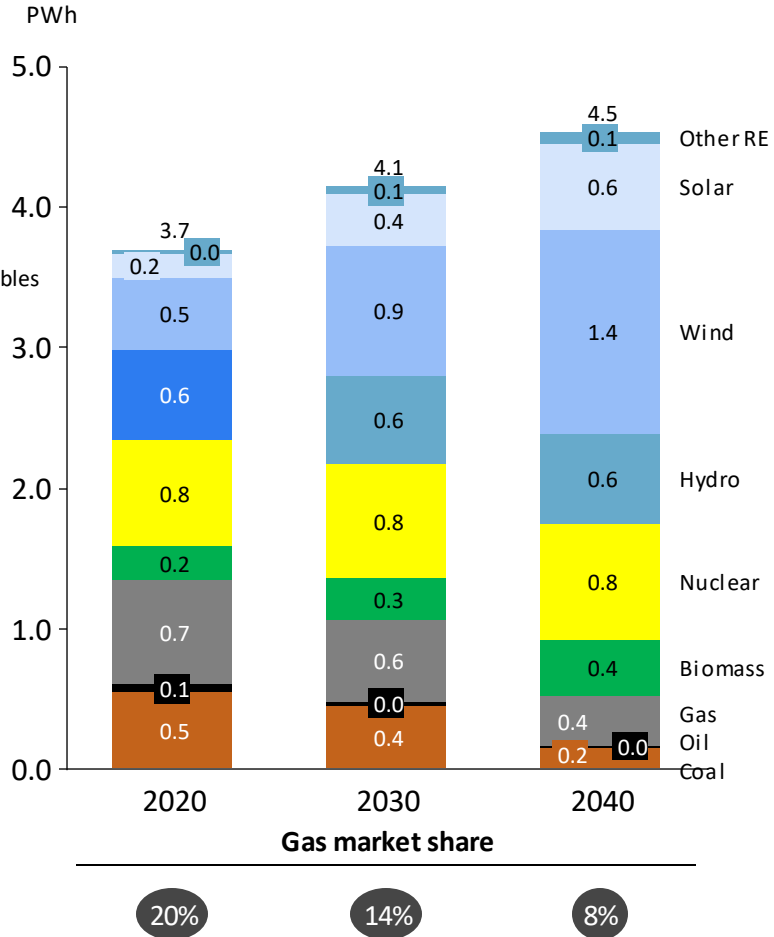
Source : Rystad Energy research and analysis

Equinor walls is the median case and spells out a declining gas share in European energy mix

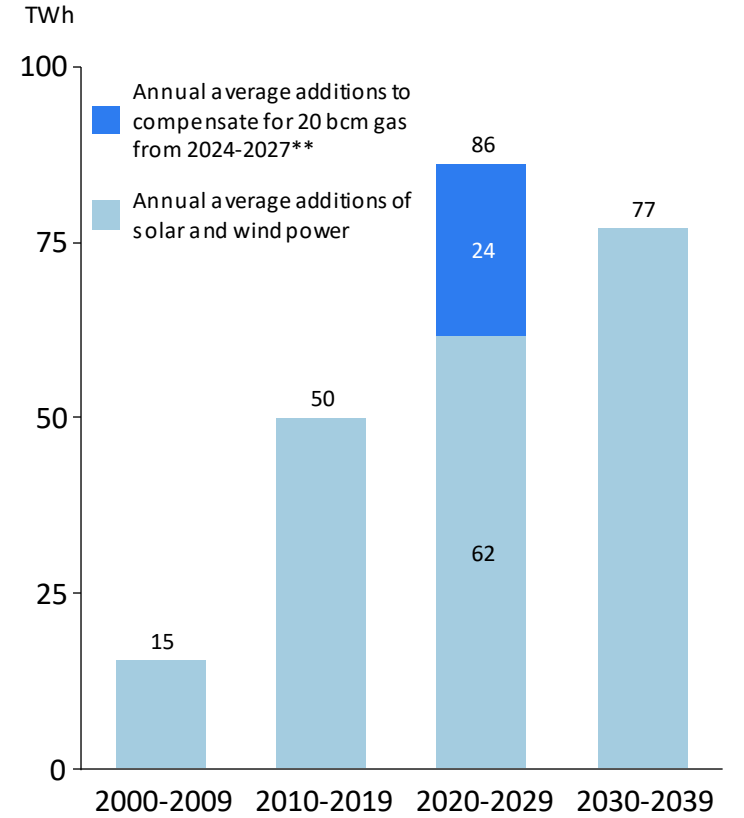
European* primary energy demand



European* final energy demand for power generation



Annual average generation additions from solar and wind

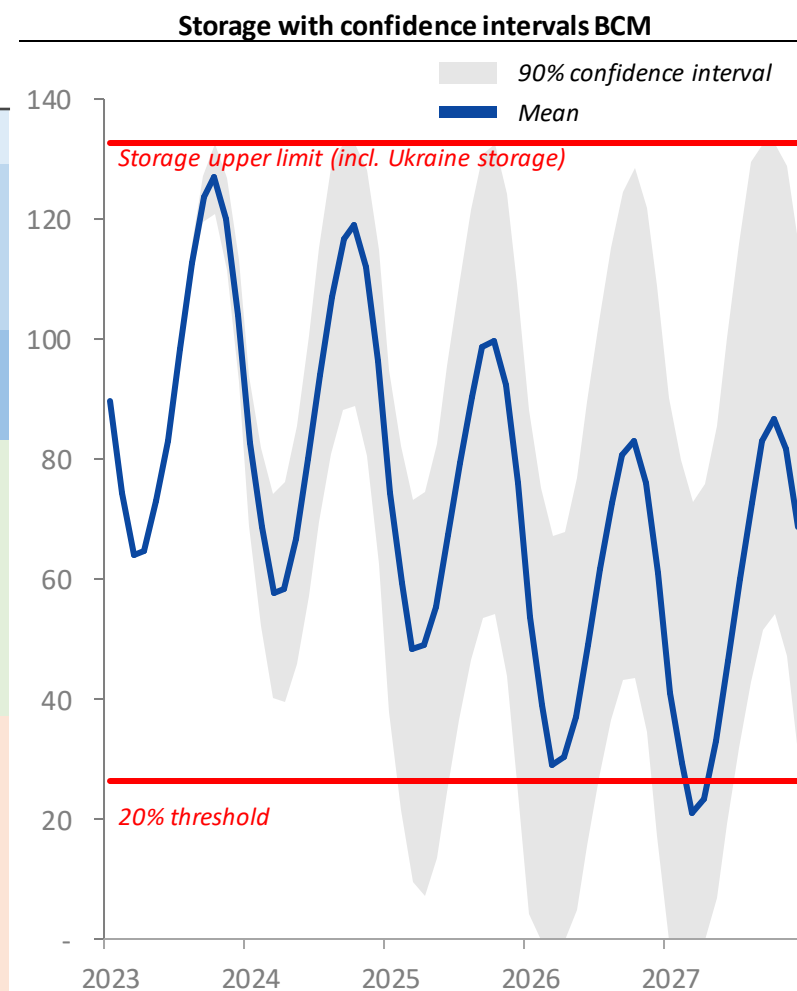


- The median scenario implies annual additions of new solar and wind power generation
- To compensate for an additional 20 bcm of gas demand in the power sector it is necessary to almost double additions in the period 2024-2027
- This ignores any limitations related to grid, supply chain, financing etc.

*Includes Türkiye, which is not typically included in other references to Europe **50% capacity factor applied to convert 20 bcm to final demand for power generation
Source: Rystad Energy, Equinor

Modelled build-up of supply, demand, and LNG cycles are centered around the mean, consistent with our deterministic analysis from the supply section

		Model outputs BCM				
Category		2023	2024	2025	2026	2027
mean	Demand	444.3	453.8	452.9	447.8	441.6
median	Demand	443.9	460.0	464.3	456.0	448.2
min	Demand	421.8	390.1	387.0	382.8	378.1
max	Demand	466.7	506.3	511.6	501.7	494.2
mean	Industry Demand	111.8	121.8	131.4	129.8	128.0
mean	Power & Household	332.1	338.2	332.9	326.2	320.2
Piped	Base	207.5	195.0	186.6	173.6	161.5
Piped	Europe piped gas	37.7	38.9	37.0	36.2	40.1
Piped	Dom increments	8.5	10.8	11.8	14.0	18.0
Piped	High-cost inc	12.8	13.3	15.2	17.9	26.3
Piped	Russia	29.6	27.3	12.6	12.6	12.6
LNG	Contracted LNG	59.9	59.2	59.0	62.0	64.9
LNG	EU Spot	110.6	112.5	120.9	130.7	139.6
LNG	Europe LNG (standalone)	170.5	171.7	179.9	192.7	204.5
LNG	Europe LNG (outages)	167.6	167.0	175.0	187.4	199.0
LNG	Europe LNG (outages + Asia)	167.6	162.6	170.8	182.2	193.4



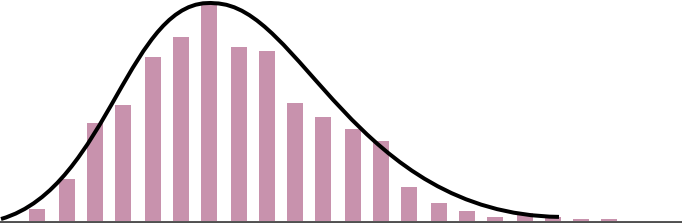
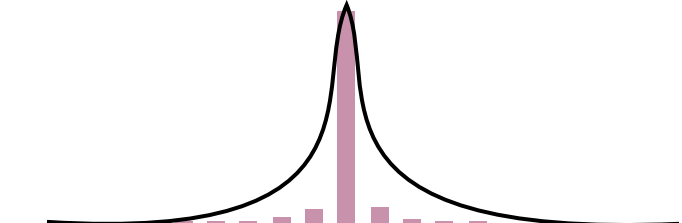
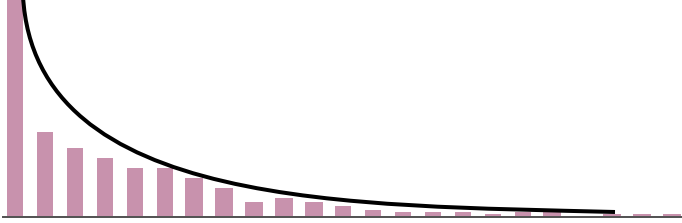
Source : Rystad Energy research and analysis

Variable Inputs: regression and distribution curves for gas volume balancing model

Group	Dependent Variable	Independent Variable	Regression	Distribution	Description
Demand	Power & Household Demand <i>Bcm</i>	HDD (Heating degree days) <i>Thousand HDD</i>			<ul style="list-style-type: none"> Power & household demand display a strong linear relationship with HDD indicating the strong correlation between gas demand and weather patterns in Europe
	Industry Demand <i>Bcm</i>	PMI (Purchasing managers index) <i>PMI figures</i>			<ul style="list-style-type: none"> Industry demand and PMI are strongly correlated, as expansion in the manufacturing or services sector, leads to an increase in industrial gas demand
Piped Supply	Russian Supply <i>Bcm</i>	Russian gas supply scenario	No Regression		<ul style="list-style-type: none"> Three individual scenarios are selected for the Russian gas supply, each with distinct probabilities

* Correlation for EU countries, with HDD numbers summed over for each country, and consumption figures summed. ** Unit for this is thousand (000) HDD
Source: Rystad Energy research and analysis, Eurostat

Variable Inputs: regression and distribution curves for gas volume balancing model

Group	Dependent Variable	Regression	Distribution	Description
Domestic Supply	Production deviation <i>(for all base production)</i> Bcm	No Regression	 Asymmetric Normal Distribution	<ul style="list-style-type: none"> By comparing Rystad Energy's forecast vintages, we observe overestimation compared to actual production. However, the historical observation also have significant skewness of several assets massively overproducing. Overall deviations follow skewed normal distribution profile
	Plateau deviation <i>(for pre-plateau production)</i> Bcm	No Regression	 T - Distribution	<ul style="list-style-type: none"> Most of assets have historically achieved the announced plateau levels, however there are observed long-tail deviations both positive and negative
	Delays <i>(for under development assets)</i> Bcm	No Regression	 Pareto Distribution	<ul style="list-style-type: none"> Phasing of under development assets follows a pareto distribution with most cases having little to no delay, however a significant number of assets also struggle with the FDP-announced rollout

* Correlation for EU countries, with HDD numbers summed over for each country, and consumption figures summed. ** Unit for this is thousand (000) HDD
 Source: Rystad Energy research and analysis, Eurostat

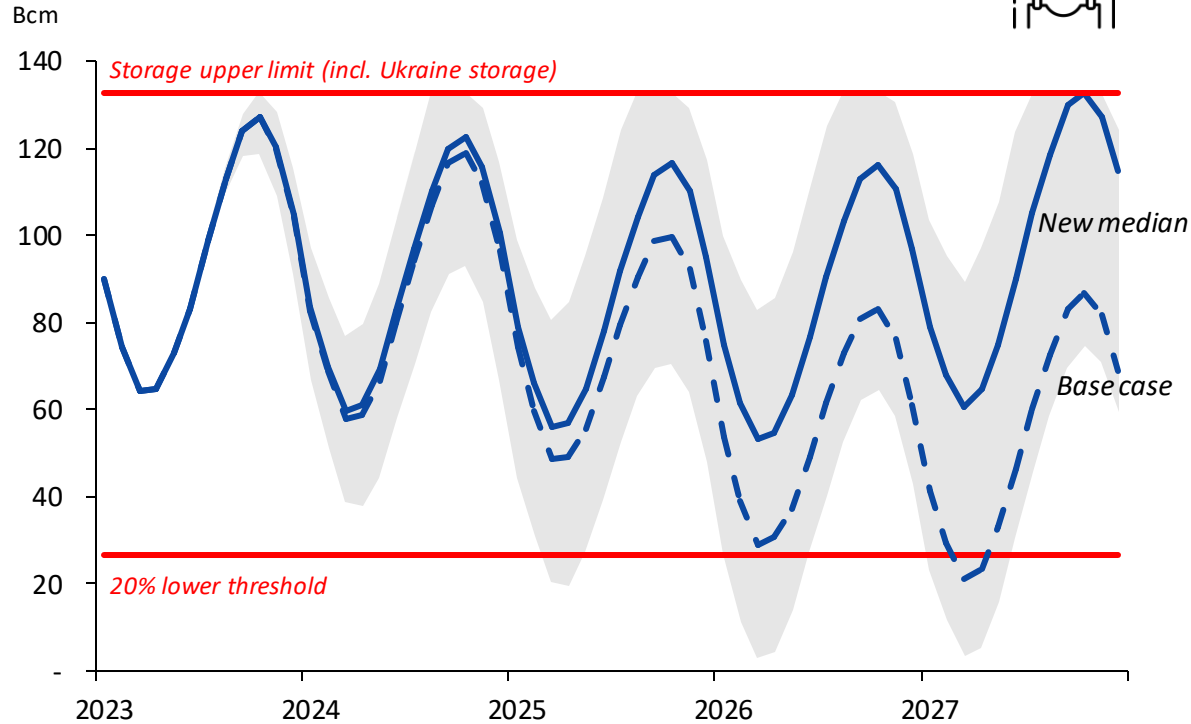
Variable Inputs: regression and distribution curves for gas volume balancing model

Group	Dependent Variable	Independent Variable	Regression	Distribution	Description
Spot LNG market	Asian LNG demand <i>Bcm</i>	\propto HDD (Heating Degree Days) <i>Thousand HDD</i>	<p>Correlation = 76%</p>	<p>Normal Distribution</p>	<ul style="list-style-type: none"> Similar to Europe, Asia exhibits a robust correlation between Heating Degree Days (HDD) and gas consumption. However, due to more varied climates, Asian countries tend to experience higher gas consumption not only in winter but also during summer.
		\propto GDP per capita <i>USD</i>	<p>Correlation = 98%</p>	<p>Asymmetric Normal Distribution</p>	<ul style="list-style-type: none"> An observable linear correlation between Asian LNG demand and GDP per capita suggests that economic growth in the region tends to drive increased demand for gas as a vital energy resource
	Global LNG production <i>Bcm</i>	\propto Unplanned outages <i>Bcm</i>		<p>Normal Distribution</p>	<ul style="list-style-type: none"> A constant figure for outages is assumed in the forecast, as is based on the trend of the historical average

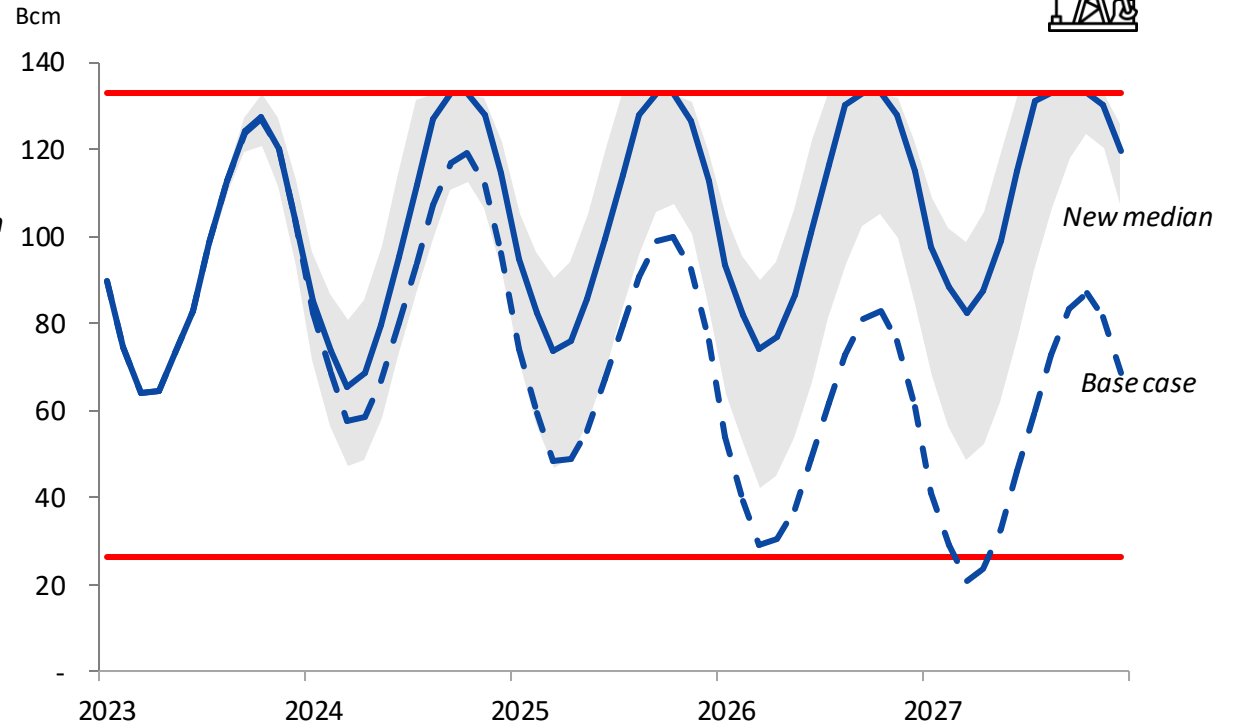
* Correlation for EU countries, with HDD numbers summed over for each country, and consumption figures summed. ** Unit for this is thousand (000) HDD
 Source: Rystad Energy research and analysis, Eurostat

Scenarios to alleviate tight balances in Europe (1/4)

Storage cycles: Ukraine transit post 2024



Storage cycles: Groningen active



82%
Confidence

Sufficient to meet threshold confidence

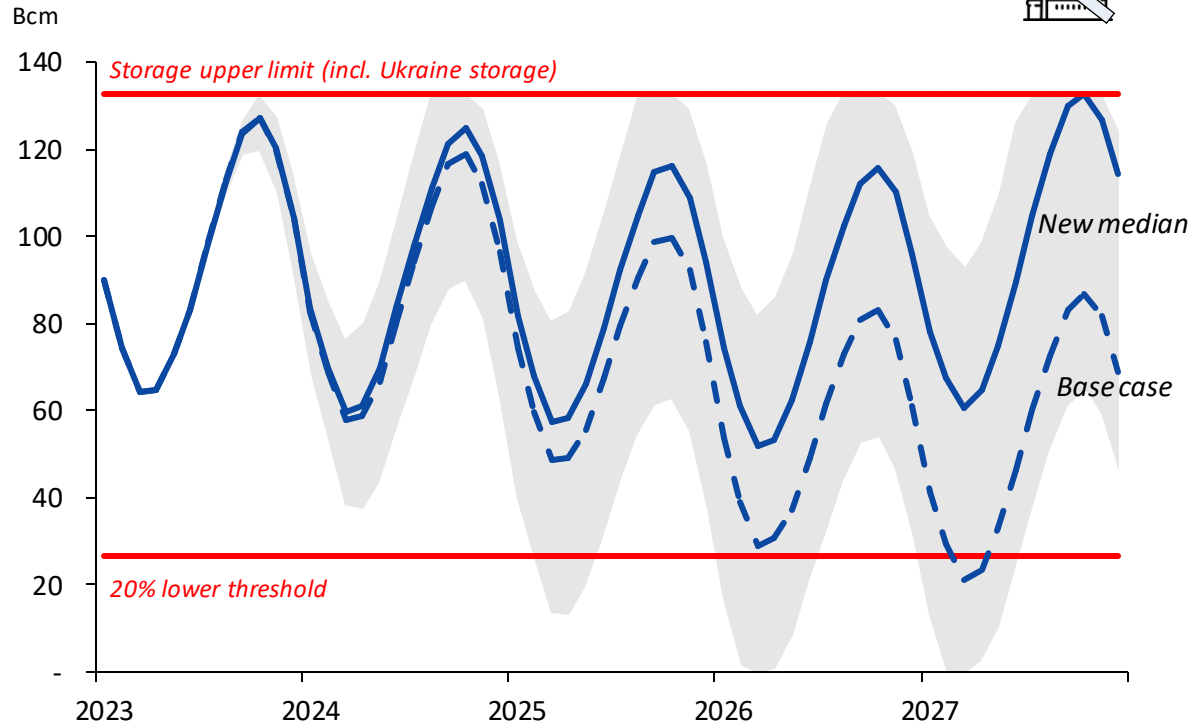
98%
Confidence

Sufficient to meet threshold confidence

Source: Rystad Energy research and analysis

Scenarios to alleviate tight balances in Europe (2/4)

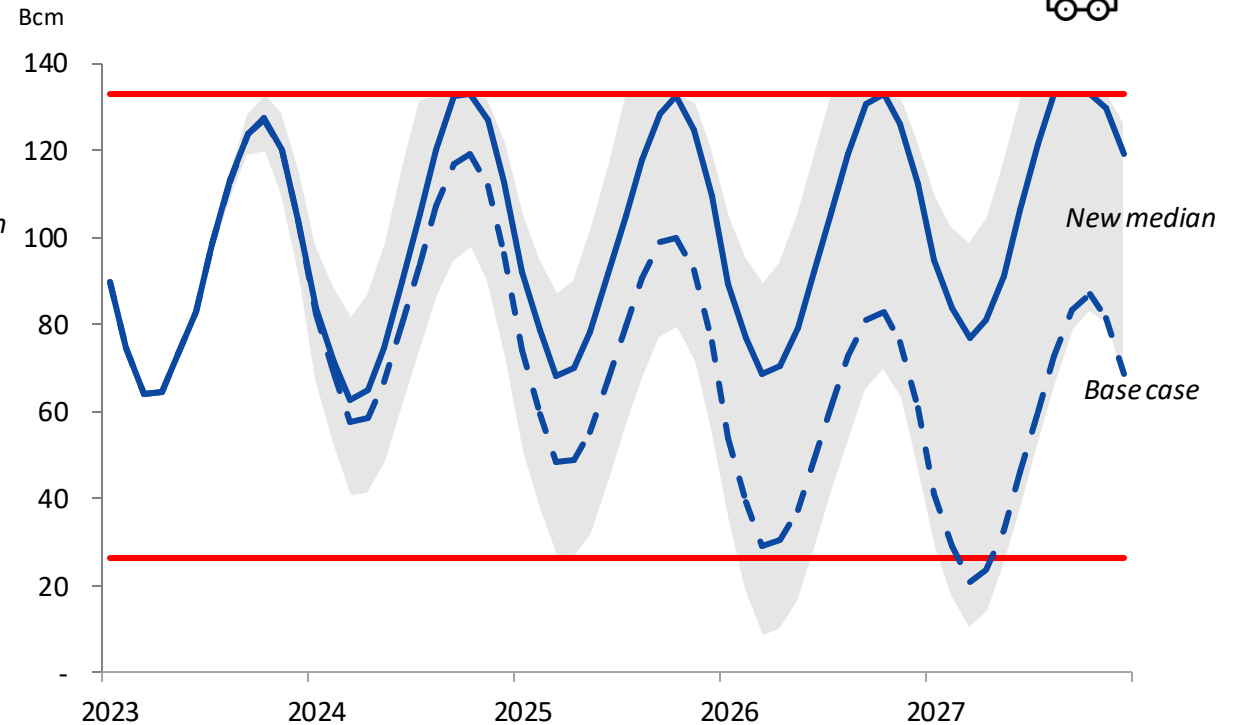
Storage cycles: Industry curtailment



79%
Confidence

Insufficient to meet threshold confidence

Storage cycles: Gas-to-coal switching



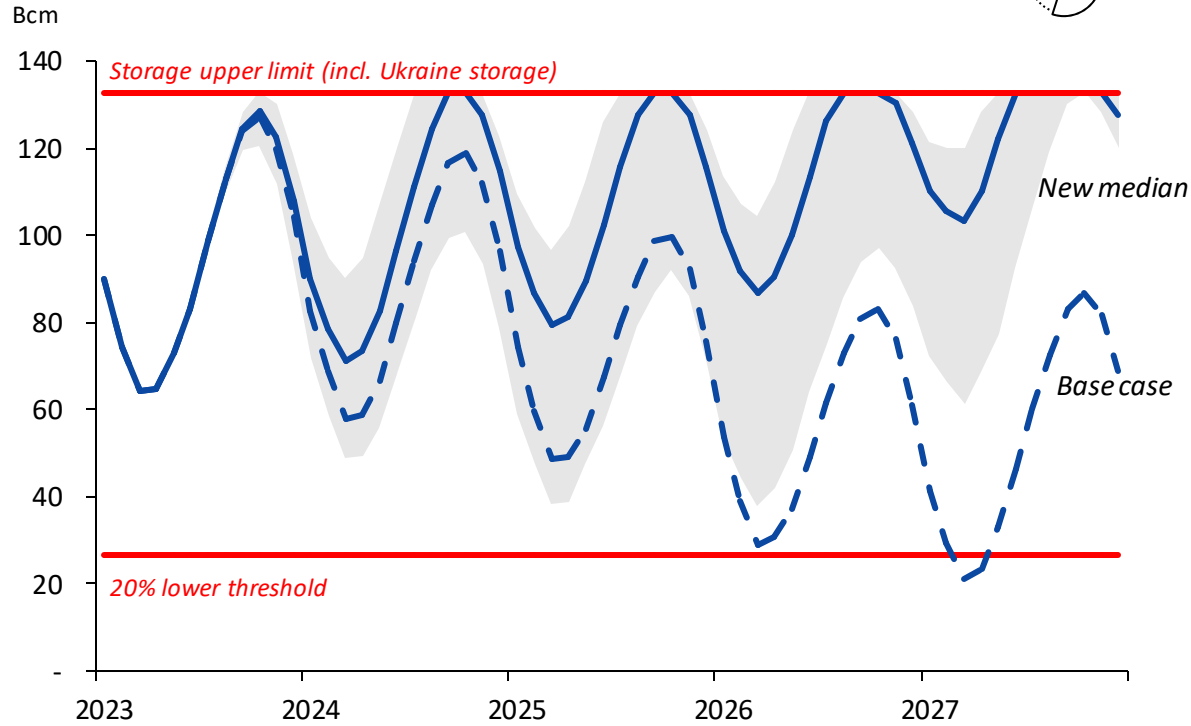
93%
Confidence

Sufficient to meet threshold confidence

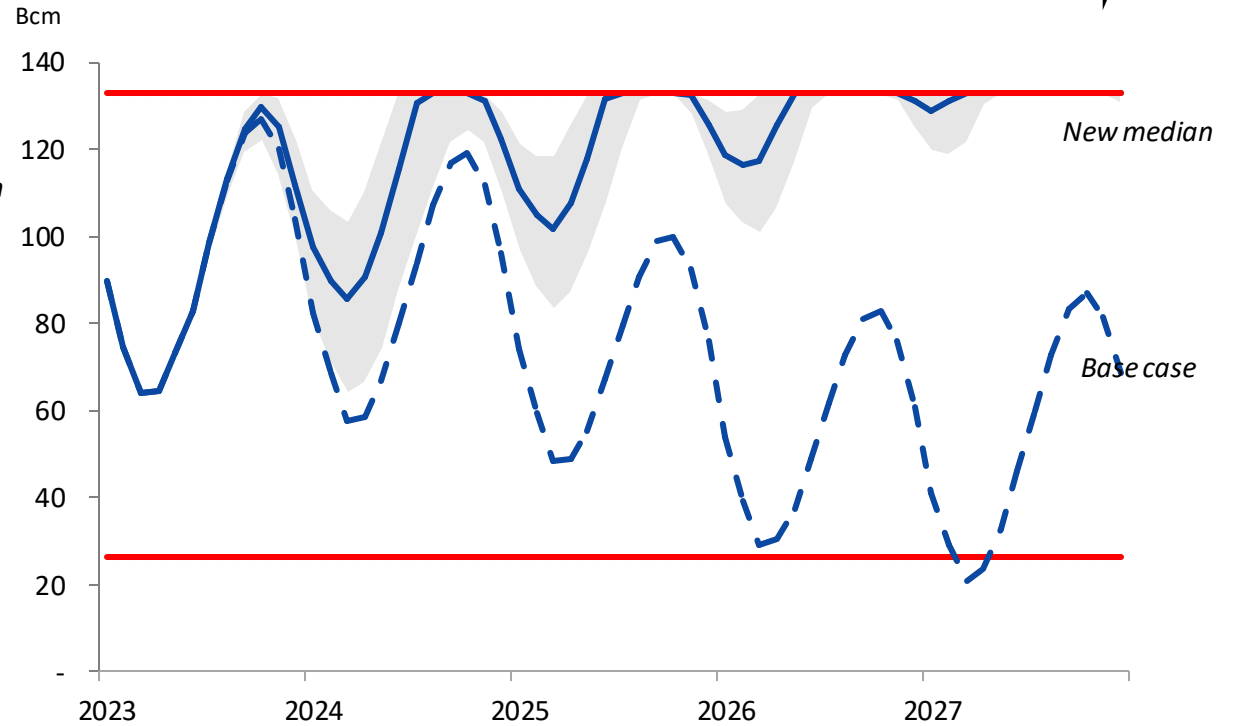
Source: Rystad Energy research and analysis

Scenarios to alleviate tight balances in Europe (3/4)

Storage cycles: Fit-for-55 demand scenario



Storage cycles: RePowerEU demand scenario



98%

Confidence

Sufficient to meet threshold confidence

100%

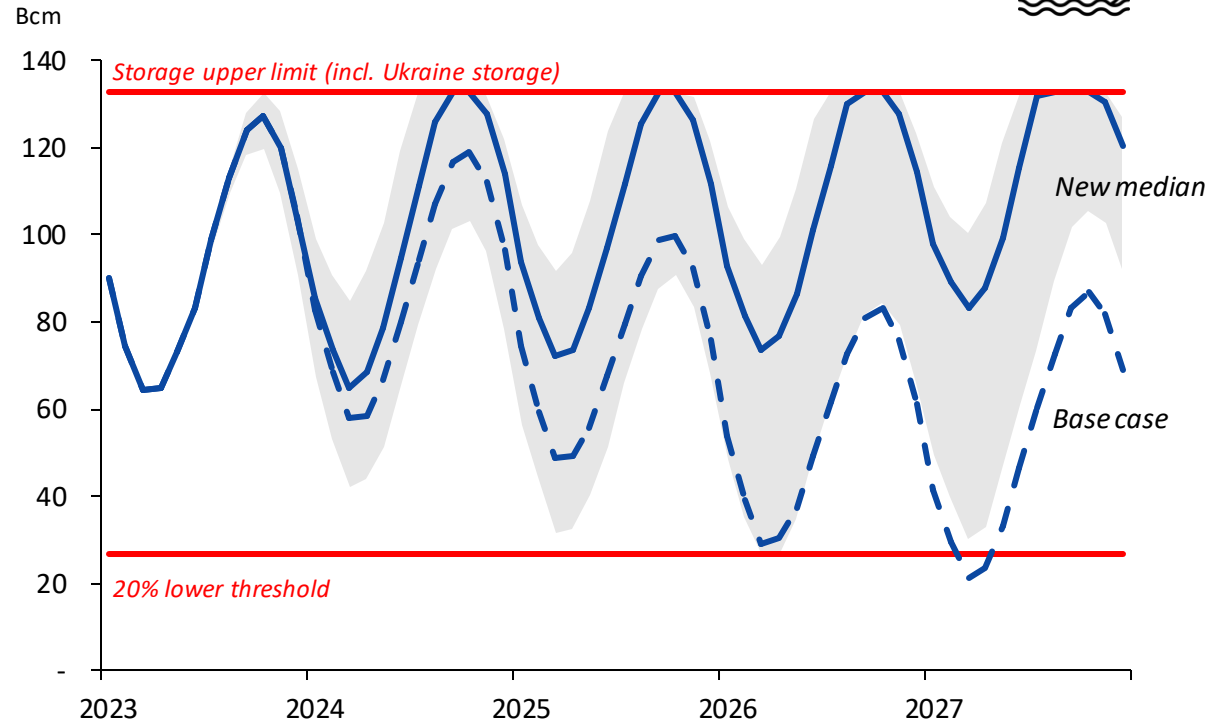
Confidence

Sufficient to meet threshold confidence

Source : Rystad Energy research and analysis

Scenarios to alleviate tight balances in Europe (4/4)

Storage cycles: Spot market share increase by 15 percentage points



97%
Confidence

Sufficient to meet threshold confidence

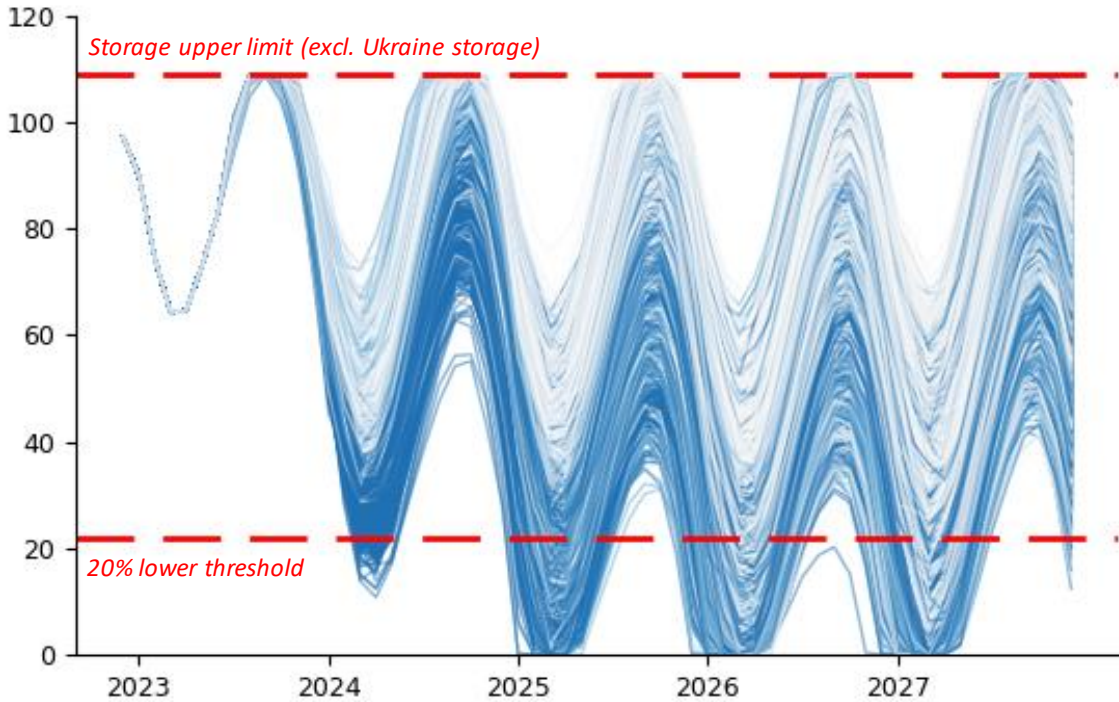
Source: Rystad Energy research and analysis

Cold winters significantly impact final storage levels, threshold more affected by sooner cold winters than later ones

Storage levels highlighted based on the proximity of a cold winter*

Bcm

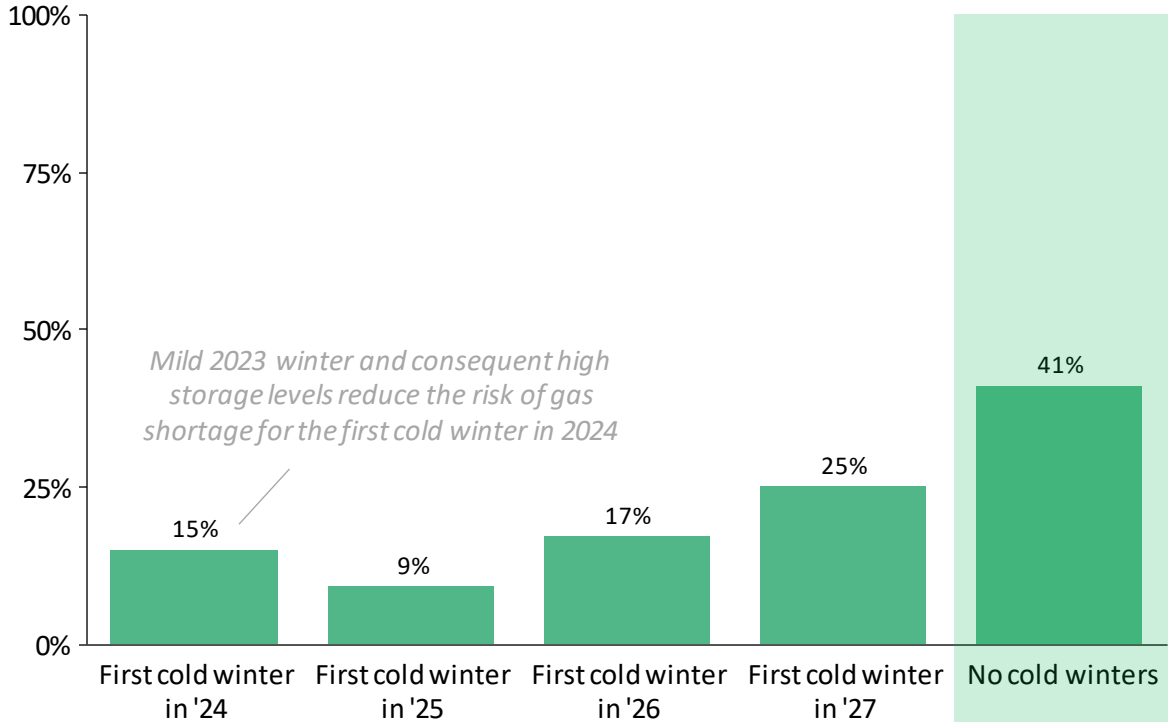
- “Cold” winter is defined as a 1/4 cold winter (P25) in each year’s simulation
- Imminent cold winter is likely to have a higher impact on the storage levels
- There is lower probability of having first cold winter occurrence later in the timeline



Effects of first cold winter occurrence on storage levels staying above threshold

% above threshold

- The cumulative weather effect makes latter years more prone to the cold winter risks
- 2024 winter benefits from current record-high storage levels, whilst the overall weather distribution returns to historic mean for latter years



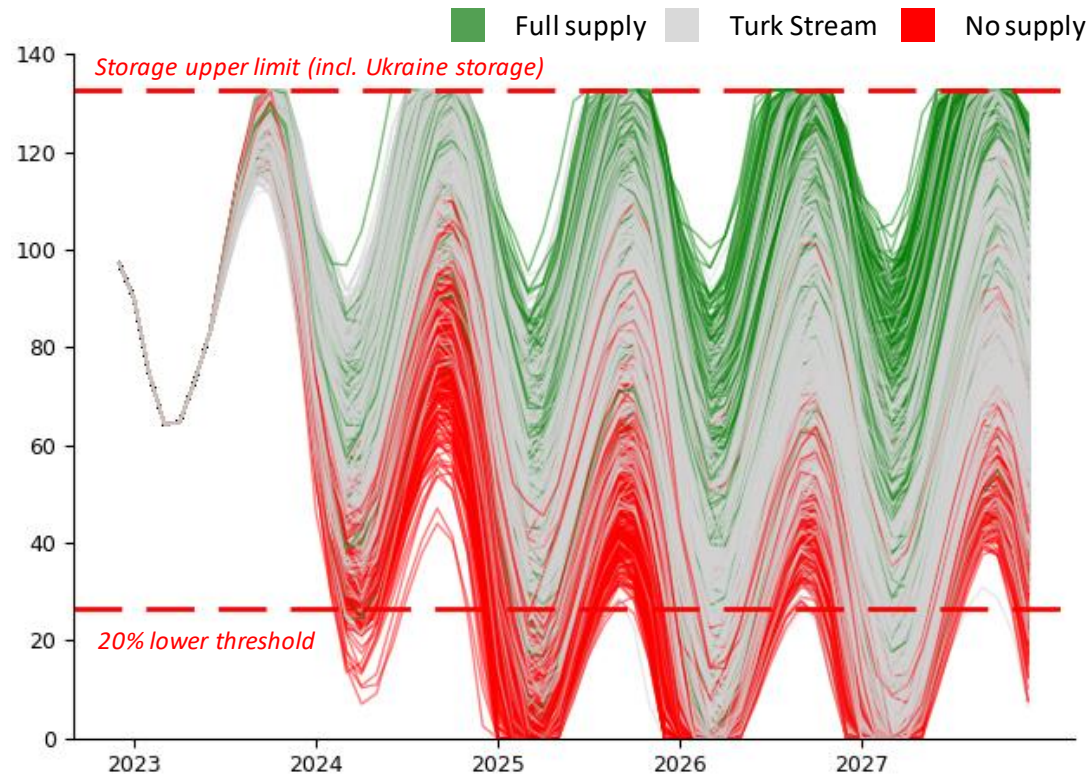
*Excludes Russian scenarios of no supply and Ukraine transit post-2024;
Source: Rystad Energy research and analysis

Russian piped volumes strongly impact storage outcomes

Storage levels highlighted based on scenario of Russian gas exports

Bcm

- Extreme scenarios significantly widen the probability pool
- “No supply” scenario has more immediate effect, whereas “Full supply” delivers more upside towards 2026/2027

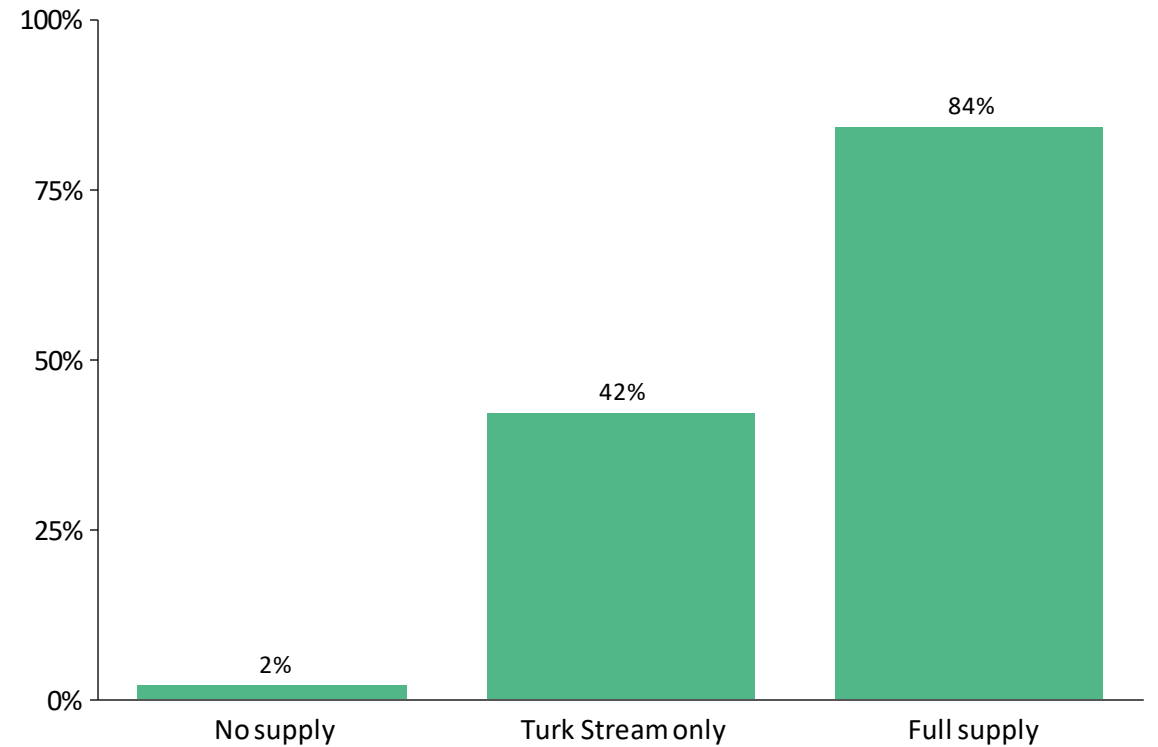


Source: Rystad Energy research and analysis

Effects of Russian scenarios on storage levels staying above threshold

% above threshold

- Russian supply can swing the confidence of staying above threshold both ways, with full supply almost reaching 80/20 benchmark
- Recontacting of transit through Ukraine is a key inflection point in the near-term

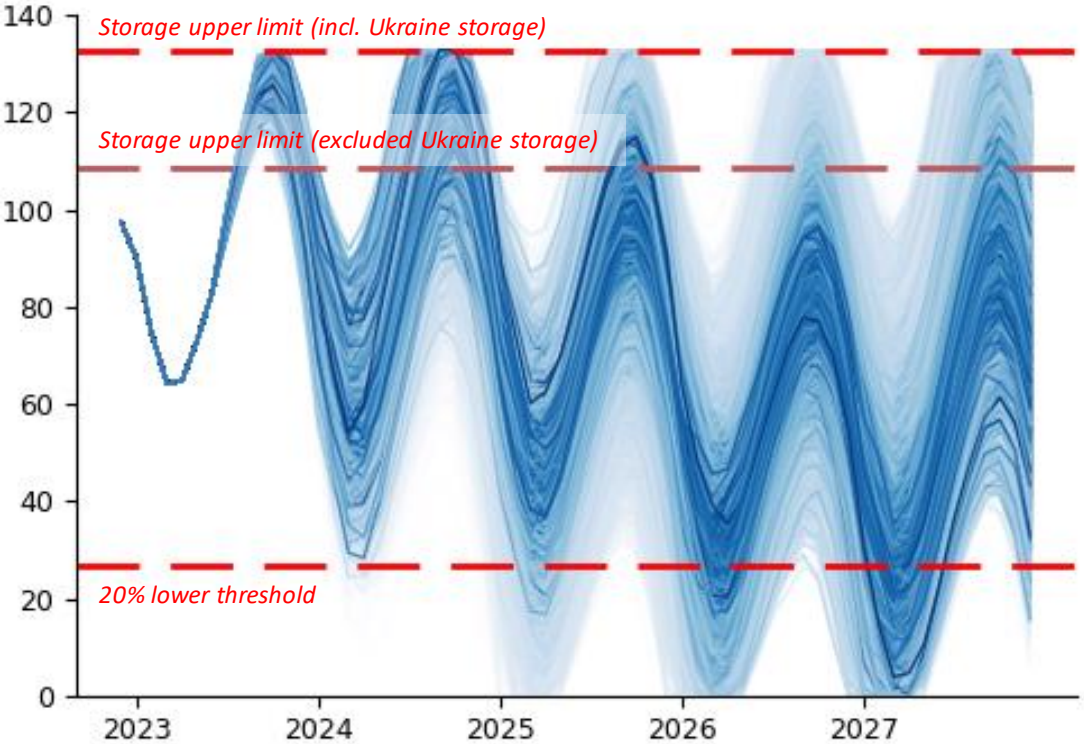


Ukrainian storage capacity can increase volumes available during periods of excessive drawdown

Increased storage levels by including Ukraine capacity

Bcm

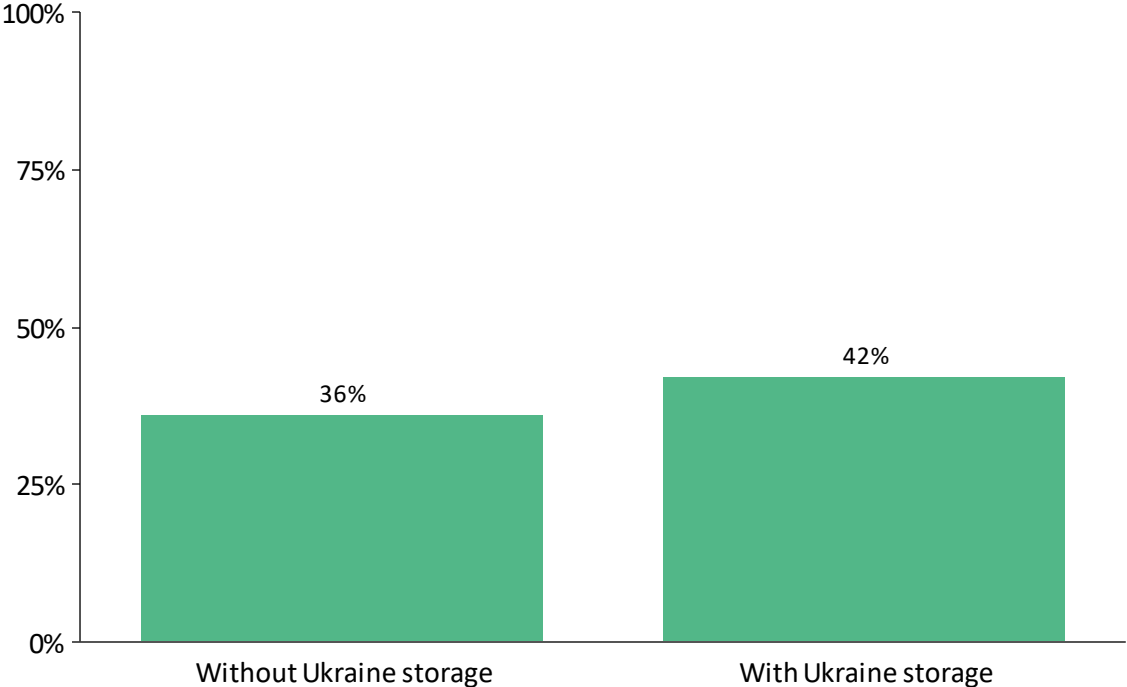
- Storage increased by 29 bcm to include Ukraine
- All other assumptions are left unchanged compared to the median case



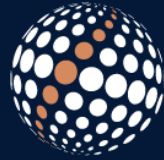
Effect of adding Ukraine storage on storage levels staying above threshold

% above threshold

- With more storage capacity such as the case of including the 29 bcm of Ukrainian storage it will be possible in many iterations to avoid supply curtailment from full storage
- The ability to store more gas effectively helps reduce the risk of storage running below the 20% threshold limit by increasing the share of successful iterations from 36% to 64%



Source : Rystad Energy research and analysis



RystadEnergy

Navigating the future of **energy**

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Headquarters: Rystad Energy, Fjordalléen 16, 0250 Oslo, Norway

Americas +1 (281)-231-2600

EMEA +47 908 87 700

Asia Pacific +65 690 93 715

Email: support@rystadenergy.com

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