RYSTAD ENERGY

REBALANCING EUROPE'S GAS SUPPLY

OPPORTUNITIES IN A NEW ERA

Co-sponsors

International Association of Oil & Gas Producers

American Petroleum Institute

Technical input from

entsog

Gas Infrastructure Europe

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The study

- EU calls for **phase out of coal, oil, gas supplies from Russia** as soon as possible; and Russia threatens to **stop supplies**
- IOGP Europe and American Petroleum Institute **co-funded study** by Rystad Energy in collaboration with 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** and **peak-day demand / supply** balances (including by **region)**
  - **infrastructure capabilities**
  - **supply sources available to Europe in short and longer term, and their cost of supply**
- Study uses on **EU demand forecasts** (EU pre-FF55 Baseline and FF55 Mix net-zero scenario); no analysis of demand reducing effects from crisis
- Building on the study, Rystad Energy together with IOGP, API and input from ENTSOG, 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

Contents of the Report

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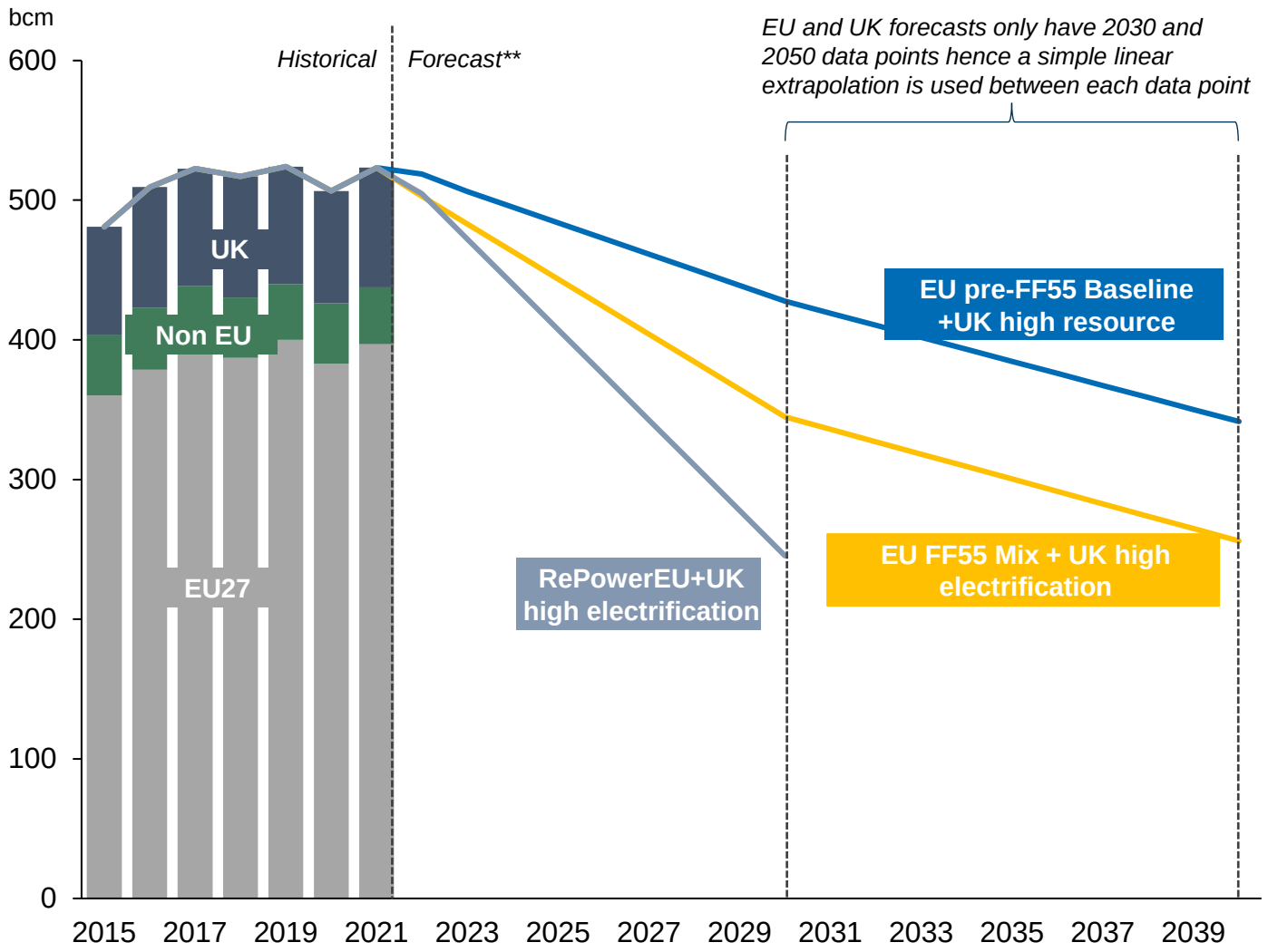
Russian gas can be displaced at reasonable cost within this decade, but until then the transition period will be challenging and call on difficult choices

	Key takeaways
2023-2025 it will be progressively possible to substitute the 150 Bcm/a Russian supplies thanks to alternative sources, a mostly integrated European market, and interconnected infrastructure able to handle new flow patterns; thereby high prices significantly contribute to the market balancing by …	• attracting spot LNG cargoes to Europe's LNG terminals in competition with demand in Asia (increasing LNG supplies from 100 Bcm in 2021 to 160 Bcm in 2023, i.e. plus 60 Bcm), • incentivizing full production from existing fields in Europe (despite decline) and maximizing imports from Algeria and other neighboring regions (increasing supplies from 280 Bcm in 2021 to 300 Bcm in 2023, i.e. plus 20 Bcm), • reducing demand: e.g. a 15% reduction vs. prior years reduces Europe's demand by 75 Bcm (balances market), • accelerating the transition to renewable energies (though with limited short-term impact due to lead times), • but high prices have severe impacts suggesting targeted support especially to vulnerable consumers while avoiding unintended consequences from market interventions
Infrastructure can mostly handle new flow patterns and supply peak-day demand if storages appropriately filled; some regions compete for globally remaining affordable gas supplies	• Pursue selected infrastructure/LNG regas investments to create (additional) regional system resilience
Starting 2026, with the right decisions now and political support, new long-term supplies from an abundance of low-cost global resources can fully substitute Russian supplies and result in pre-crisis price expectation levels	• While supplies from Europe's domestic resources and its neighbors are declining, LNG imports from an abundance of global resources can balance Europe's market • Despite assumed 35% demand reduction by 2040 (EU pre-FF55 Baseline Scenario), new LNG imports in order of 200 Bcm/year needed until and beyond 2040

Source: Rystad Energy research and analysis, ENTSOG

Study assumes demand reductions from 520 bcm to 260 or 340 bcm by 2040

European demand outlook by scenario



Demand scenarios are based on:

- EU pre-Fit for 55 Baseline (excluding 2030 datapoint) and Repower EU UK high resources scenarios
- EU Fit for 55 Mix and UK high electrification scenario, and
- RePowerEU and UK high electrification scenario

For the purpose of the analysis, ENTSOG data granularity as published in the TYNDP 2022 Scenario Report has been used

Countries included in the scope are: EU, UK, Norway, Albania, Moldova, Montenegro, North Macedonia, Serbia, Switzerland, Ukraine
Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy

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The study groups supplies by source, increment and timing

Gas source	Increment group	Timing	Full resource potential 2022-2040 BCM	Comment
Domestic	Base	Both	2099	• Domestic resources connected to the European demand via pipelines • Includes reserves in key fields such as Troll, Ormen Lange and Culzean
	Increment contingent	Long term	653	• Includes all domestic resources not yet sanctioned for development • Numerous small and low cost developments that benefit from existing infrastructure
	Increment exploration		150	• Exploration expected to yield limited potential given the mature nature of the domestic hydrocarbon basins
Special domestic increment	Troll max	Short term	32.9	• Short term potential in maximizing the Troll field output according to 2021 levels
	Higher GCV		23.6	• Volume equivalent impact of increasing energy content in gas export
	Groningen		382	• Key short term domestic production increment, should the politically guided curtailment be reversed
	Barents pipe	Long term	144	• Key long term domestic production increment • Connects resources in the Barents Sea to the existing Norwegian pipeline network
	European shale		455	• Possible to produce 30 Bcm/yr from 2027, however politically sensitive
Piped gas	Europe piped gas imports	Both	564	• Expected minimum imports from North Africa (Algeria and Libya) and Azerbaijan
	Algeria increase	Short term	606	• Potential increase in Algerian exports, should gas be marketed instead of reinjected • Export increase has been staggered to capture increasing marginal cost
	Turkey pass-through		89.5	• Potential re-routing of Turkey's share of TANAP gas from Azerbaijan • Export increase has been staggered to capture increasing marginal cost
	TR/Azerbaijan expansion	Long term	387	• Long term expansions of the TANAP/TAP infrastructure • Includes multiple phases which have been staggered to capture increasing marginal cost
LNG	LT Contracted	Both	858	• All known LNG contracts with Europe as destination
	Spot/FOB LNG	Short term	1522	• Maximum potential of spot and US LNG FOB imports • The market will be shared with Asia and 100% market share is therefore unlikely
	Available for LT contracts	Long term	7863	• 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

*Full resource potential is based on resources that are already producing or under development
Source: Rystad Energy research and analysis

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The study ranks supplies by earliest availability and cost of supply

Timing	Increment grouping	Indicative combined political and economic cost of supply EUR/MWh	Cost increase	Comment
Both	Base	Low	Short term	Lowest cost supply
	Europe piped gas imports			Base cost of supply from Algeria, Libya and Azerbaijan
	Long-term LNG imports			Contracted gas
Short term	Algeria sustained until 2026 at 2021	Medium		Behavior observed in 2021 hence reasonable cost of supply
	Troll max			Maximum utilisation of the Troll field
	TR pass-through (10-40% of TANAP)	High		Possible reroute as a function of high prices and expanded Turkish LNG import capacity
	Higher GCV			Behavior observed in 2022 at high gas price levels- higher gross calorific content of gas
	LNG spot market	130		Defined ceiling of what market share of spot LNG will be acquired by Europe (approx. 40USD/Mmbtu)
	Groningen	Last resort		Viewed as last resort gas supply only called upon if all other sources are exhaused including pushing LNG up to its ceiling
	Algeria 75% Marketed	Too high		Too expensive to be considered, demand will decline before the increment is called upon
	TR pass-through (70% of TANAP)			Too expensive to be considered, demand will decline before the increment is called upon
Long term	Increment contingent and exploration	Lower	Long term	Contingent resources around Europe and exploration efforts competitive vs long term LNG
	TANAP/TAP expansion Phase 1			Possible pipe expansion project that may be competitive with long term LNG
	Barents pipe			Possible pipe expansion project that may be competitive with long term LNG
	Long term LNG	30		Key number, long term LNG expected to cost around 9 USD/Mmbtu on the back of vast low cost gas in the US
	European shale gas	Too high		European shale gas resources, considered too politically challenging to be monetized
	TANAP/TAP expansion Phase 2&3			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

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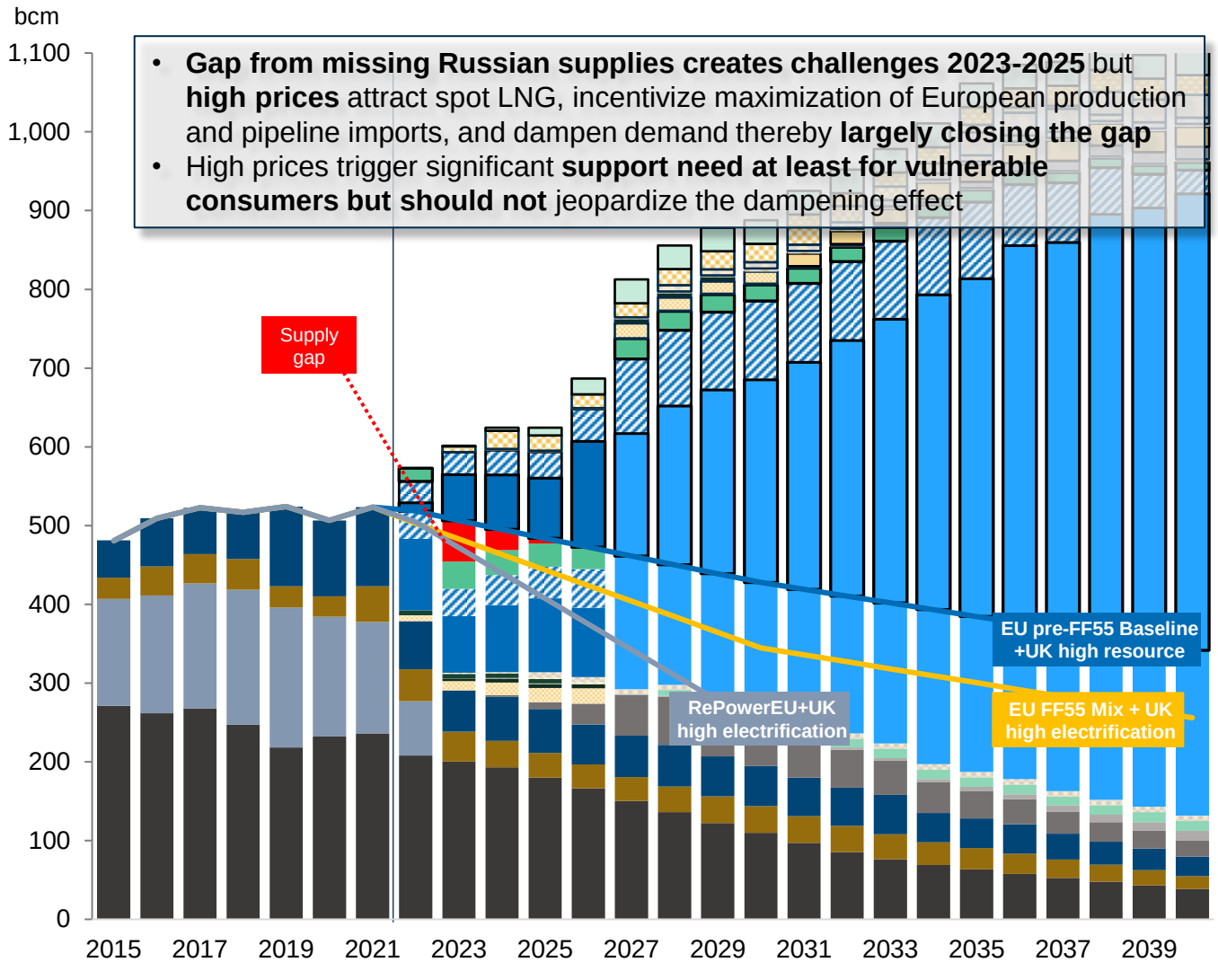
No Russian supplies as of 2023 creates supply gap in 2023 - 2025

Gas source	Increment group	Timing
Domestic	Base	Both
	Increment contingent	Long term
	Increment exploration	
Special domestic increment	Troll max	Short term
	Higher GCV	
	Groningen	
	Barents pipe	Long term
	European shale	
Russia	Russian piped gas	Short term
Piped gas	Europe piped gas imports	Both
	Algeria increase	Short term
	Turkey pass-through	
	TR/Azerbaijan expansion	Long term
LNG	LT Contracted	Both
	Spot/FOB LNG	Short term
	Available for LT contracts	Long term

Production by increment group

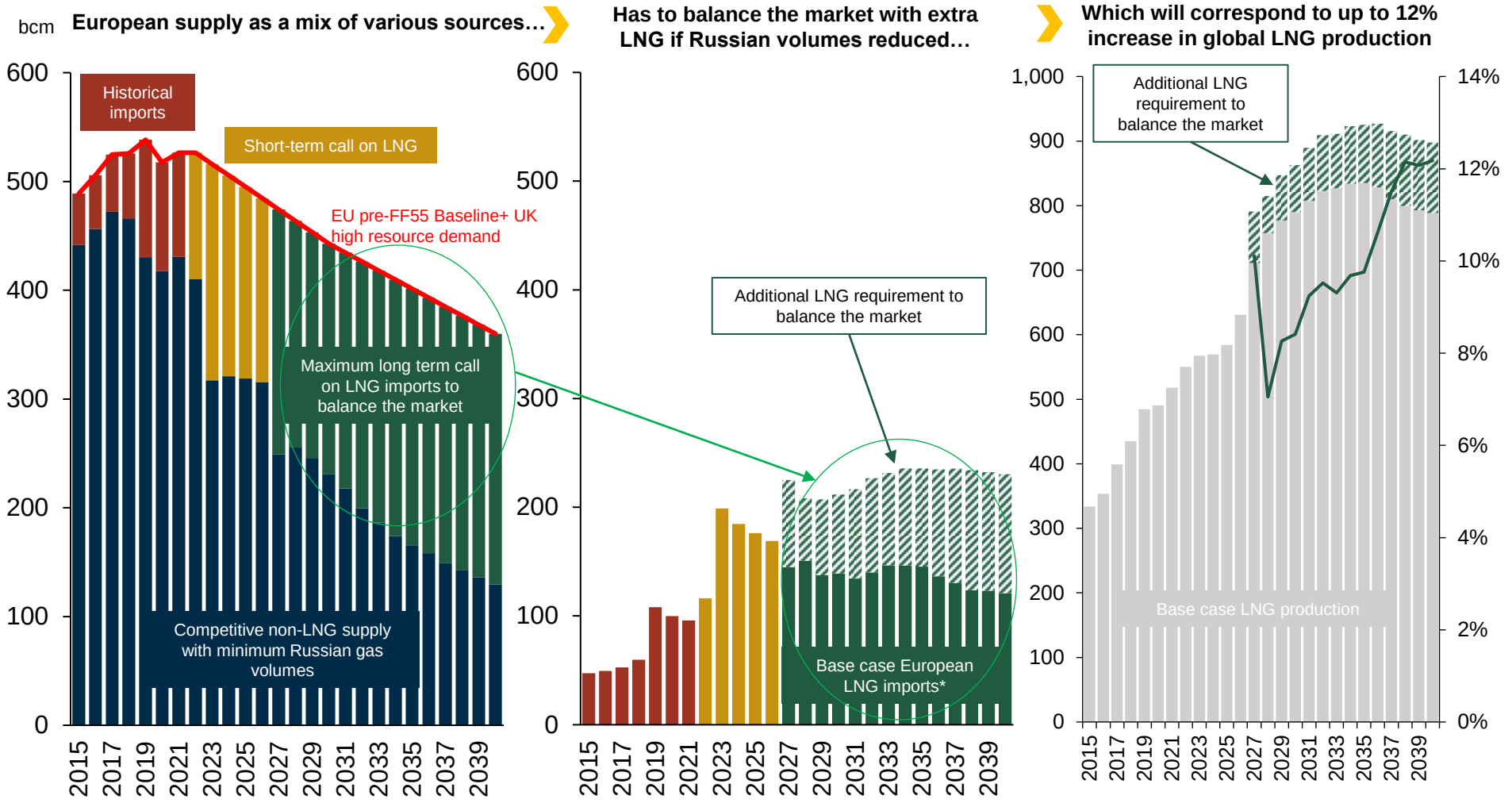


- **Gap from missing Russian supplies creates challenges 2023-2025** but **high prices** attract spot LNG, incentivize maximization of European production and pipeline imports, and dampen demand thereby **largely closing the gap**
- High prices trigger significant **support need at least for vulnerable consumers but should not** jeopardize the dampening effect

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

Russian gas displacement to Europe will result in incremental call on LNG, sourced from the global market

European LNG requirement in a micro and macro environment



*Base case European LNG imports as forecast under normal market circumstances in Rystad Energy Gas Market Cube
Source: Rystad Energy GasMarketCube, Rystad Energy research and analysis

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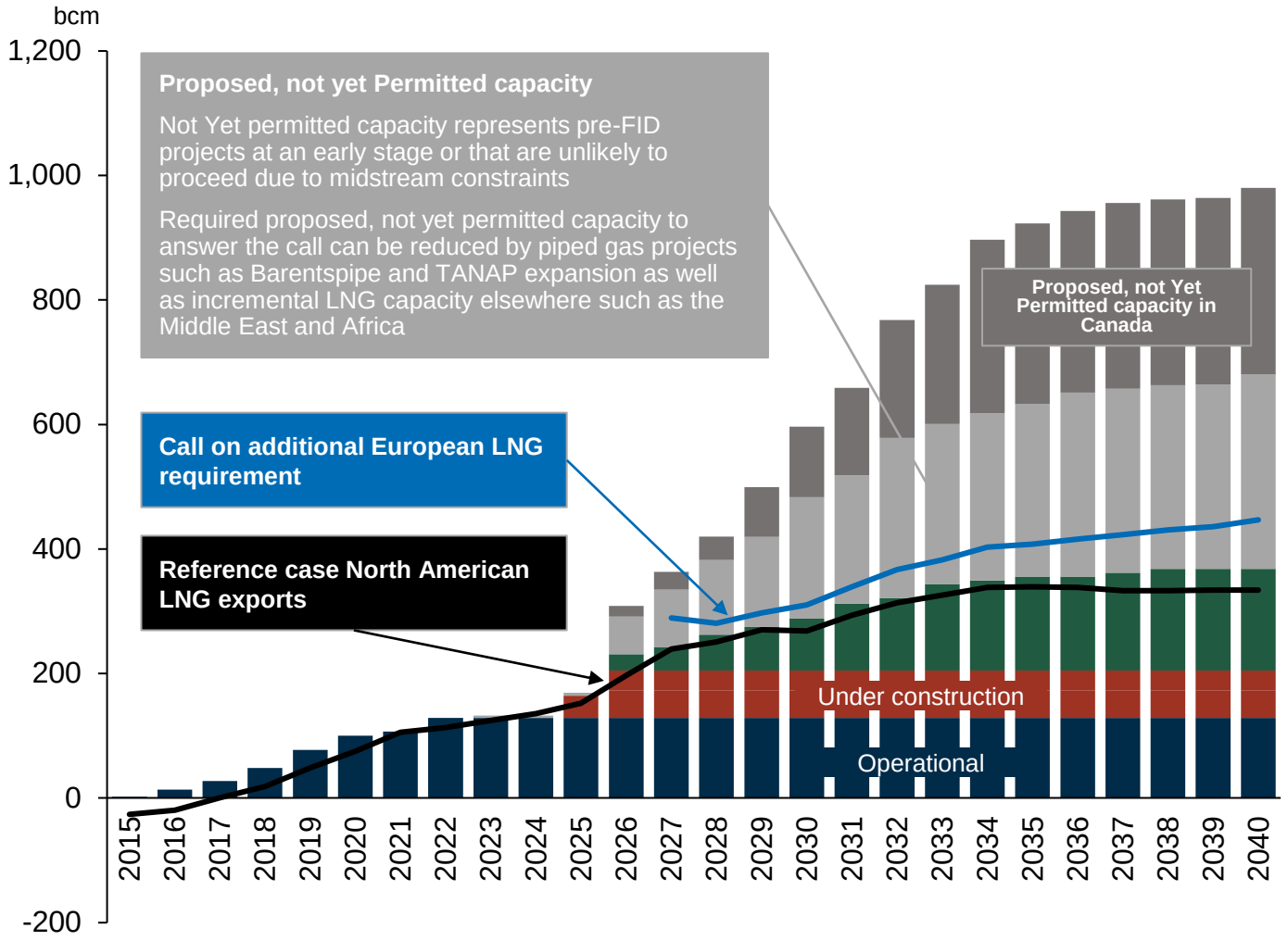
N America could supply new European LNG long-term requirements

North American LNG exports capacity vs European LNG imports requirement



Assumptions

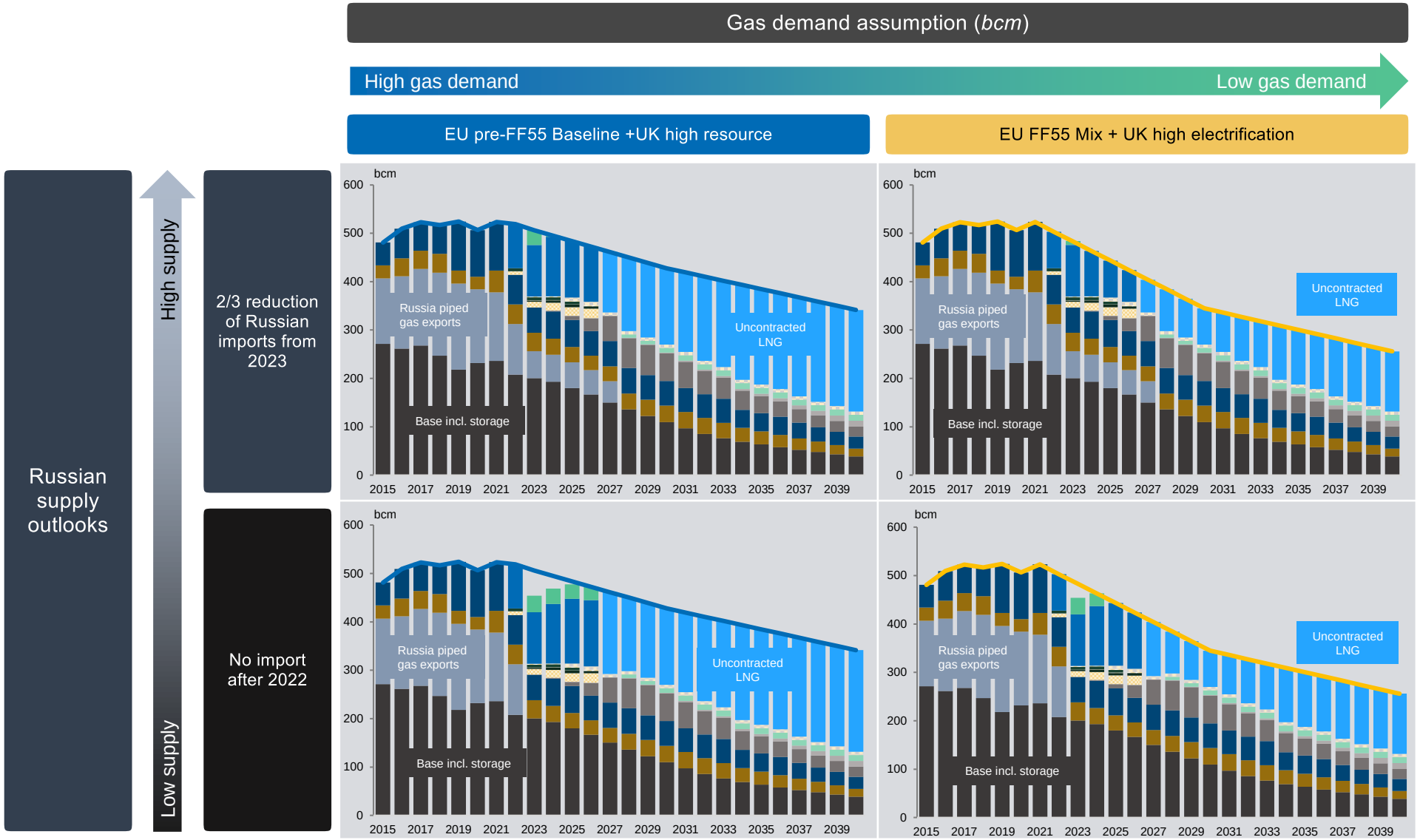
1. Future North American projects will be able to produce LNG with similar cost structure as other projects
2. There is a sufficient support from policy makers to trigger infrastructure investments both midstream in North America, but also the liquefaction and regas facilities
3. Incremental call on LNG to Europe (*chart: blue line*) represents additional requirement for North American LNG exports to Europe as per maximum European LNG demand based on EU pre-FF55 Baseline +UK high resource scenario, assuming no Russian gas imports from 2023

Results

Europe's increased requirement for LNG imports resulting from reduced natural gas supply from Russia, can be met by the North American LNG exports, but can also be supported by projects in other regions such as the Middle East and Africa

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

All scenario permutations indicate challenging short term outlook



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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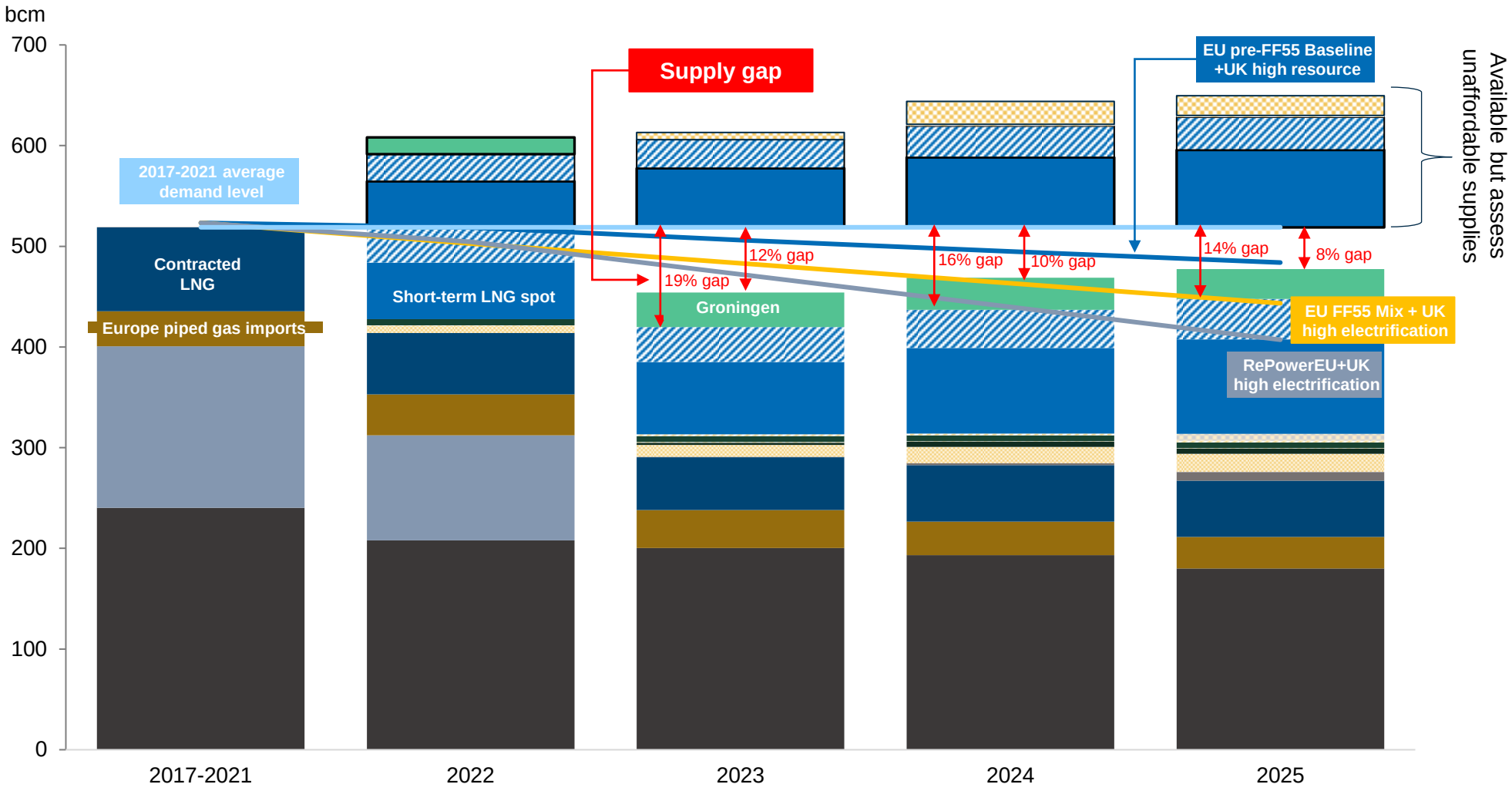
Supply gap versus 2017-2021 average demand: gap of up to 19%

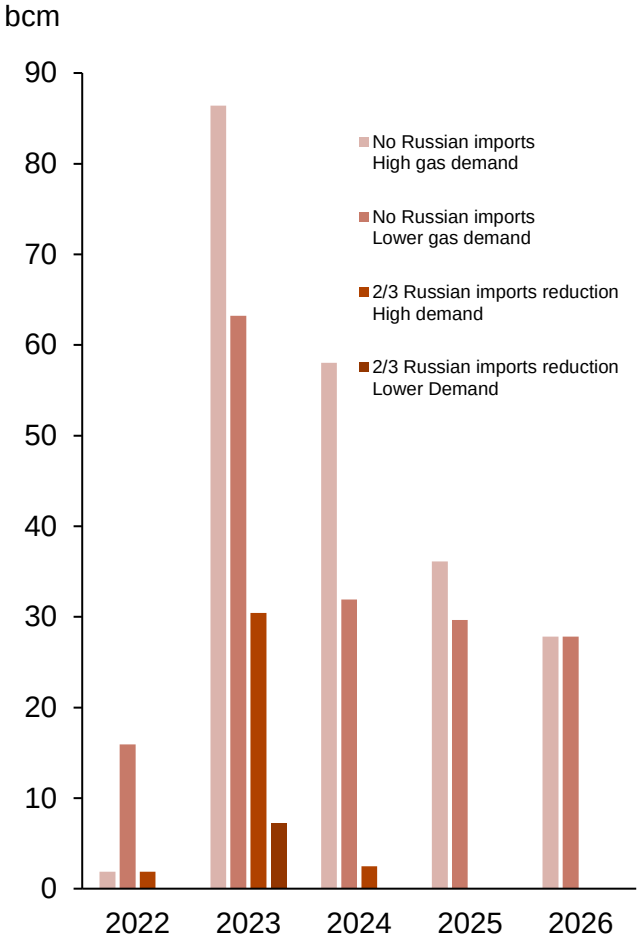
Short-term supply with high-cost / non-affordable gas filtered out, and without Russia from 2023



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

Disrupted Russian supply likely to create a short-term supply deficit with difficult choices

Implied supply deficit from various permutations without Groningen production



Assessment

Short-term supply and demand balances are very constrained and will call on difficult decisions

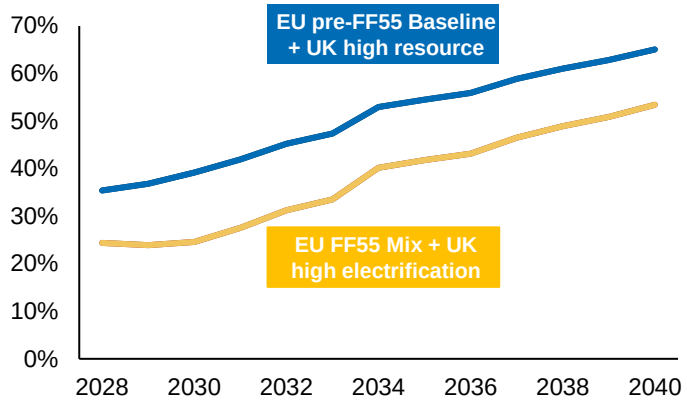
There are three key options either alone or as a combination that can help bridge short term supply and demand balance

- Demand management with negative impact on standard of living and economic output
- Net storage withdrawal although supply security for winter 2023/2024 will deteriorate
- Increase LNG market share through increased price and/or restart Groningen production

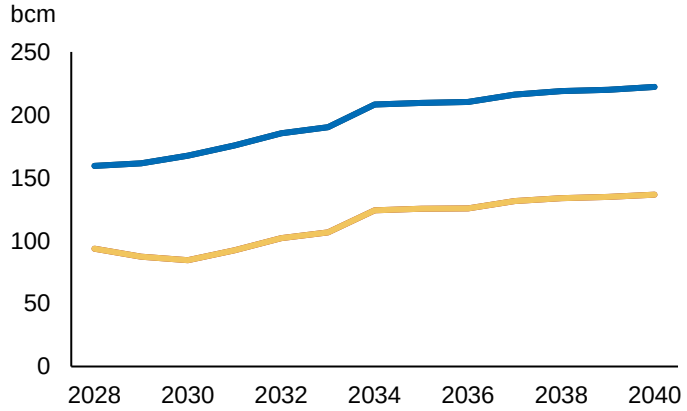
Source: Rystad Energy research and analysis

Long term new capacity expansion is required and could act as a future insurance policy

Call on capacity expansion* market share



Call on capacity expansion* absolute volume



Assessment

Increased long term gas export capacity is required despite undesired lock in risk

However, it is arguably sensible to risk over investment in gas acting as insurance policy versus a possible new energy crunch

Emissions go up when coal is used as an energy supply of last resort

High energy prices result in energy poverty and their regressive tax nature has the biggest impact on the least fortunate

Investments, business and consumers desire stability

* Capacity expansion represents future projects and their volumes which are not yet in place, including TANAP expansion, Barents pipe and uncontracted LNG
Source: Rystad Energy research and analysis

Infrastructure is in place to handle new flows patterns, but a fair allocation of scarce commodity is the key regional question

Regional assessment of European gas supply rebalancing in face of a complete Russian gas supply disruption

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

- European efforts to build infrastructure and market resilience are now paying dividends
- Reverse flow, regas terminals and new interconnectors can help cope with missing East to West gas from Russia
- TSO, shippers and other stakeholders have to reorganize and collaborate in new manners to facilitate the new flow patterns

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

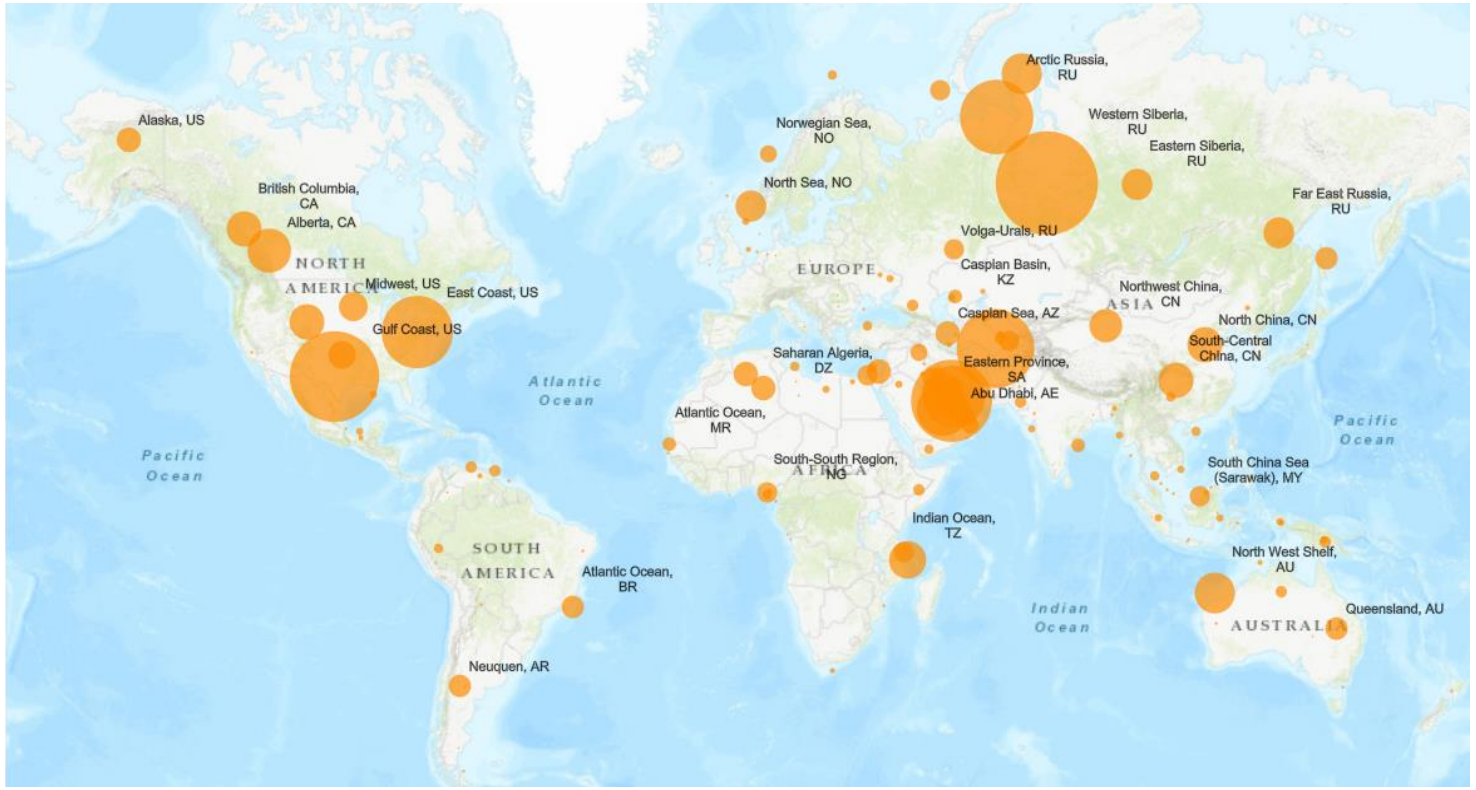
- Scarce commodity can be allocated based on highest payer leaving poorer regions without supply
- Gas can be allocated based on distance to import point implying that land locked countries typically will be without supply
- Commodity can be allocated according to a distribution key such as proportional share of gas demand in 2021

Source: Rystad Energy research and analysis

Content

Abundant Middle Eastern and North American gas resources can displace Russian gas

Discovered gas resources per province



Resources (Billion cm)

14,000

10,500

7,000

3,500

- As illustrated in the map above, Europe is resource poor. Russia, on the other hand, has plenty of gas resources.
- The map also points to that North America and the Middle East are resources rich. Gas resources from these regions are abundant enough to potentially displace Russian gas going forward.

Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube

European gas demand is 13% of global demand

Gas demand pre Covid-19 per country*

Gas demand (Billion cm)

890

668

445

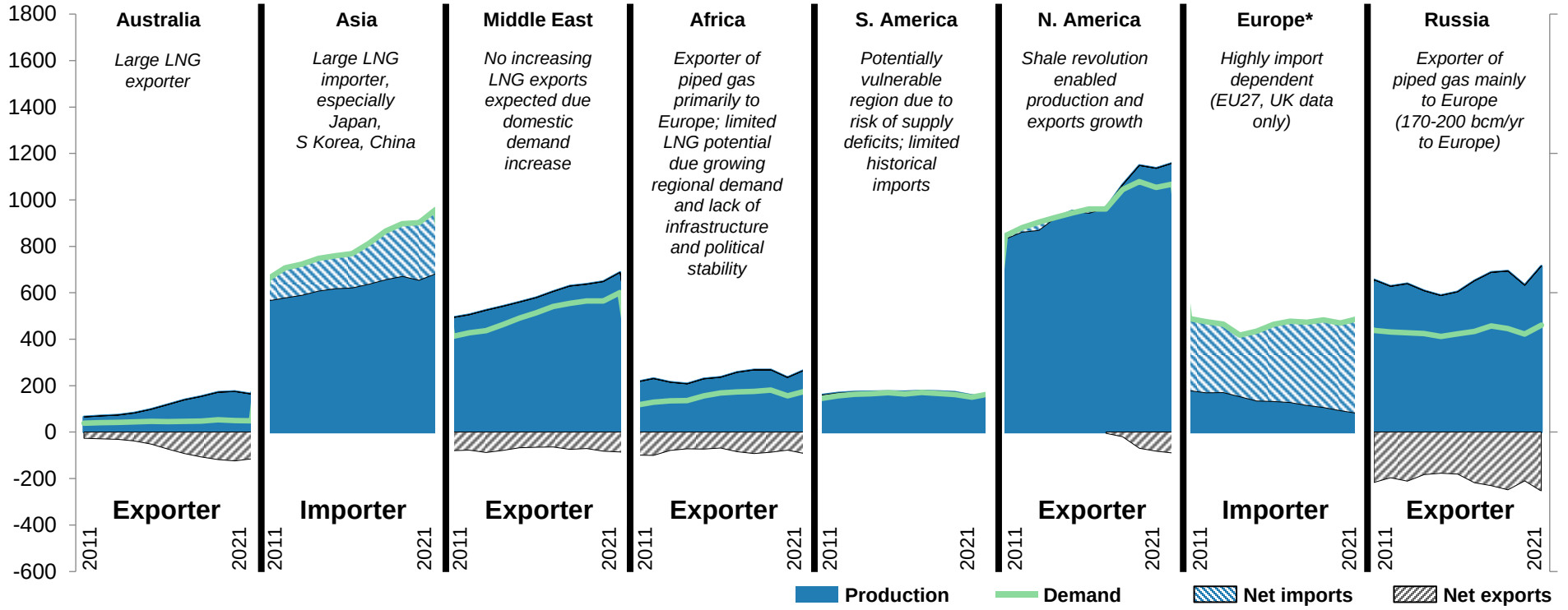
223

- The map illustrates global gas demand in 2019, i.e., before the spread of Covid-19.
- Global gas demand in 2019 amounted to 3,914 Bcm, out of which Europe used 524 Bcm.

*2019 gas demand
Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube

Europe and Asia are the key demand centers with import requirements

Global natural gas balances 2011-2021

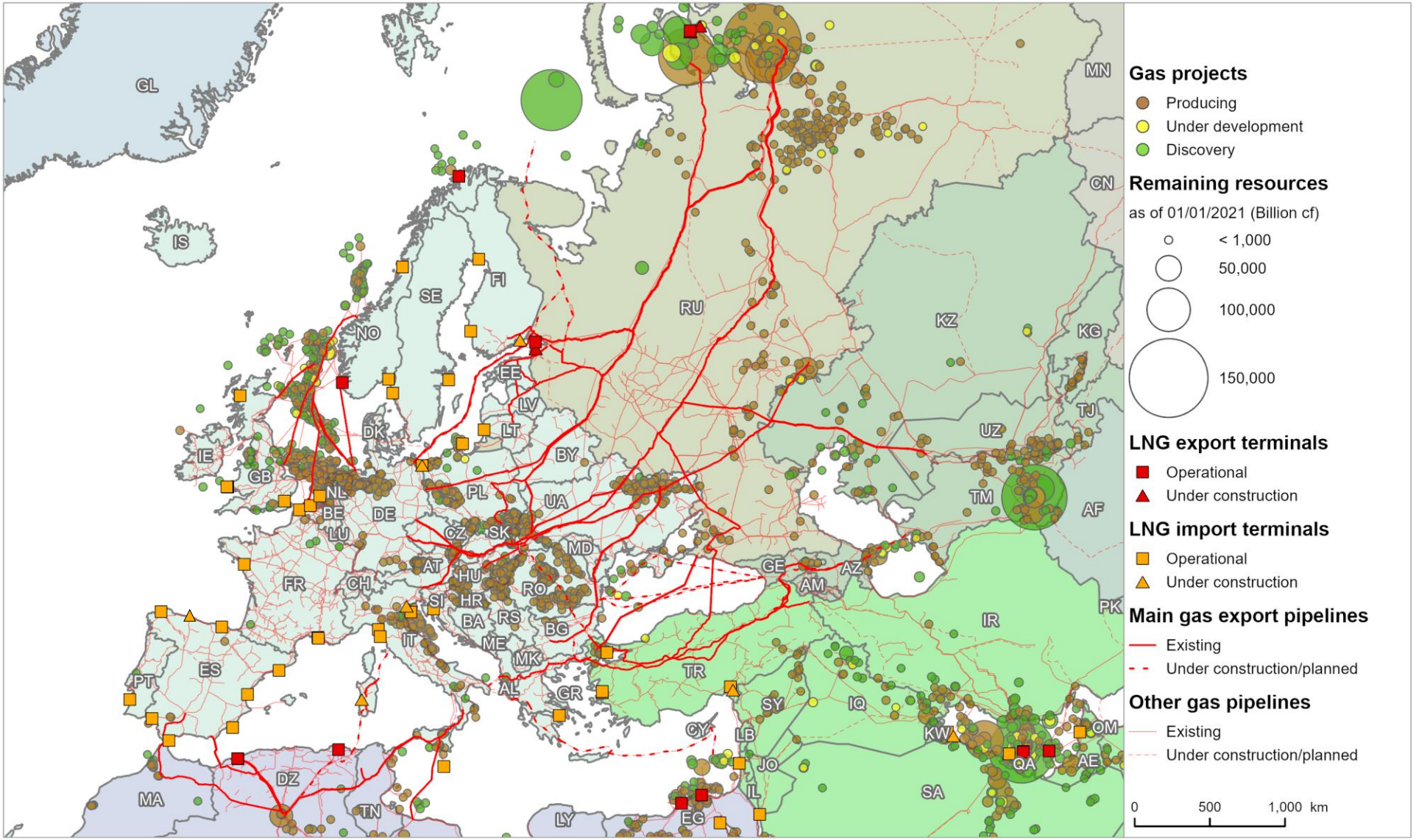


- The chart above shows historical global demand and production by region and the resulting exports and imports flows from 2011-2021.
- The shale in North America is set to turn largest consumer of natural towards also being amongst the most important export hubs for natural gas in the form of LNG.
- Asia and Europe are expected to remain the key demand hubs being highly dependent on imports, both in terms of pipeline supply from Russia and Africa, but also increasingly in terms of LNG in recent years, supported by shale gas from North America.

*Europe only includes EU27 and UK.
Source: Rystad Energy research and analysis; Rystad Energy GasMarketCube

Content

Norway, Russia and LNG imports represent key sources of gas supply to Europe



Source: Rystad Energy research and analysis

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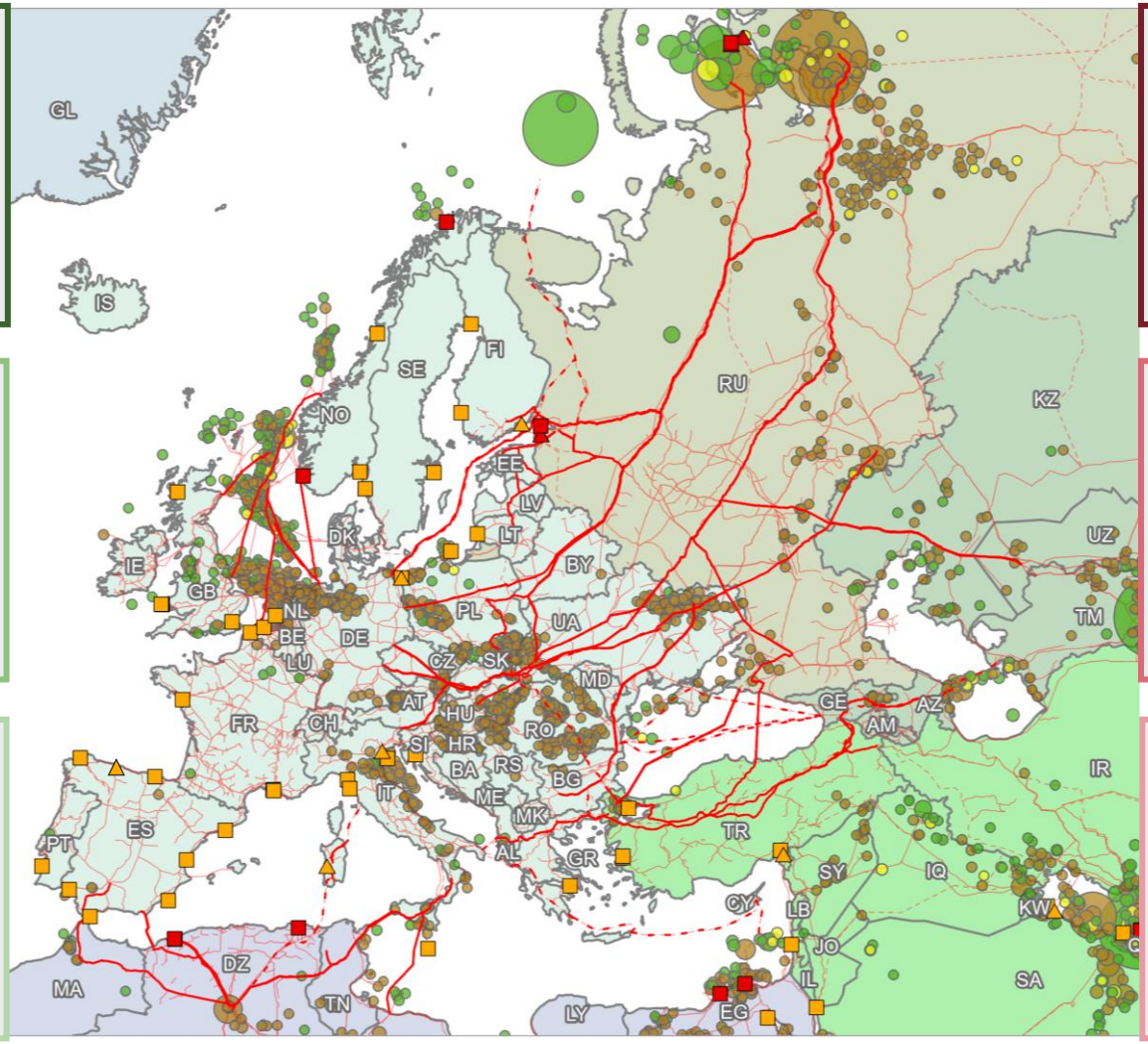
The European gas market is driven by supply, demand and infrastructure



Indigenous production

North Sea production dominates local supply (Norway with the largest share, followed by UK, Netherlands then Denmark). Smaller scale onshore production takes place in Germany, Poland, Hungary and Romania

LNG imports

Large scale regasification terminals in 11 European countries with new facilities planned in multiple countries.
Smaller regasification terminals also exist but are not connected to the wider network

Pipeline imports

Most come from Russia via pipelines in Ukraine, Belarus, Turkey and under the Baltic Sea (Nord Stream). Azeri gas comes via Turkey into Greece, Algerian and Libyan gas arrives in Spain and Italy via pipelines under the Mediterranean

Gas demand characteristics

Demand driven primarily by three sectors:

Power production, residential and commercial settings and industrial usage

Internal gas transport infrastructure

Interconnection exists between most neighboring European countries. The last connection between Poland and Lithuania also established (Baltic states and Finland therefore no longer isolated from the rest of Europe)

Storage and seasonality

Imports largely consistent due to large continent wide storage capacity (113 bcm).

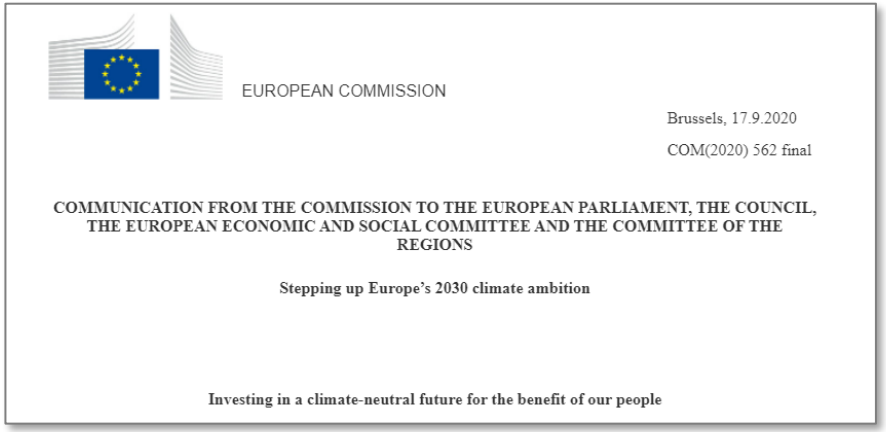
Ukraine has most (33.6 bcm) followed by Germany (25 bcm) and Italy (20 bcm)

Source: Rystad Energy research and analysis

Content

Key demand numbers are from the European Commission and UK Government outlooks

Stepping up Europe's 2030 climate ambition- European Commission



EUROPEAN COMMISSION

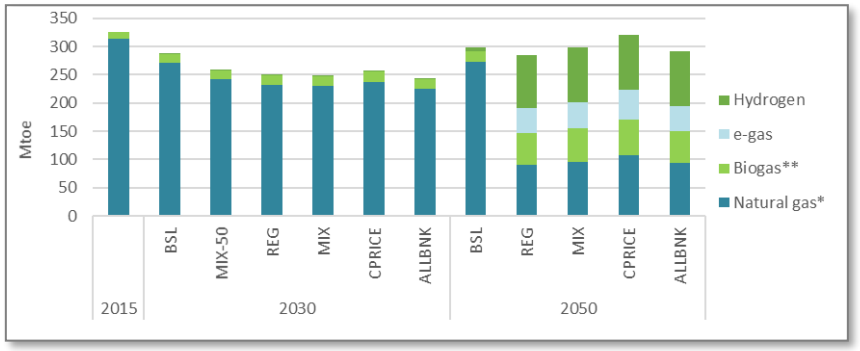
Brussels, 17.9.2020

COM(2020) 562 final

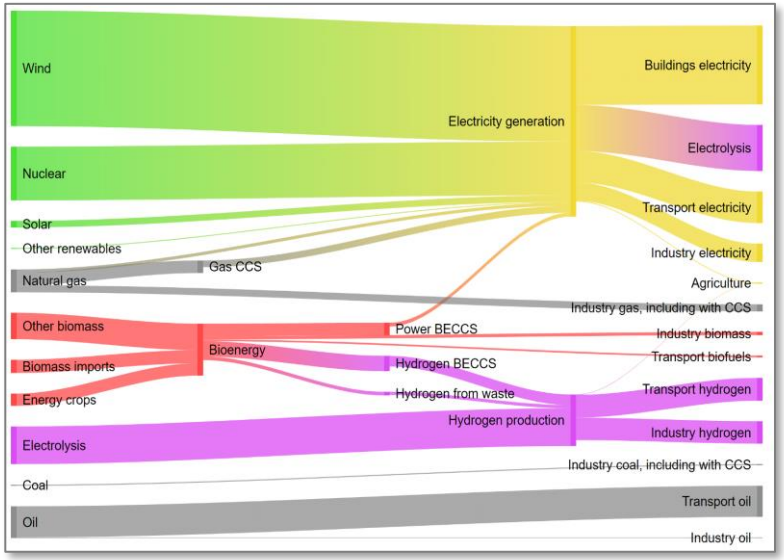
COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Stepping up Europe's 2030 climate ambition

Investing in a climate-neutral future for the benefit of our people



UK Net Zero Strategy: Build Back Greener- HM Government



Source: European Commission, UK Department for Business, Energy & Industrial Strategy

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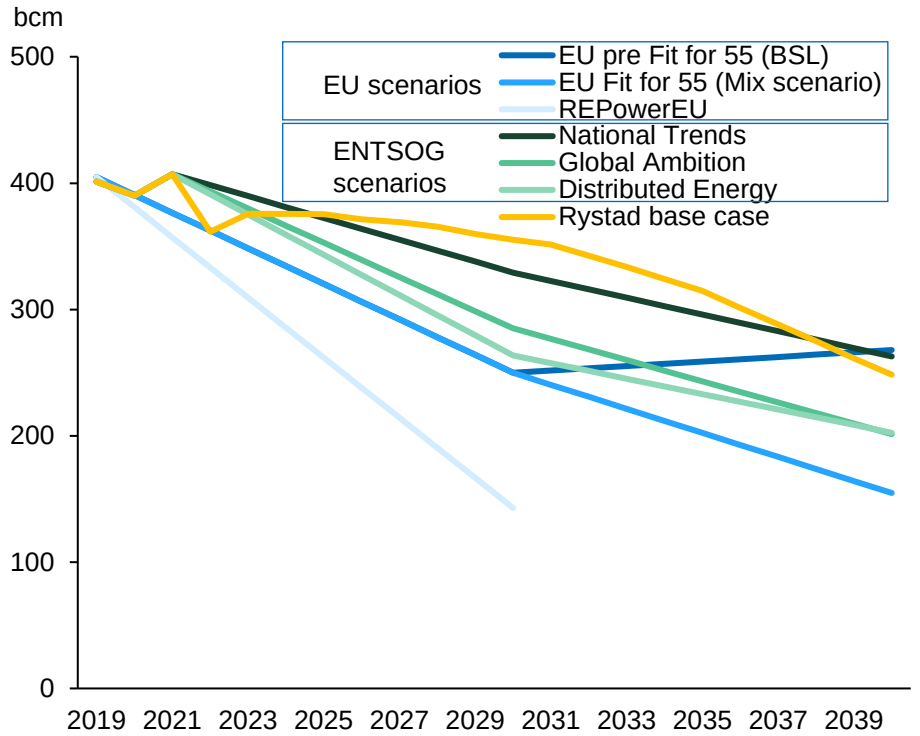
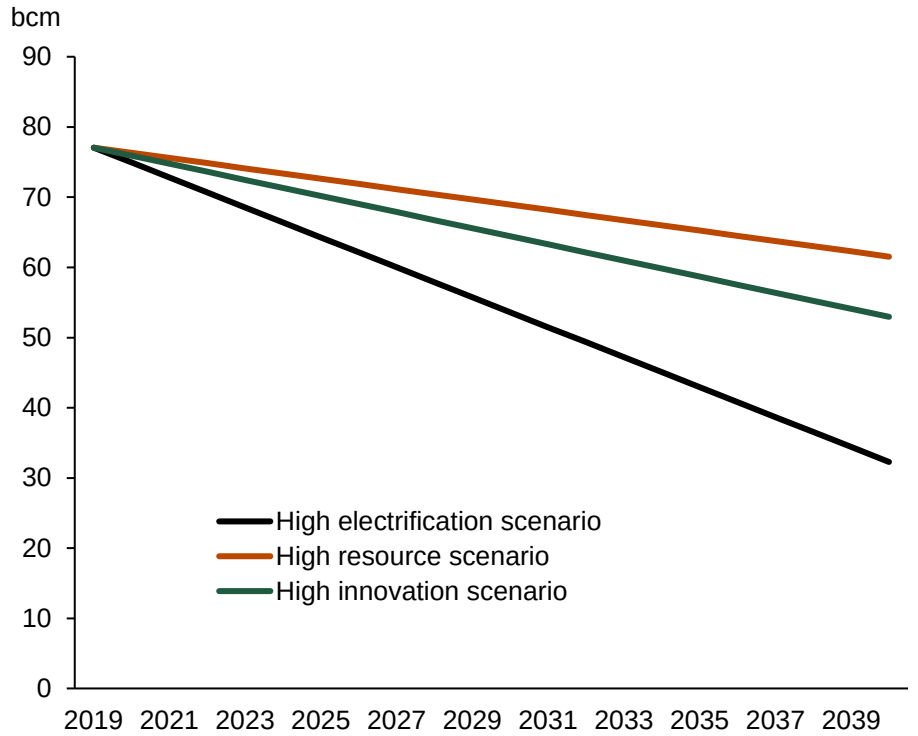
All demand scenarios point to lower consumption by 2040

EU natural gas demand scenarios



- For EU pre Fit for 55, EU Fi for 55 (mix scenario) and RePowerEU, three data points used: 2019, 2030 and 2050 with linear extrapolation in-between
- For ENTSOG's National Trends, Global Ambition and Distributed Energy, three data point have been used: historical 2021, 2030 and 2040 with linear extrapolation in between
- Growth rates applied to all non-EU countries and Norway to help calculate complete demand outlook

UK natural gas demand scenarios



- For UK natural gas demand scenarios, two data points used: 2019 and 2050 with linear extrapolation in-between

*RePowerEU scenario assumes 310bcm gas demand reduction by 2030 compared to 2020, less 60bcm diversification measures (LNG and piped gas)
Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy

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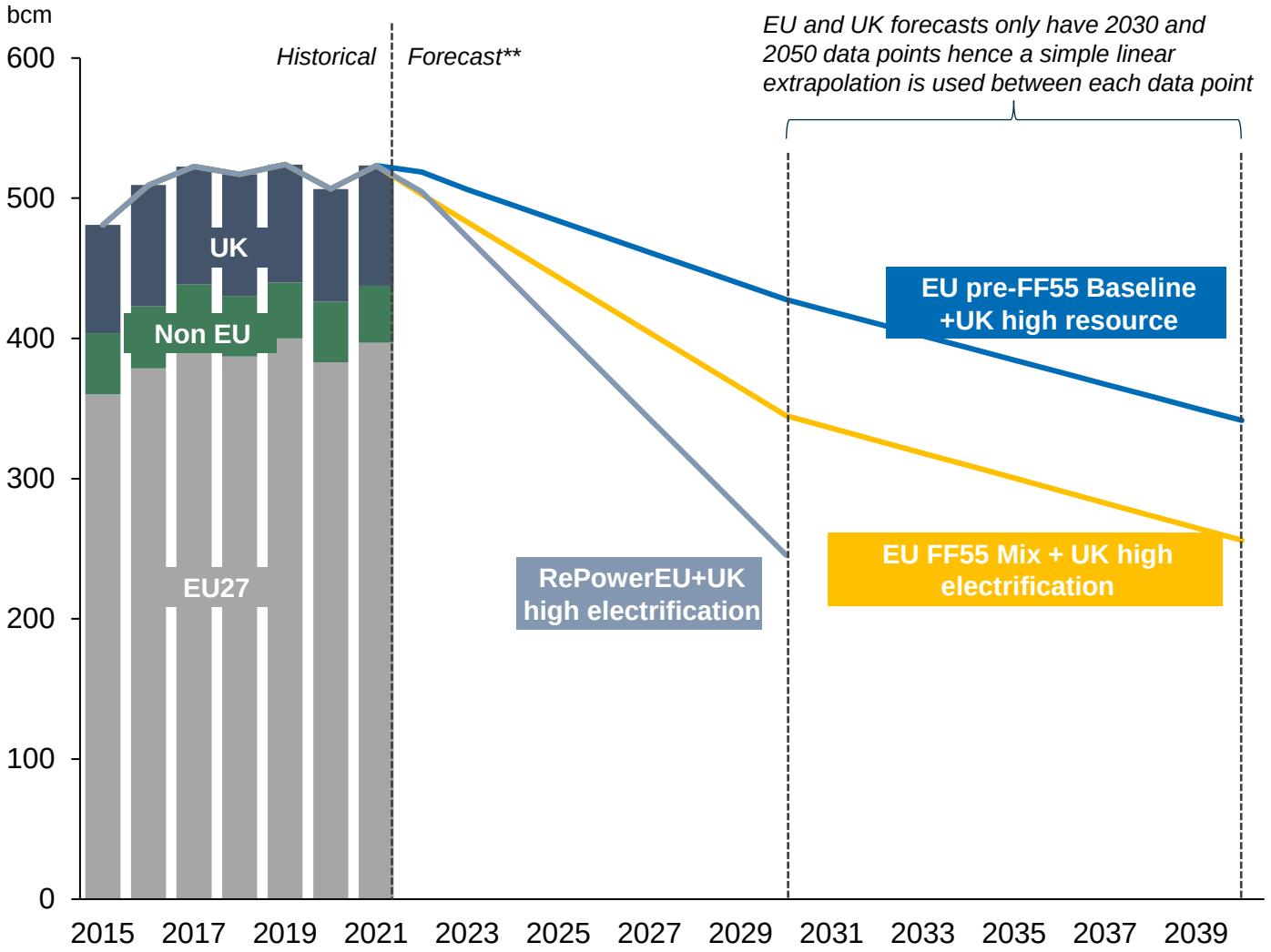

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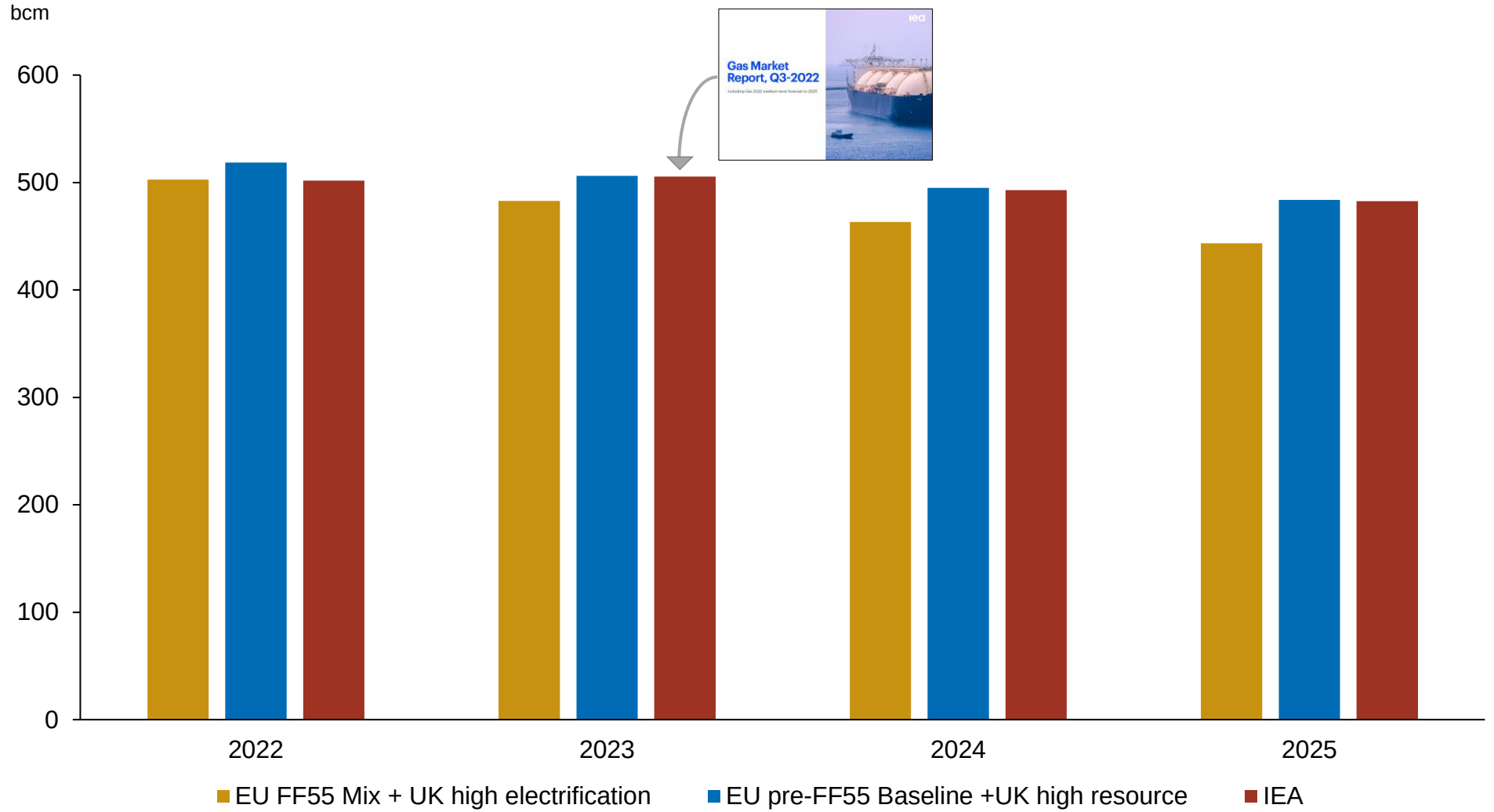
Applied demand outlooks are in line with recent IEA's Gas Market Report

IEA Gas Market Report Q3 2022 vs High/Low demand outlook*



* IEA numbers based on Gas Market Report Q3 2022, adjusted by Rystad Energy's view on Turkey's gas demand; includes EU and non-EU countries
Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, IEA

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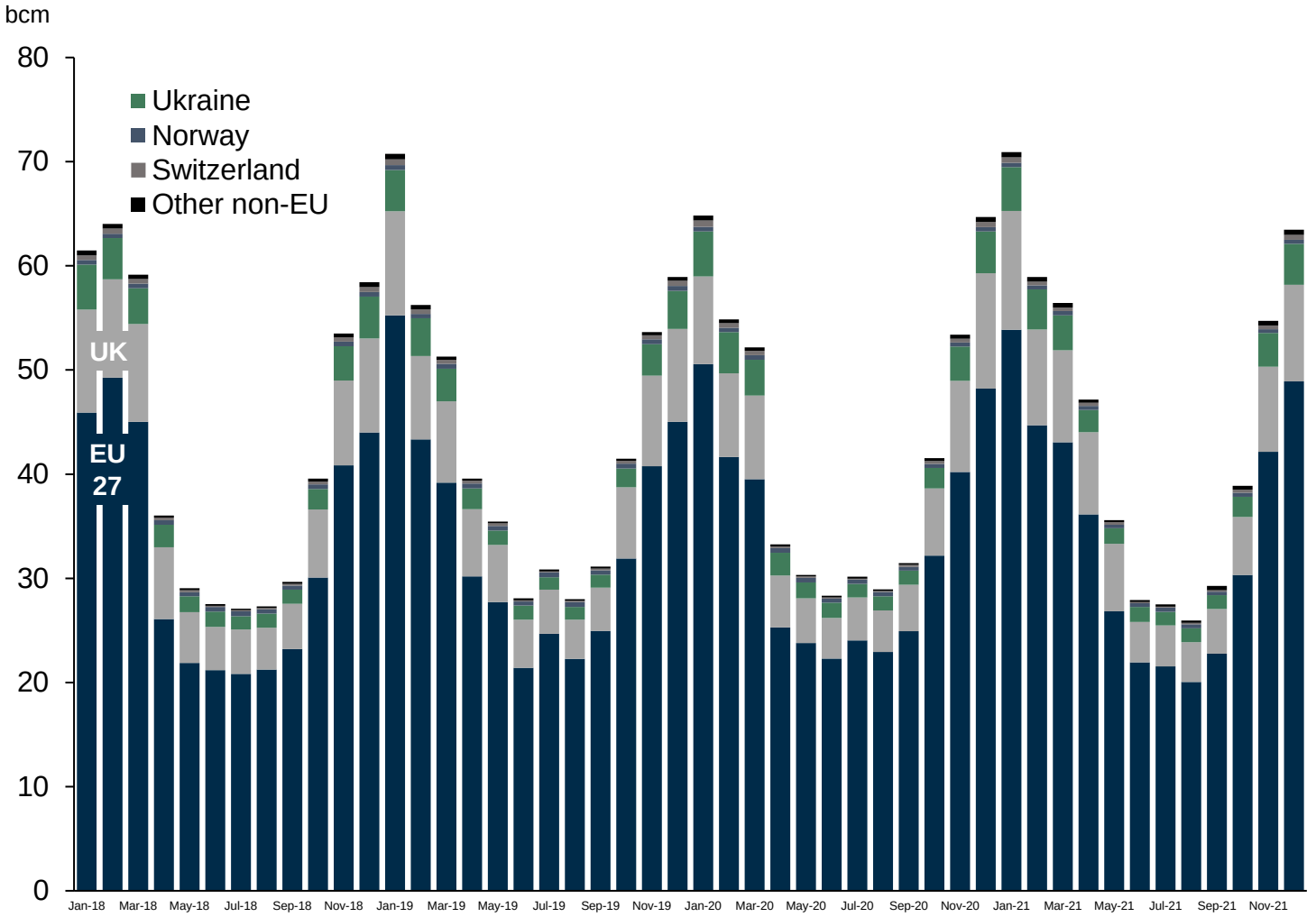
Content

European demand is highly seasonal with maximum monthly demand typically in January and minimum occurring during in the summer months

European demand by month

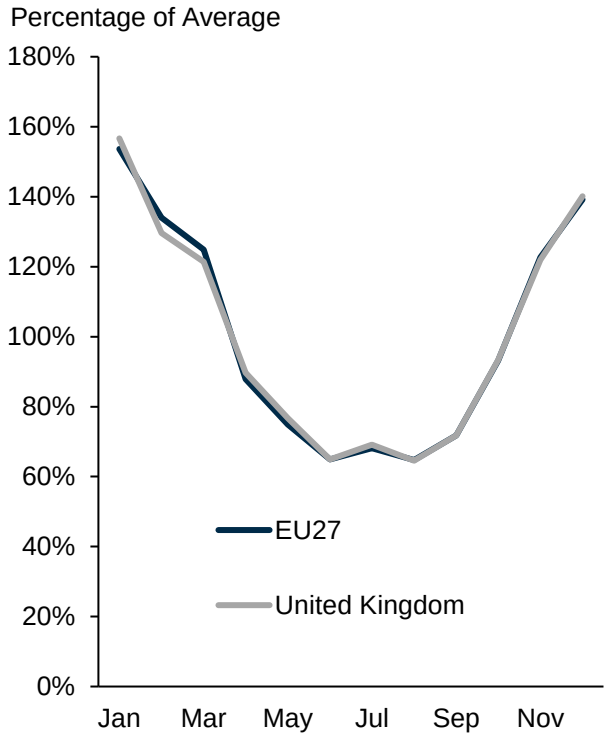


- Historically, European gas demand has been highly seasonal, peaking at around 70 bcm per month in January.
- During the summer months, consumption more than halves, to around 30 bcm per month.
- From October onwards, gas demand quickly ramps up to around 60 bcm, depending mainly on how cold the winter is.
- Typically, excess gas is stored during the summer months to be sold during the winter when prices are higher, but due to high prices in 2022 it is challenging to fill the gas storages.

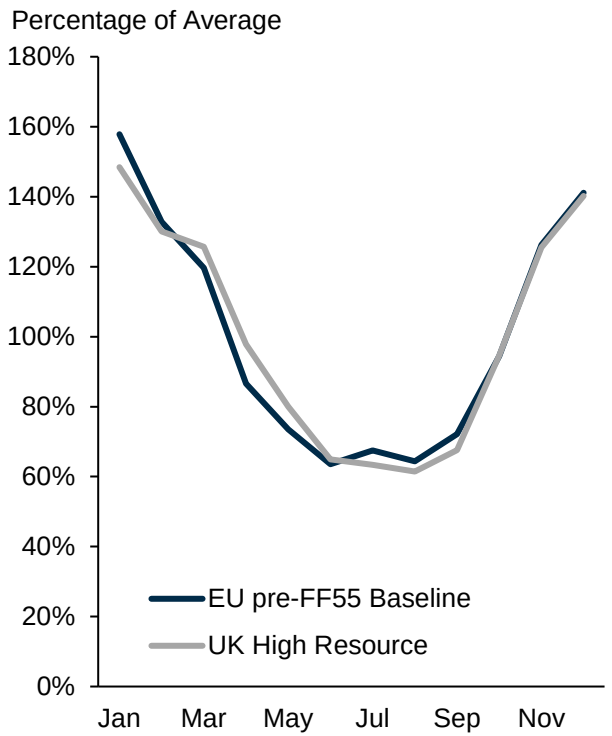
Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy, Eurostat

Different scenarios forecast different seasonality patterns: EU FF55 Mix + UK High Electrification forecast a much flatter seasonality

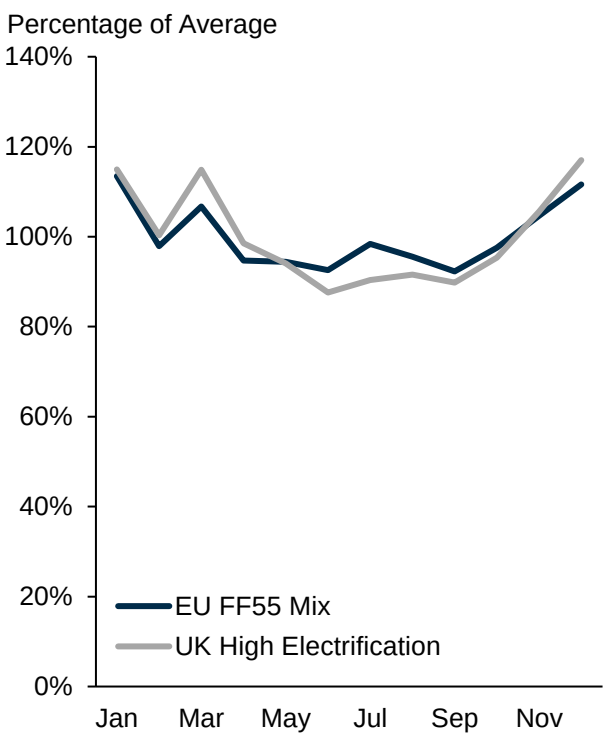
Historic 2018-2021



EU pre-FF55 Baseline + UK High Resource 2030



EU FF55 Mix + UK High Electrification 2030



Demand scenarios seasonality:

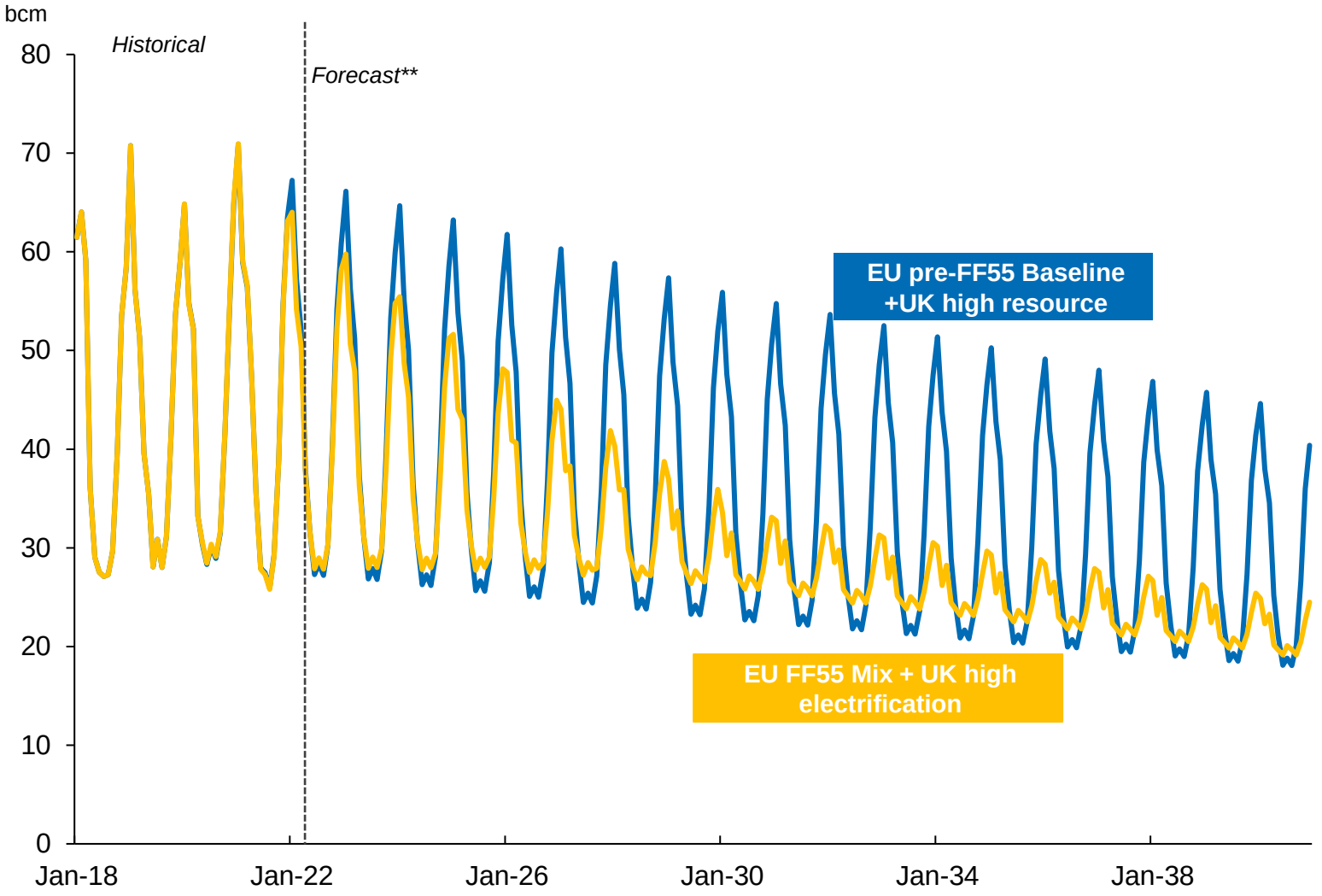
- Historic data taken from Eurostat and other national statistics providers show strong seasonality
- EU pre-Fit for 55 Baseline (excluding 2030 datapoint) and RePowerEU UK high resources scenarios show a continuation of that seasonality with minor changes
- EU Fit for 55 Mix and UK high electrification scenario demonstrate a significant flattening of seasonal variation with demand in winter only marginally higher than demand in summer
- For both scenarios Ukraine, Switzerland and other non-EU countries are modelled the same as the EU27 countries

For the purpose of the analysis, ENTSOG data granularity as published in the TYNDP 2022 Scenario Report has been used

Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy, ENTSOG TYNDP

Seasonality of scenarios combined with annual figures implies a steeper drop off of peak demand during winter months for the EU Fit For 55 mix + UK high electrification scenario

European demand outlook by scenario (monthly)



Demand scenarios are based on:

- EU pre-Fit for 55 Baseline (excluding 2030 datapoint) and countries UK high resources scenarios
- EU Fit for 55 Mix and UK high electrification scenario

For the purpose of the analysis, ENTSOG data granularity as published in the TYNDP 2022 Scenario Report has been used

Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy, ENTSOG TYNDP 2022

Content

The supply stack is grouped by source, increment and timing to map out full potential

Gas source	Increment group	Timing	Full resource potential 2022-2040 BCM	Comment
Domestic	Base	Both	2099	• Domestic resources connected to the European demand via pipelines • Includes reserves in key fields such as Troll, Ormen Lange and Culzean
	Increment contingent	Long term	653	• Includes all domestic resources not yet sanctioned for development • Numerous small and low cost developments that benefit from existing infrastructure
	Increment exploration		150	• Exploration expected to yield limited potential given the mature nature of the domestic hydrocarbon basins
Special domestic increment	Troll max	Short term	32.9	• Short term potential in maximizing the Troll field output according to 2021 levels
	Higher GCV		23.6	• Volume equivalent impact of increasing energy content in gas export
	Groningen		382	• Key short term domestic production increment, should the politically guided curtailment be reversed
	Barents pipe	Long term	144	• Key long term domestic production increment • Connects resources in the Barents Sea to the existing Norwegian pipeline network
	European shale		455	• Possible to produce 30 Bcm/yr from 2027, however politically sensitive
Piped gas	Europe piped gas imports	Both	564	• Expected minimum imports from North Africa (Algeria and Libya) and Azerbaijan
	Algeria increase	Short term	606	• Potential increase in Algerian exports, should gas be marketed instead of reinjected • Export increase has been staggered to capture increasing marginal cost
	Turkey pass-through		89.5	• Potential re-routing of Turkey's share of TANAP gas from Azerbaijan • Export increase has been staggered to capture increasing marginal cost
	TR/Azerbaijan expansion	Long term	387	• Long term expansions of the TANAP/TAP infrastructure • Includes multiple phases which have been staggered to capture increasing marginal cost
LNG	LT Contracted	Both	858	• All known LNG contracts with Europe as destination
	Spot/FOB LNG	Short term	1522	• Maximum potential of spot and US LNG FOB imports • The market will be shared with Asia and 100% market share is therefore unlikely
	Available for LT contracts	Long term	7863	• 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

*Full resource potential is based on resources that are already producing or under development
Source: Rystad Energy research and analysis

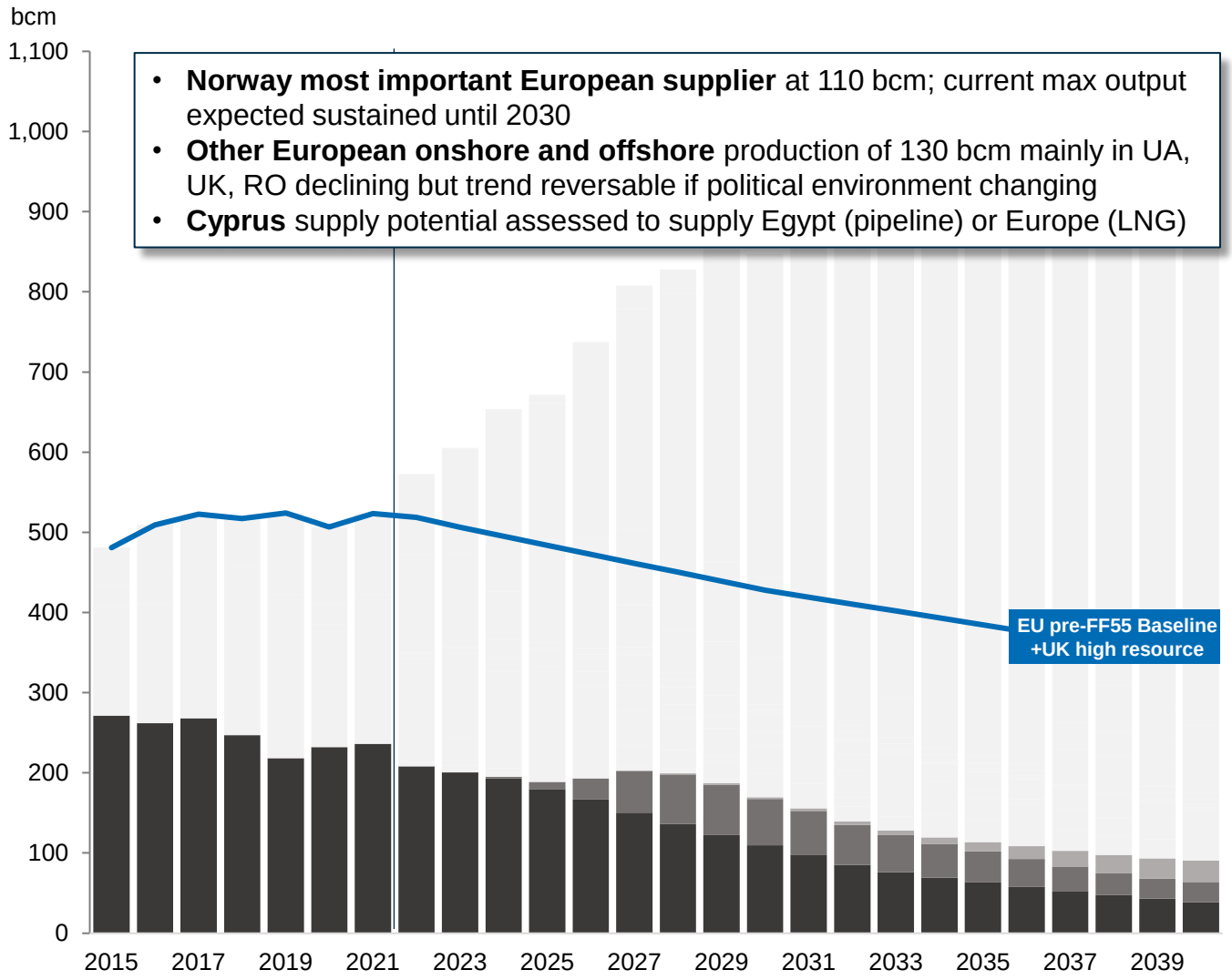
Content

Content

Domestic supplies important but challenged by resource potential, political environment

Gas source	Increment group	Timing
Domestic	Base	Both
	Increment contingent	Long term
	Increment exploration	
Special domestic increment	Troll max	Short term
	Higher GCV	
	Groningen	
	Barents pipe	Long term
	European shale	
Russia	Russian piped gas	Short term
Piped gas	Europe piped gas imports	Both
	Algeria increase	Short term
	Turkey pass-through	
	TR/Azerbaijan expansion	Long term
LNG	LT Contracted	Both
	Spot/FOB LNG	Short term
	Available for LT contracts	Long term

Production by increment group



- **Norway most important European supplier** at 110 bcm; current max output expected sustained until 2030
- **Other European onshore and offshore** production of 130 bcm mainly in UA, UK, RO declining but trend reversable if political environment changing
- **Cyprus** supply potential assessed to supply Egypt (pipeline) or Europe (LNG)

Source: Rystad Energy research and analysis

Content

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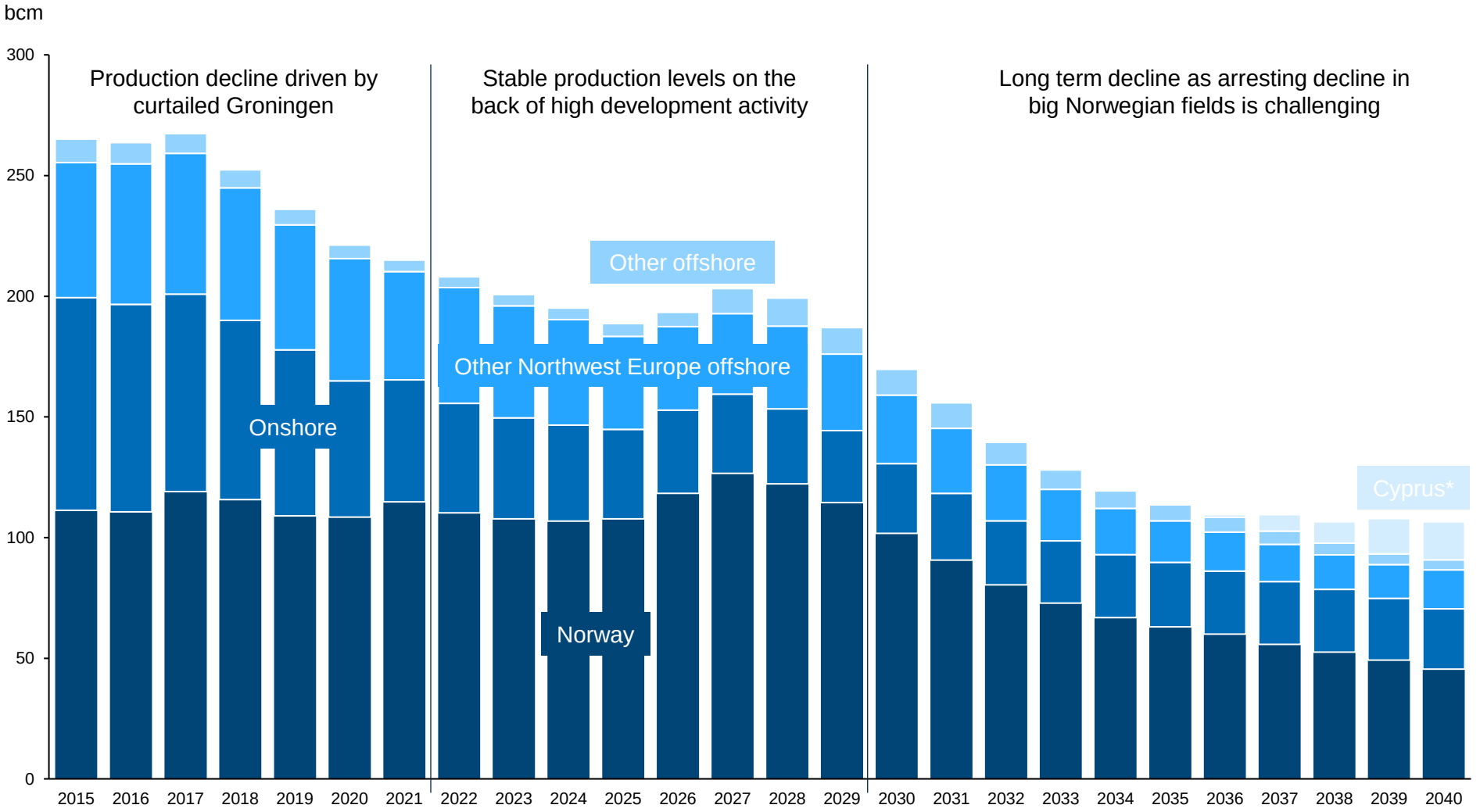
Significant domestic resources are available despite declining production trend

Overview of European domestic production



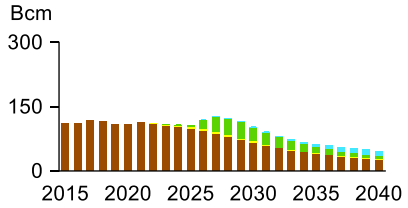
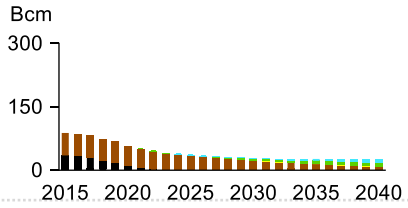
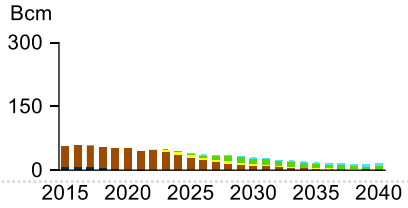
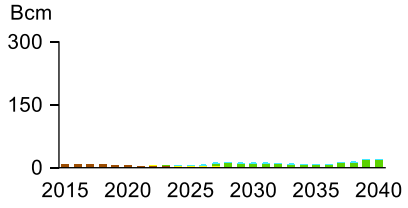
*Cyprus resources are not included further in the study as any production from the Eastern Mediterranean is assumed to either be used for local consumption, exported as LNG from Egypt or exported as LNG from Cyprus Source: Rystad Energy research and analyses

Content

RYSTAD ENERGY

European domestic production divided in four groups to illustrate key contributors

Overview of European domestic production

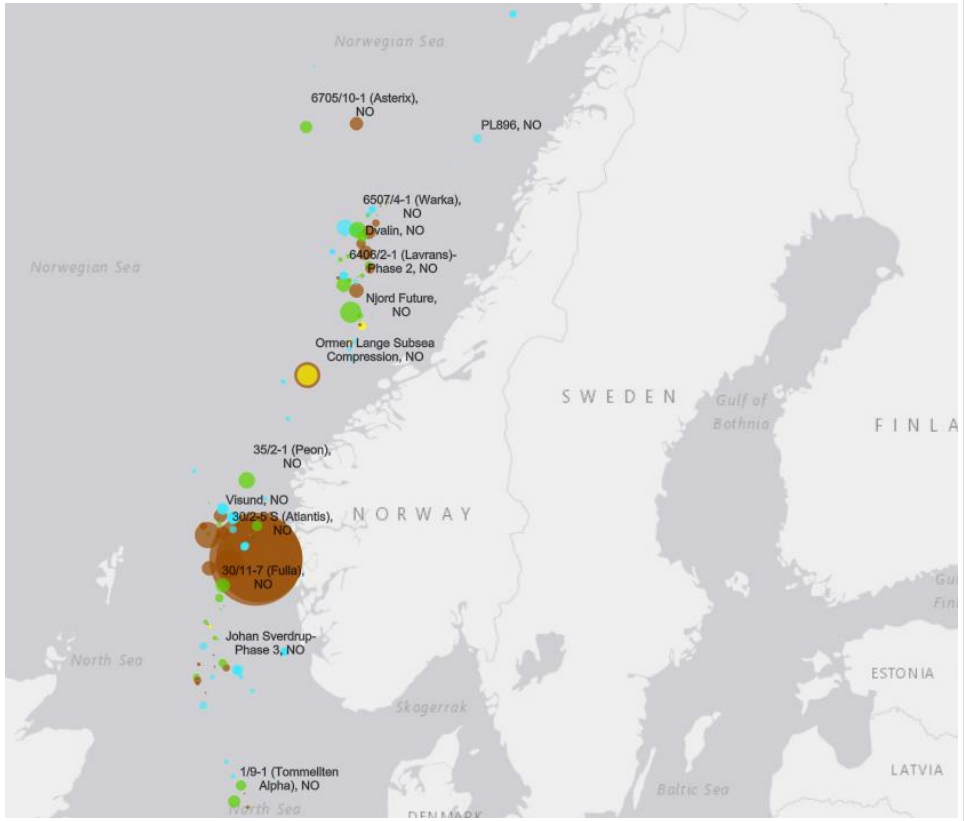
Production group	Production profile	Share of total domestic production 2022-2040	Key fields	Comment
Norway		57%	• Troll • Aasgard • Oseberg • Ormen Lange	• *Norway is the single biggest contributor to domestic production* • *Current output levels are at maximum capacity levels and expected to be maintained towards 2030* • *Post 2030 the decline in big fields such as Troll and Oseberg will most likely imply decline overall* • *Production and resources from the Barents Sea excluded as they are captured via LNG and the Barentspipe increment*
Onshore activity		20%	• Shebelynske • Yablunivske • Groningen	• *Domestic onshore production primarily from Ukraine, Romania and the Netherlands* • *The Groningen field used to be the by far biggest field, but is intended to seize production by 2023* • *Potential restart of Groningen production is captured as a separate increment*
Offshore North West Europe		18%	• Culzean • Laggan • Tolmount • Elgin/Franklin	• *Includes UK, Netherlands, Denmark and Ireland with UK as the biggest contributor* • *Recent developments have helped arresting decline* • *Contingent resources for the most part viewed as competitive, but insufficient to prevent decline*
Other offshore		6%	• Domino • Cassiopea • Pelican South • Herodotus	• *Other onshore is primarly Black Sea activity outside Romania and Ukraine* • *The deepwater Domino discovery in the Romanian Neptune block is a key development project* • *Cyprus resources are not included further in the study as any production from the Eastern Mediterranean is assumed to either be used for local consumption, exported as LNG from Egypt or exported as LNG from Cyprus*

Source: Rystad Energy research and analyses

Content

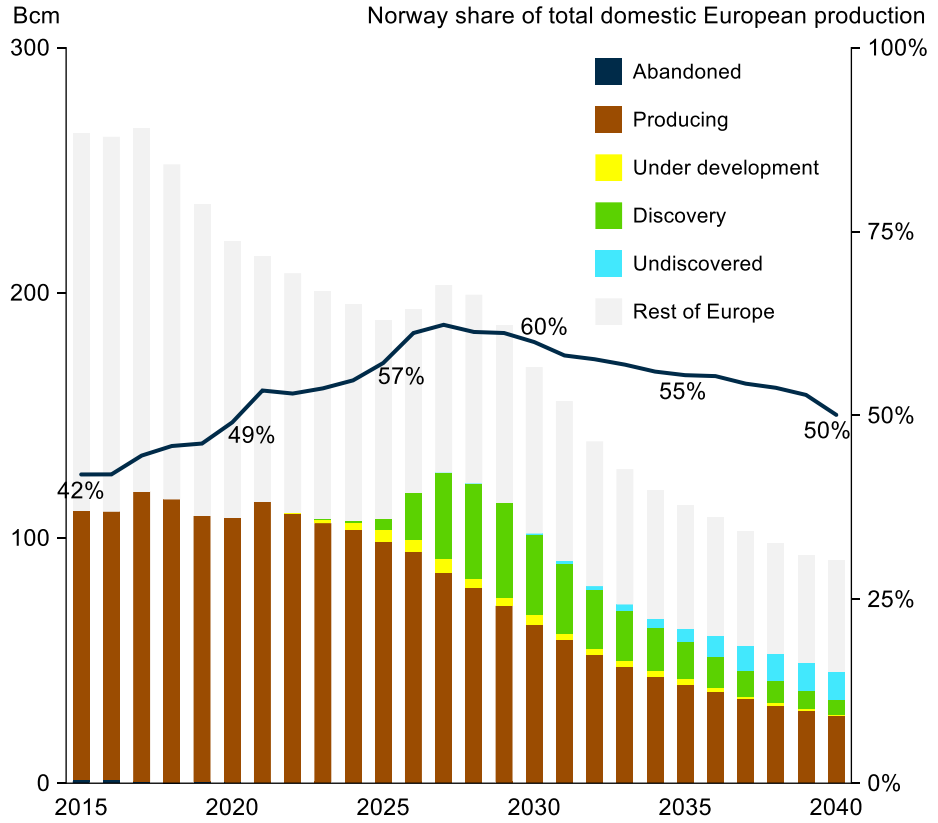
Norwegian production will stay at maximum levels in the 2020s before declining

Map*



- Norwegian gas production is concentrated in the North Sea on the back of the giant Troll field
- The Norwegian Sea is an important region with multiple new developments expected and also the most active gas exploration agenda
- Resources in the Barents Sea are not included as they are defined as part of the LNG pool and a potential increment should Barents pipe be built

Production profile



- Norwegian production has stayed just north of 100 bcm since 2015 and is expected to continue this trends towards 2030
- This level also represents the infrastructure capacity currently in place with only marginal possible increases in gas production
- Longer term production is expected to decline as the big fields are depleted, but Norway will retain a domestic production share above 50%

*Map illustrates gas production between 2022 and 2040.
Source: Rystad Energy research and analyses

Content

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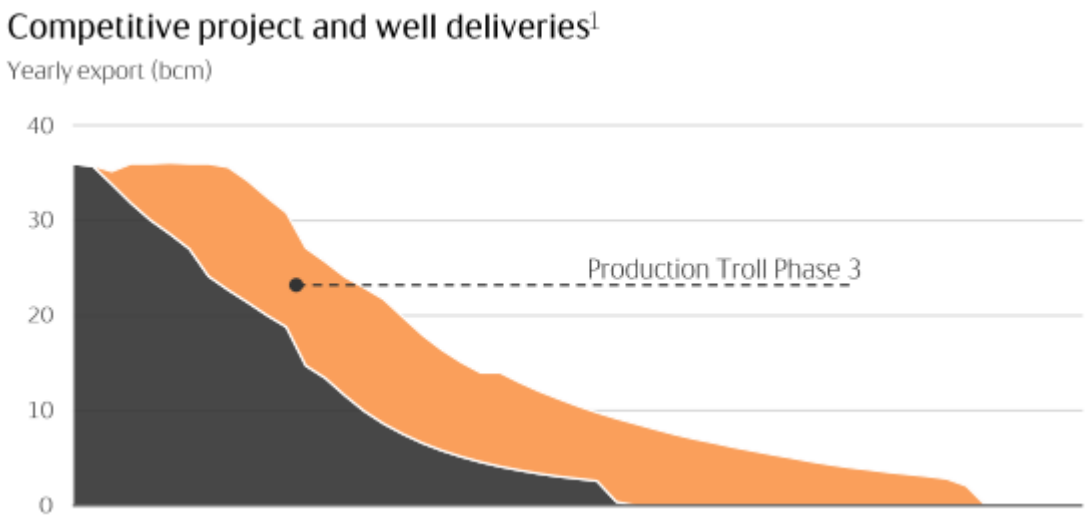
Norwegian decline inevitable post 2030 due to Troll and unavailable exploration potential

Troll will enter decline

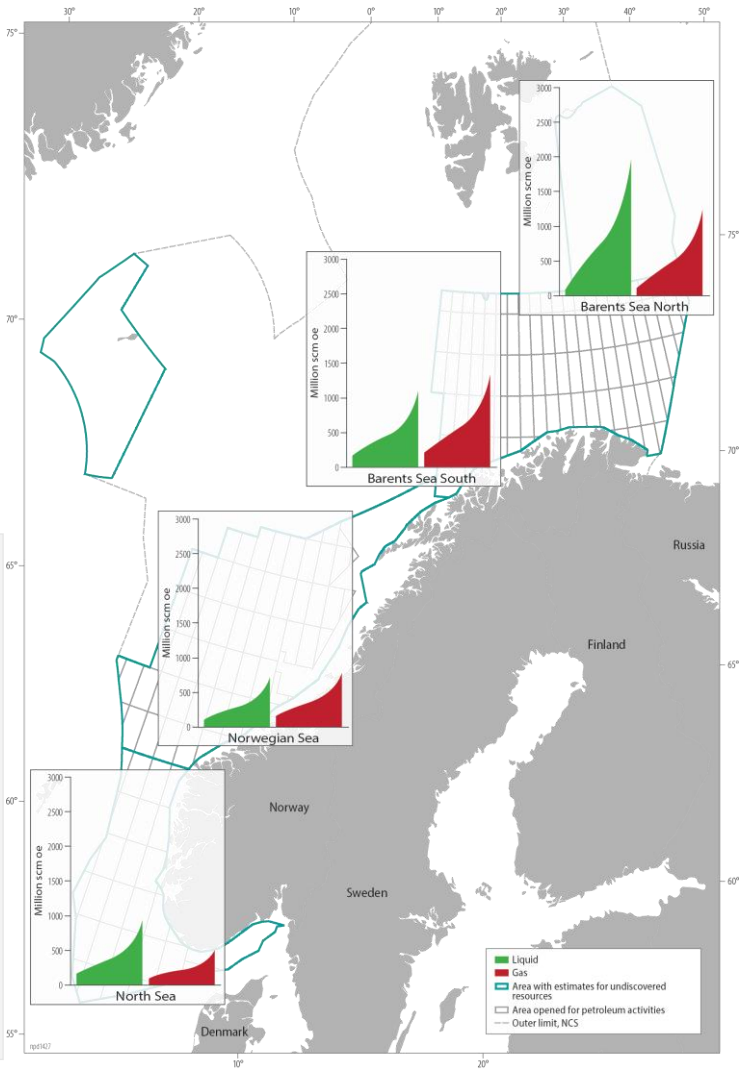


Norway is currently a critical gas supplier to Europe with its roughly 100 bcm of annual exports. This export level is expected to endure towards 2030 on the back of a flurry of development projects maintaining production levels. After 2030; however, the portfolio of development projects are expected to diminish, and they are nevertheless too small to compensate for decline in the giant Troll field.

Top chart:
Equinor's illustration on how phase 3 of Troll will help extend plateau production towards 2030 before decline commences

Right map:
The Norwegian Petroleum Directorate estimates significant remaining exploration potential on the Norwegian continental shelf, but most of the potential is in the Barents Sea South (opened for petroleum activity) and Barents Sea North (closed for petroleum activity). Given the lack of gas export capacity from the Barents Sea, the gas resources are currently viewed as stranded and unable to help compensate for declining gas production in the North Sea and Norwegian Sea

Exploration potential is stranded



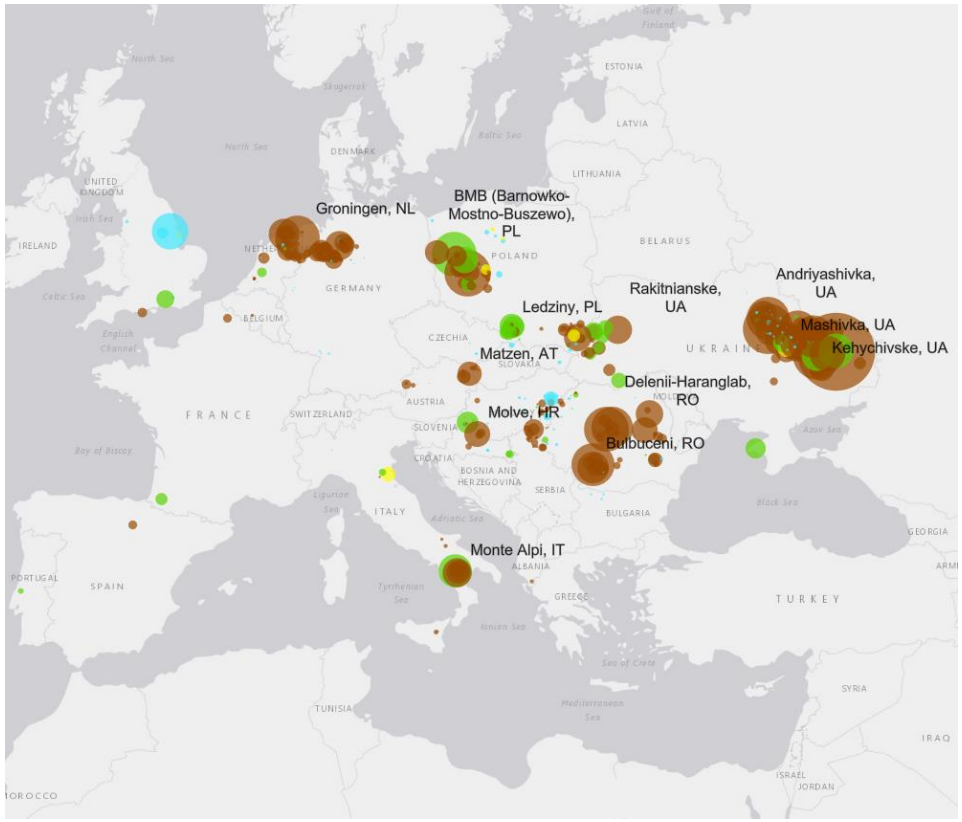
Source: Rystad Energy research and analysis, Equinor, NPD

Content

RYSTAD ENERGY

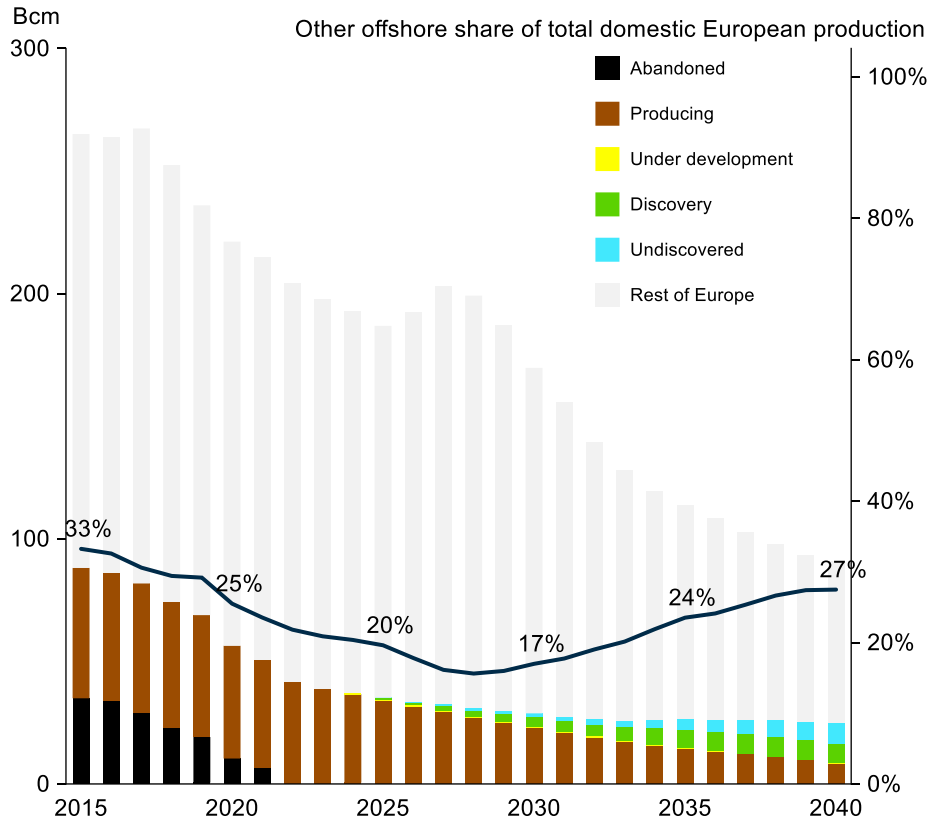
Onshore production highly dependent on Dutch and Ukrainian conflict political outcomes

Gas production, 2022-2040*



- Onshore production comes from the Netherlands, Romania and Ukraine
- Political decisions are critical for future Dutch and Ukrainian production
- For Dutch onshore production, the decisions on Groningen production will be important with the intended shut down in 2023 reflected in this data
- For Ukraine, it is the ongoing conflict and its impact on production that creates uncertainty

Production profile



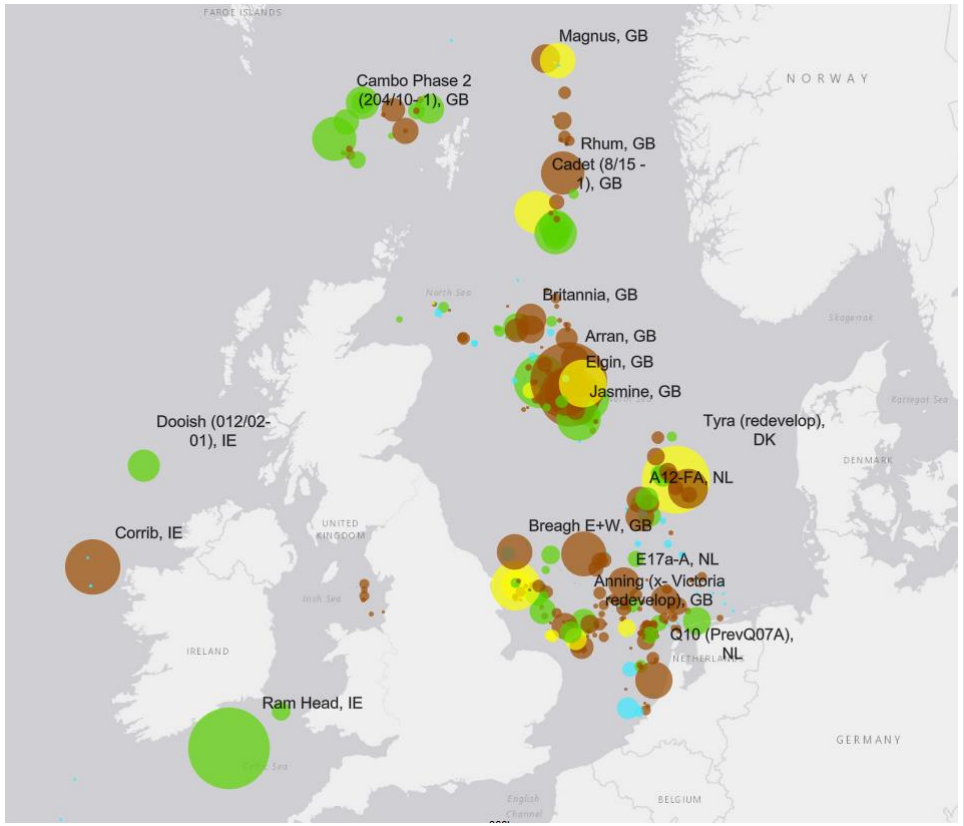
- Onshore production declined fast from 2015 as curtailments to Groningen production was put in place to prevent tremors
- Outlook points to limited resources that can help arrest decline
- Shale is probably the only resource base that could radically change production outlook, but the cost of supply is considered too high to be competitive with LNG imports (see appendix for additional details)

*Map illustrates gas production between 2022 and 2040.
Source: Rystad Energy research and analyses

Content

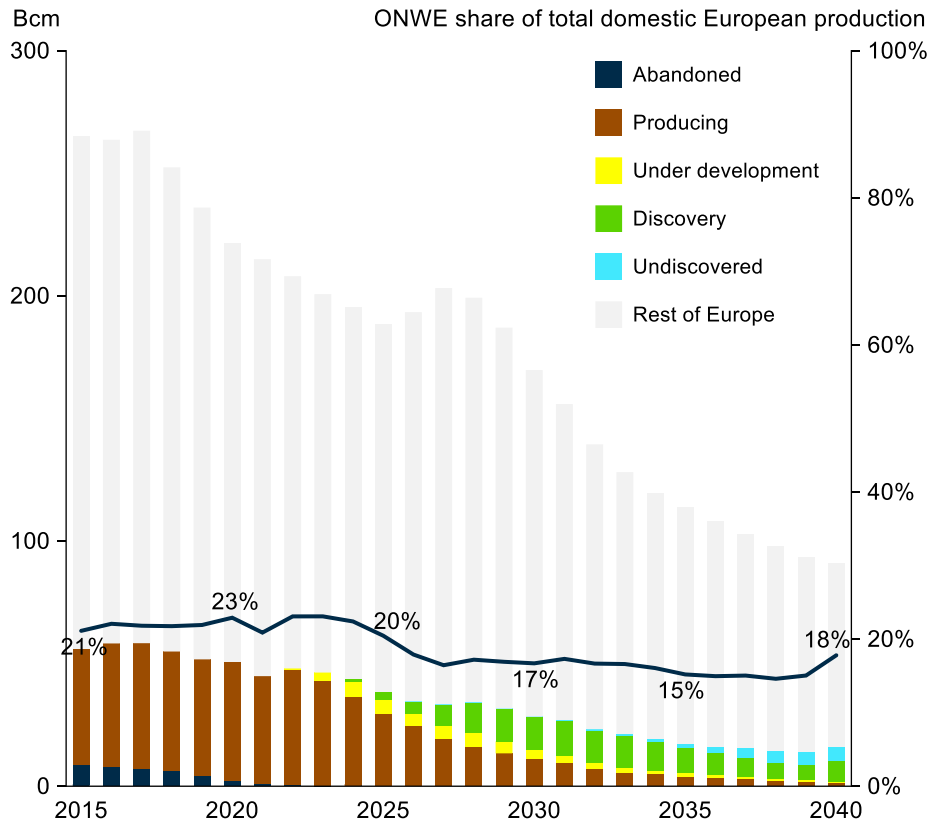
Offshore Northwest Europe expected to decline, but has numerous smaller projects that can be called upon

Gas production, 2022-2040*



- The remaining potential offshore Northwest Europe outside Norway is primarily located in the United Kingdom
- Numerous projects are under development and promising discoveries are being matured, but they are all of relatively small nature and not expected to arrest overall decline in production

Production profile



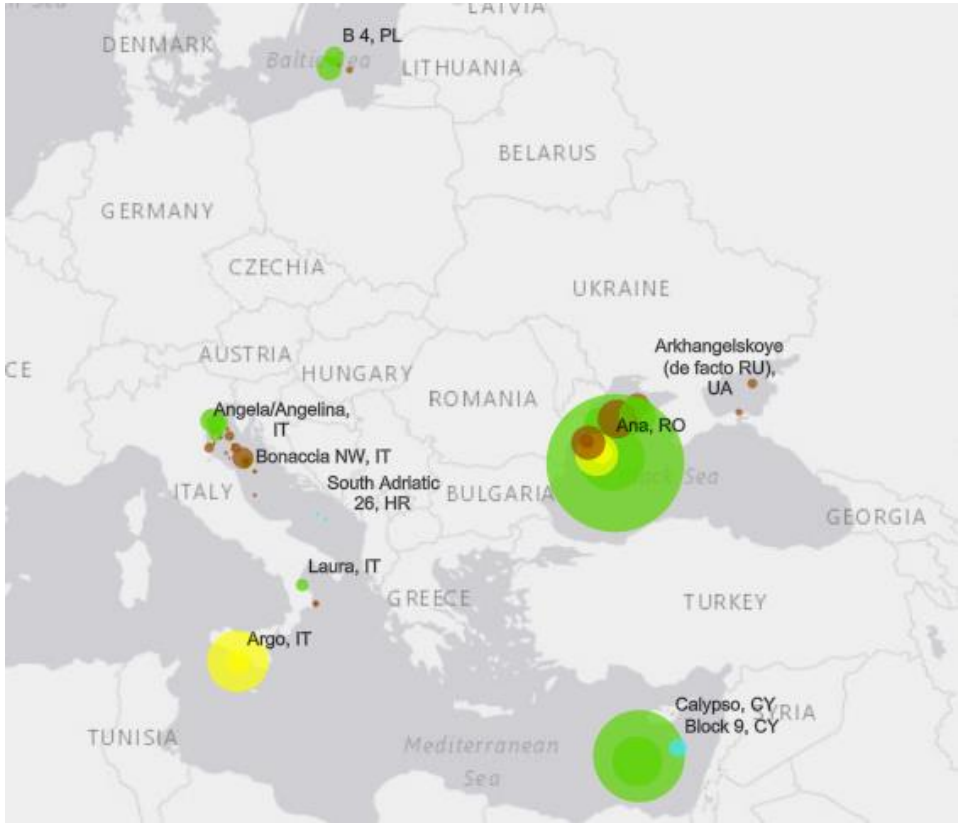
- A constant effort to maintain production levels have been ongoing since 2015 with big projects such as Cygnus, Culzean and Tolmount contributing to arresting decline from existing fields
- Going forward, it will be important to realize the remaining smaller accumulations while infrastructure is in place to avoid stranded resources

*Map illustrates gas production between 2022 and 2040.
Source: Rystad Energy research and analyses

Content

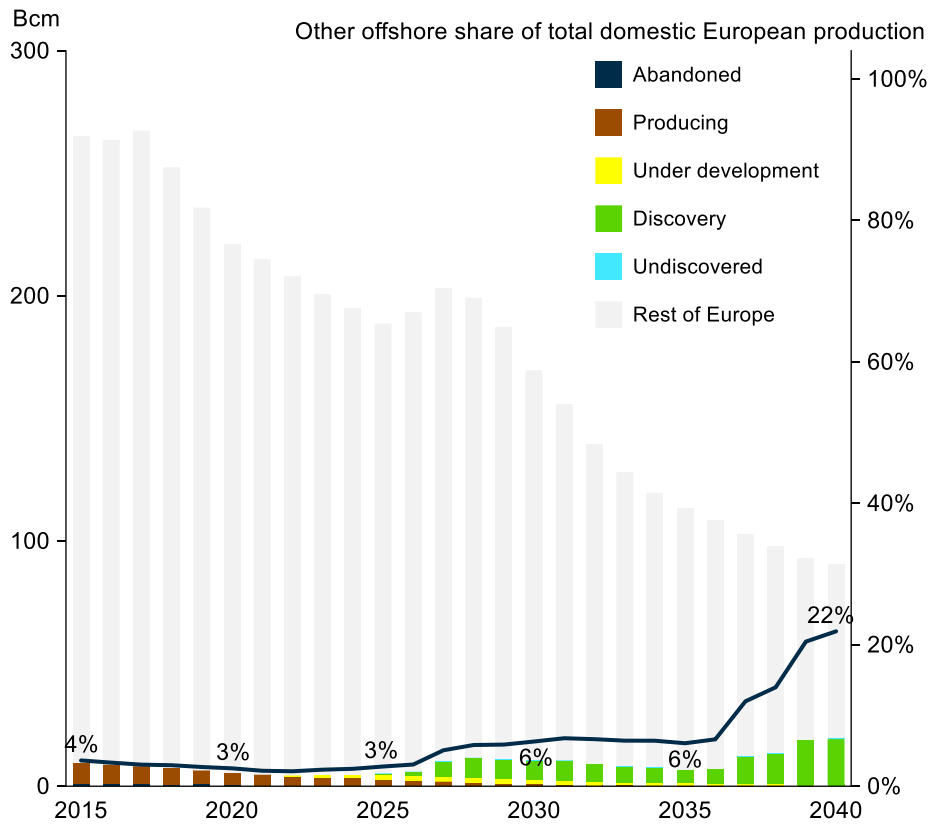
Other offshore resources is primarily related to the Romanian Black Sea Neptune block

Gas production, 2022-2040



- The key resource base in other offshore production is located in the Black Sea outside Ukraine and Romania
- Ukrainian production is subject to the same ongoing conflict consideration as the onshore Ukrainian production
- The Romanian Neptune block containing the Domino discovery is the key contingent offshore resource outside Northwest Europe

Production profile



- The key consideration for the other offshore production is start up for the Romanian discoveries
- Current assumption is for the Neptune Block to start production towards the later part of the 2020s
- Resources from Eastern Mediterranean are not included as any production from this area will at best be transported to Europe via LNG and not pipe

*Map illustrates gas production between 2022 and 2040.
Source: Rystad Energy research and analyses

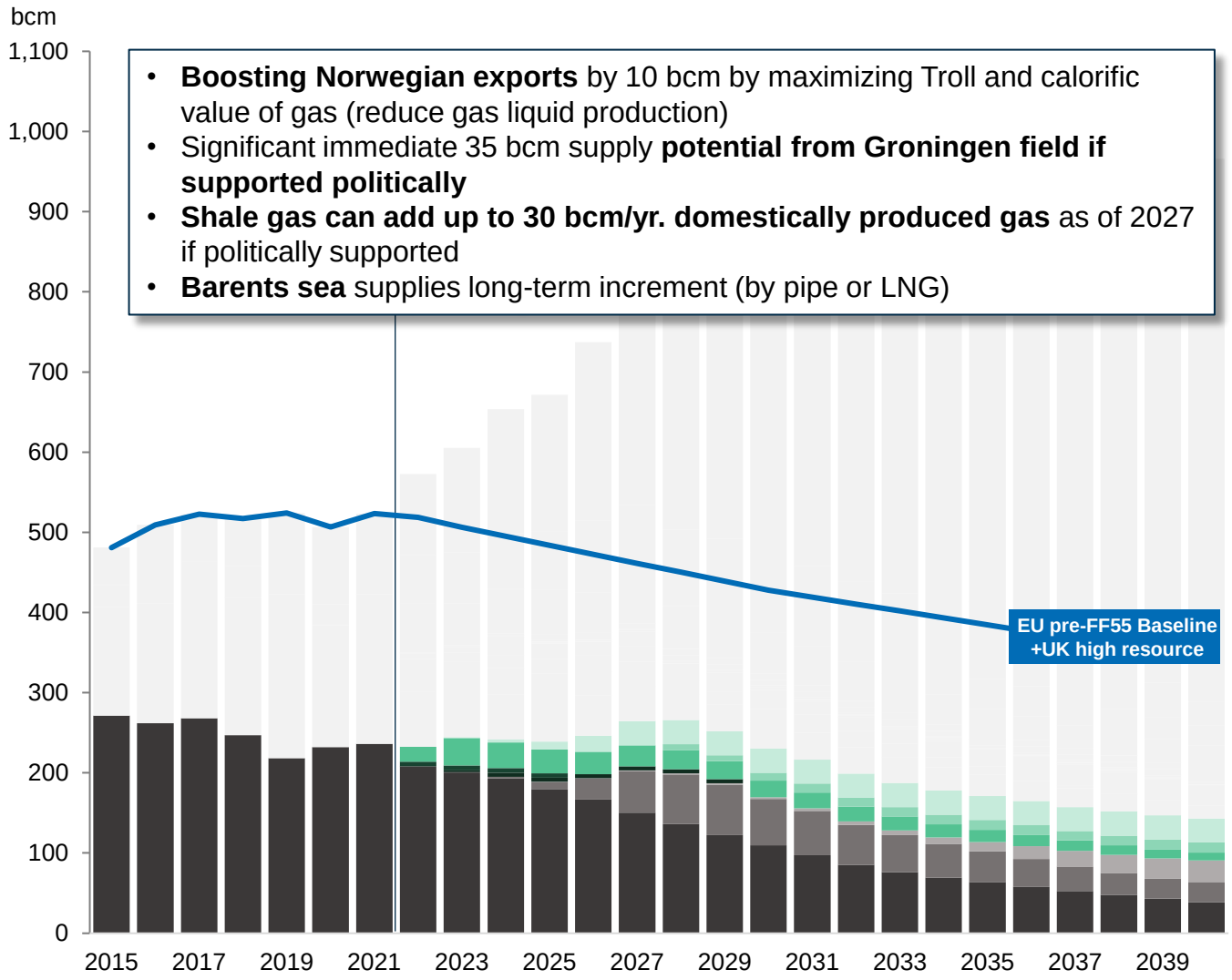
Content

Content

Moderate maximization of domestic supplies possible

Gas source	Increment group	Timing
Domestic	Base	Both
	Increment contingent	Long term
	Increment exploration	
Special domestic increment	Troll max	Short term
	Higher GCV	
	Groningen	
	Barents pipe	Long term
	European shale	
Russia	Russian piped gas	Short term
Piped gas	Europe piped gas imports	Both
	Algeria increase	Short term
	Turkey pass-through	
	TR/Azerbaijan expansion	Long term
LNG	LT Contracted	Both
	Spot/FOB LNG	Short term
	Available for LT contracts	Long term

Production by increment group



- **Boosting Norwegian exports** by 10 bcm by maximizing Troll and calorific value of gas (reduce gas liquid production)
- Significant immediate 35 bcm supply **potential from Groningen field if supported politically**
- **Shale gas can add up to 30 bcm/yr. domestically produced gas** as of 2027 if politically supported
- **Barents sea** supplies long-term increment (by pipe or LNG)

Source: Rystad Energy research and analysis

Content

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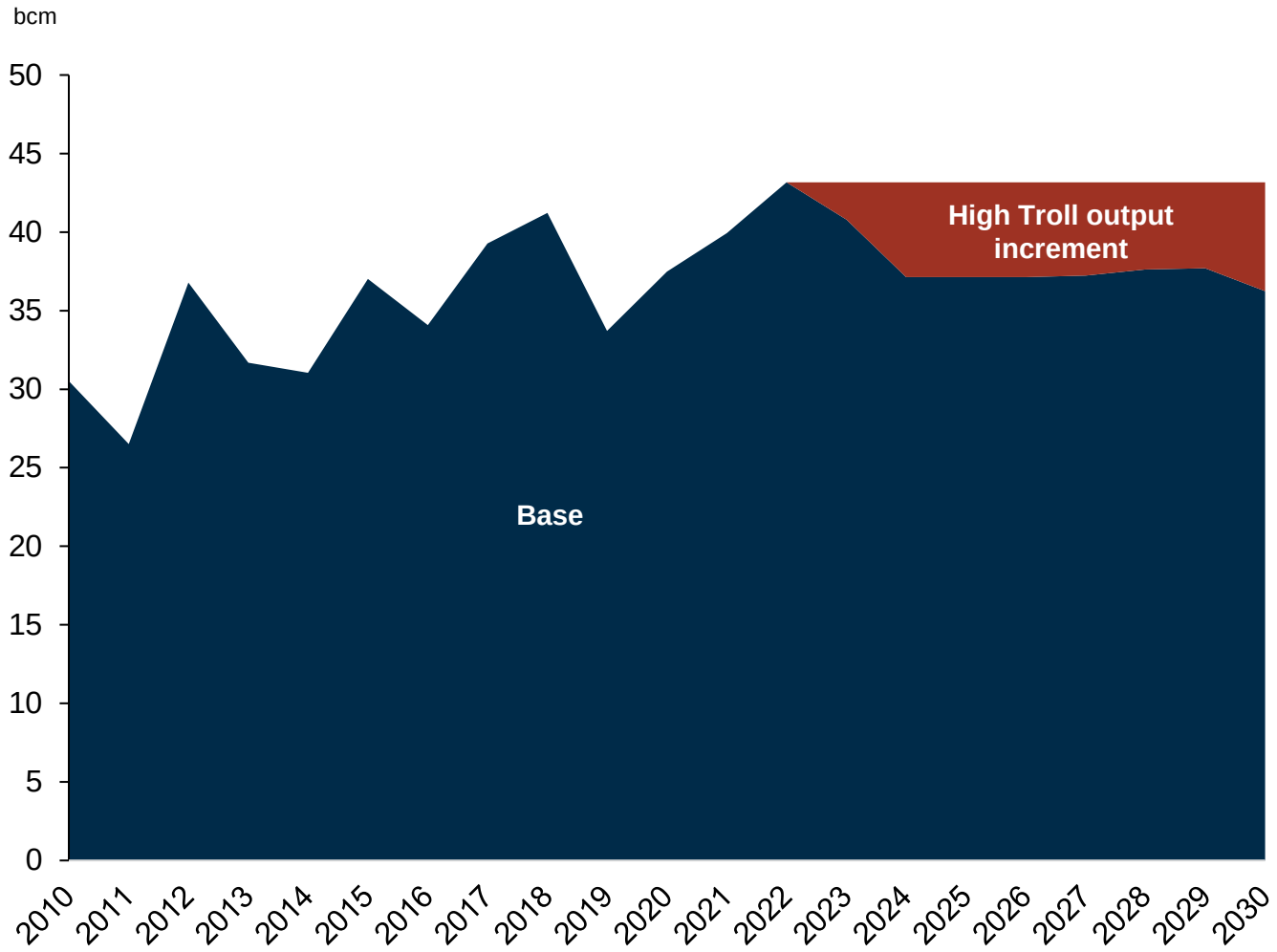
Increment from maintaining Troll at elevated gas offtake levels

Gas production at Troll

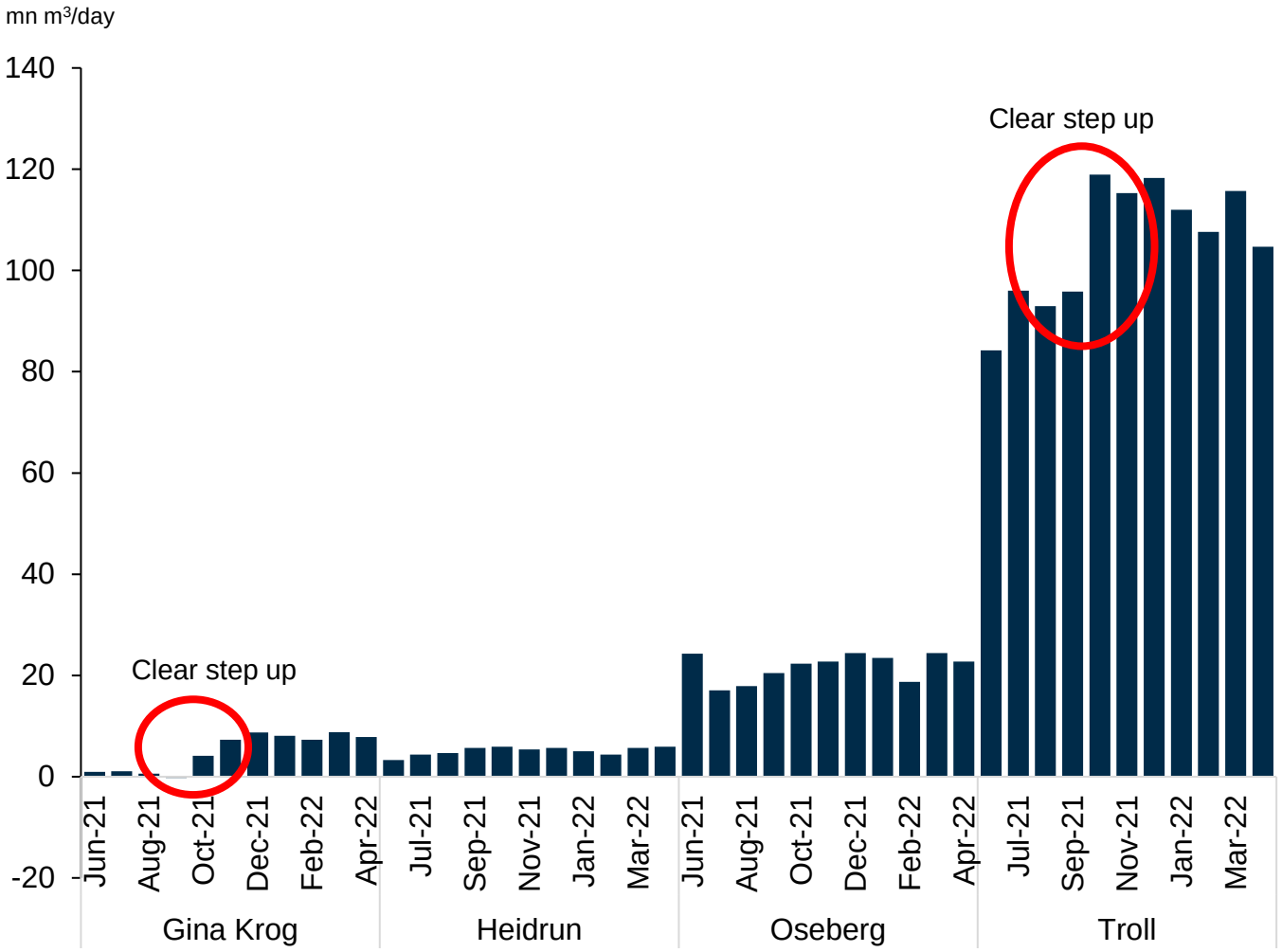


- Troll is the largest gas producing field in the North Sea, producing 40bcm in 2021
- Troll has typically been used as a swing producer and seen its gas production curtailed in favor of pressure support for oil production – the increment implies removing these curtailments from the field's full production potential
- This scenario, albeit unsustainable in the long term, would see an additional 5bcm of production annually

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

Troll and Gina Krog showing upticks in gas production in October 2021

Selected Norwegian Field Production by Month (May 2022 figures not yet released)

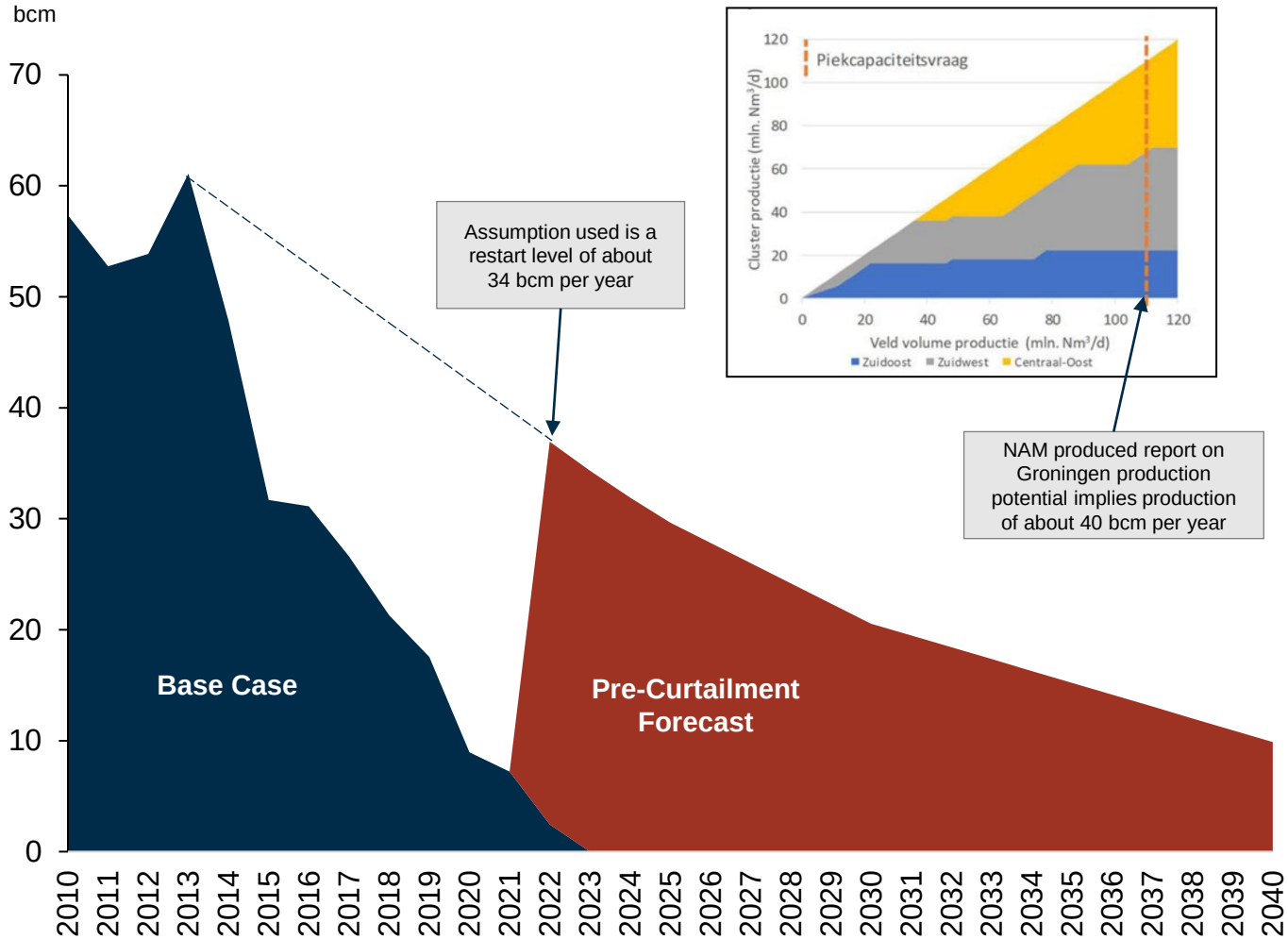


- The gas production year starts in October, this is typically where you would see a step change in production for any given field
- Both Gina Krog and Troll showed upticks in production in that month
- Announcements have been made in March 2022 to boost production at several of these fields, data is not yet available for May 2022

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

Netherlands' Groningen has potential to provide more gas than it does at present if there is political will to undo the curtailments in the last 5 years

Gas production at Groningen

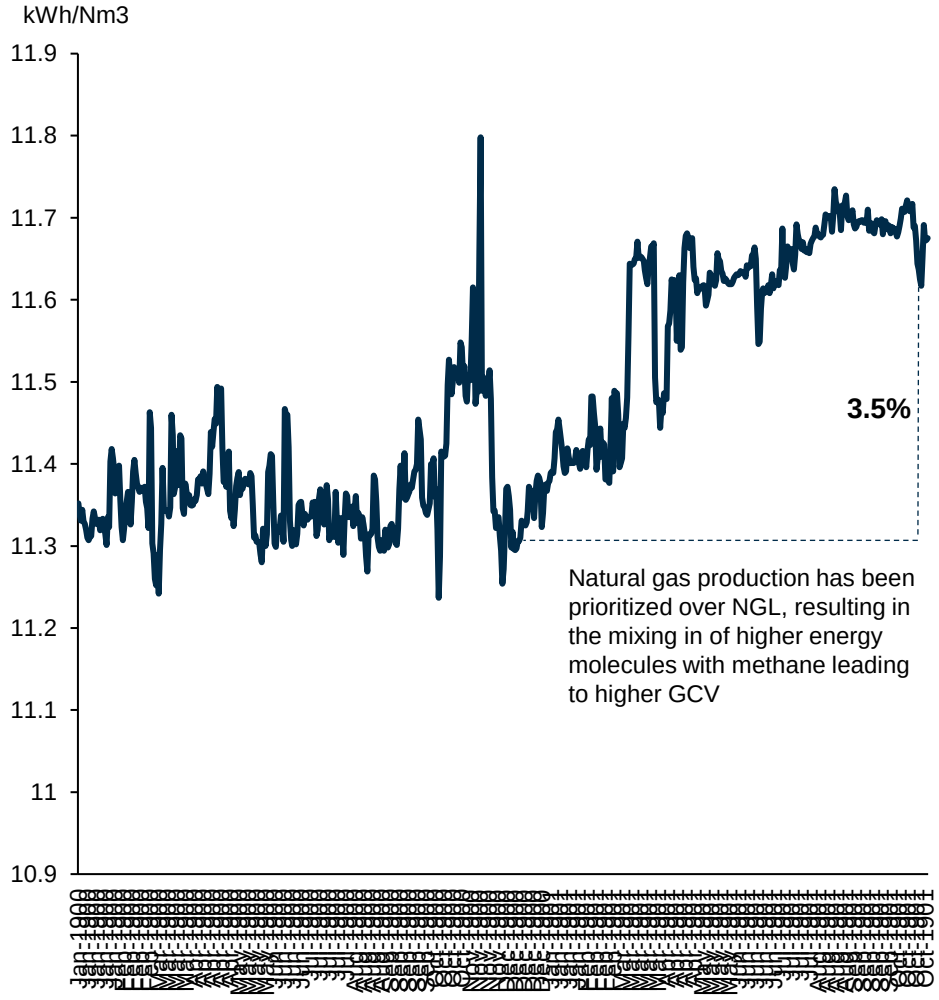


- Earthquakes as a result of production at the Groningen field in the Netherlands led to the Dutch government's decision to curtail production on the field
- Current plans would see production wind down in 2022 with no production forecast in 2023
- Rystad's view before the curtailment would have seen production continue throughout the 2030s and into the 2040s
- If that were to be realized once again then between 20 and 30 bcm per year would be available throughout the rest of 2020s

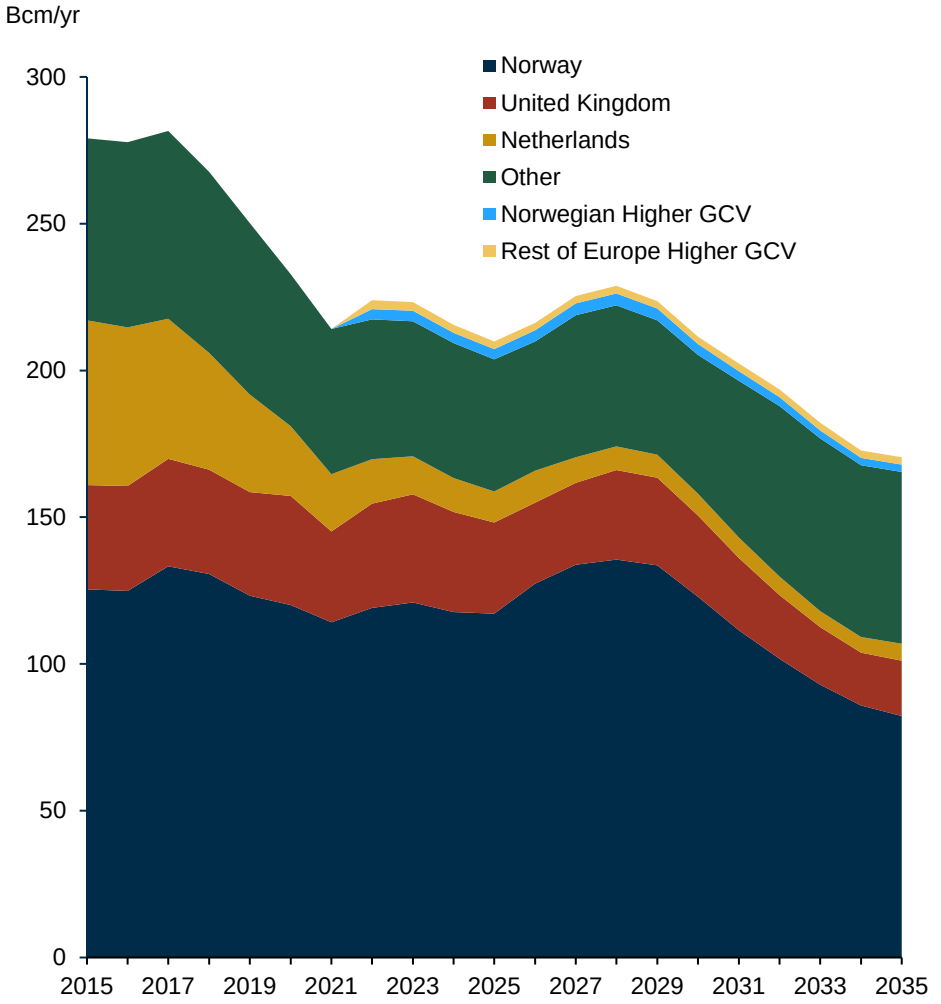
Source: Rystad Energy Gas Market Cube, Rystad Energy research and analysis, NAM

Energy content increases (GCV) seen in Norwegian deliveries to Germany would yield an equivalent of 3% increase in volumes

Gross caloric value of Norwegian Gas Delivered to Dornum, Germany



European Gas Production



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

Content

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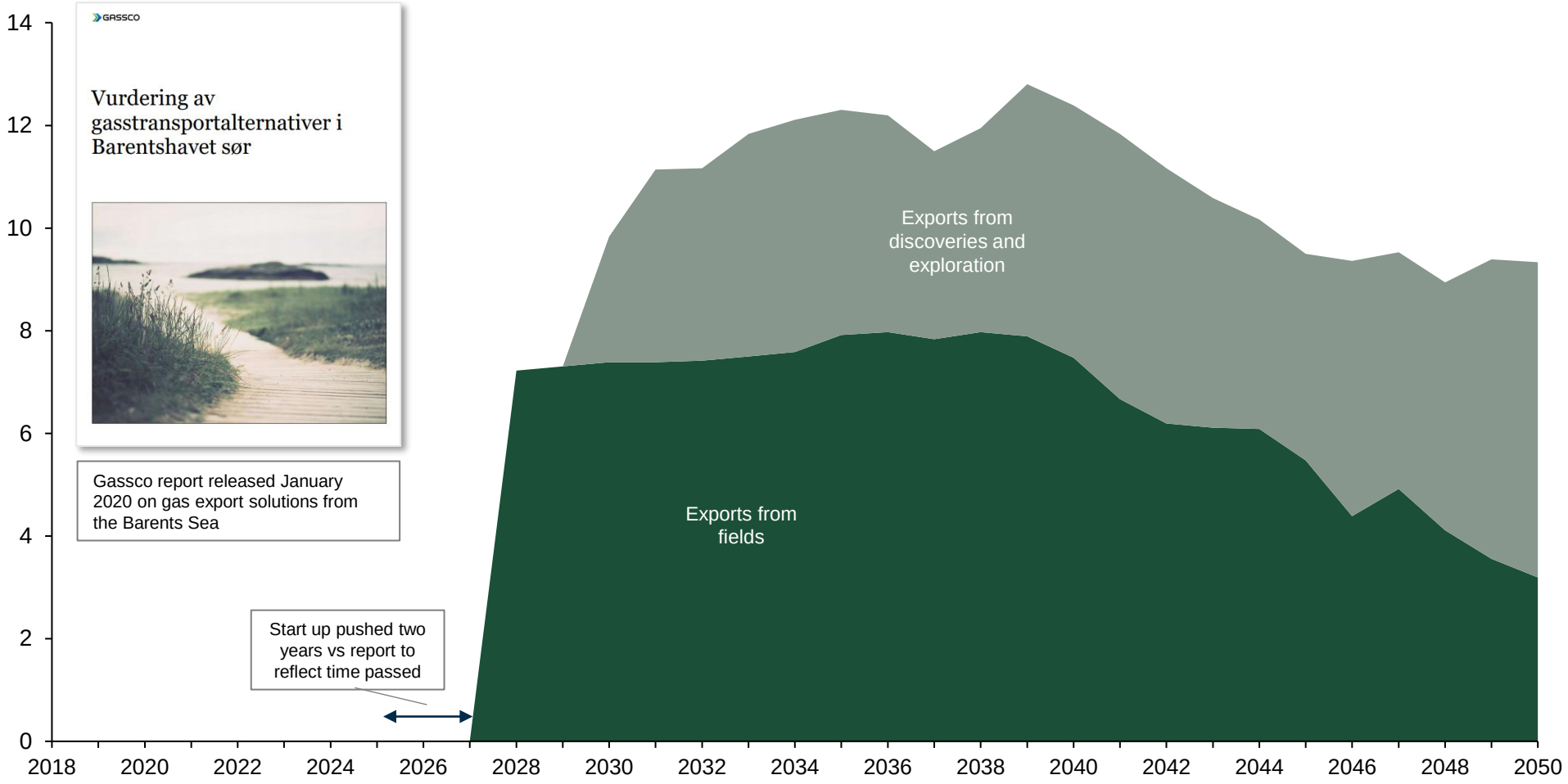
Potential Barents Sea piped volumes based on Gassco's report

Barents Sea piped gas export potential as reported by Gassco

Billions Sm3 per year

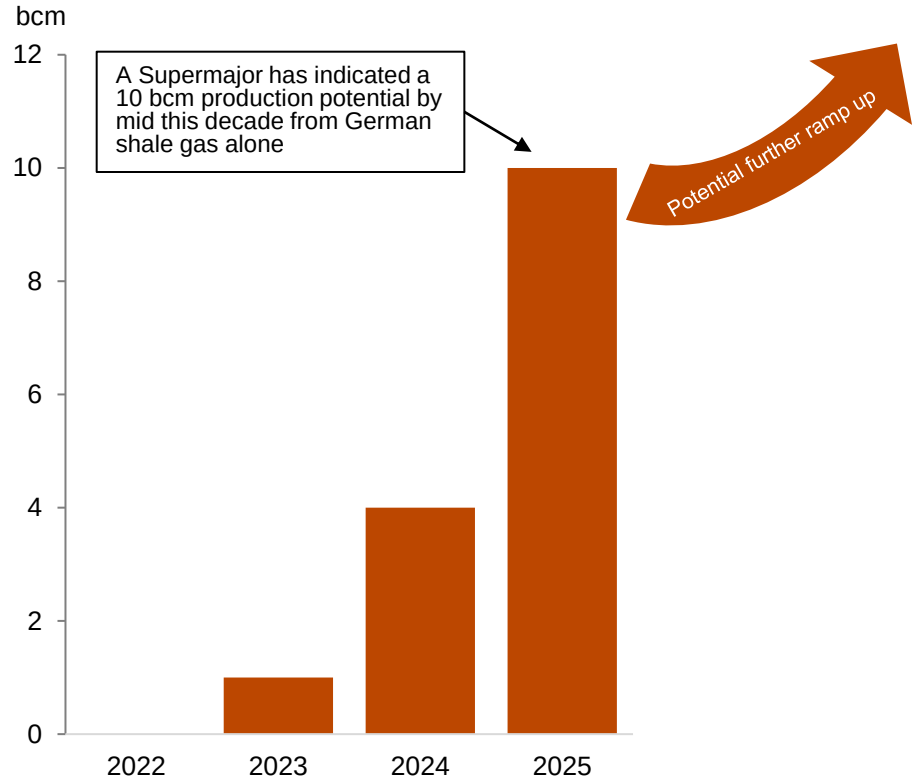


Source: Gassco

Content

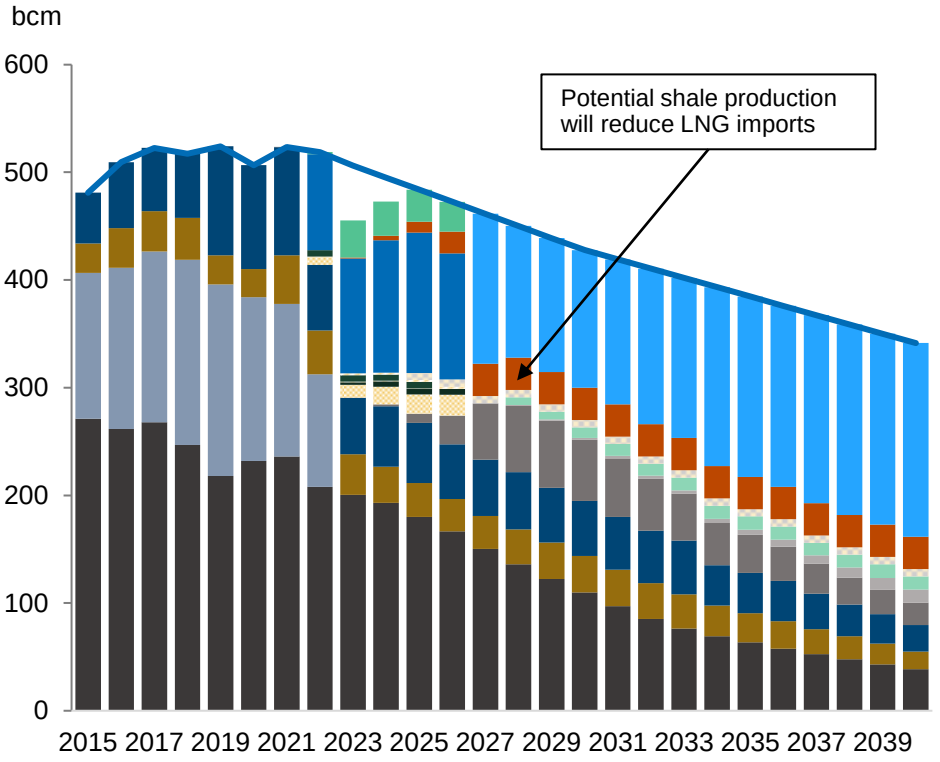
European shale resources are vast, but with uncertain economical potential

Possible European shale gas production



- A Supermajor has indicated that permit process permitting, the German shale potential can reach 10 bcm production by mid 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 production ramp up likely possible, but no indication given on max potential

Impact on European supply potential

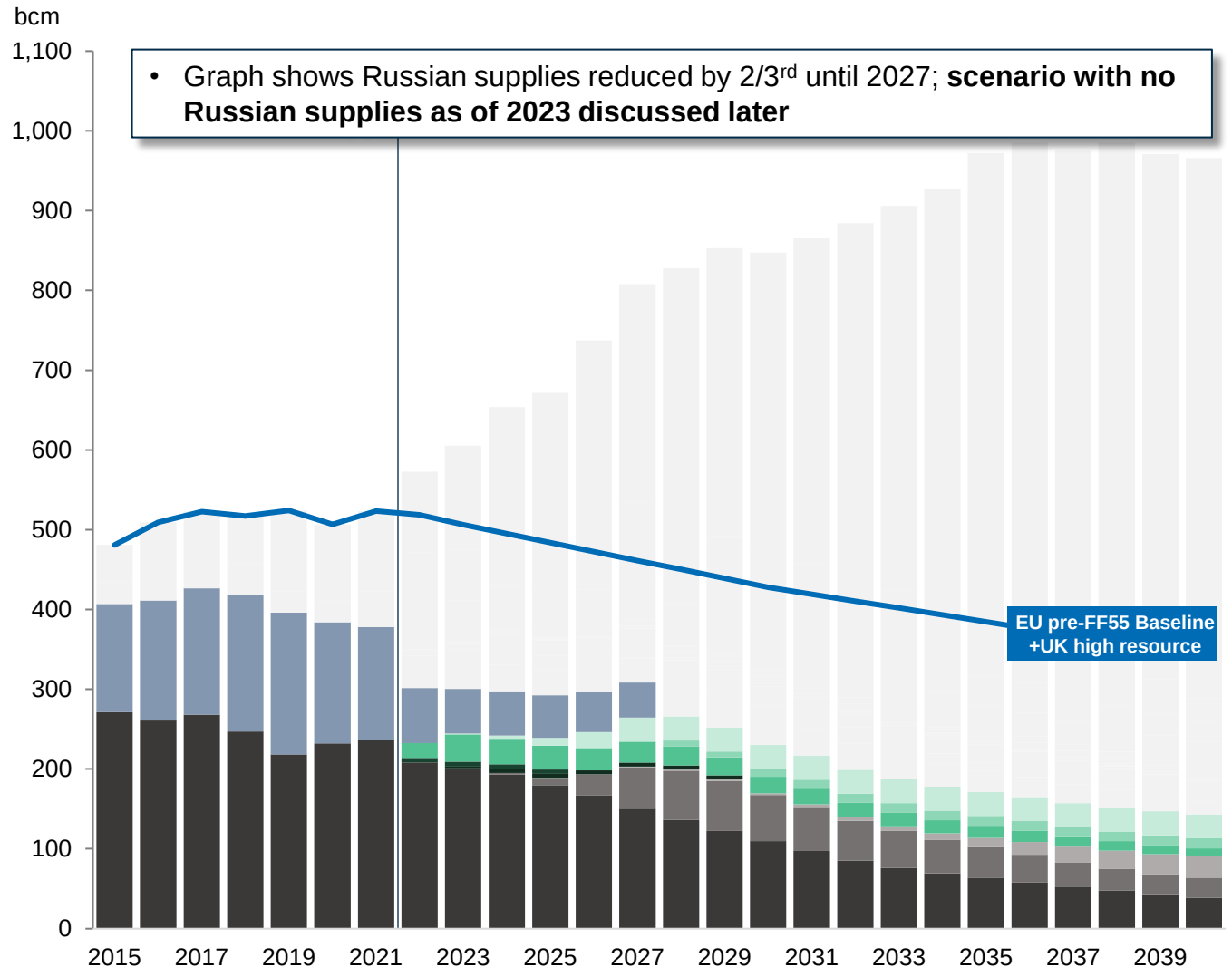


- Putting shale production into the wider balance context reveals that any production until 2027 will help reduce but not eliminate the burden on Groningen production and demand reduction to reach balance
- From 2027 onwards any shale production (in the chart assumed to ramp up towards 30 bcm per year) will reduce required LNG imports
- A key assumption is that shale production outcompetes long run marginal cost LNG

Content

Russian piped gas supply assumed to reduce by 2/3 as of 2023 and cease in 2027

Gas source	Increment group	Timing
Domestic	Base	Both
	Increment contingent	Long term
	Increment exploration	
Special domestic increment	Troll max	Short term
	Higher GCV	
	Groningen	
	Barents pipe	Long term
	European shale	
Russia	Russian piped gas	Short term
Piped gas	Europe piped gas imports	Both
	Algeria increase	Short term
	Turkey pass-through	
	TR/Azerbaijan expansion	Long term
LNG	LT Contracted	Both
	Spot/FOB LNG	Short term
	Available for LT contracts	Long term



Source: Rystad Energy research and analysis

Content

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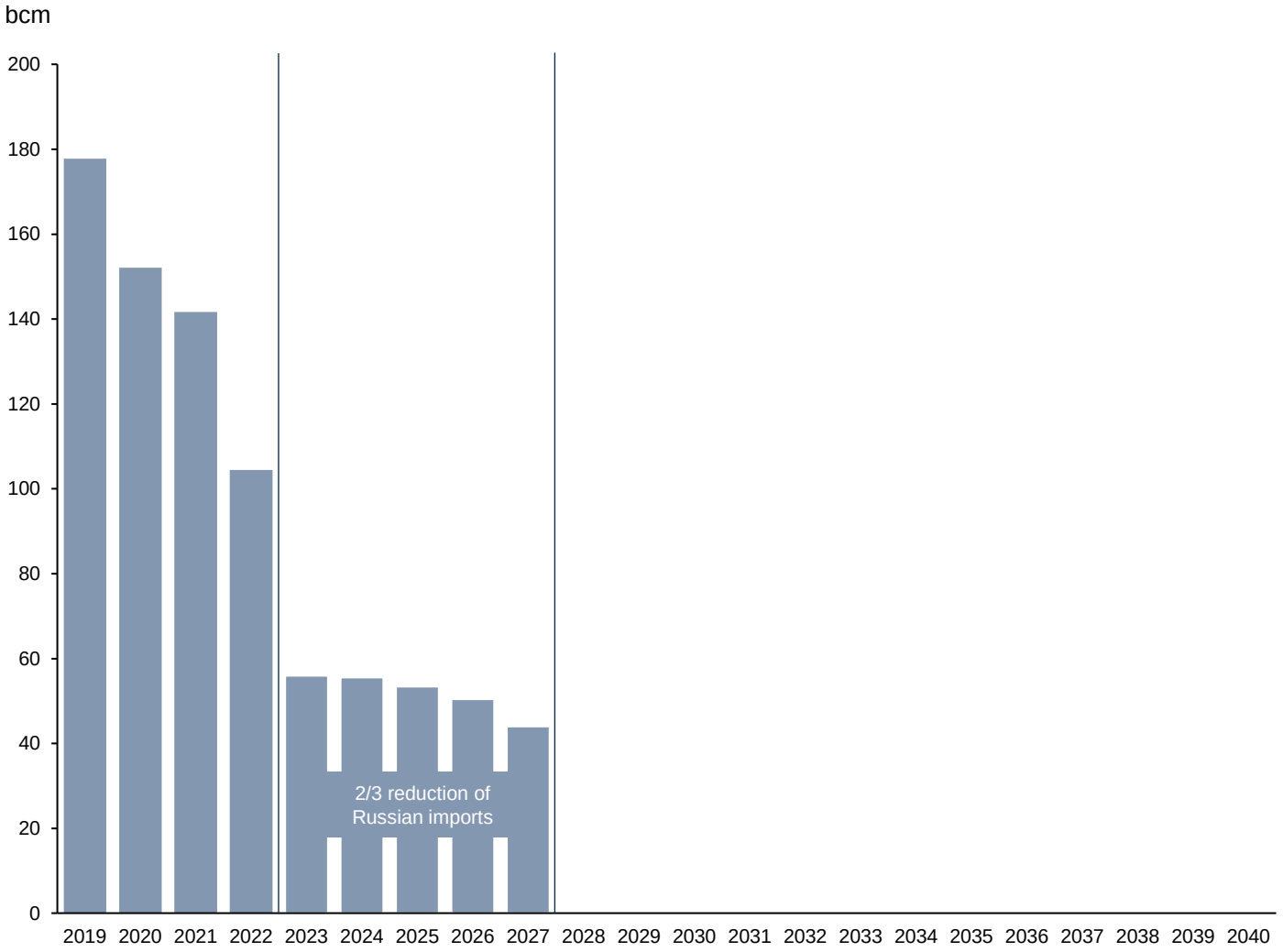
The level of Russian imports towards 2027 ranges between 0 and 55 bcm

Russian piped gas supply scenario



The chart illustrates two approaches to what Russian gas supply might look like towards 2040

The most conservative approach is for Russian imports to seize after 2022

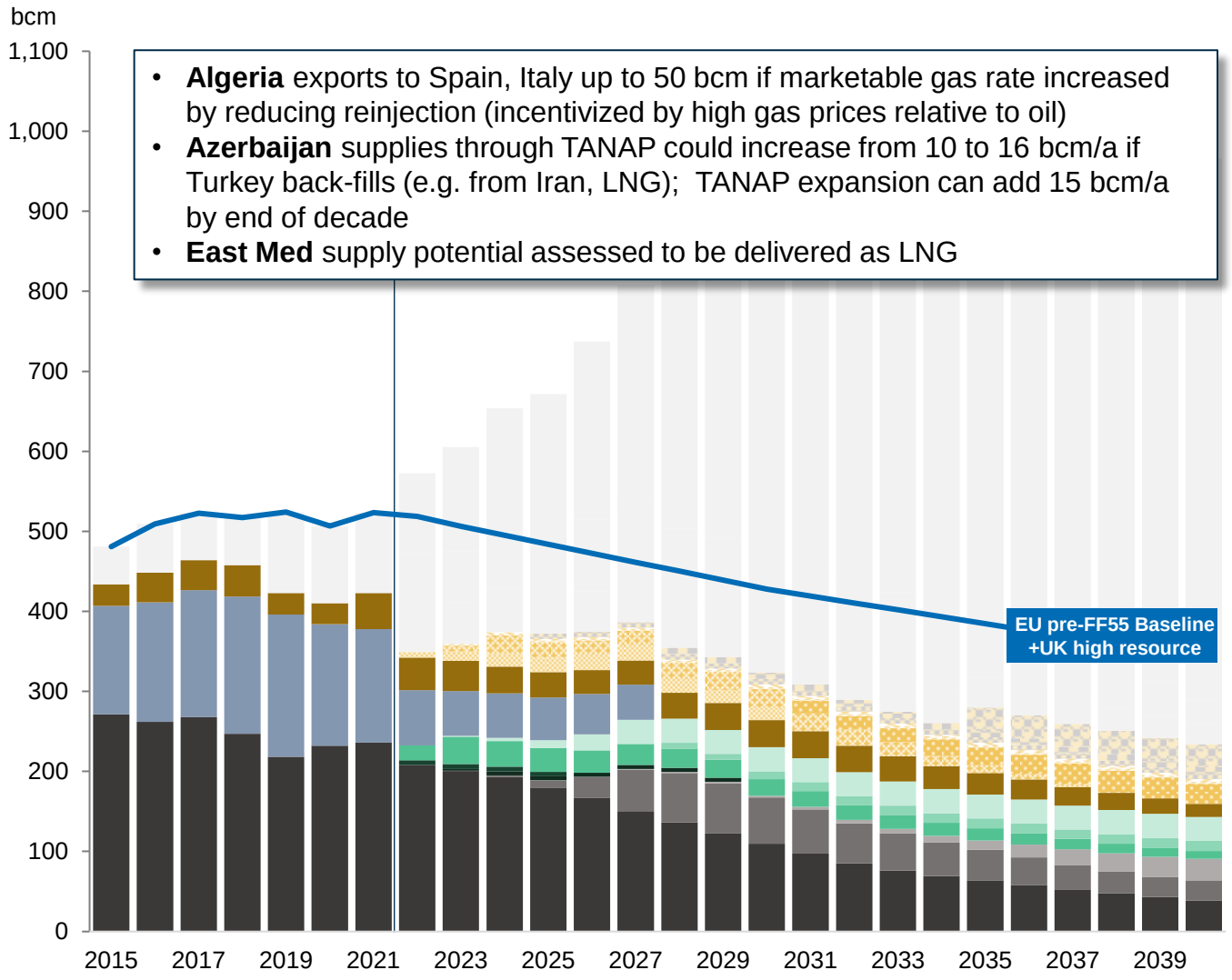
An incremental view is to allow for an import level consistent with the implied 2/3 reduction of Russian imports as stated by the European Commission

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

Content

Non-Russian other pipeline imports to Europe contribute about 10% of overall supplies

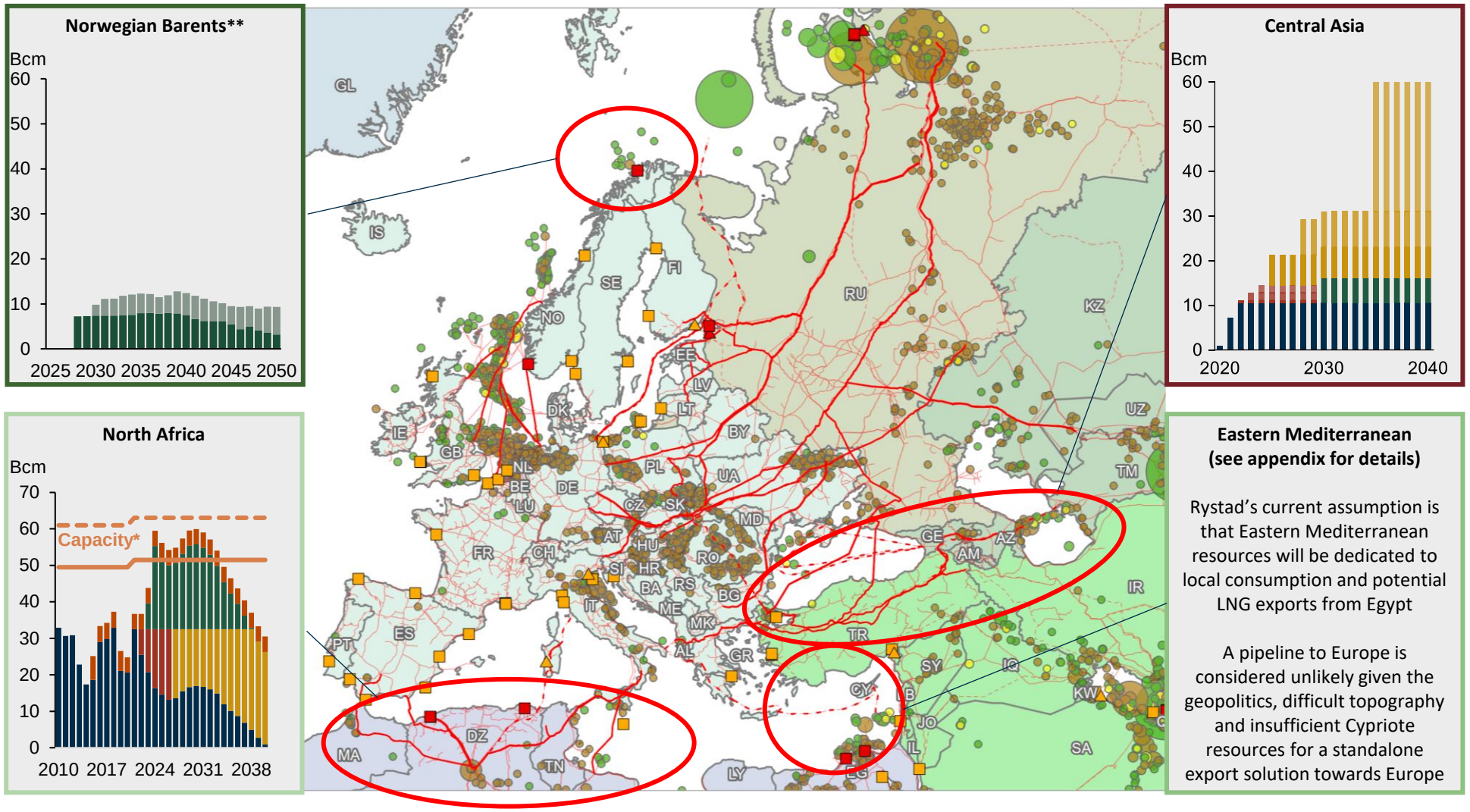
Gas source	Increment group	Timing
Domestic	Base	Both
	Increment contingent	Long term
	Increment exploration	
Special domestic increment	Troll max	Short term
	Higher GCV	
	Groningen	
	Barents pipe	Long term
	European shale	
Russia	Russian piped gas	Short term
Piped gas	Europe piped gas imports	Both
	Algeria increase	Short term
	Turkey pass-through	
	TR/Azerbaijan expansion	Long term
LNG	LT Contracted	Both
	Spot/FOB LNG	Short term
	Available for LT contracts	Long term



Source: Rystad Energy research and analysis

Content

Pipeline expansions around Europe can help increase piped gas supply



Eastern Mediterranean (see appendix for details)

Rystad's current assumption is that Eastern Mediterranean resources will be dedicated to local consumption and potential LNG exports from Egypt

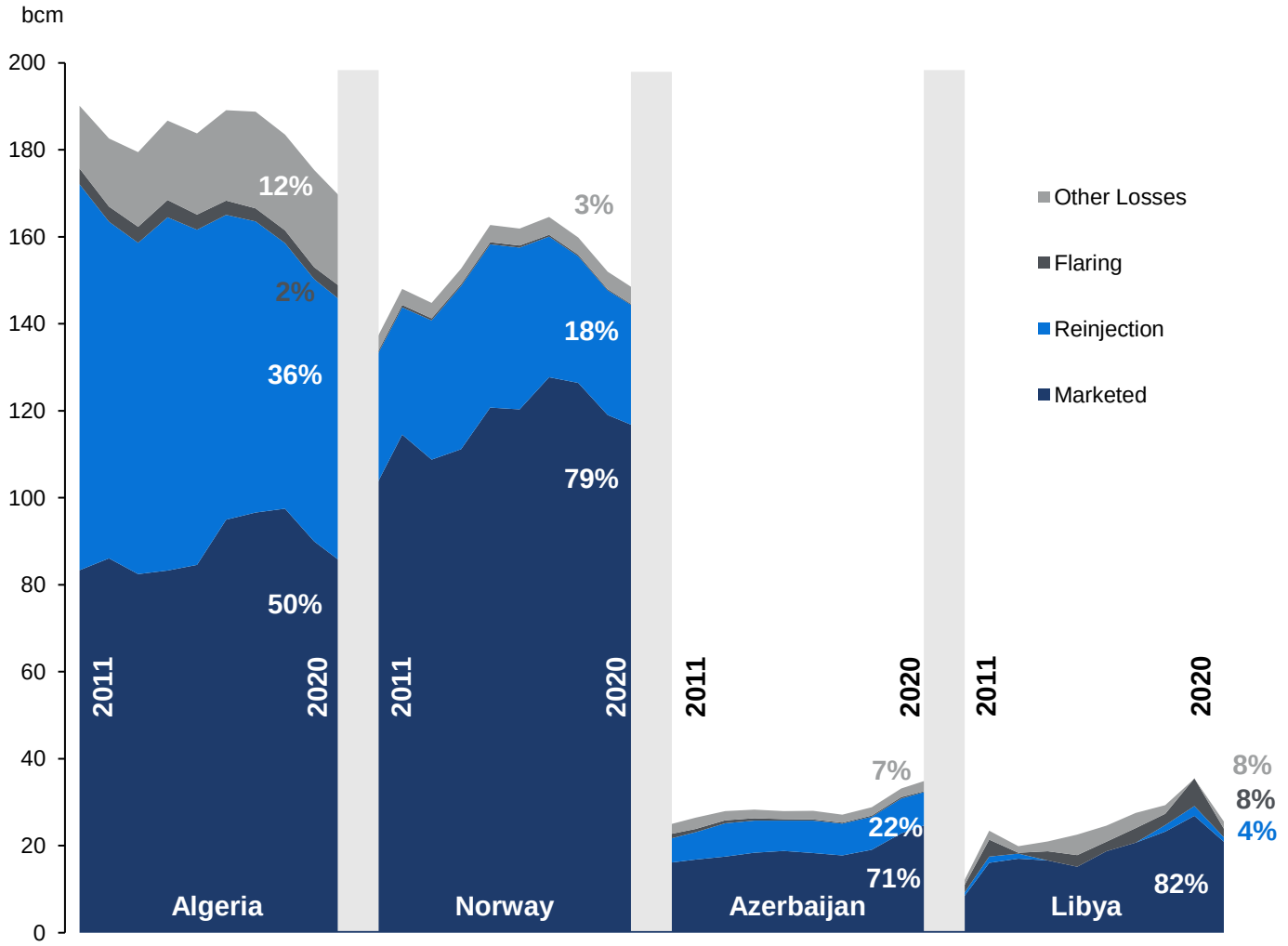
A pipeline to Europe is considered unlikely given the geopolitics, difficult topography and insufficient Cypriote resources for a standalone export solution towards Europe

*Solid line suggests capacity given Medgaz pipeline, Transmed pipeline and Greenstream pipeline. Dashed line includes GME pipeline as well. **See domestic increments for additional details
Source: Rystad Energy research and analysis

Content

Algeria reinject far more gas than other potential European suppliers

Gross Natural Gas Production*



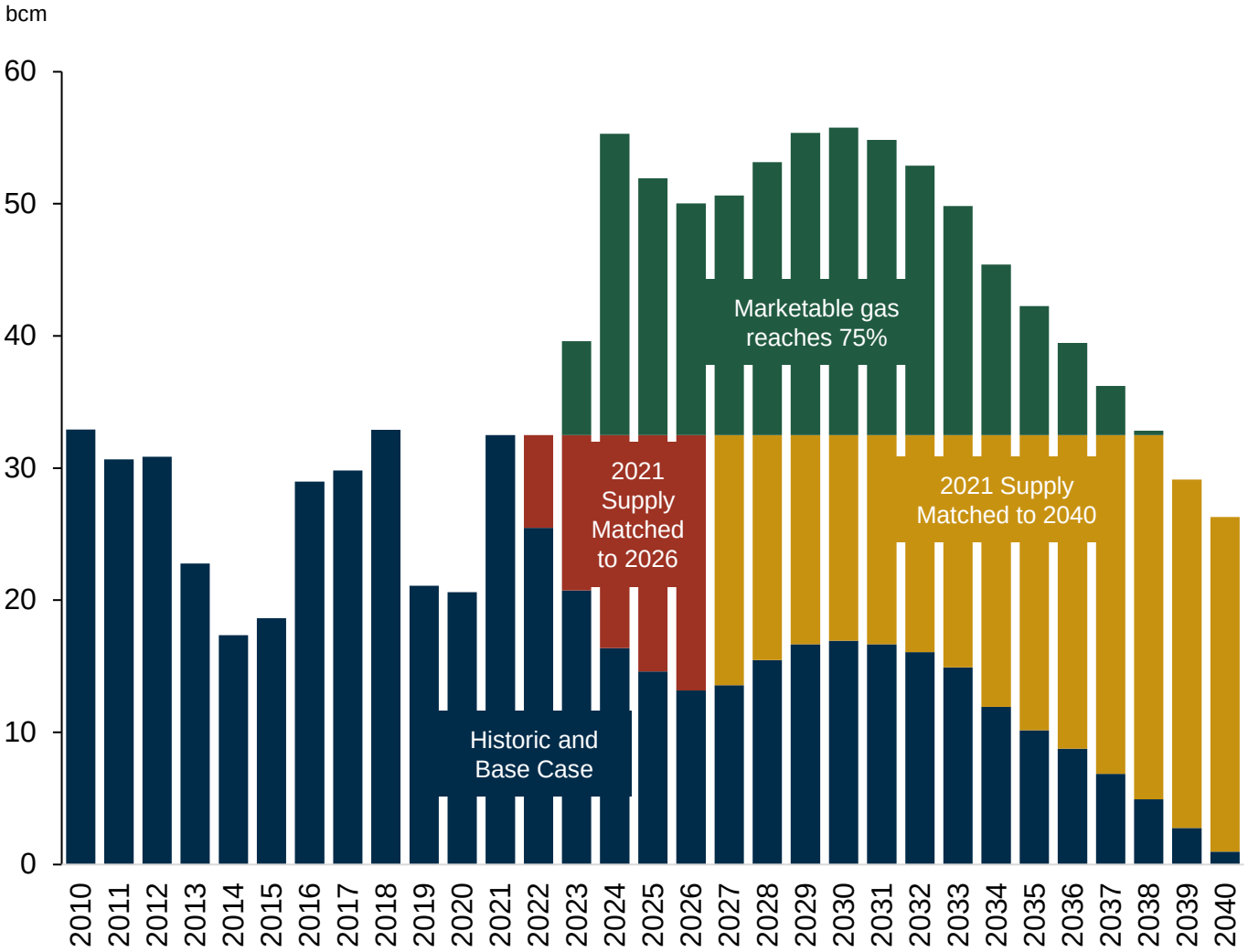
- Algeria has a higher gross production of natural gas than Norway, however much of it is not marketed due to reinjection, flaring and other losses
- Norway and Azerbaijan see comparatively fewer losses to these processes, allowing for marketable gas rates of 79% and 71% for 2020 respectively
- Gas reinjection occurs in order to produce more oil. The oil and gas prices determine which hydrocarbon is favored, with a high relative gas price causing gas production to be prioritized

* Percentages shown for 2020
Source: Rystad Energy Gas Market Cube, Rystad Energy research and analysis, GECF

Content

Substantial potential for more Algerian gas supply if marketable production rates increase to 75% in line with other European suppliers

Incremental supply scenarios from Algeria to Italy and Spain



- The base case scenario forecasts a decline in recent levels of pipeline export with a modest bounce through the late 2020s and early 2030s
- Due to Algeria's high level of reinjection, flaring and other losses, there is significant scope to increase its marketable gas production
- There is a trade-off between injection and bringing to market, as lower rates of gas injection reduce oil production rates
- The high case scenario on the chart to the left (green) assumes that all additional gas produced, if the marketable rate reaches 75%, would be exported via pipeline
- The other two scenarios (red and yellow) assume that, by way of increased marketable gas or otherwise, 2021 levels of export are matched through to 2026 and 2040 respectively

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

Content

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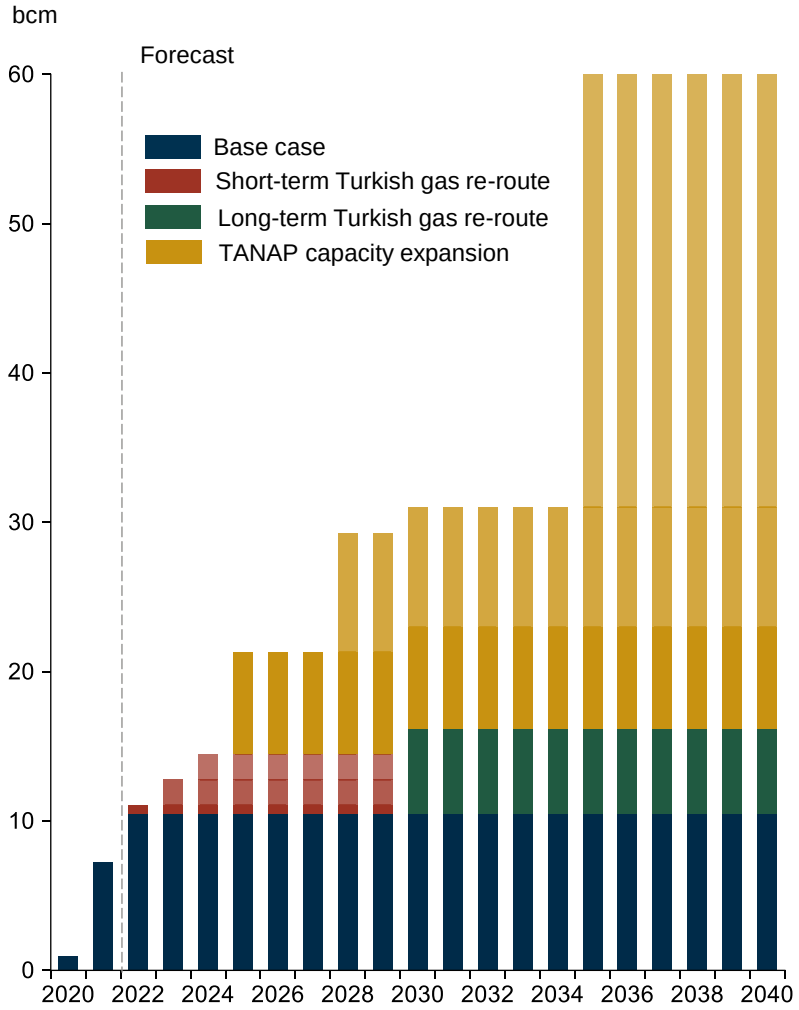
There is a potential for an increase of the Central Asian gas deliveries via TANAP, both in the short and long-term

Potential of the Central Asian gas exports to Europe via TANAP



	Key characteristics	Increment
Base case	• 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
Short-term Turkish gas re-route	• 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 or Russia	2022: **10%** 2023: **40%** 2024: **70%**
Long-term Turkish gas re-route	• As a result of Turkish domestic gas production increase, full re-route is feasible from 2030	2030: **100% (5.7bcm)**
TANAP capacity expansion	• With the planned TANAP expansion, the capacity could increase up to 23bcm by 2025, up to 31bcm by 2028 and at the final stage to 60bcm (2035) • This expansion would require construction of additional compressor stations • In this scenario, it is assumed all new capacity will be dedicated to supply Europe • Capacity expansion to 60bcm would require additional gas sources to be involved, such as Turkmenistan or Iran	2025: **23bcm** 2028: **31bcm** 2035: **60bcm**

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

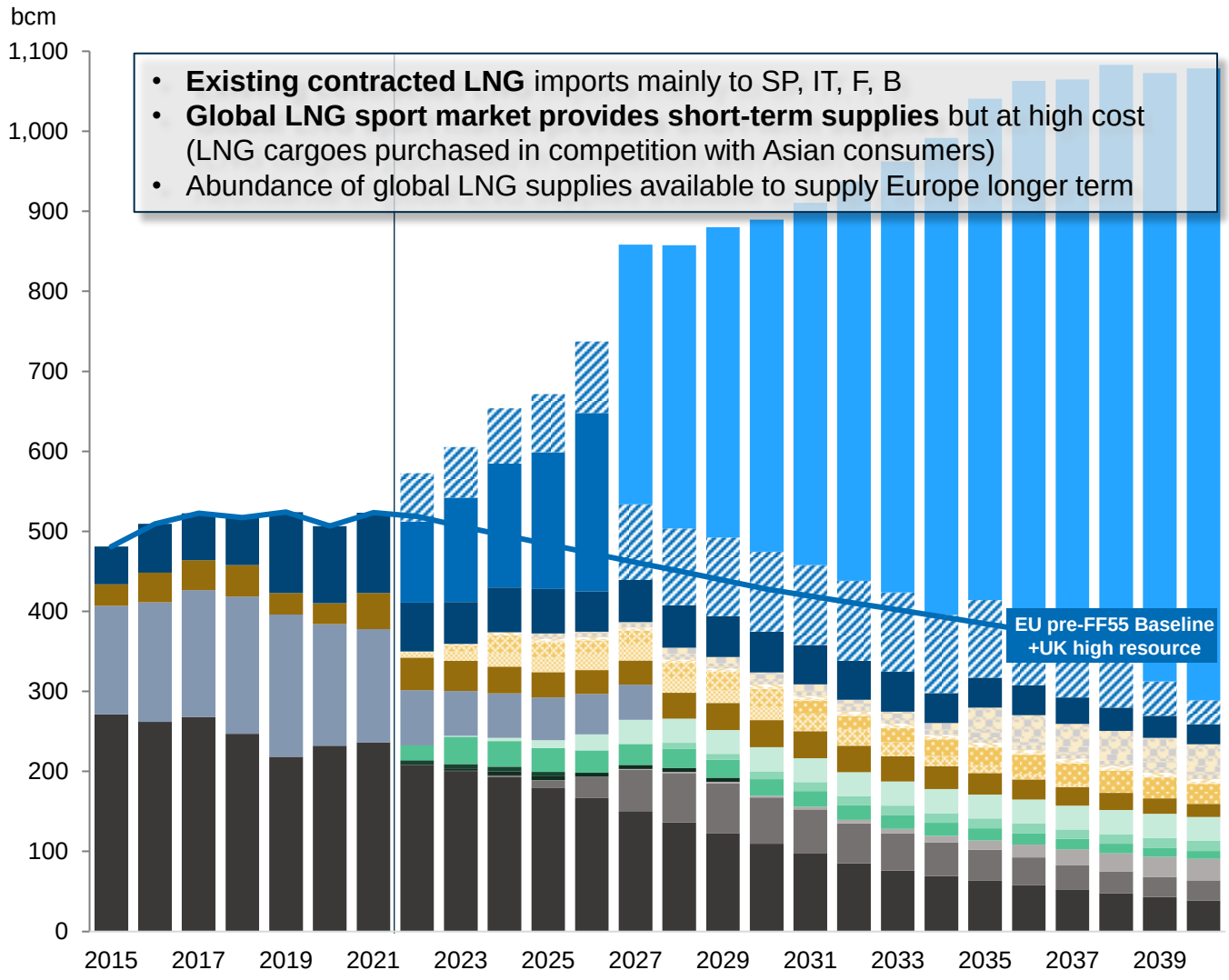
Content

Content

LNG is a crucial market balancing factor for Europe, both in the short and long-term

Gas source	Increment group	Timing
Domestic	Base	Both
	Increment contingent	Long term
	Increment exploration	
Special domestic increment	Troll max	Short term
	Higher GCV	
	Groningen	
	Barents pipe	Long term
	European shale	
Russia	Russian piped gas	Short term
Piped gas	Europe piped gas imports	Both
	Algeria increase	Short term
	Turkey pass-through	
	TR/Azerbaijan expansion	Long term
LNG	LT Contracted	Both
	Spot/FOB LNG	Short term
	Available for LT contracts	Long term

Production by increment group



Source: Rystad Energy research and analysis

Content

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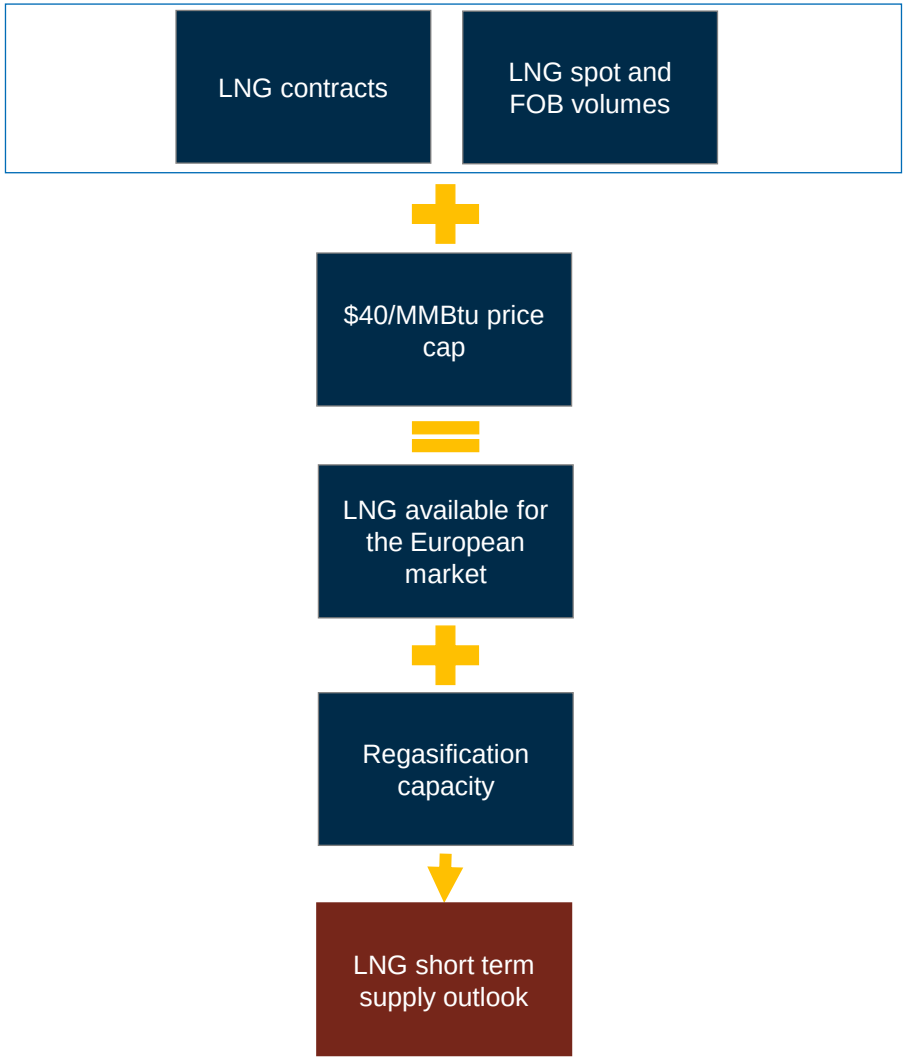
LNG supply methodology have separate approaches for short- and long-term supply

Short-term supply outlook

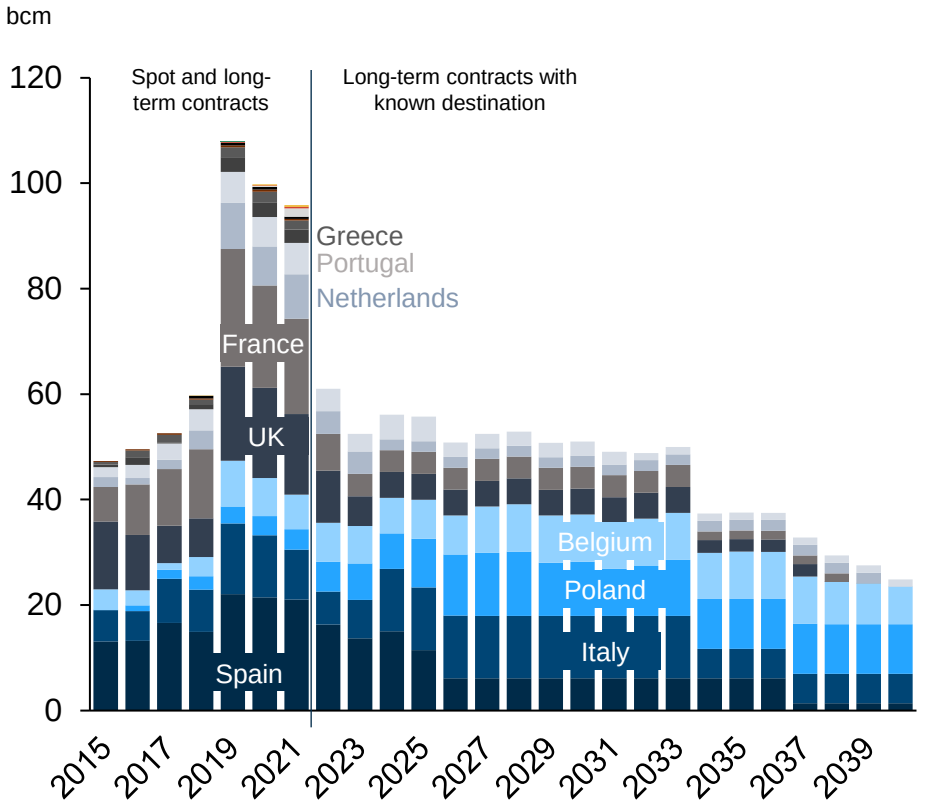


Long-term supply outlook

Step	Description
1 Reference	• Reference case for global supply and demand of LNG • This reference includes a view on global balances outside Europe to determine what the call on LNG is • It also contains a view on global liquefaction projects that are part of the reference case, which includes resources such as Australia, Qatar and the US
2 Maximum LNG increment	• Identify the maximum incremental call from European LNG demand as a function of demand and Russian supply permutations • If this maximum increment can be met with imports from alternative sources, it will help support long term balances for Europe under all identified circumstances
3 Potential supply	• Given that the reference case already has baked in LNG expansions, the increment will have to come from supply regions that can deliver above and beyond the reference case assumption • With the scale and pace required to meet the increment, it is likely only North America and the Middle East that can respond with additional capacity
4 Europe rebalancing implications	• With the knowledge from previous steps,it will be possible to understand how global LNG will be able to balance European gas markets under all permutations identified • 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

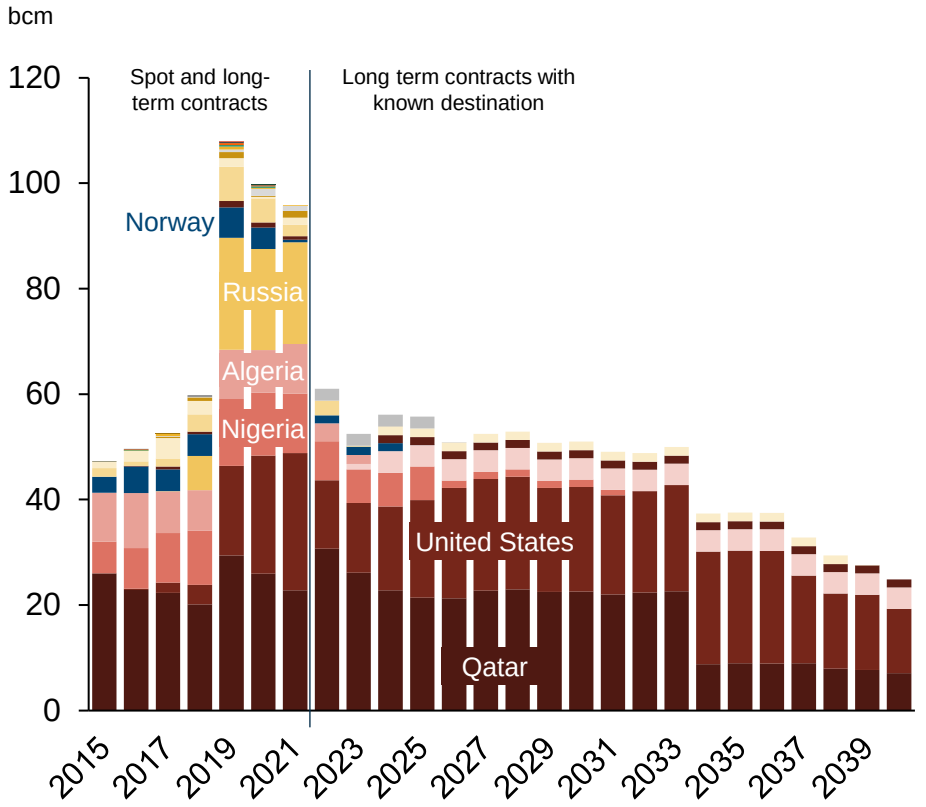
Contracted LNG is primarily sourced from Qatar and the United States

Contracted LNG imports by importing countries



- Long term contracts are primarily related Spain, Italy, Poland and Belgium
- In particular Poland has been active in the LNG market to secure long-term supply
- The 2019-2021 spike in imports was driven by high spot deliveries

Contracted LNG exports by exporting countries

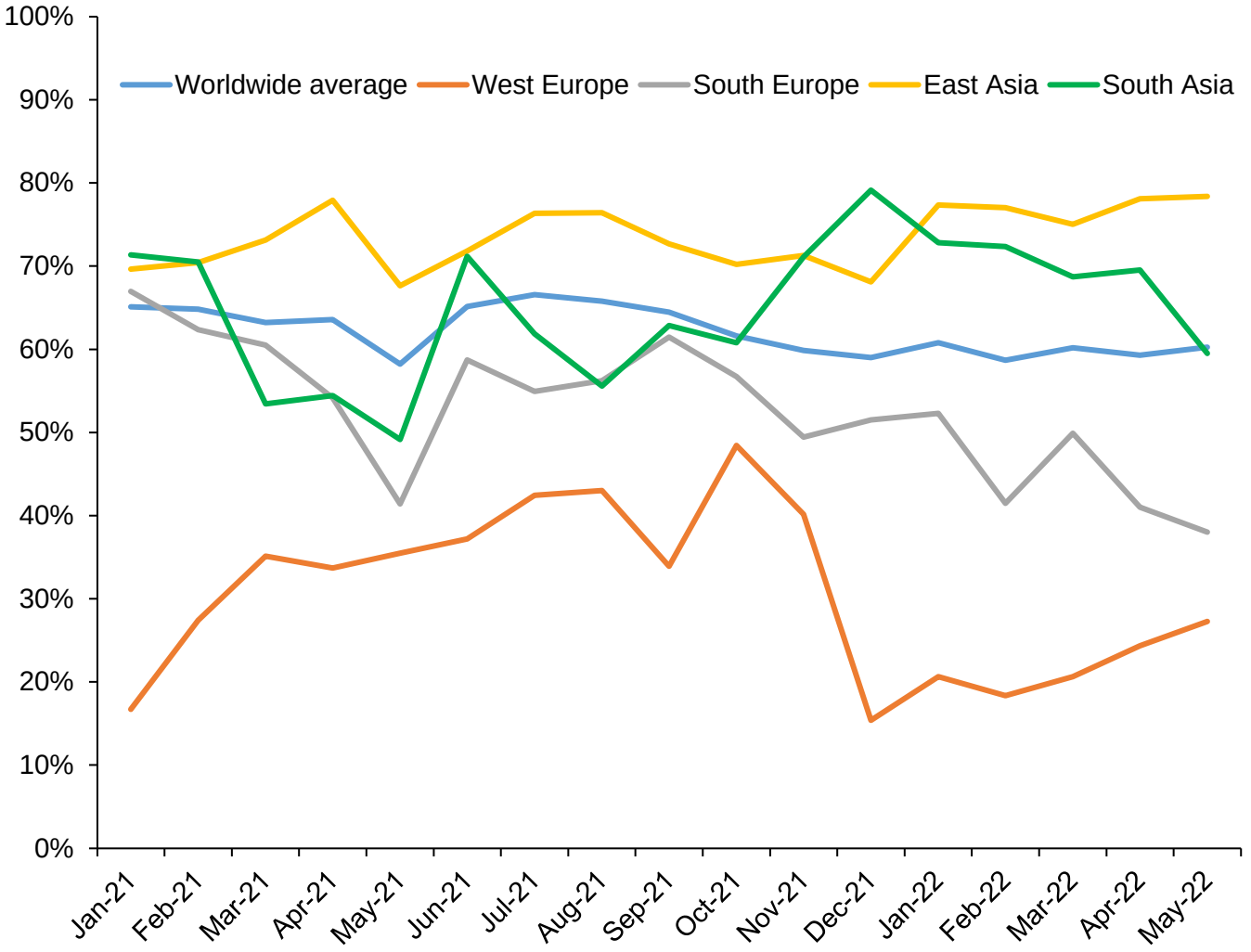


- Qatar and the United States are the primary LNG suppliers to Europe
- In 2019 and 2020, the spot cargoes used Europe as a buyer of last resort due to global oversupply
- This situation changed dramatically in 2021 when spot cargoes were rather coming to Europe to meet demand as the continent moved out of COVID and Russian supplies started to decline

Source: Rystad Energy research and analyses; Rystad Energy GasMarketCube

Asia has typically imported LNG on contracts while Europe has relied on the spot market

Share of contracted volumes in LNG imports

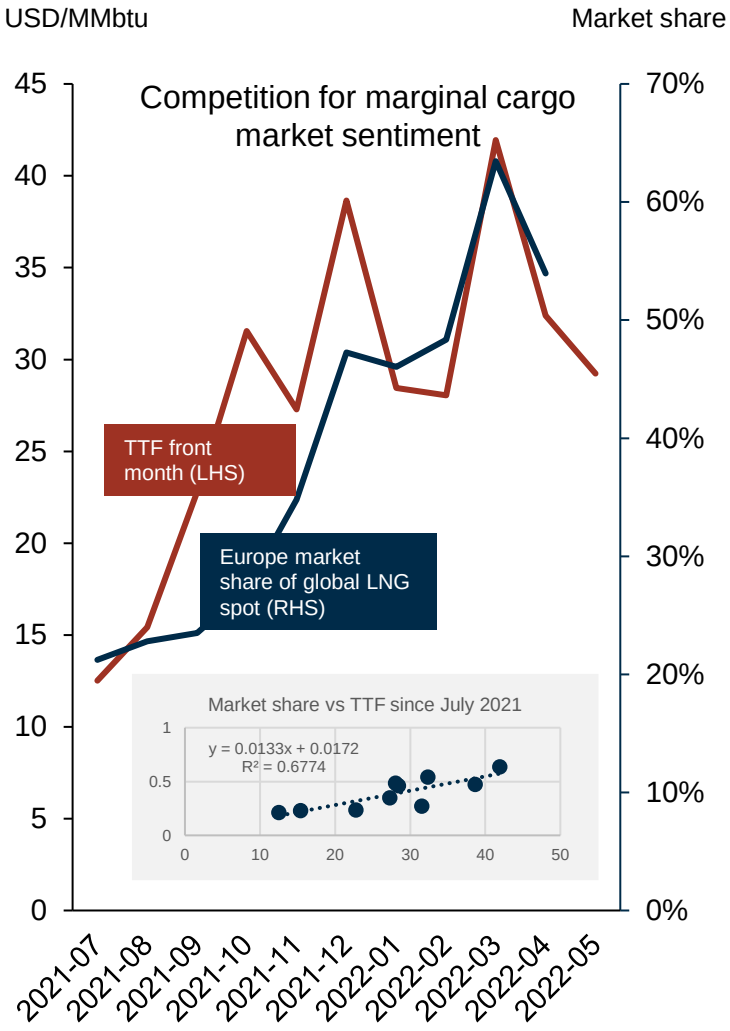


- Global LNG trades remain dominated by contracted supplies, the share of which is standing at 60%. The share of contracted volumes in East Asia's LNG imports is the highest around the globe – having climbed to nearly 80% from 70% last year as high spot LNG prices have hammered spot buying in the region.
- The lowest share of contracted volumes is seen in Western Europe, averaging at 22% this year, down from 34% in 2021. The Russian war in Ukraine has spurred a spot buying spree in the region.

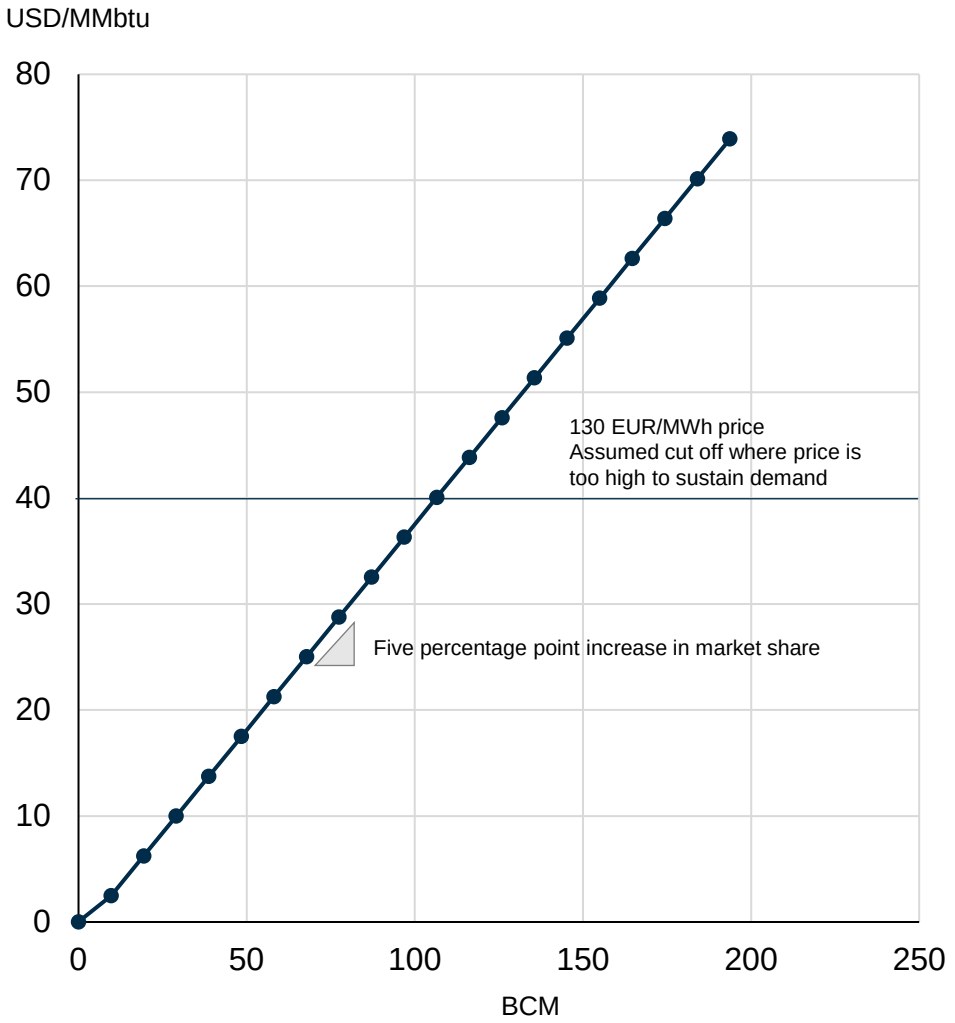
Source: Rystad Energy LNGTradeCube

Buying spot LNG in a tight market has its cost as Europe has to outcompete primarily Asia for marginal cargoes

European LNG spot market share vs TTF



Possible cost of supply for incremental market share of spot LNG

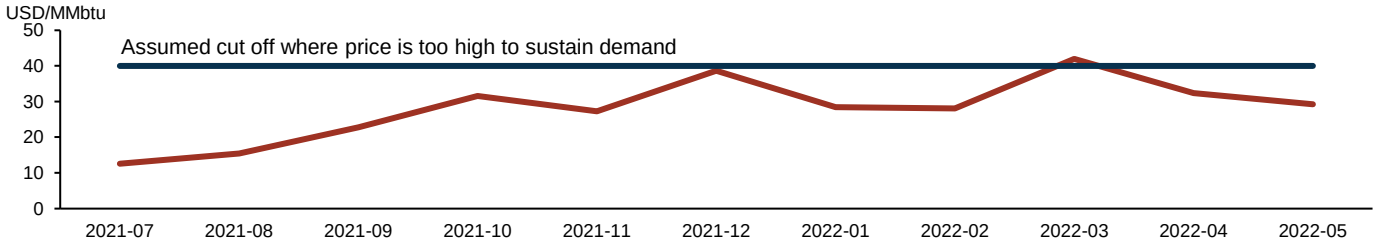


Source: Rystad Energy research and analysis

Content

40 USD/MMBtu (EUR 134/MWh) used as price cap to define upper level of short-term LNG market share

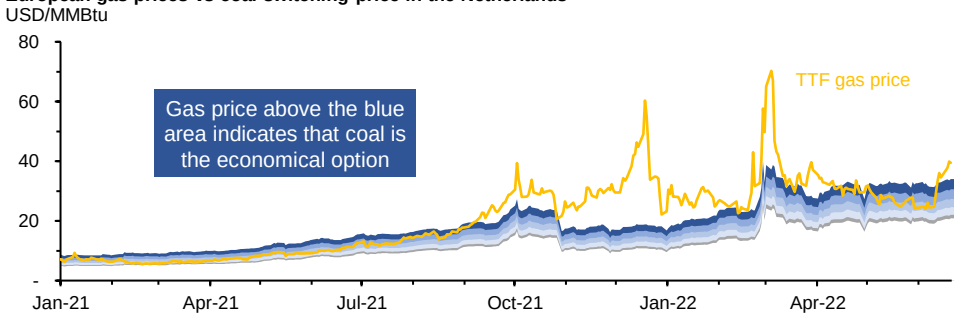
TTF front month



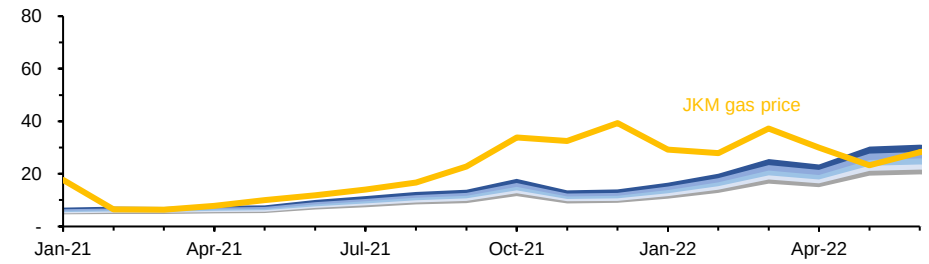
Gas price of 40 USD/MMBtu (EUR134/MWh) is too high to sustain demand. As a consequence, consumption switched from gas to coal before the gas price falls to sustainable levels.

Gas-to-coal switching

European gas prices vs coal-switching price in the Netherlands



JKM gas price vs coal-switching price in Japan



Increased coal consumption

Power generation from coal in Germany

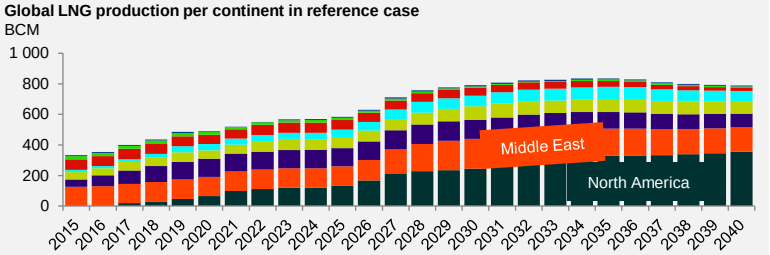
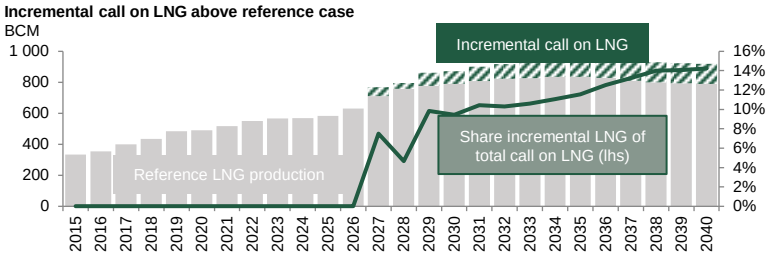
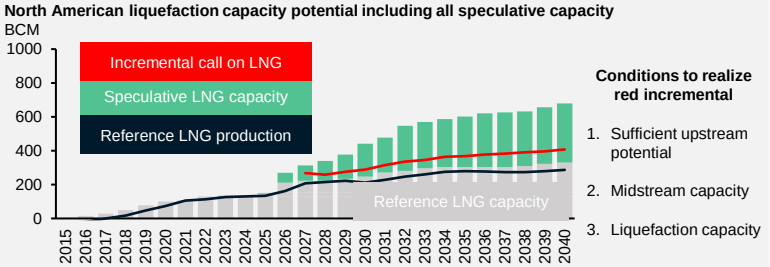
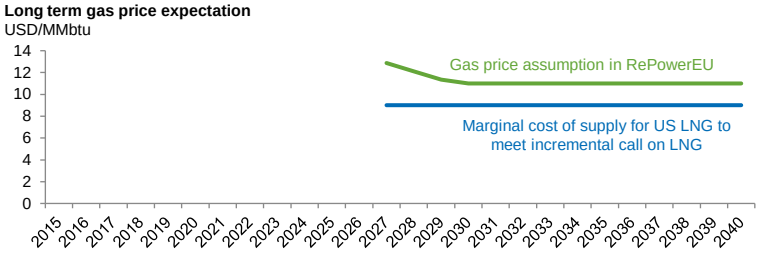
Germany fires up coal plants to avert gas shortage as Russia cuts supply

Higher gas prices have resulted in higher coal consumption in Germany.

In Asia, the capacity utilization in coal power plants has increased as ramping up coal power production makes sense when the power price is high.

Source: Rystad Energy research and analysis; GasMarket Cube; Eikon; EIA

Four step process to ascertain if LNG can meet the maximum call on new European long-term supply within reasonable time and cost

Step	Description	Illustration
1 Reference	• Reference case for global supply and demand of LNG • This reference includes a view on global balances outside Europe to determine what the call on LNG is • It also contains a view on global liquefaction projects that are part of the reference case which includes resources such as Australia, Qatar and the US	
2 Maximum LNG increment	• Identify the maximum incremental call from European LNG demand as a function of demand and Russian supply permutations • If this maximum increment can be met with imports from alternative sources, it will help support long term balances for Europe under all identified circumstances	
3 Potential supply	• Given that the reference case already has baked in LNG expansions, the increment will have to come from supply regions that can deliver above and beyond the reference case assumption • With the scale and pace required to meet the increment it is likely only North America and the Middle East that can respond with additional capacity	
4 Europe rebalancing implications	• With the knowledge from previous steps it will be possible to understand how global LNG will be able to balance European gas markets under all permutations identified • 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: GasMarketCube, Rystad Energy analysis

Content

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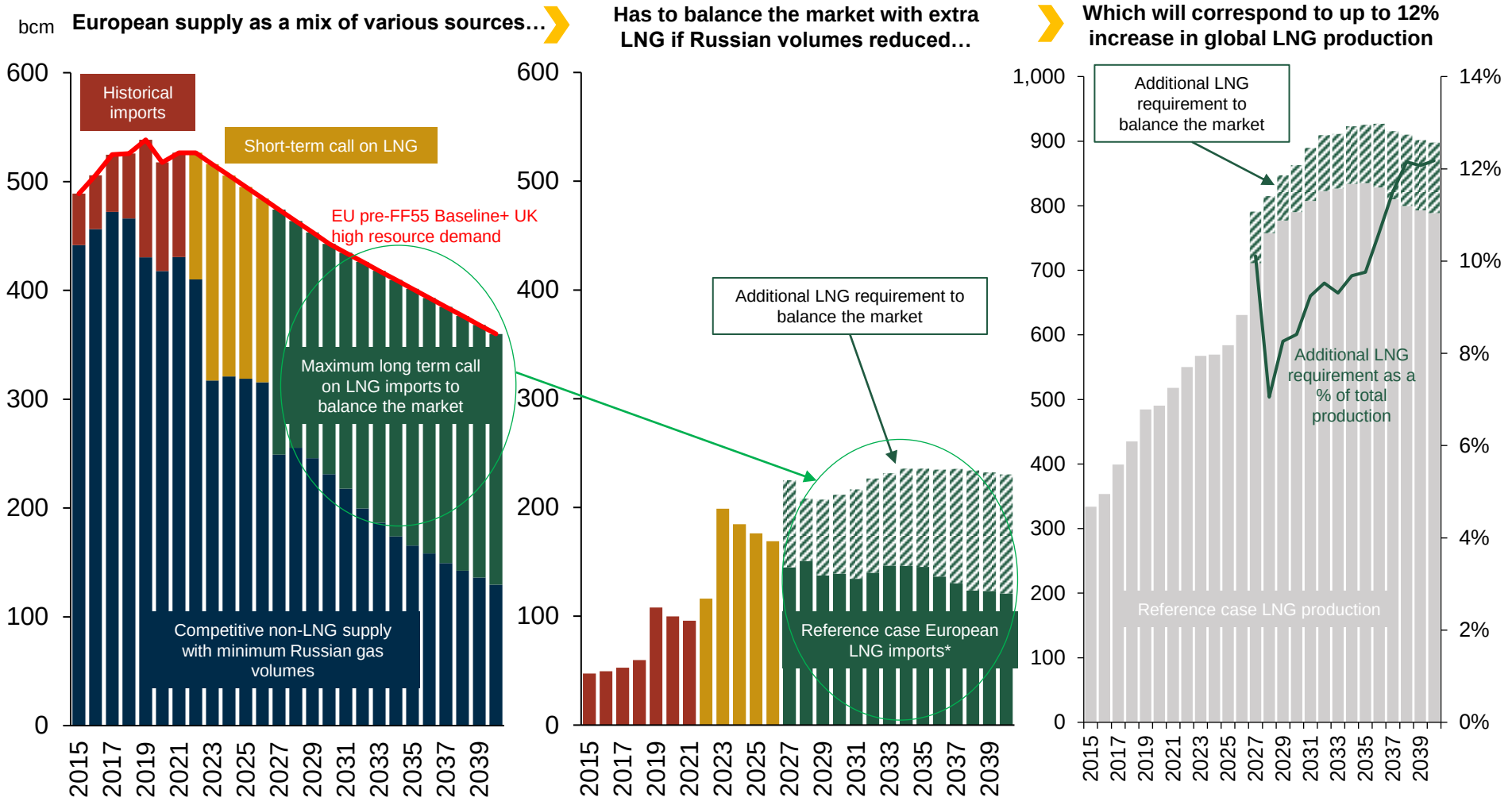
Russian gas displacement to Europe will result in incremental call on LNG, sourced from the global market

European LNG requirement in a micro and macro environment



*Reference case European LNG imports as forecast under normal market circumstances in Rystad Energy Gas Market Cube
Source: Rystad Energy GasMarketCube, Rystad Energy research and analysis

Content

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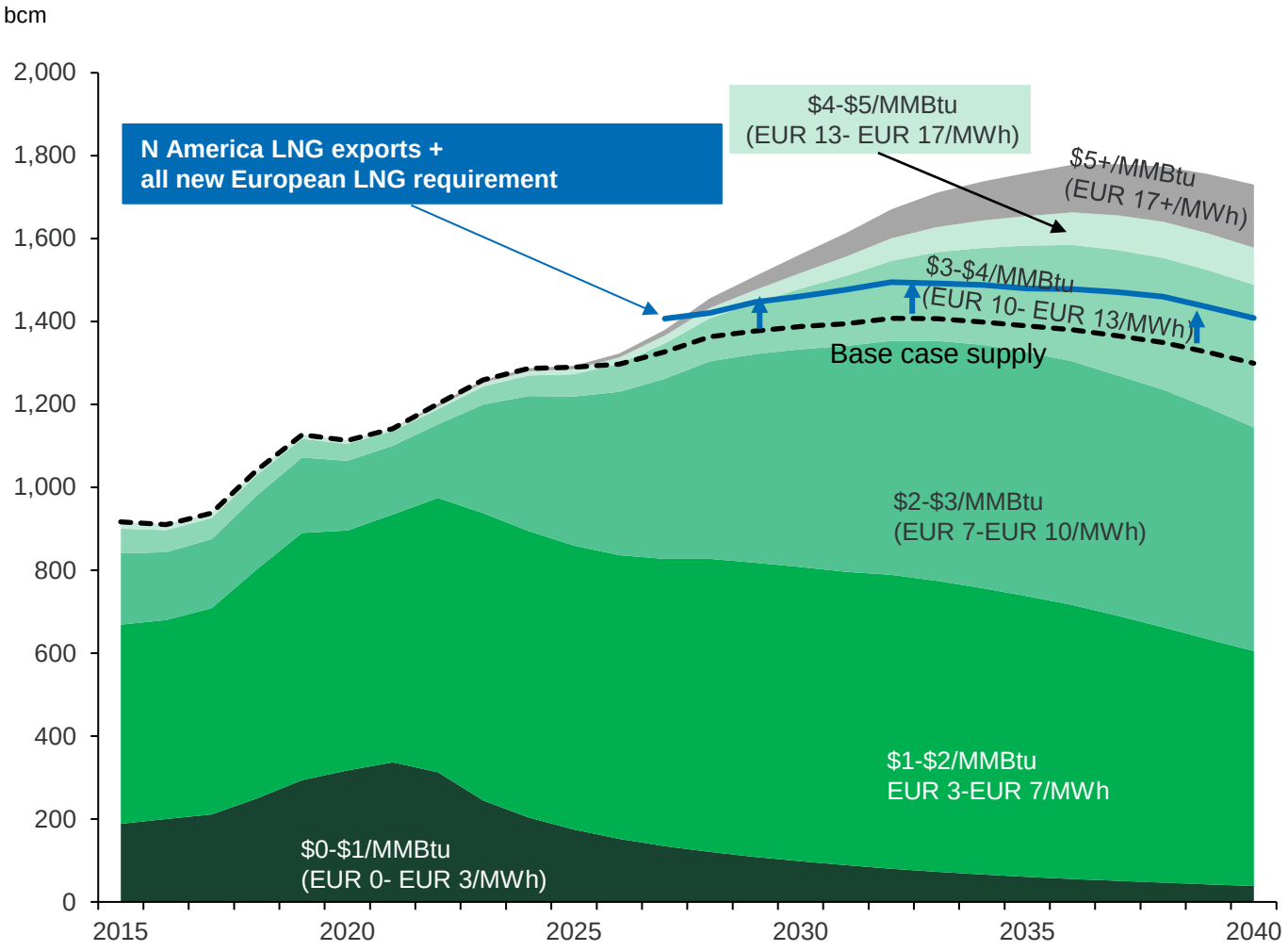
Low-cost supplies in N America; new European demand ~7% production increase

US and Canada natural gas supply potential by lifecycle and breakeven price

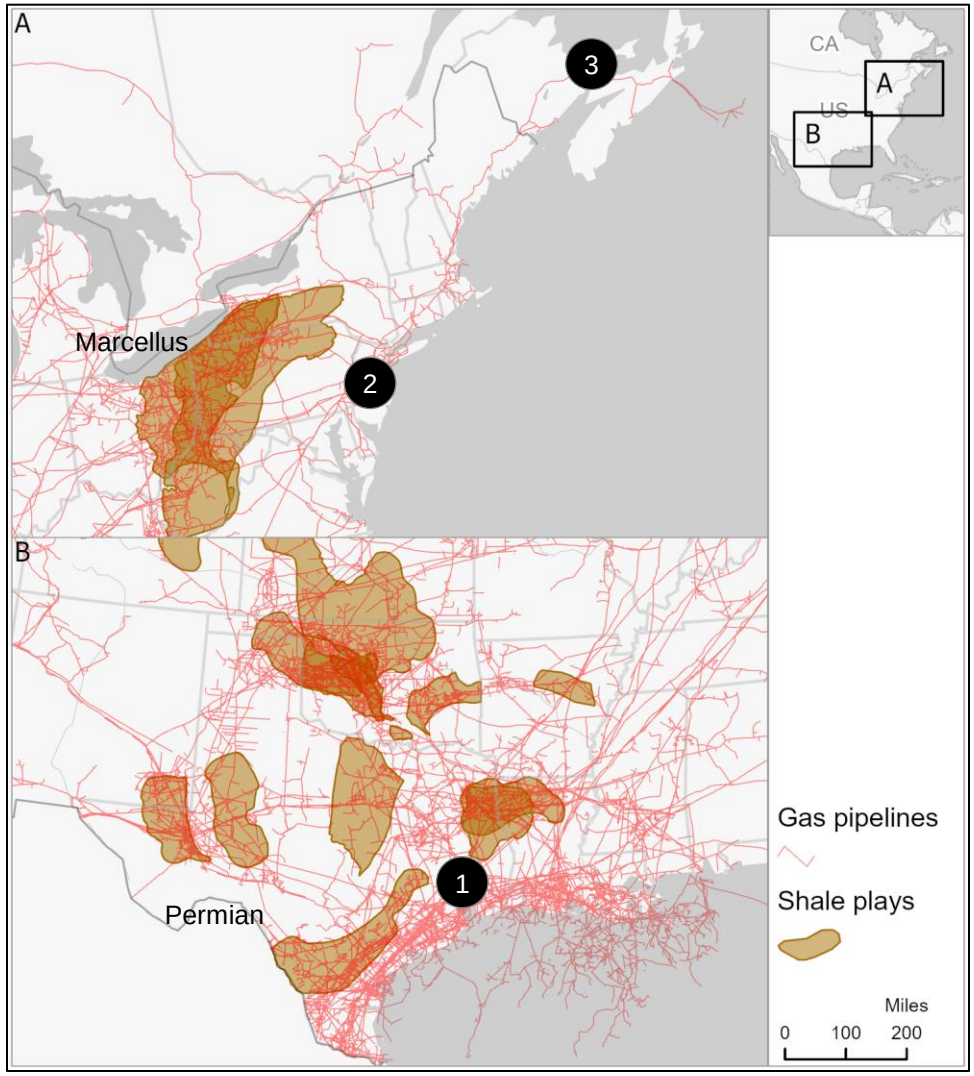


- North America is abundant in natural gas resources and has sufficient potential to supply low-cost gas to the market at a breakeven price of up to $4/mmbtu
- Even an increased demand in Europe, as a result of the reduced supply from Russia, can be met by North American upstream potential outside 2027
- **Call on additional European LNG requirement** based on EU pre-FF55 Baseline+ UK high resource scenario to test the max threshold

Note: Breakeven based on a 7.5% real hurdle rate
Source: Rystad Energy GasMarketCube

North American midstream investments required to aid the displacement of Russian gas

North American LNG exports capability



North American LNG exports

1. US LNG exports capacity to Europe is predominantly located in the Gulf Coast, in Texas and Louisiana. The support for midstream and downstream investments, resulted in numerous LNG terminals; however, the potential of the region to capture “easy-to-reach” opportunities is getting exhausted
2. There is potential to monetize the US east coast resources; however, lack of midstream infrastructure is blocking downstream investments
3. Canadian export potential is untapped, with only a few projects moving into realization. TC Canadian Mainline is currently underutilized.

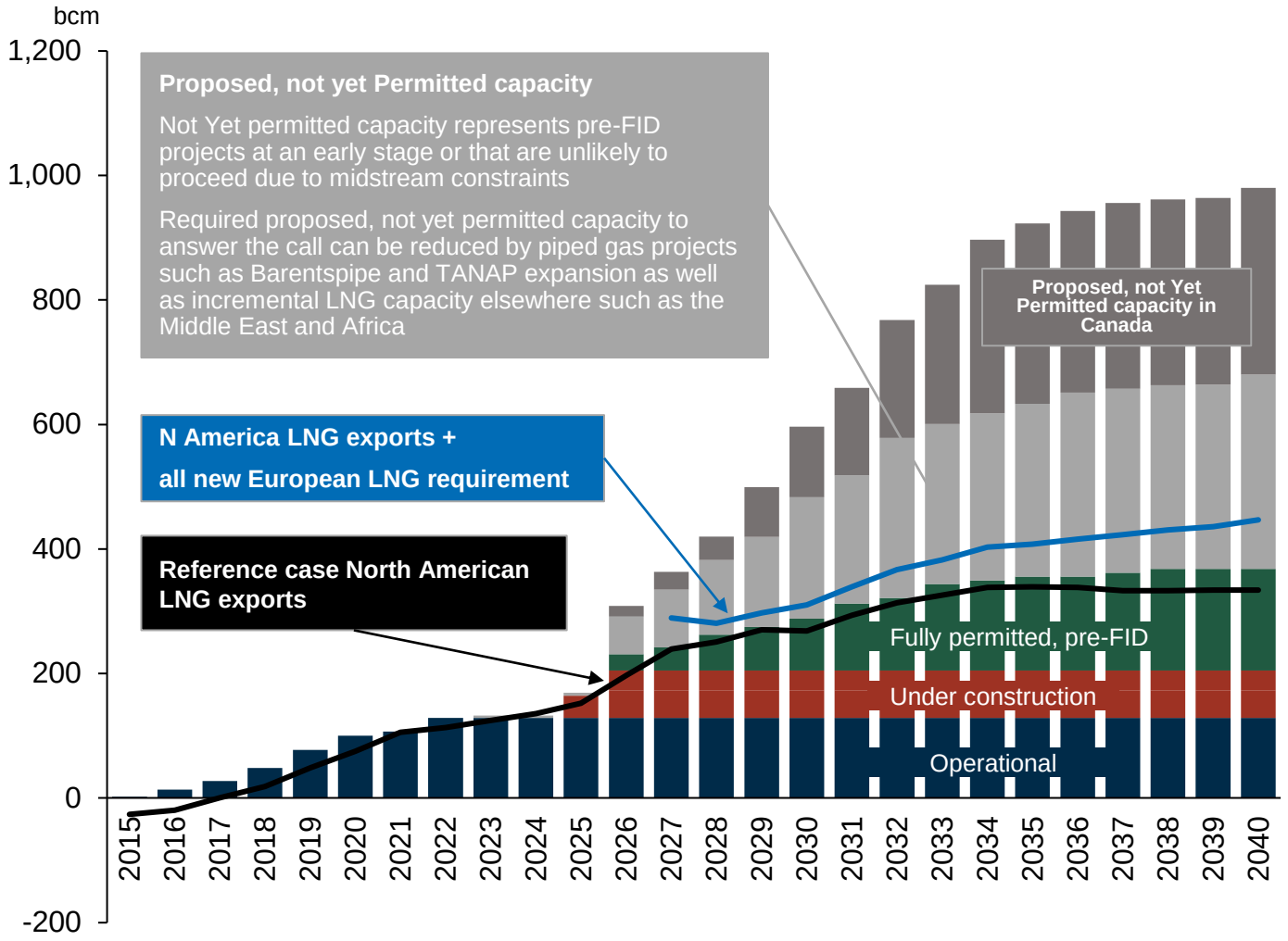
Challenges

Missing North America midstream infrastructure is a bottleneck for the region to displace Russian gas in Europe via additional liquefaction capacity. Issues with pipelines permitting prevents inland upstream gas resources to be monetized via exports as LNG to Europe

Source: Rystad Energy research and analysis

N America could supply new European LNG long-term requirements

North American LNG exports capacity vs European LNG imports requirement



Assumptions

1. Future North American projects will be able to produce LNG with similar cost structure as other projects
2. There is a sufficient support from policy makers to trigger infrastructure investments both midstream in North America, but also the liquefaction and regas facilities
3. Incremental call on LNG to Europe (*chart: blue line*) represents additional requirement for North American LNG exports to Europe as per maximum European LNG demand based on EU pre-FF55 Baseline +UK high resource scenario, assuming no Russian gas imports from 2023

Results

Europe's increased requirement for LNG imports resulting from reduced natural gas supply from Russia, can be met by the North American LNG exports, but can also be supported by projects in other regions such as the Middle East and Africa

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

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

Russian export pipeline network and LNG terminals

Name	Nordstream
Capacity	55 bcm/yr

Name	Nordstream2
Capacity	55 bcm/yr (cancelled)

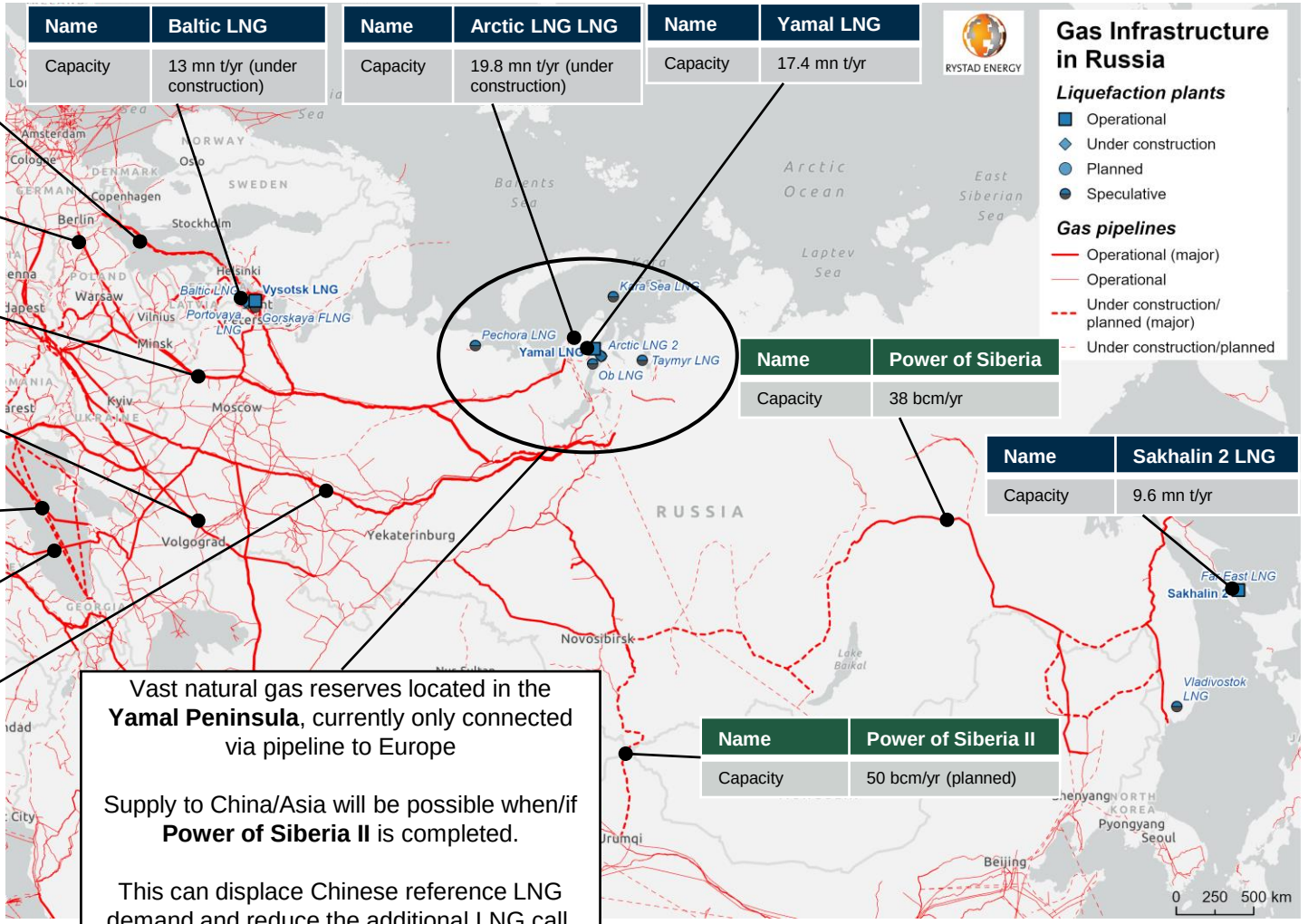
Name	Yamal
Capacity	32.9 bcm/yr

Name	Soyuz
Capacity	26.1 bcm/yr

Name	Turk Stream
Capacity	31.5 bcm/yr

Name	Blue Stream
Capacity	16 bcm/yr

Name	Brotherhood
Capacity	100 bcm/yr



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 in this study

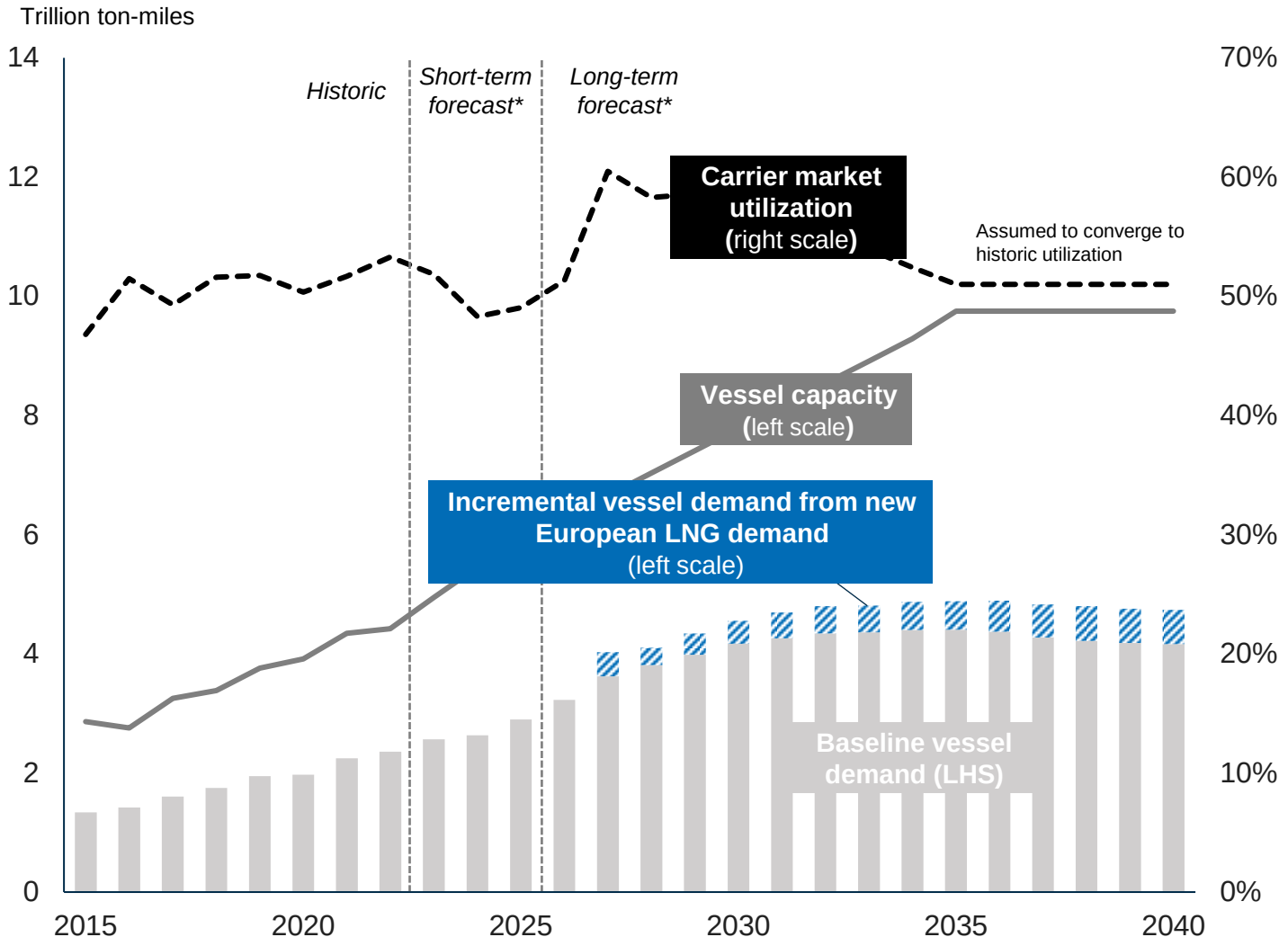
Legend

	Europe pipeline
	Asia pipeline
	LNG terminal

Source: Rystad Energy research and analysis

LNG carrier fleet expected to handle more LNG trade

Forecast of the global LNG carrier market



- The left chart shows the global LNG carrier market, measured in total ton-miles of LNG demanded and potentially supplied until 2040.
- Considering the ratio of vessel demand to total capacity, the short-term horizon exhibits little risk of market tightness. As practically all shipyards are constructing carriers at full capacity, vessel capacity should grow faster than demand until 2025. Increased utilization occurs in 2027 in a scenario of incremental European demand, while convergence towards historical averages is expected in the longer term.
- Vessel capacity is forecasted from public order-books of LNG carriers (216 ships in total) and a fleet utilization of 95 knm** per year. Vessel demand is forecasted under an assumption of increasing distance travelled per tonne of LNG over time. Under increased European imports, transport distances would decrease, all else equal, yielding lower market tightness.

*Short-term forecast of vessel capacity based on public order-books of LNG vessels. Long-term forecast based on historic growth rates of vessel supply. **Thousand nautical miles.
Source: Rystad Energy research and analysis; IGU World LNG Report 2022

Content

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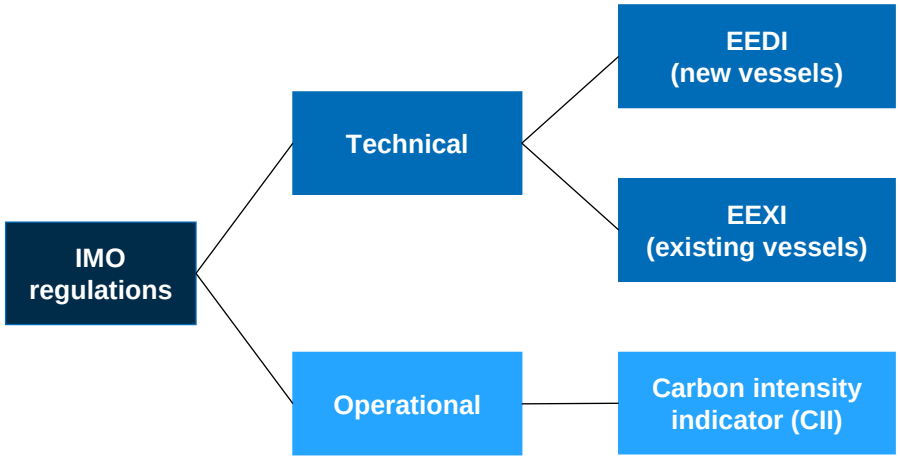
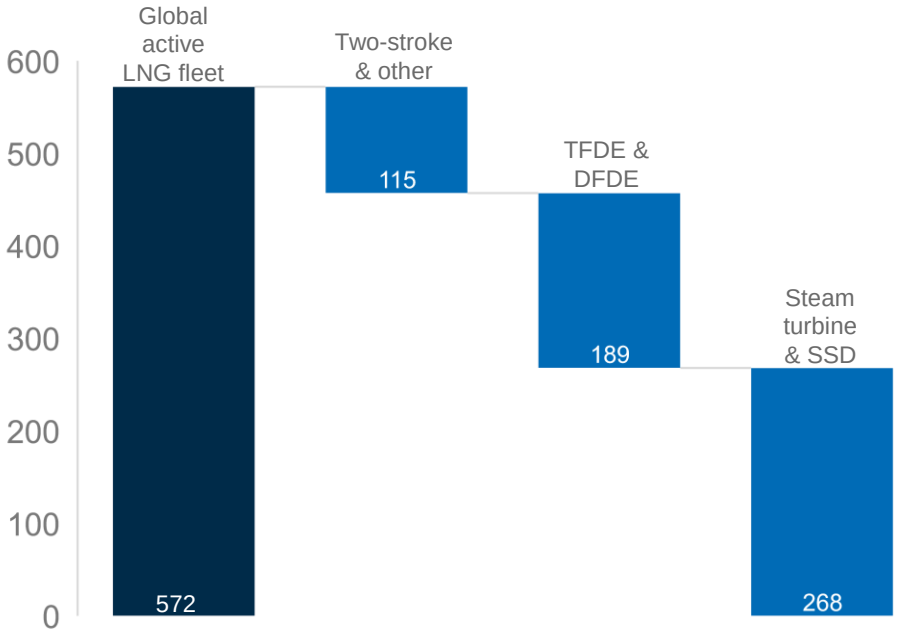
~50% of vessels are at risk of being scrapped or will have to reduce speed due to IMO

IMO regulations overview



Fleet exposure to IMO regulations



- IMO targets a reduction of 50% in CO2 emissions and 70% in carbon intensity by 2050. This is achieved by technical and operational vessel requirements.
- The technical requirements will be based on two indexes indicating the energy efficiency of a ship; EEXI for existing vessels and EEDI for new vessels. EEDI is already implemented, while EEXI will be implemented in 2023. Requirements may be shifted down over time.
- The operational requirement will be set by a carbon intensity indicator (CII), measured in CO2 per dwt-nm. The CII requirements will be implemented in 2023 and will be tightened gradually in line with IMO's carbon intensity target. The rate of change is unknown.

- Steamers and SSDs have the worst annual efficiency ratio (AER), measured as CO2 per dwt-nm. TFDEs and DFDEs have mid-level AER, while two-strokes have the lowest AER.
- Rate of change in IMO restrictions is unknown. The vessels with highest AER are more exposed to rapidly tightening restrictions.
- As IMO restrictions are tightened, steamers and SSDs are at risk. TFDEs and DFDEs are possibly at risk, while two-strokes are not at risk.
- Possible solutions for vessels failing to meet IMO restrictions are scrapping and slow speeding, both of which would decrease supply of ton-miles and tighten the market.

Source: GasMarketCube, Rystad Energy research and analyses

Recent contracted volumes of US LNG deals has unlocked new capacity

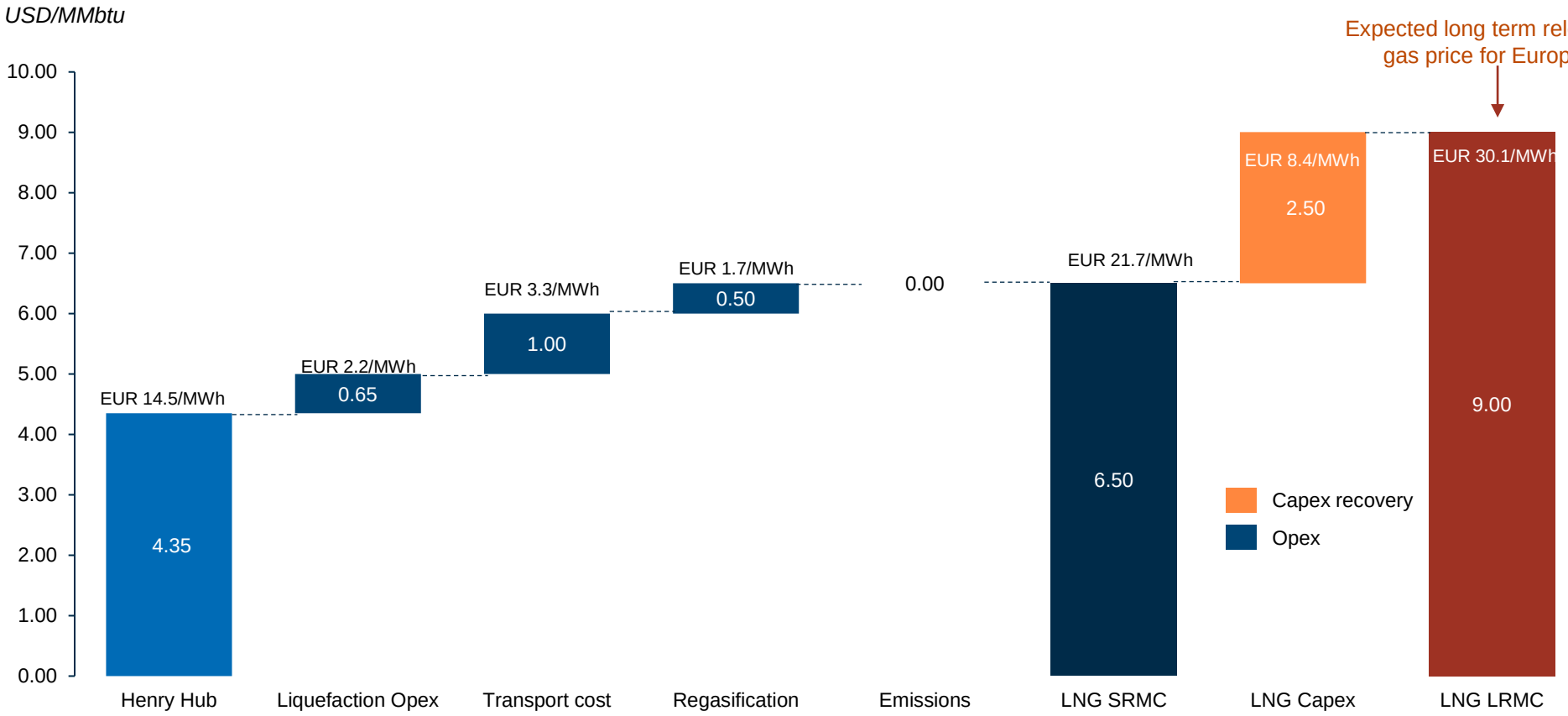
US LNG export capacity agreements

Date announced	Volume (mtpa)	Term (years)	Buyer	Seller	Project
7-Mar-22	2	20	Shell	Energy Transfer	Plaquemines
17-Mar-22	1	20	NewFortress energy	Energy Transfer	Plaquemines
17-Mar-22	1	20	NewFortress energy	Energy Transfer	CP2
29-Mar-22	2.2	20	Venture Global	Energy Transfer	Lake Charles
31-Mar-22	2	20	Guangzhou Development Gas Trading	MPLNG	Mexico Pacific Limited
6-Apr-22	1.5	20	Venture Global	NextCarbon Solutions	Rio Grande LNG
2-May-22	1.75	15	ENGIE	NextCarbon Solutions	Rio Grande LNG
2-May-22	2	20	[illegible]	Energy Transfer	Lake Charles
3-May-22	0.4	18	SK	Energy Transfer	Lake Charles
10-May-22	1	20	ExxonMobil	Energy Transfer	Plaquemines
10-May-22	1	20	ExxonMobil	Energy Transfer	CP2
11-May-22	1	20	Petronas	Energy Transfer	Plaquemines
25-May-22	0.4	20	POSCO	Cheniere	Corpus Stage 3
5-Jun-22	0.7	25	Towngas	Energy Transfer	Lake Charles
9-Jun-22	1.75	15	Equinor	Cheniere	Cheniere Marketing
21-Jun-22	0.75	20	EnBW	Energy Transfer	CP2
21-Jun-22	0.75	20	EnBW	Energy Transfer	Plaquemines
22-Jun-22	1	15	Chevron	Cheniere	Cheniere Marketing
22-Jun-22	1	15	Chevron	Cheniere	Sabine Pass Liquefaction
22-Jun-22	1	20	Chevron	Energy Transfer	CP2
22-Jun-22	1	20	Chevron	Energy Transfer	Plaquemines

Source: ICIS

Long-term European LNG supply cost expectations compare with pre-crisis levels once market distressed

LNG price forecast buildup based on long term Henry Hub assumption



Assumptions

Marginal LNG supply source assumed to be Henry Hub	*15% cost of gas feedstock*	*Transport via 150,000 m3 tanker using fuel oil from US to Europe*	*Based on what is understood to be standard regas rates*	*Emission tax would increase LNG cost*	*Based on common $2-3 uplift in global LNG contracts*

Source: Rystad Energy research and analysis

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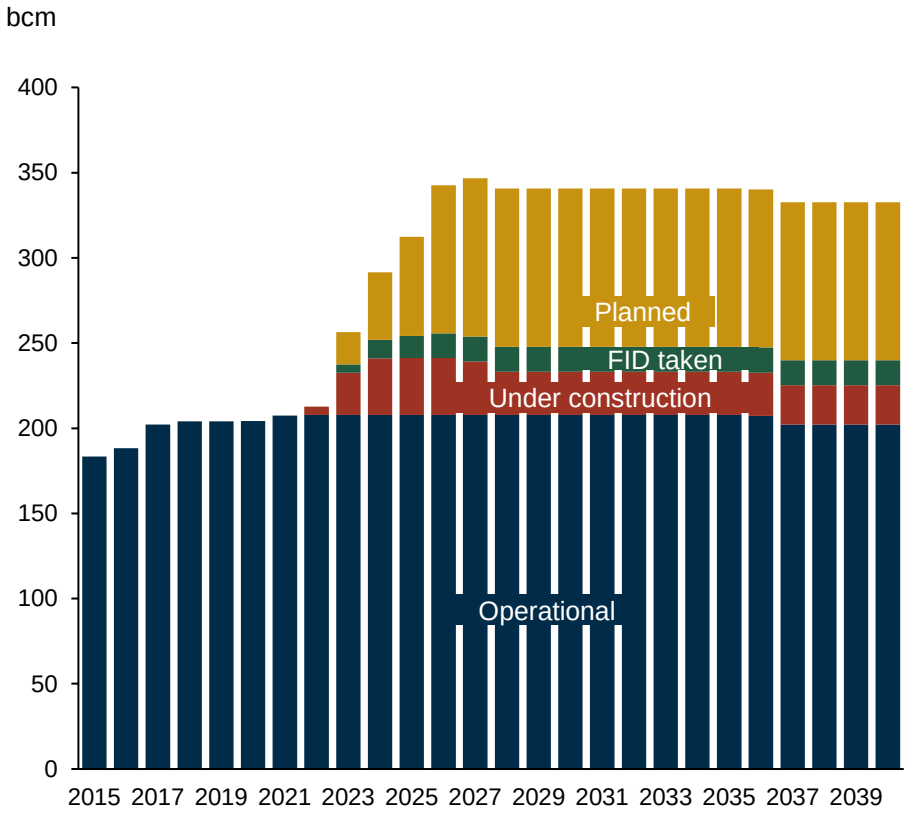
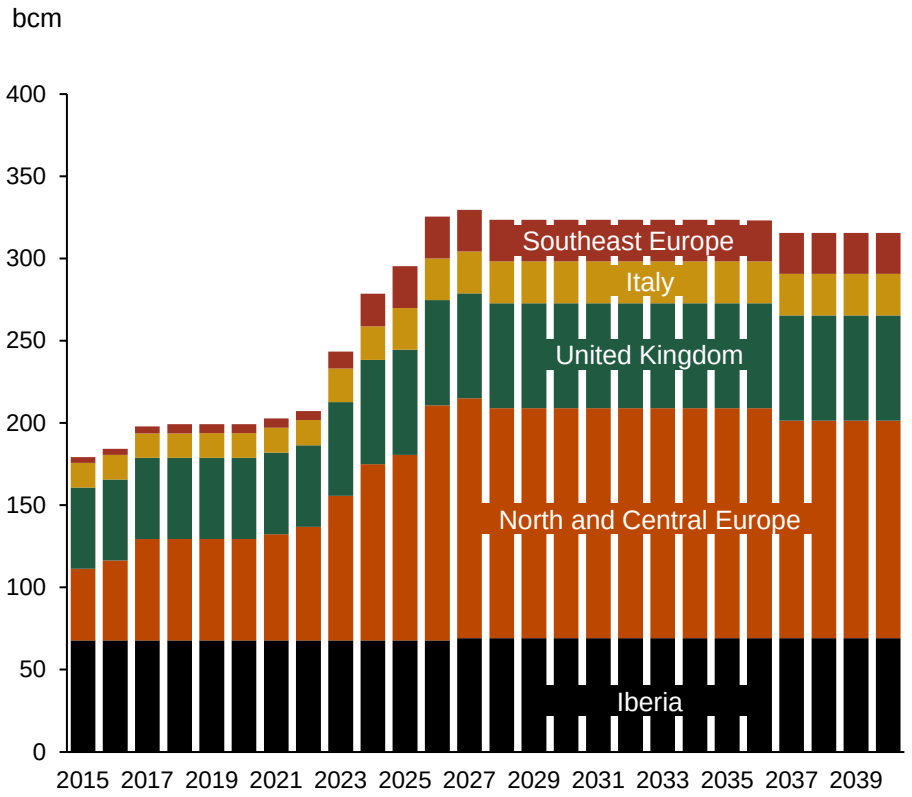
European LNG regas/import capacity can grow by 120 bcm to 330 bcm per year

Infrastructure status on European regas capacity



- In 2021, European regasification capacity stood at 207bcm and is expected to grow to 330bcm by 2040, if all the planned projects go ahead
- Fast deploying FSRU units can help expand capacity rapidly

European regas capacity split by geography



- In 2021, Iberia and North&Central Europe accounted for over 30% of the market each; however, it is North&Central Europe that is expected to drive the regasification capacity in Europe over the forecast period

Source: Rystad Energy research and analysis; Rystad Energy GasMarketCube

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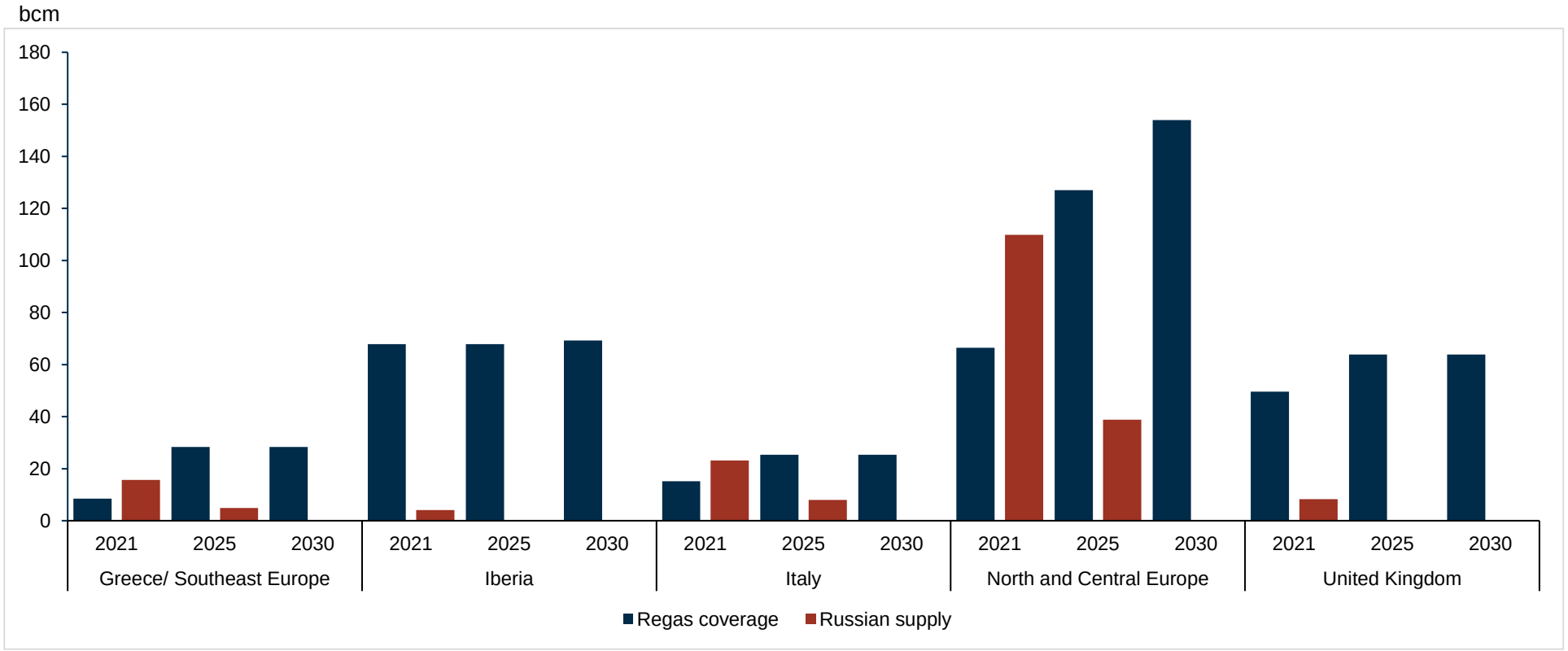
European areas will have higher flexibility with increased regasification capacity

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



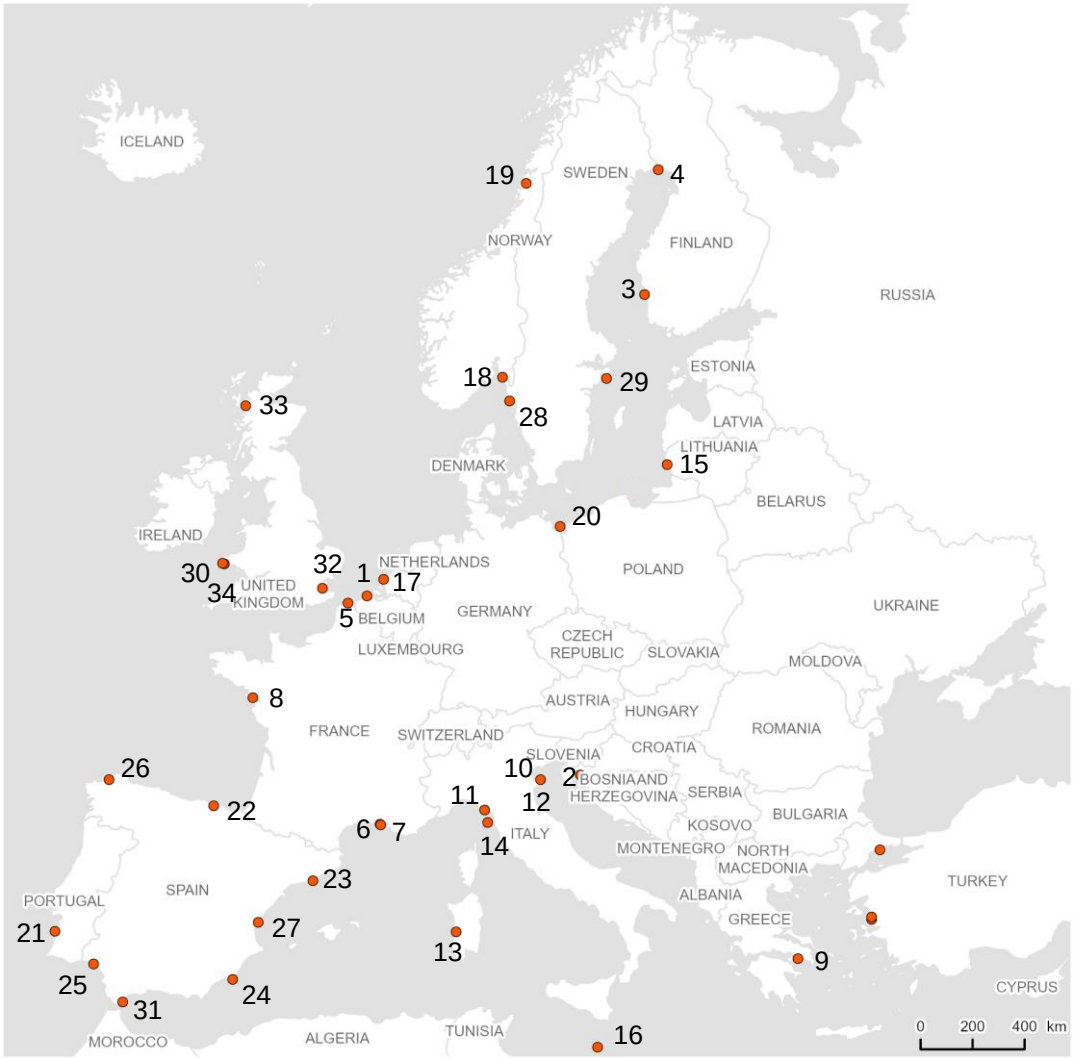
- The chart above illustrates the comparison between regional regas capacity and Russian gas imports in 2021, 2025 and 2030
- For all areas, the regas capacity is expected to increase, according to announced and on-going projects. As European gas demand is expected to remain relatively flat towards 2030, increased regasification capacity will lead to higher flexibility for the European areas
- North&Central Europe, Southeast Europe and Italy are expected to be impacted the most due to reliance on Russian gas

Source: Rystad Energy research and analysis

Existing European regasification capacity is not evenly spread across the continent

European operational LNG regasification capacity, 2022

Belgium	mt	
Zeebrugge	6.6	1
Croatia	**mt**	
Krk	2.1	2
Finland	**mt**	
Pori	0.2	3
Tornio Manga	0.4	4
France	**mt**	
Dunkerque	9.6	5
Fos Cavaou	6	6
Fos Tonkin	2.2	7
Montoir-de-Bretagne	7.3	8
Greece	**mt**	
Revithoussa 1&2	3.7	9
Italy	**mt**	
Adriatic	5.8	10
Panigaglia	2.5	11
Ravenna	<0.1	12
Sardinia	0.3	13
Toscana FSRU	2.7	14
Lithuania	**mt**	
Klaipeda	3	15
Malta	**mt**	
Electrogas	0.4	16



Netherlands	mt	
Gate (Rotterdam)	8.8	17
Norway	**mt**	
Frederikstad	0.1	18
Mosjøen	0.4	19
Poland	**mt**	
Świnoujście	3.7	20
Portugal	**mt**	
Sines	5.8	21
Spain	**mt**	
Bilbao	5.1	22
Barcelona	12.8	23
Cartagena	8.6	24
Huelva	8.6	25
Mugardos	2.6	26
Sagunto	6.4	27
Sweden	**mt**	
Lysekil	0.2	28
Nynäshamn	0.4	29
UK	**mt**	
Dragon	5.6	30
Gibraltar	<0.1	31
Grain 1,2&3	15	32
Mowi	0.2	33
South Hook	15.6	34

Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube

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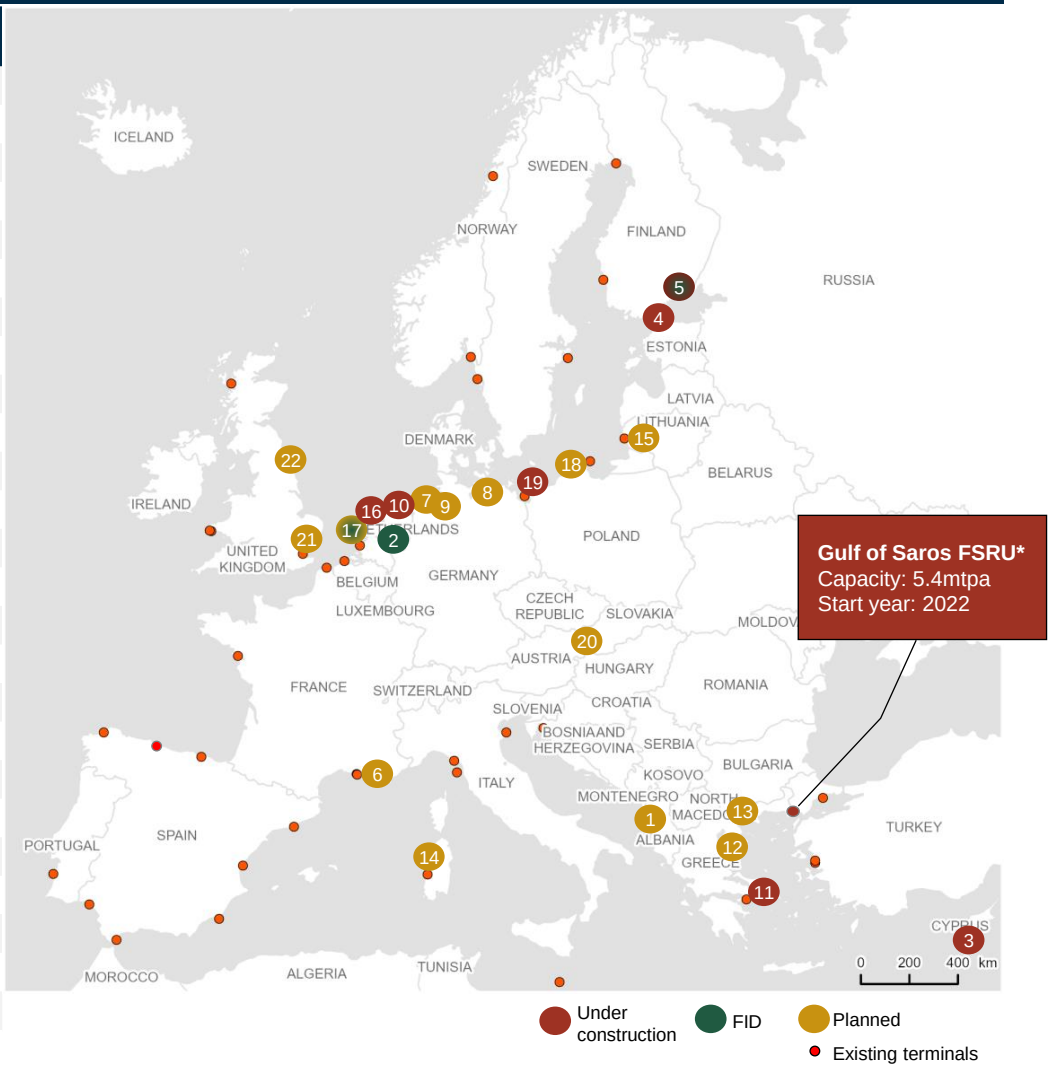
New regas terminals will enable rebalancing in challenged European regions and increase future market resilience

Future LNG regasification capacity in Europe between 2022 and 2040

Country	Plant name	Capacity Mtpa	
Albania	Albania LNG terminal (Port of Vlora)	2.5	1
Belgium	Zeebrugge 2 Expansion Step 1	4.7	2
Belgium	Zeebrugge 2 Expansion Step 2	1.3	2
Cyprus	Cyprus FSRU	0.6	3
Estonia	Paldiski LNG	1.8	4
Finland	Hamina FSRU	3.7	5
Finland	Hamina LNG	0.6	5
France	Fos Cavaou 2	6.2	6
Germany	Brunsbuettel LNG Terminal	5.9	7
Germany	Rostock LNG	6.0	8
Germany	Stade LNG	9.8	9
Germany	Wilhelmshaven FSRU	7.4	10
Greece	Alexandroupolis LNG	4.0	11
Greece	Argo FSRU	3.4	12
Greece	Thrace INGS FSRU	4.0	13
Italy	ENI FSRU, location pending	3.7	
Italy	FSRU near Sardinia	3.7	14
Lithuania	Klaipedos Nafta FSRU 2	3.0	15
Netherlands	Eemshaven FSRU	5.9	16
Netherlands	Gate LNG terminal (LNG Rotterdam) expansion 1	1.1	17
Netherlands	Gate LNG terminal (LNG Rotterdam) expansion 2	4.8	17
Poland	Gaz-System Gdansk FSRU	3.2	18
Poland	Swinoujscie	4.3	19
Slovakia	Bratislava LNG terminal	0.6	20
United Kingdom	Port Meridian LNG	5.0	21
United Kingdom	Teesside GasPort - Trafigura	5.5	22



*The Turkish Gulf of Saros FSRU has been added despite Turkey being out of the study's scope as the investment may provide additional supply to southeast Europe
Source: Rystad Energy research and analysis; Rystad Energy GasMarketCube

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Content

The cost of supply framework is deployed to filter out uncompetitive resources

Gas source	Increment group	Timing	Full resource potential 2022-2040 BCM	Share of full potential	Comment
Domestic	Base	Both	2099 2099		• Lowest cost supply and therefore expected to reach its full potential
	Increment contingent	Long term	653 618		• Vast majority of contingent resources viewed as competitive
	Increment exploration		150 68.5		• Exploration efforts in remote areas without infrastructure viewed as non-competitive • Support for exploration activity important to realize this supply
Special domestic increment	Troll max	Short term	32.9 17.6		• Only competitive until long-term LNG help normalize market conditions by 2027
	Higher GCV		23.6 23.6		• Only relevant in short term under very high gas price conditions
	Groningen		382 34.8		• Called upon as a last supply resort in the very short term • Otherwise viewed as non-competitive due to political cost
	Barents pipe	Long term	144 144		• Included under the assumption that long term demand uncertainty is alleviated and helps support business case
	European shale		455		• Possible to produce 30 Bcm/yr from 2027, however politically sensitive
Russia	Russian piped gas	Short term	364 364		• Represents the maximum Russian gas potential towards 2027 with assumptions used in the report
Piped gas	Europe piped gas imports	Both	564 564		• Similar to the base, considered to be low cost supply from North Africa and Azerbaijan
	Algeria exports	Short term	606 72.1		• Only competitive in the short term with high gas price support
	TANAP re-route		89.5 9.69		• Only competitive in the short term with high gas price support
	TANAP/TAP expansion	Long term	387 109		• Only first phase expansion included • Other phases anticipated to require more investments and resources outside Azerbaijan
LNG	Contracted LNG	Both	858 858		• Similar to base, considered to be low cost supply of already existing LNG contracts
	Spot/FOB LNG	Short term	1522 624		• Key short term supply resource • Only a portion realistically relevant for Europe as other markets such as Asia are competing for the same supply
	Uncontracted LNG	Long term	7863 2527		• Europe will not need the entire global LNG potential • Asia will be the key other region with LNG demand stimulating to global LNG capacity expansion

Full potential Competitive

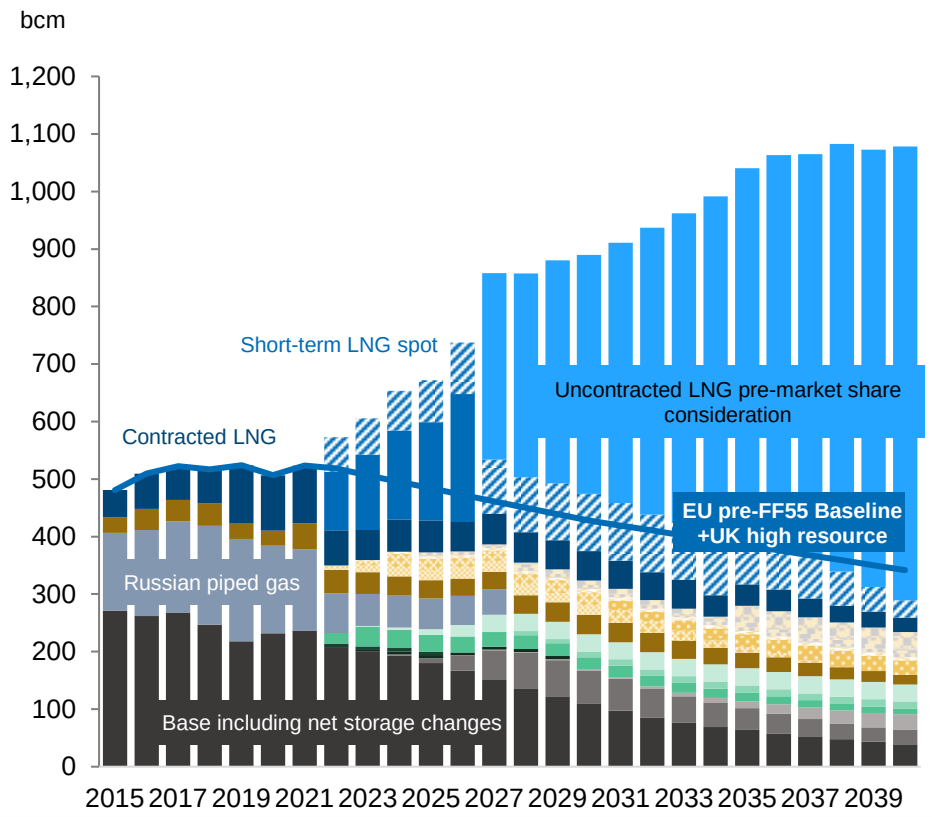
Source: Rystad Energy research and analysis

Content

RYSTAD ENERGY

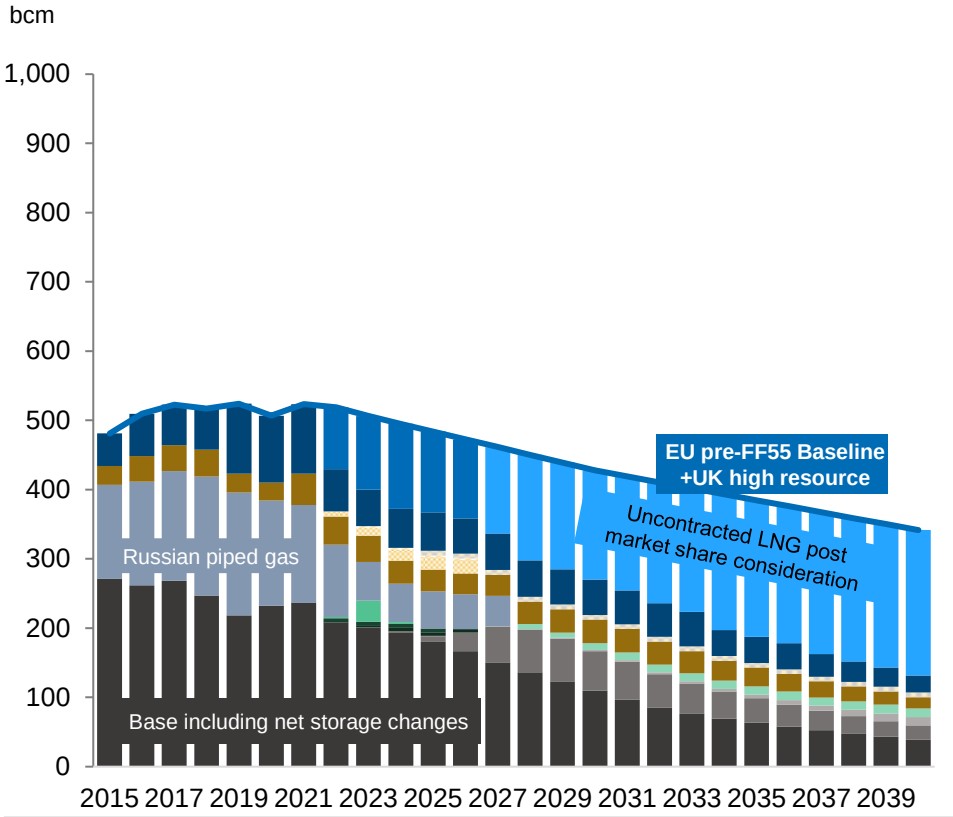
Applying the competitive lens will shave off oversupply and uncompetitive supply

Full supply stack without competition



- The full theoretical supply stack has no constraints on cost and competition
- This implies the full potential of all high-cost increments, and all uncontracted LNG is available
- Compared to the maximum demand outlook this supply potential is much higher than required

Supply stack with competitive lens applied



- When a cost competition is applied various increments are removed from the supply stack as LNG is expected have lower cost and provide sufficient supply to meet maximum demand
- The full LNG potential is also greatly reduced which is natural given remaining LNG demand outside Europe

Source: Rystad Energy research and analysis; Rystad Energy GasMarketCube

The study ranks supplies by earliest availability and cost of supply

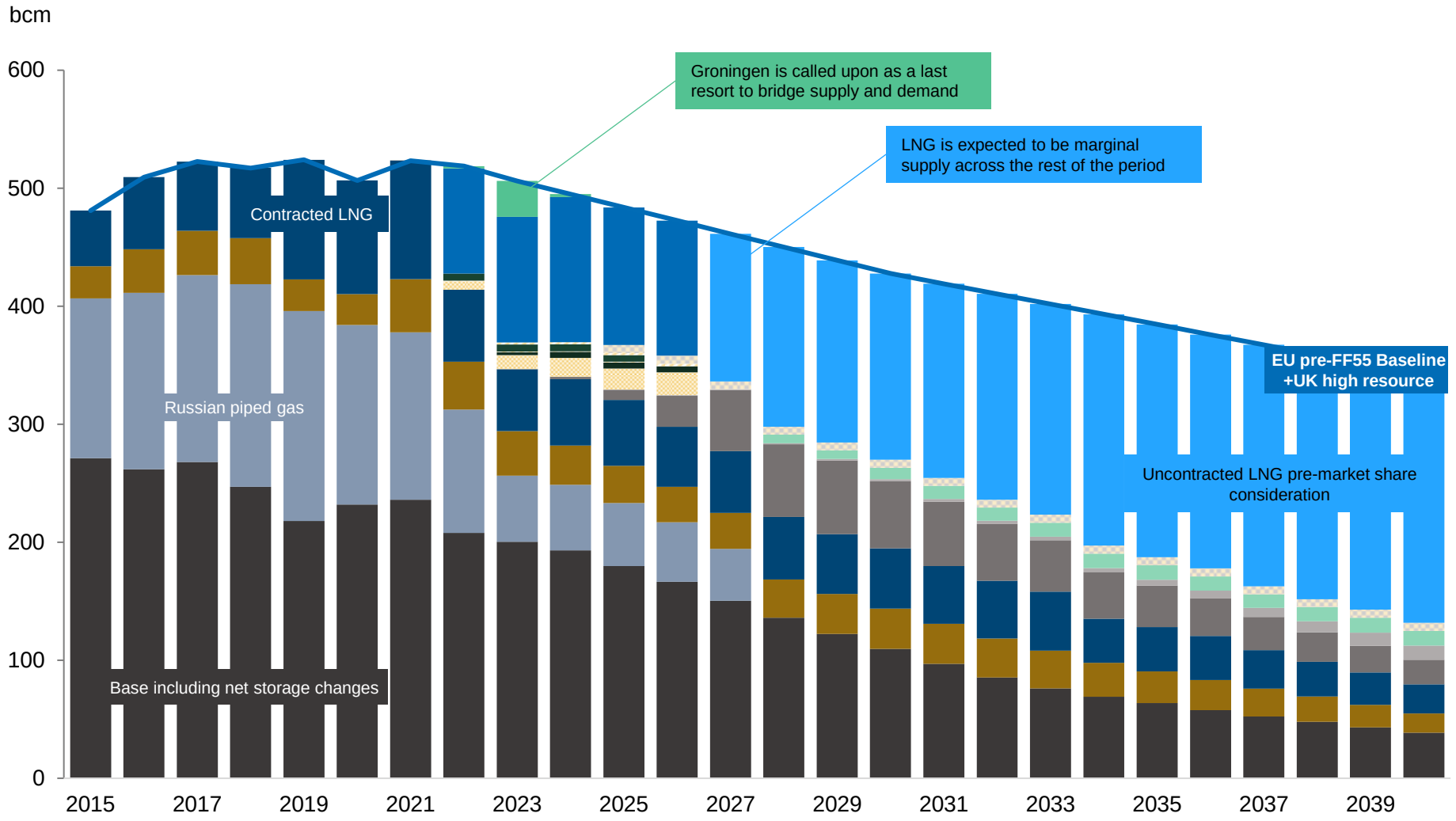
Timing	Increment grouping	Indicative combined political and economic cost of supply EUR/MWh	Cost increase	Comment
Both	Base	Low	Short term	Lowest cost supply
	Europe piped gas imports			Base cost of supply from Algeria, Libya and Azerbaijan
	Long-term LNG imports			Contracted gas
Short term	Algeria sustained until 2026 at 2021	Medium		Behavior observed in 2021 hence reasonable cost of supply
	Troll max			Maximum utilisation of the Troll field
	TR pass-through (10-40% of TANAP)	High		Possible reroute as a function of high prices and expanded Turkish LNG import capacity
	Higher GCV			Behavior observed in 2022 at high gas price levels- higher gross calorific content of gas
	LNG spot market	130		Defined ceiling of what market share of spot LNG will be acquired by Europe (approx. 40USD/Mmbtu)
	Groningen	Last resort		Viewed as last resort gas supply only called upon if all other sources are exhaused including pushing LNG up to its ceiling
	Algeria 75% Marketed	Too high		Too expensive to be considered, demand will decline before the increment is called upon
	TR pass-through (70% of TANAP)			Too expensive to be considered, demand will decline before the increment is called upon
Long term	Increment contingent and exploration	Lower	Long term	Contingent resources around Europe and exploration efforts competitive vs long term LNG
	TANAP/TAP expansion Phase 1			Possible pipe expansion project that may be competitive with long term LNG
	Barents pipe			Possible pipe expansion project that may be competitive with long term LNG
	Long term LNG	30		Key number, long term LNG expected to cost around 9 USD/Mmbtu on the back of vast low cost gas in the US
	European shale gas	Too high		European shale gas resources, considered too politically challenging to be monetized
	TANAP/TAP expansion Phase 2&3			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

Content

With rank applied to supply stack the marginal supply across the period is emphasized

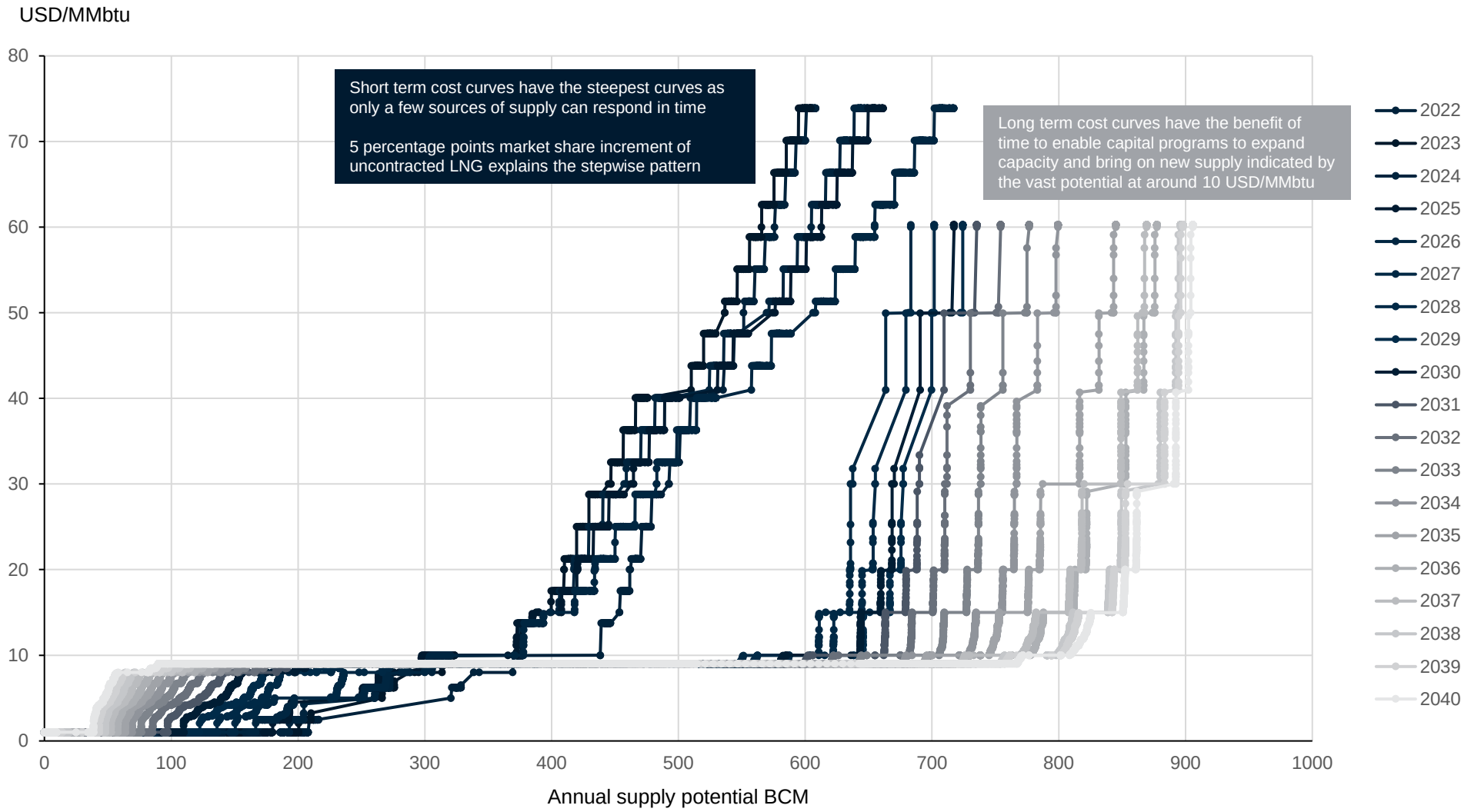
Supply stack with competitive lens and rank applied



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

Intersecting annual cost curves with annual demand estimate informs gas price outlooks

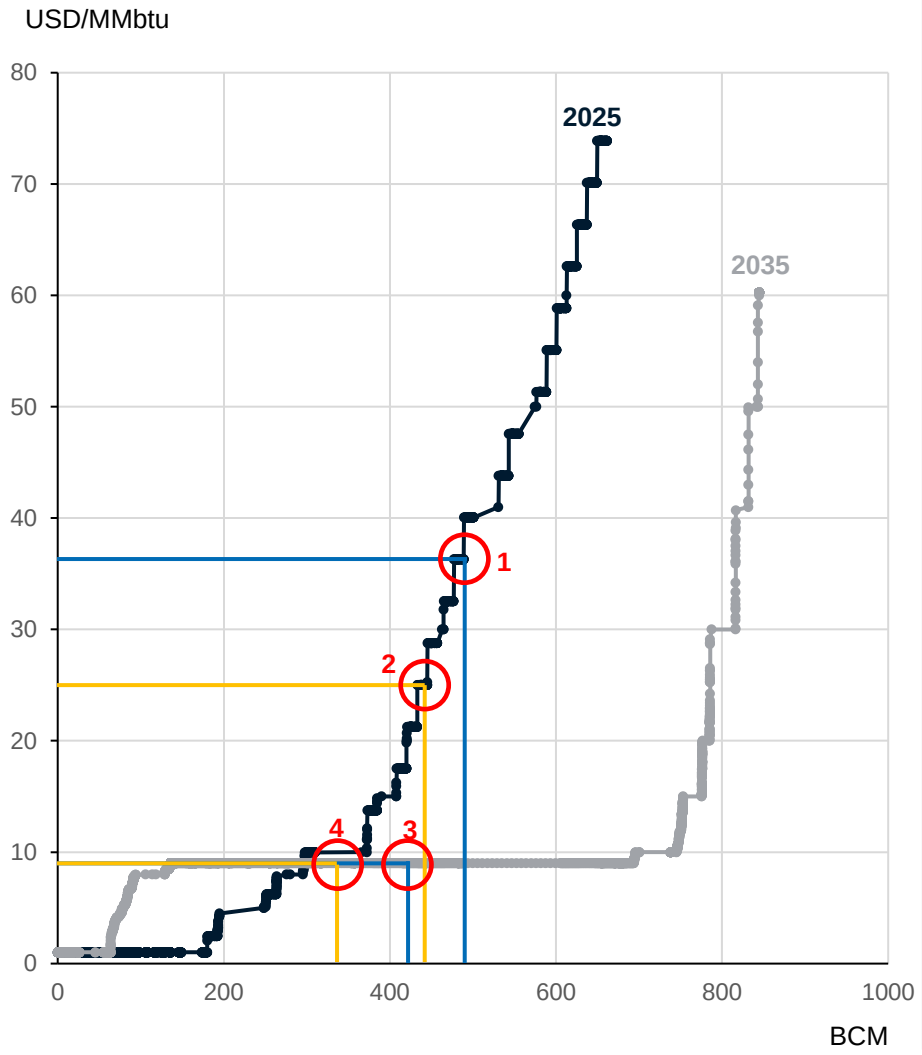
European gas cost of supply



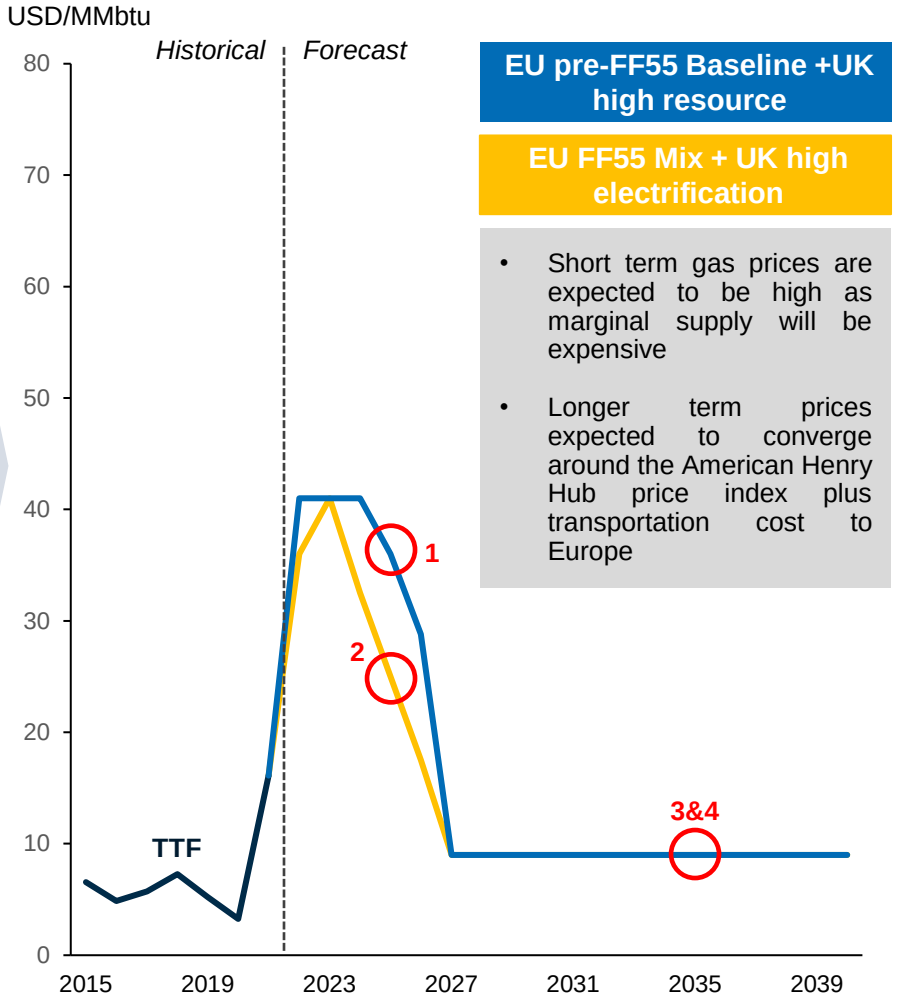
Source: Rystad Energy UCube; Rystad Energy research and analysis

Prices will remain high until new LNG supply is available

European gas cost of supply



European gas cost in demand scenarios



EU pre-FF55 Baseline +UK high resource

EU FF55 Mix + UK high electrification

- Short term gas prices are expected to be high as marginal supply will be expensive
- Longer term prices expected to converge around the American Henry Hub price index plus transportation cost to Europe

Source: Rystad Energy UCube; Rystad Energy research and analysis

Derived gas prices are similar to what is in the RePowerEU outlook

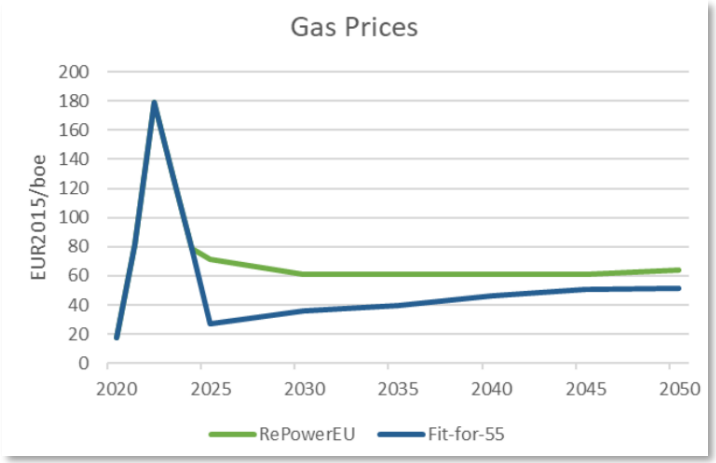
RePowerEU long-term gas price assumption

EUROPEAN COMMISSION

Brussels, 18.5.2022
SWD(2022) 230 final

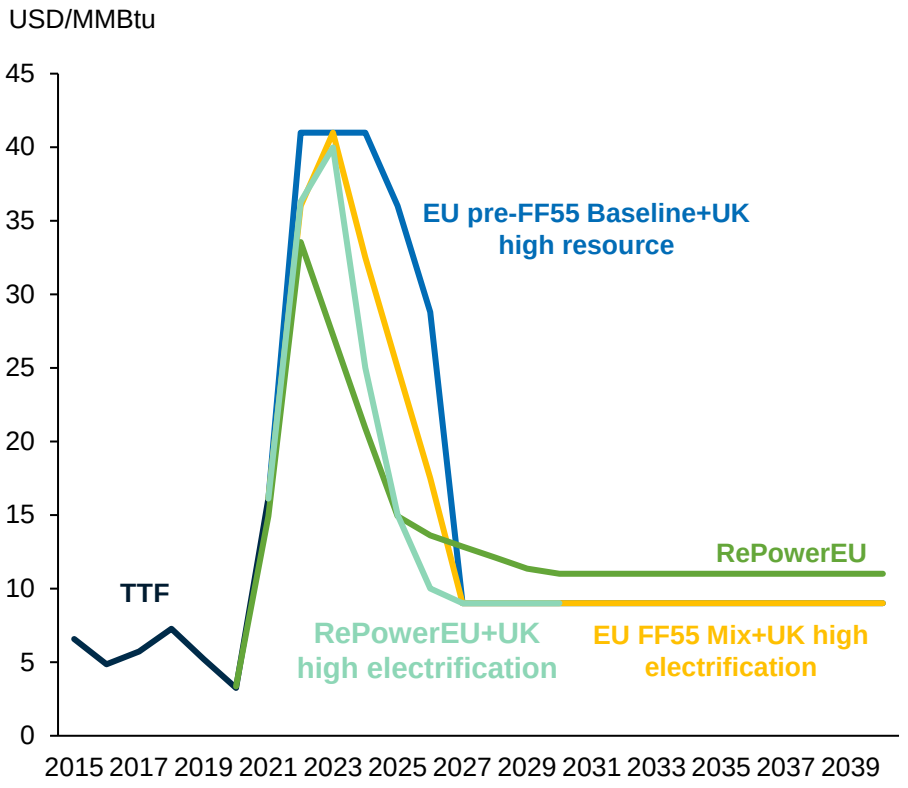
COMMISSION STAFF WORKING DOCUMENT

IMPLEMENTING THE REPOWER EU ACTION PLAN: INVESTMENT NEEDS, HYDROGEN ACCELERATOR AND ACHIEVING THE BIO-METHANE TARGETS



- The RePowerEU document illustrates what gas price assumption is embedded in the outlook
- Compared to Fit for 55 the price has been upwards adjusted likely to reflect a more constrained gas supply outlook

European gas price in demand scenarios



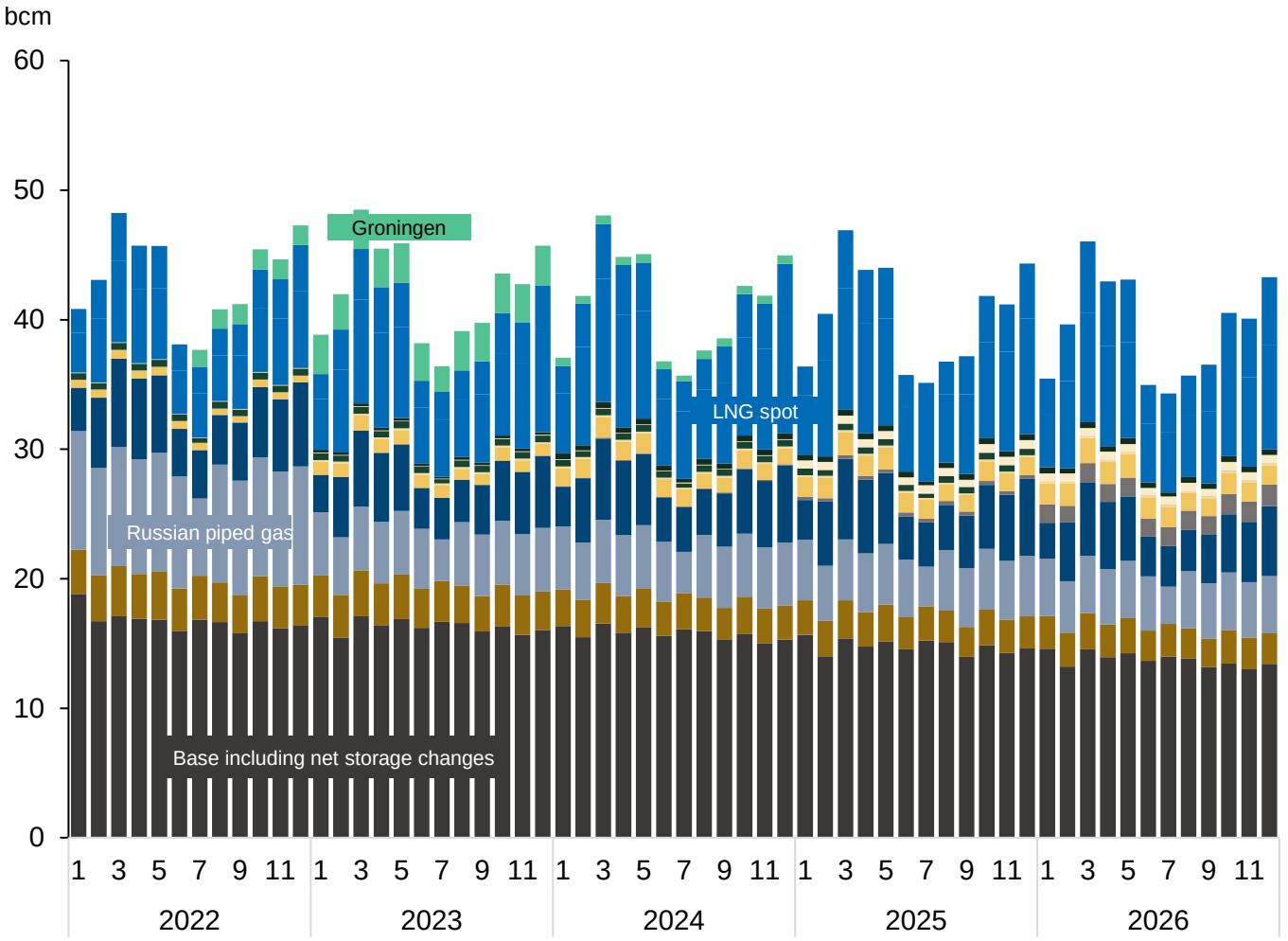
- The derived prices from the cost of supply framework produces a similar, albeit higher, short term outlook versus RePowerEU
- Longer term prices are on the other hand lower possibly owing to a stronger belief in LNG availability

Note: Gas prices converted from EUR2015/boe to USD/MMBtu using an inflation change of 11.54% between 2015 and 2022, converting from EUR to USD by a factor of 1.04, and converting from USD/boe to USD/MMBtu by dividing by a factor of 6.2. Source: Rystad Energy research and analysis; European Commission

Content

Supply potential is broken down to monthly numbers using historical patterns

Monthly competitive supply stack split on increments



Assumptions

1. Most increments use historical patterns to break down future annual supply numbers on a monthly granularity
2. The key exception is all domestic supply where there is an assessment the next 5 years on how maintenance schedules and project start ups can impact monthly numbers

Results

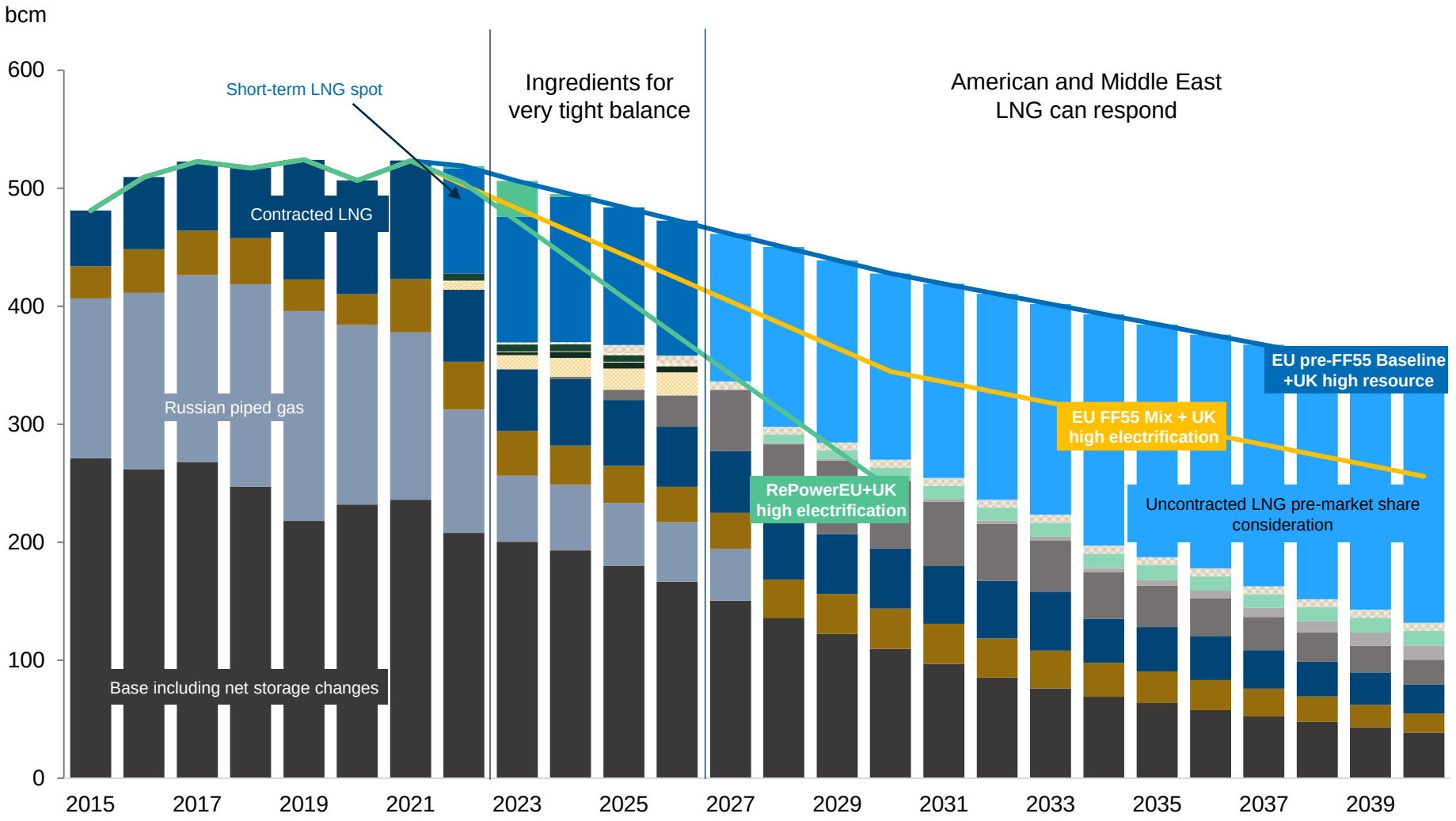
The patterns and assessments come together to create a monthly supply outlook towards 2027 that can be compared to demand and ultimately assess implied storage movements as well as ability to meet peak demand numbers

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

Content

Balancing the European market in the short-term is expected to be challenging, while American and Middle Eastern suppliers can respond in the long-term

Supply stack with competitive lens applied by supply cost

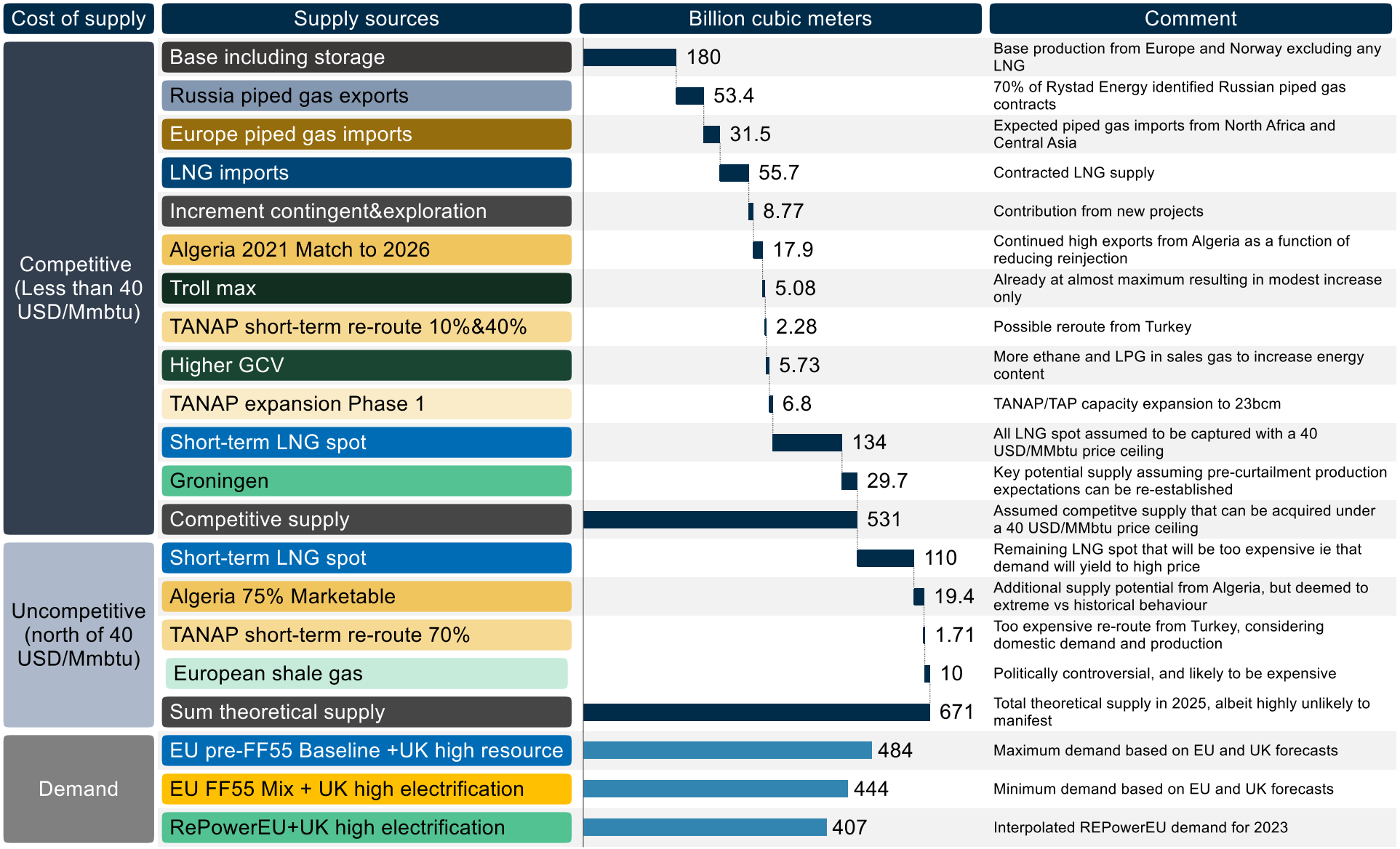


Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy

2023:
Short term LNG and Groningen are the key incremental supply sources

Cost of supply	Supply sources	Billion cubic meters	Comment
Competitive (Less than 40 USD/Mmbtu)	Base including storage	193	Base production from Europe and Norway excluding any LNG
	Russia piped gas exports	55.9	70% of Rystad Energy identified Russian piped gas contracts
	Europe piped gas imports	37.7	Expected piped gas imports from North Africa and Central Asia
	LNG imports	52.4	Contracted LNG supply
	Algeria 2021 Match to 2026	11.8	Continued high exports from Algeria as a function of reducing reinjection
	Troll max	2.38	Already at almost maximum resulting in modest increase only
	TANAP short-term re-route 10%	0.57	Possible reroute from Turkey
	Higher GCV	5.99	More ethane and LPG in sales gas to increase energy content
	TANAP short-term re-route 40%	1.71	Possible reroute from Turkey additional increment
	Short-term LNG spot	107	All LNG spot assumed to be captured with a 40 USD/MMbtu price ceiling
	Groningen	34.3	Key potential supply assuming pre-curtailment production expectations can be re-established
	Competitive supply	503	Assumed competitve supply that can be acquired under a 40 USD/MMbtu price ceiling
Uncompetitive (north of 40 USD/Mmbtu)	Algeria 75% Marketable	7.11	Additional supply potential from Algeria, but deemed to extreme vs historical behaviour
	Short-term LNG spot	87.2	Remaining spot LNG that will be too expensive ie that demand will yield to high price
	European shale gas	1	Politically controversial, and likely to be expensive
	Sum theoretical supply	598	Total theoretical supply in 2023, albeit highly unlikely to manifest
Demand	EU pre-FF55 Baseline +UK high resource	506	Maximum demand based on EU and UK forecasts
	EU FF55 Mix + UK high electrification	483	Minimum demand based on EU and UK forecasts
	RePowerEU+UK high electrification	472	Interpolated REPowerEU demand for 2023

2025:
More LNG is available, but without Russian supply there is still a minor shortage

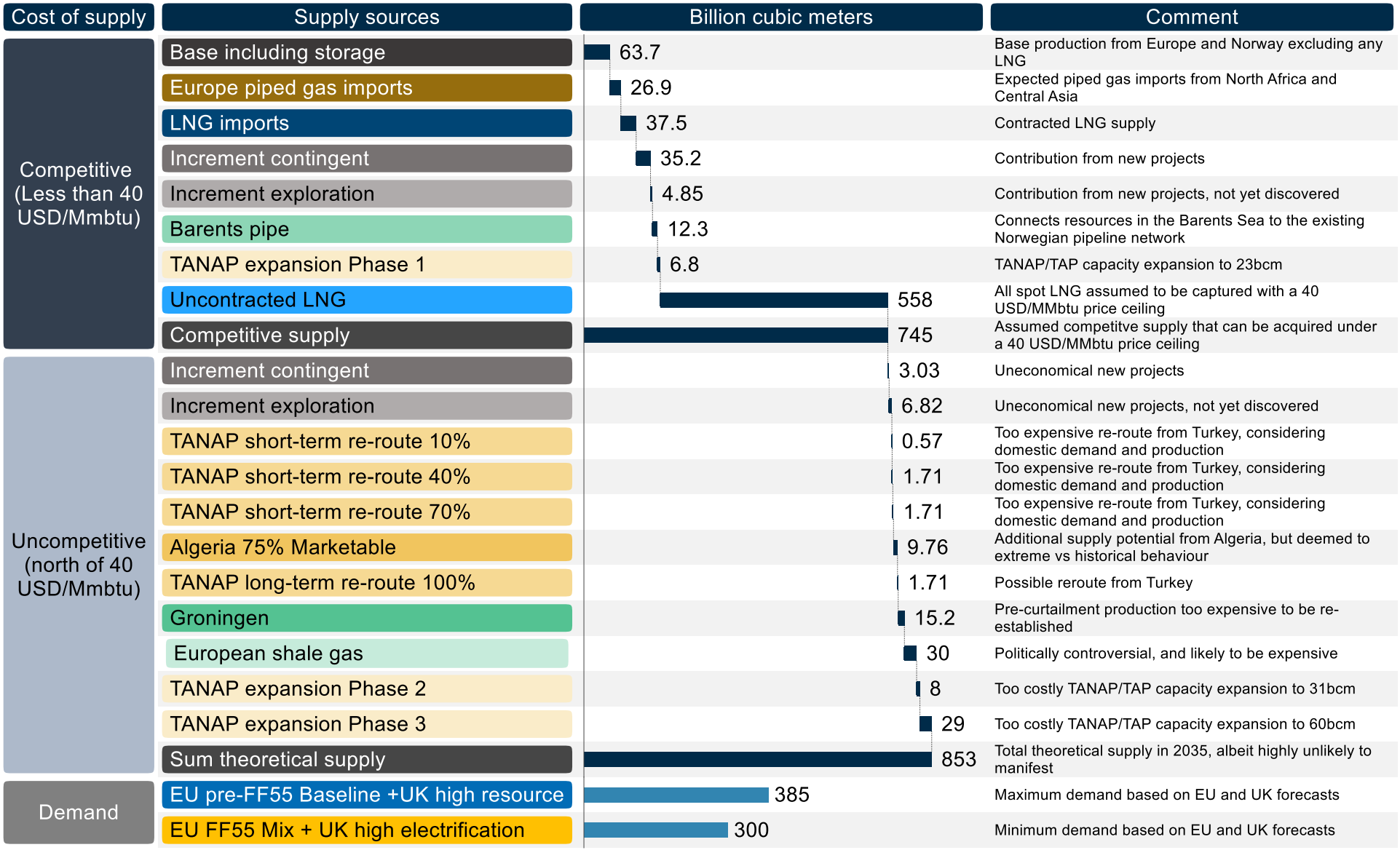


2030:
Short term increments too expensive and outcompeted by the long-term increments

Cost of supply	Supply sources	Billion cubic meters	Comment
Competitive (Less than 40 USD/Mmbtu)	Base including storage	110	Base production from Europe and Norway excluding any LNG
	Europe piped gas imports	34.1	Expected piped gas imports from North Africa and Central Asia
	LNG imports	51	Contracted LNG supply
	Increment contingent	56.9	Contribution from new projects
	Increment exploration	1.68	Contribution from new projects, not yet discovered
	Barents pipe	9.83	Connects resources in the Barents Sea to the existing Norwegian pipeline network
	TANAP expansion Phase 1	6.8	TANAP/TAP capacity expansion to 23bcm
	Uncontracted LNG	373	All spot LNG assumed to be captured with a 40 USD/MMbtu price ceiling
	Competitive supply	643	Assumed competitve supply that can be acquired under a 40 USD/MMbtu price ceiling
Uncompetitive (north of 40 USD/Mmbtu)	Increment contingent	0.747	Uneconomical new projects
	Increment exploration	0.666	Uneconomical new projects, not yet discovered
	Algeria 2021 Match to 2026	15.6	Too expensive exports resulting from reinjection reduction
	TANAP short-term re-route 10%	0.57	Too expensive re-route from Turkey, considering domestic demand and production
	TANAP short-term re-route 40%	1.71	Too expensive re-route from Turkey, considering domestic demand and production
	TANAP short-term re-route 70%	1.71	Too expensive re-route from Turkey, considering domestic demand and production
	Algeria 75% Marketable	23.3	Additional supply potential from Algeria, but deemed to extreme vs historical behaviour
	TANAP long-term re-route 100%	1.71	Too expensive re-route from Turkey, considering domestic demand and production
	Groningen	20.6	Pre-curtailment production too expensive to be re-established
	European shale gas	30	Politically controversial, and likely to be expensive
	TANAP expansion Phase 2	8	Too costly TANAP/TAP capacity expansion to 31bcm
	Sum theoretical supply	747	Total theoretical supply in 2030, albeit highly unlikely to manifest
Demand	EU pre-FF55 Baseline +UK high resource	428	Maximum demand based on EU and UK forecasts
	EU FF55 Mix + UK high electrification	345	Minimum demand based on EU and UK forecasts
	RePowerEU+UK high electrification	245	Interpolated REPowerEU demand for 2023

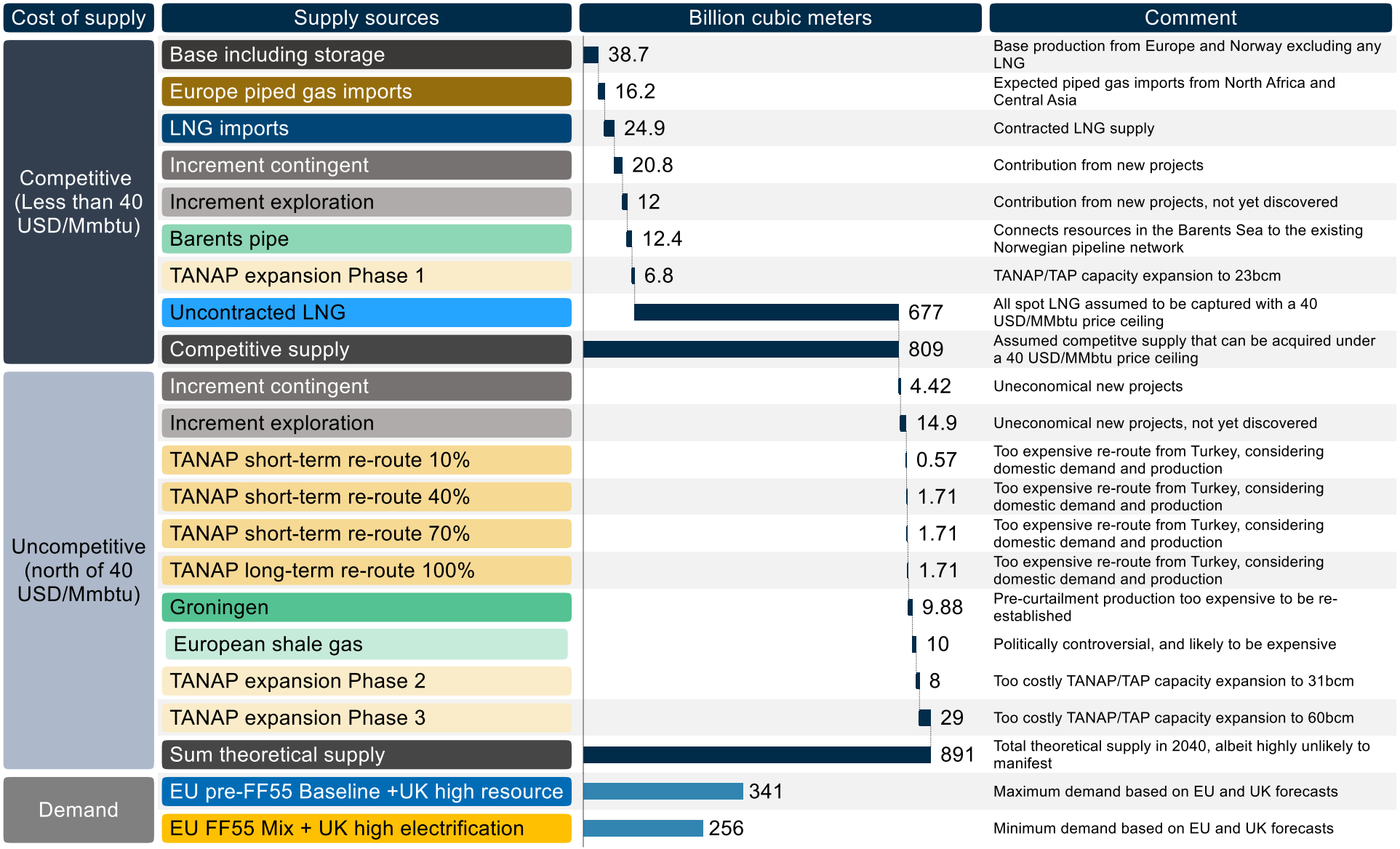
Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy

2035:
The same trend as in 2030 continues with increasing LNG resources available



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

2040:
Decreasing demand and non-LNG supply sources implying higher LNG market share



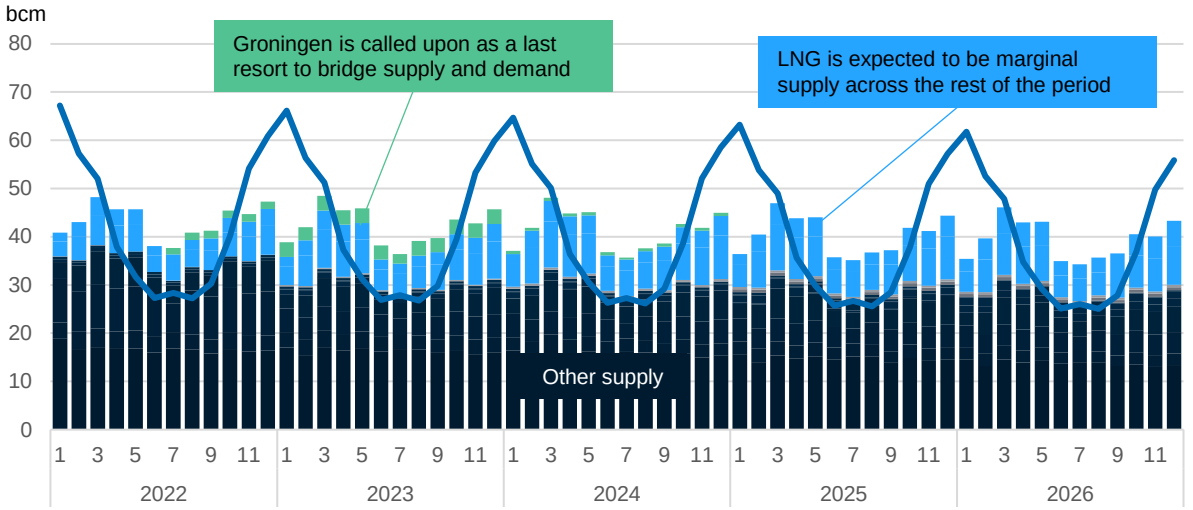
Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy

Content

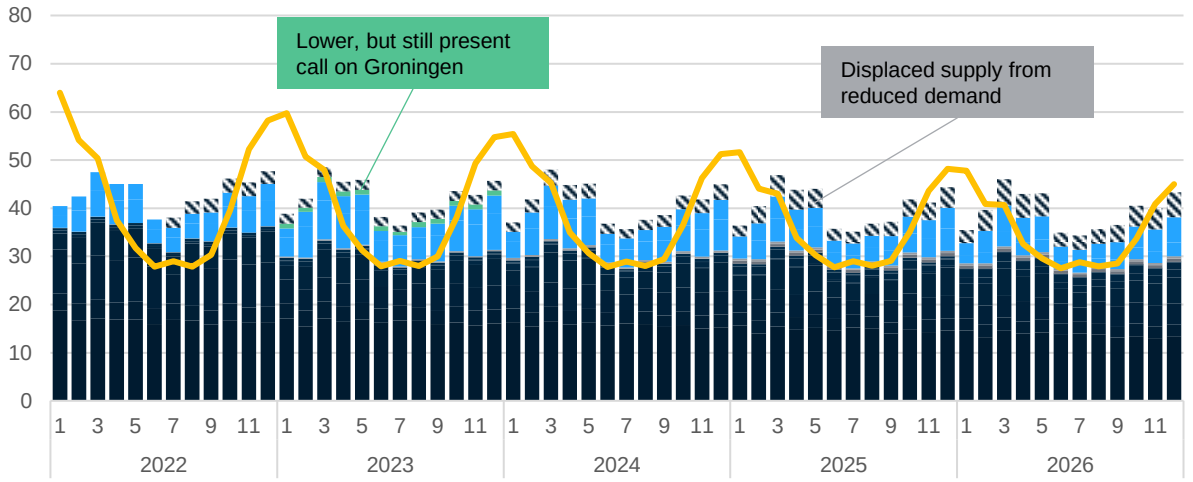
Groningen is critical to meet supply in 2023 as Russia declines and LNG is exhausted

Monthly supply with demand scenarios

EU pre-FF55 Baseline +UK high resource



EU FF55 Mix + UK high electrification

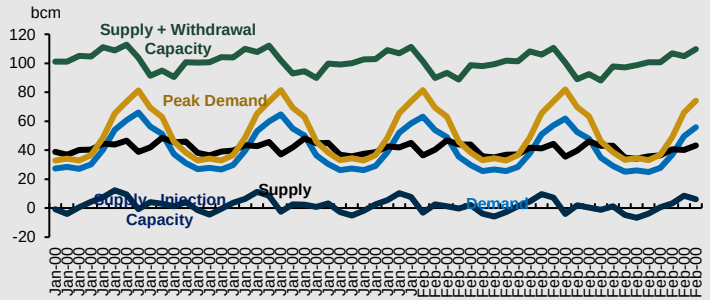
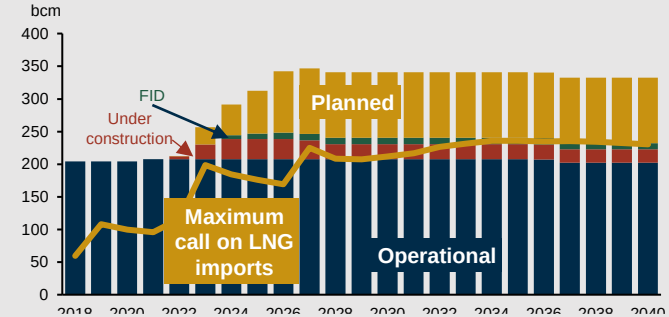
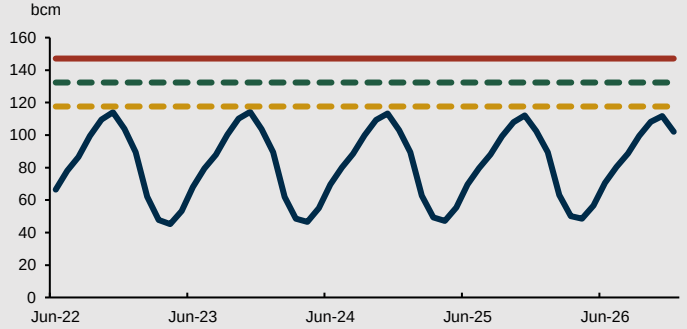


- In both demand scenarios there is insufficient supply in 2023 to avoid calling on Groningen supply
- For the pre Fit For 55 demand outlook the Groningen call is also present in 2022 and 2024
- For both scenarios this implies that there is insufficient short term gas to reach the 80% and 90% storage level targets
- For other years it is LNG that will serve as the marginal cargo that will be displaced should demand be lower than expected or other supply higher than expected
- Should Russia stop all exports from 2023 there is insufficient supply to balance the market and demand will have to be curtailed

Note: Supply includes Russian gas according to the 2/3 import reduction target until 2027
Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy

Infrastructure on a continental level is enough to meet demand in base scenario

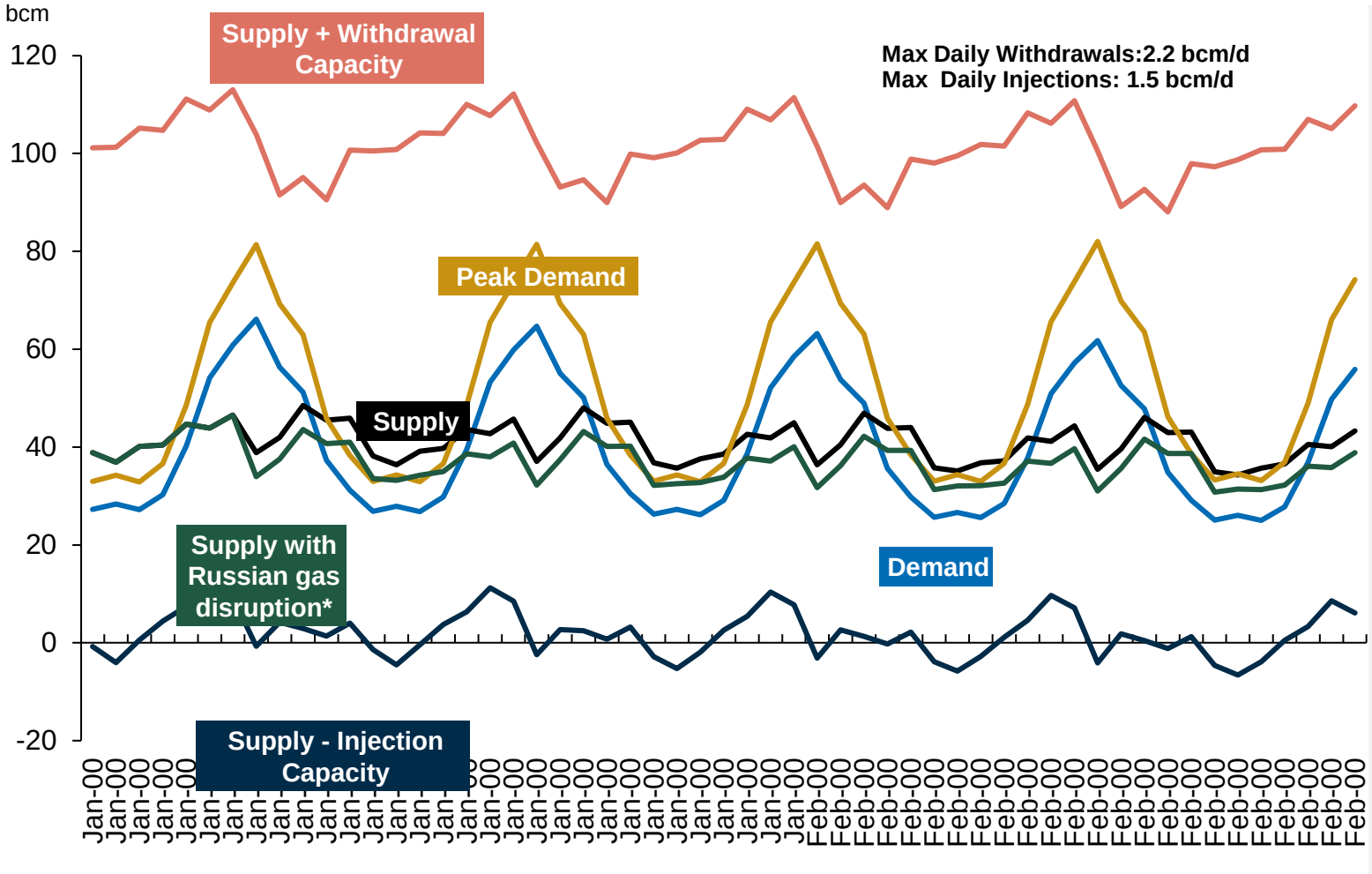
Infrastructure Capabilities

	Illustration	Caveats
Peak Supply		• This is a continental view • Individual countries have varying storage capacities, Germany and Ukraine have significant amounts; the United Kingdom and Greece have little to no capacity • There is only one storage site in the baltic states (located in Latvia)
Regasification Capacity		• There are significant bottlenecks from Spain and the United Kingdom to the rest of Europe, the two countries with the most capacity • Spain to France: 7.4bcm/yr • UK to Belgium/Netherlands: 44.5 bcm/yr
Storage Inventories		• Storage inventory targets of 80% in October 2022 and 90% in 2023 are unachievable • This assumes average temperatures, a cold winter drawing on more natural gas for heating will severely dent peak inventories in future years

Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy, ENTSOG TYNDP 2022

For peak periods (injections and withdrawals) there more than enough potential supply to meet demand

EU pre-FF55 Baseline +UK high resource



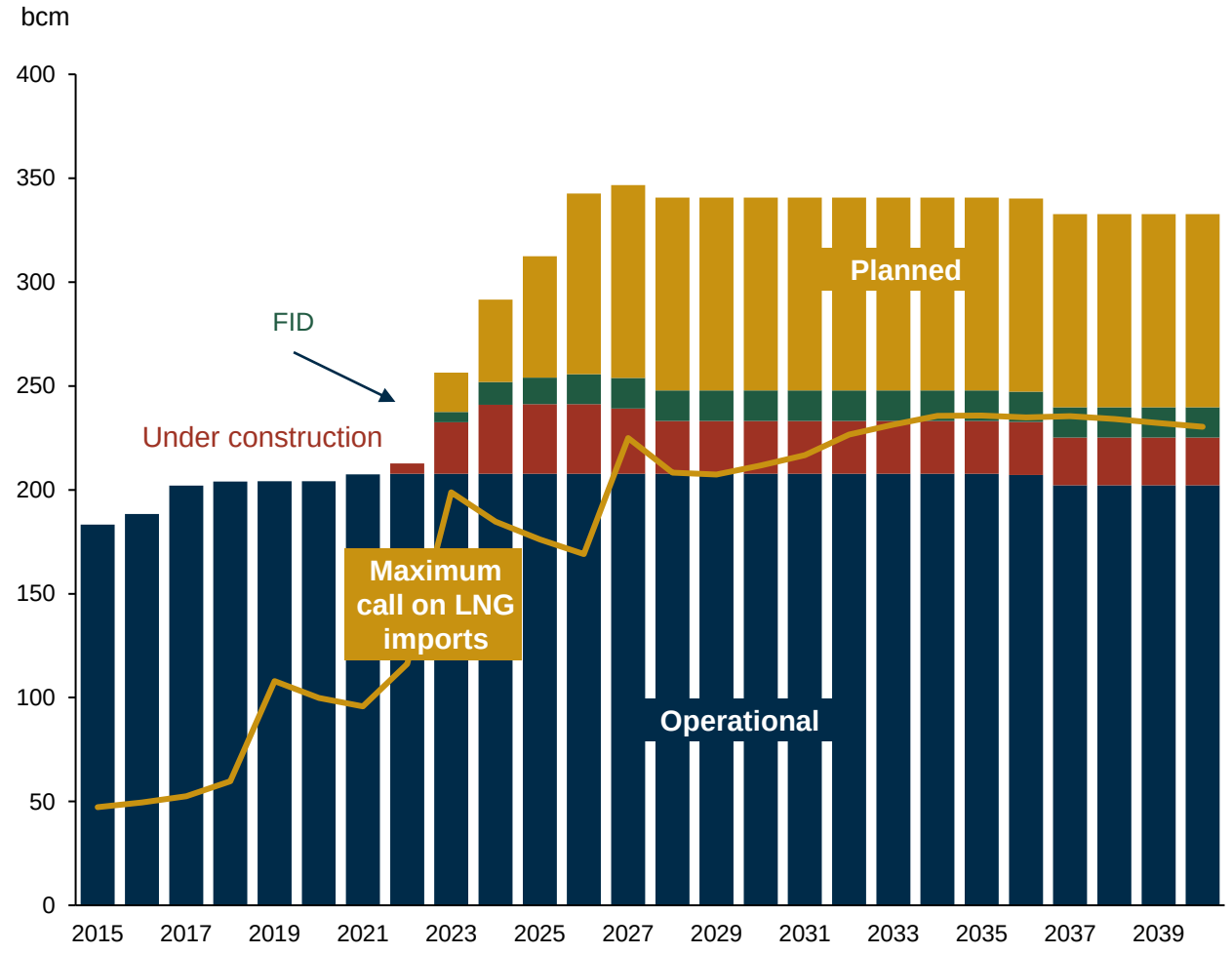
- The chart to the left shows supply, demand, peak demand and two values showing the limits of the system for any given month
- Storage acts as a safety valve on the system so it can be balanced for any given point in time
- Injection and withdrawal capacity are more than large enough in order to meet peak demand, the bottom line demonstrates how much storage sites can absorb when demand is at its minimum

*Russian gas disruption assumes no Russian gas imports from January 2023

Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy, ENTSOG TYNDP 2022

European LNG Regas capacity set to grow during the rest of the 2020s

European LNG Regas Capacity and Call on LNG resources

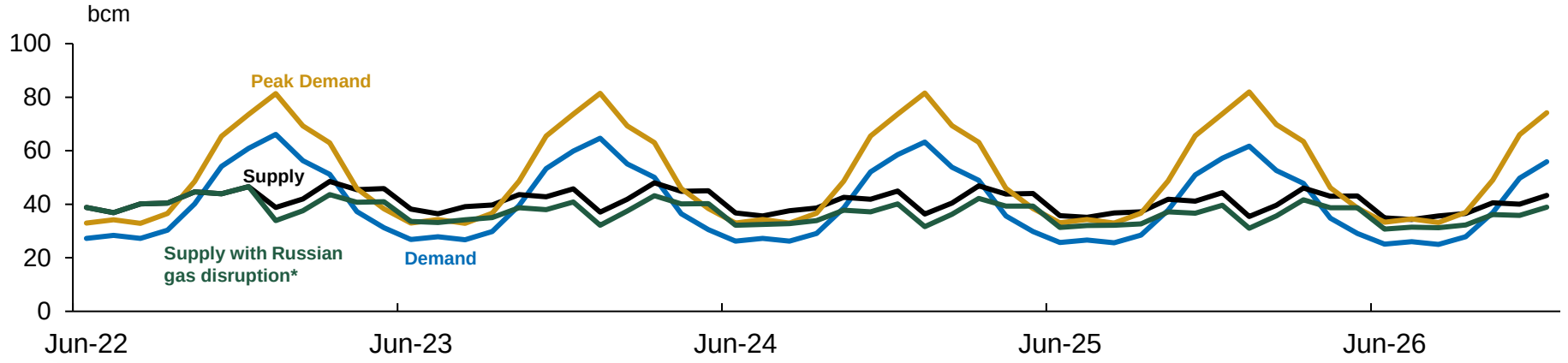


- Spain has the most regasification capacity of any European country (60.8bcm/yr) but with limited connectivity across the Pyrenees to the rest of Europe (8.4bcm/yr)
- The United Kingdom (50.2bcm/yr) has the next most but has better connectivity to the rest of the European network (44.5bcm/yr)
- Germany currently has no capacity for regasification owing to long standing reliance on Russian piped gas there are plans to install approximately 40bcm/yr capacity by the late 2020s
- Italy is expected to boost its regasification capacity by approximately 10bcm/yr to 25bcm/yr in the coming years too

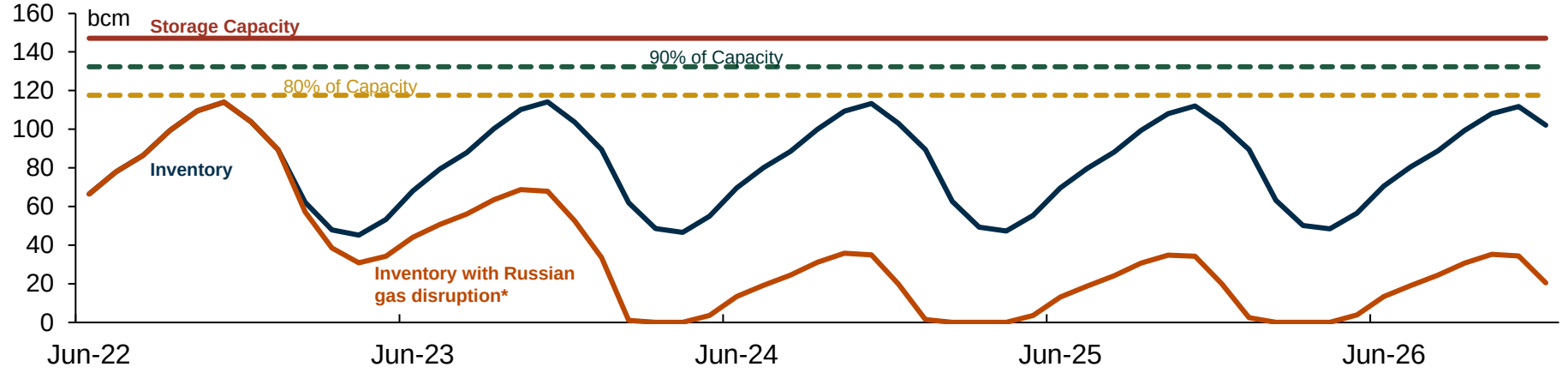
Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy, ENTSOG TYNDP 2022

Impossible to reach storage targets without demand reduction or higher imports

EU pre-FF55 Baseline +UK high resource



Implied European Storage Inventories



*Russian gas disruption assumes no Russian gas imports from January 2023
Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy, ENTSOG TYNDP 2022

Content

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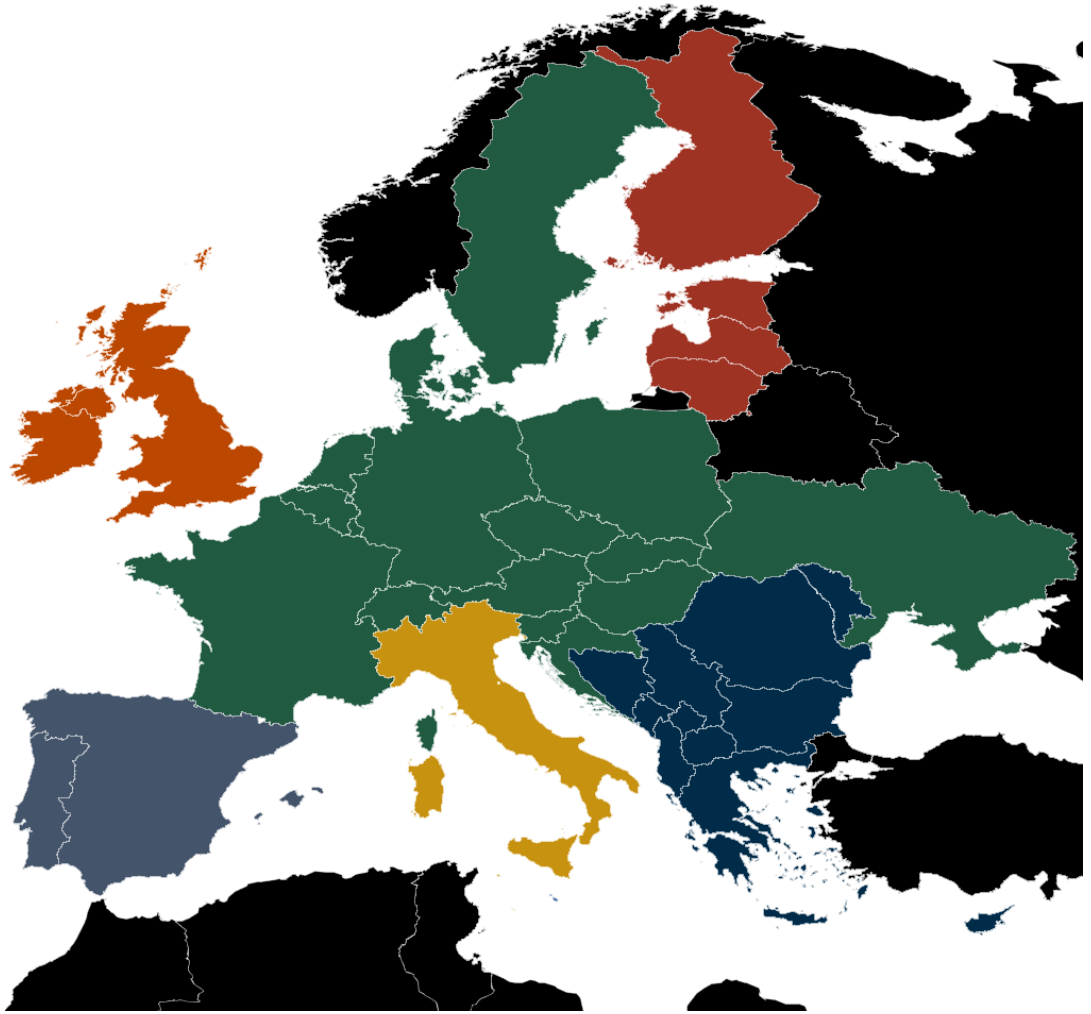
Content

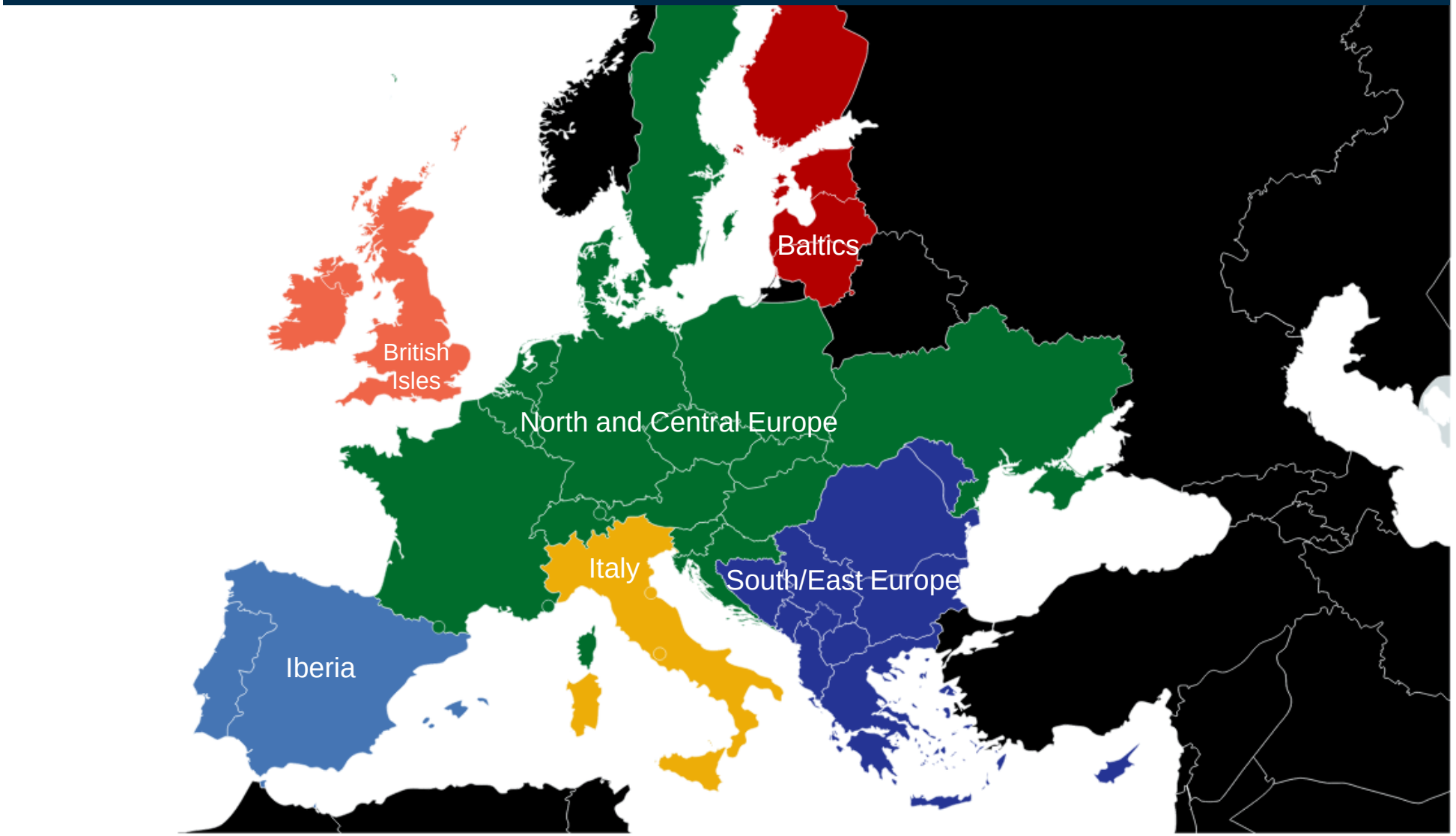
Regional balances are created based on grouping specific countries together

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



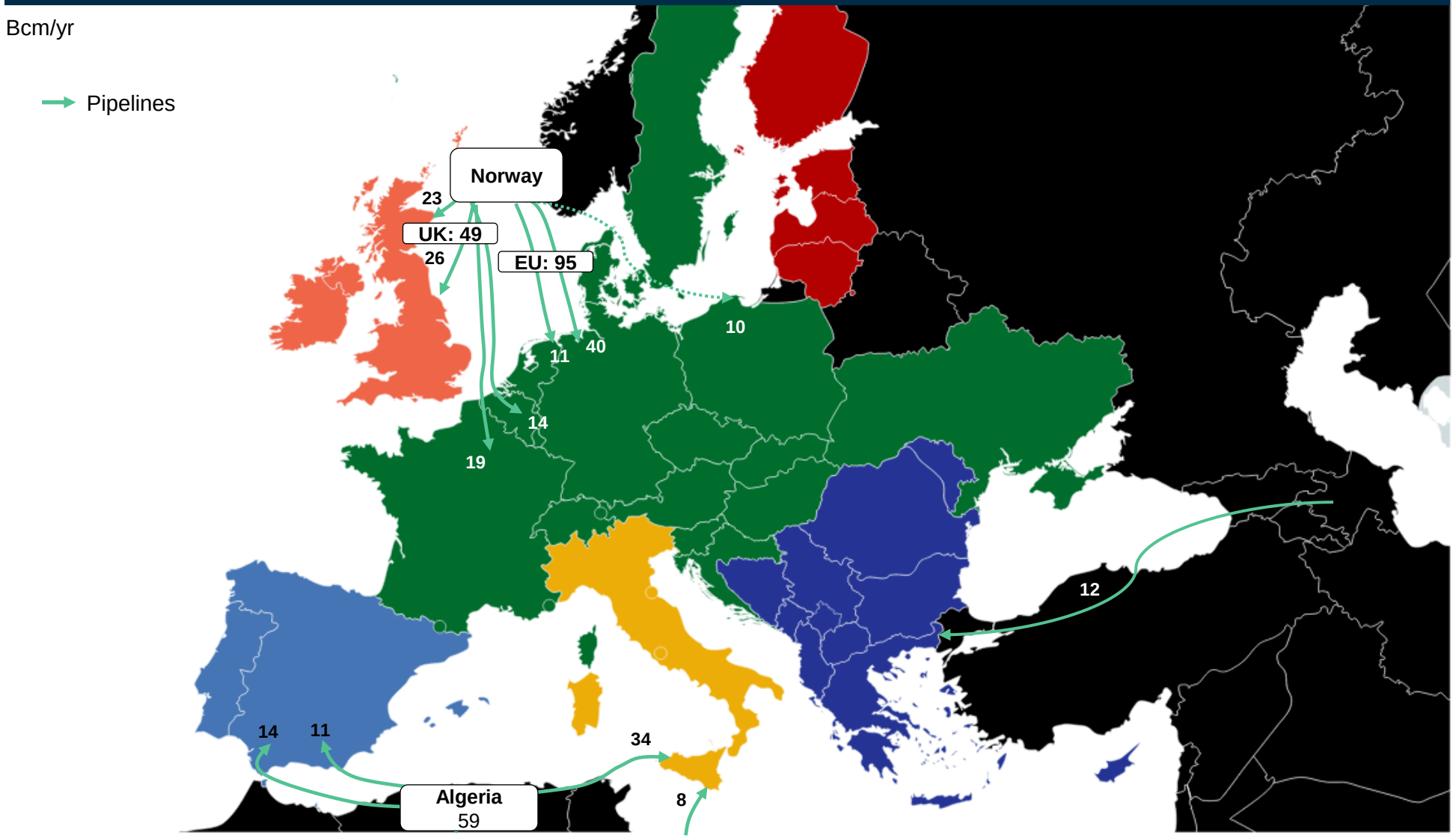
Regional grouping of countries which are relatively well connected by infrastructure

Grouping of European markets into regions



Non-Russian pipeline imports from North Sea, N Africa, and Turkey

LNG and non-Russian pipeline import capacities by region



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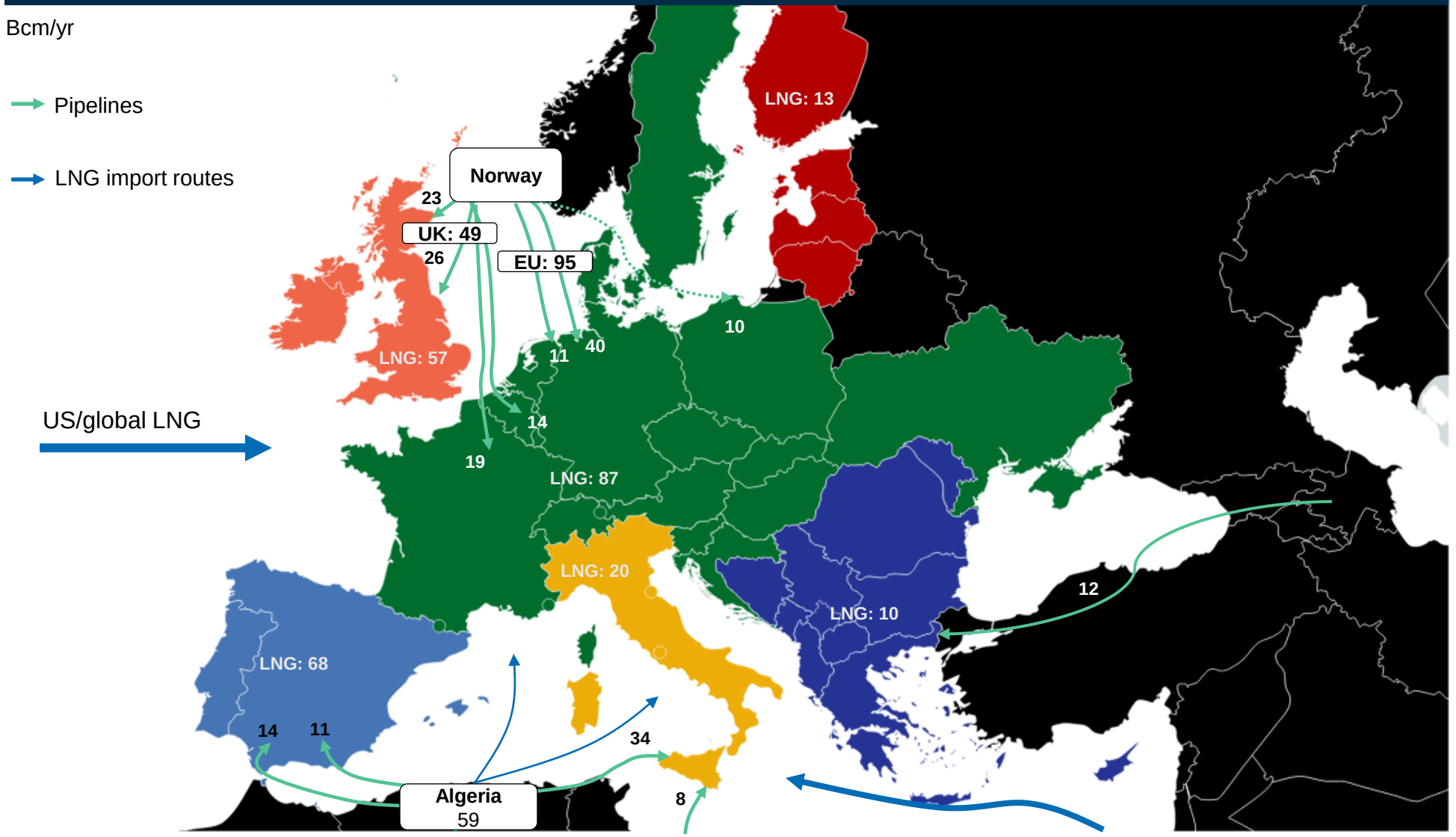
Significant LNG regas capacity into Europe; interconnecting regions through rerouting

LNG and non-Russian pipeline import capacities by region



Content

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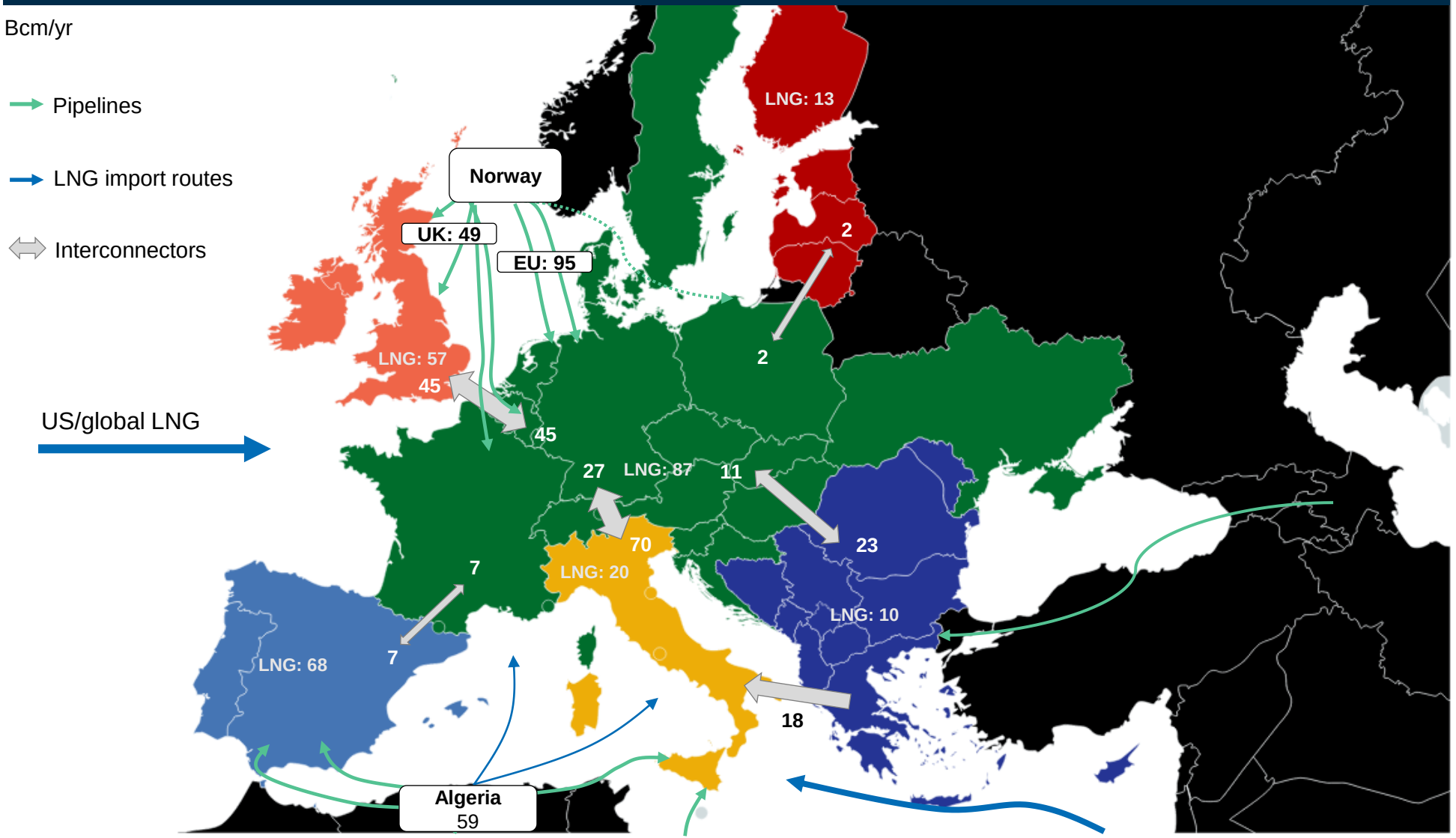
Connectivity between regions varies with significant bottlenecks between Spain and France; Poland and Lithuania and no capacity for reverse flows from Italy to Greece

Regions and the interconnectivity between them, 2023



Content

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Various principles deployed to develop a view on regional supply and demand balances

Infrastructure/gas flows assessment

Gas market flows assumptions

- Optimization of intra-regional flows for security of supply and according to enhanced capacities*
- Allocation of LNG based on rules (*up to demand/ up to capacity/up to LNG availability*)
- Norwegian gas flowing according to price implying N&C Europe will take as much supply as possible
- Loyal to piped gas contracts from North Africa to Spain and Central Asia to Italy
- No bottlenecks within regional groups considered
- Russian import reduction distributed evenly within all regions according to historical Russian imports
- Removal of gas odorization hurdles to allow gas flowing from west to east
- N&C Europe as a destination for residual LNG supply once all other regions are satisfied
- No view on supply deficit allocation across regions outside what is implied by the LNG allocation

*Conditional firm technical capacity as provided by TSOs to allow for more gas to be transported from Western to Eastern Europe
Source: Rystad Energy research and analysis, ENTSOG

Infrastructure is in place to handle new flows patterns, but a fair allocation of scarce commodity is the key regional question

Regional assessment of European gas supply rebalancing in face of a complete Russian gas supply disruption

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

- European efforts to build infrastructure and market resilience are now paying dividends
- Reverse flow, regas terminals and new interconnectors can help cope with missing East to West gas from Russia
- TSO, shippers and other stakeholders have to reorganize and collaborate in new manners to facilitate the new flow patterns

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

- Scarce commodity can be allocated based on highest payer leaving poorer regions without supply
- Gas can be allocated based on distance to import point implying that land locked countries typically will be without supply
- Commodity can be allocated according to a distribution key such as proportional share of gas demand in 2021

Source: Rystad Energy research and analysis

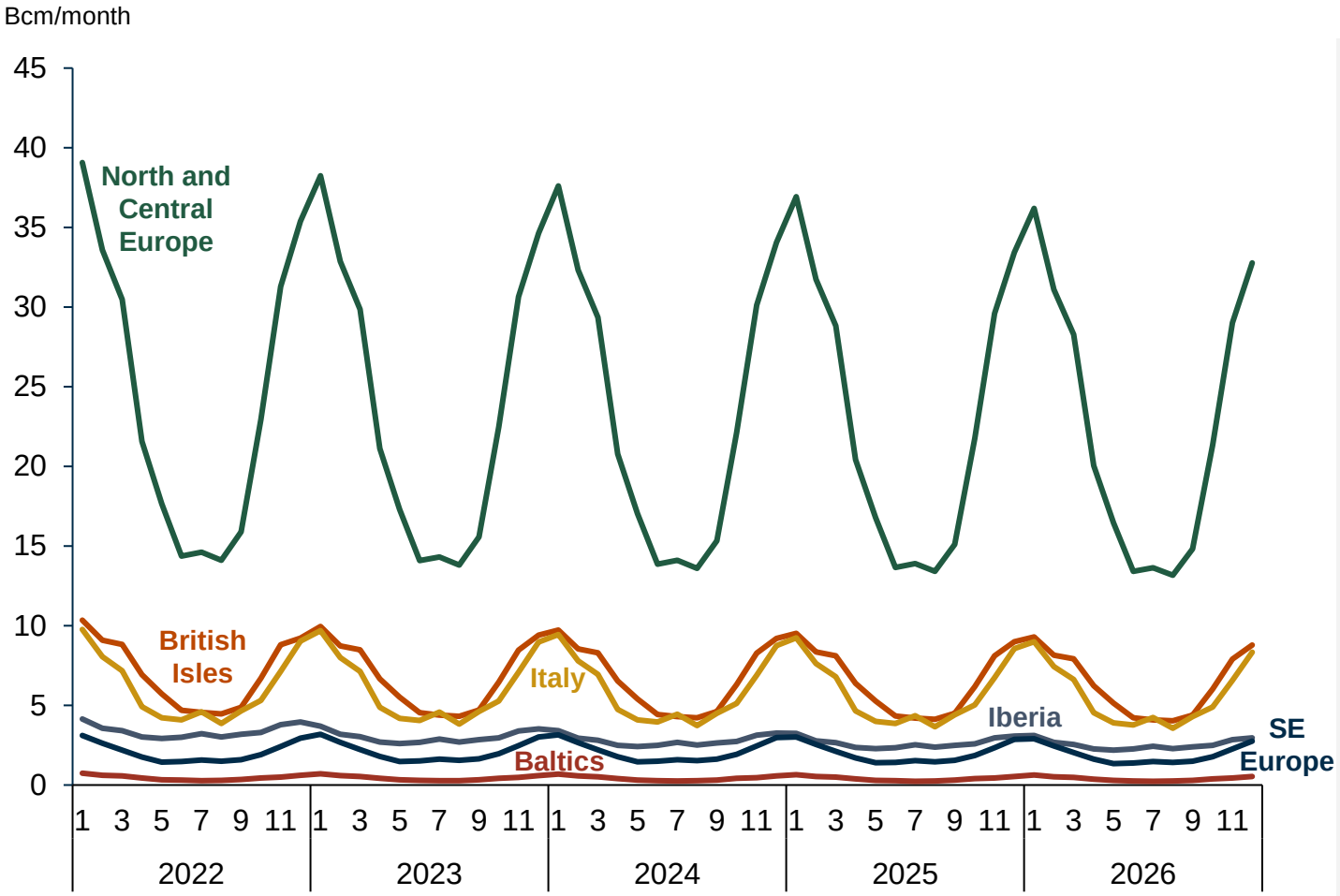
Sufficient commodity supply on a continental level is the main challenge - Regional analysis show no particular constraints on peak demand and infrastructure

	Regionalization analysis		
	Annual level	Maximum infrastructure capacity	Constrained supply
Description	• Assessment of how well each region is able to supply itself on an annual level with existing infrastructure, while respecting contractual obligations for piped gas • Expected gas availability taken into account	• Assessment of how well each region is able to meet peak demand days should all infrastructure be available at maximum capacity	• Assessment intended to be a hybrid where available commodity is constrained by anticipated LNG, storage availability and contracted piped gas
Caveat	• Seasonality patterns and consequent constraints on infrastructure not accounted for • No assumptions made on intra-regional constraints • Norway imports treated as flexible volumes, prioritizing the continental market	• Assumes gas is available at any given type to max out send-out capacity from storage and regas facilities • No assumptions made on intra-regional constraints	• LNG supply adjusted to its availability on a daily level • Norway imports treated as flexible volumes, prioritizing the continental market • No assumptions made on intra-regional constraints, but TSO interviews indicate commodity and not infrastructure as main constraint
Findings	• Italy and Southeast Europe unable to be independently supplied without relying on interconnectors • Europe overall in a supply deficit without Russian gas • The deficit is allocated to North and Central Europe as it is defined as the residual destination for remaining LNG supply	• All regions have sufficient daily send-out capacity to meet expected peak demand	• Storage is key to meet peak demand days, but requires Russian gas to be at sufficient filling level • Interconnectors can help balance out supply across regions at low storage levels, but only down to about 25-30% fill rate

Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy, ENTSOG, TSO interviews

North and Central Europe is the largest demand region by far; British Isles, Italy and Iberia are middling; Southeast Europe and the Baltics are the smallest

Demand by Infrastructure Regions



- Seasonality pattern holds for all regions albeit with a sharper peak in winter months for North and Central Europe
- The British Isles and Italy have very similar demand levels
- The smoothest demand pattern is in Iberia
- Southeast Europe has a pronounced seasonality as do the Baltics

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

Without Russian gas in 2023: while interconnectors/LNG reroute can shift supplies, there will be a competition for limited commodity

Annual level

Regional balances, 2023 (unit: bcm/year)

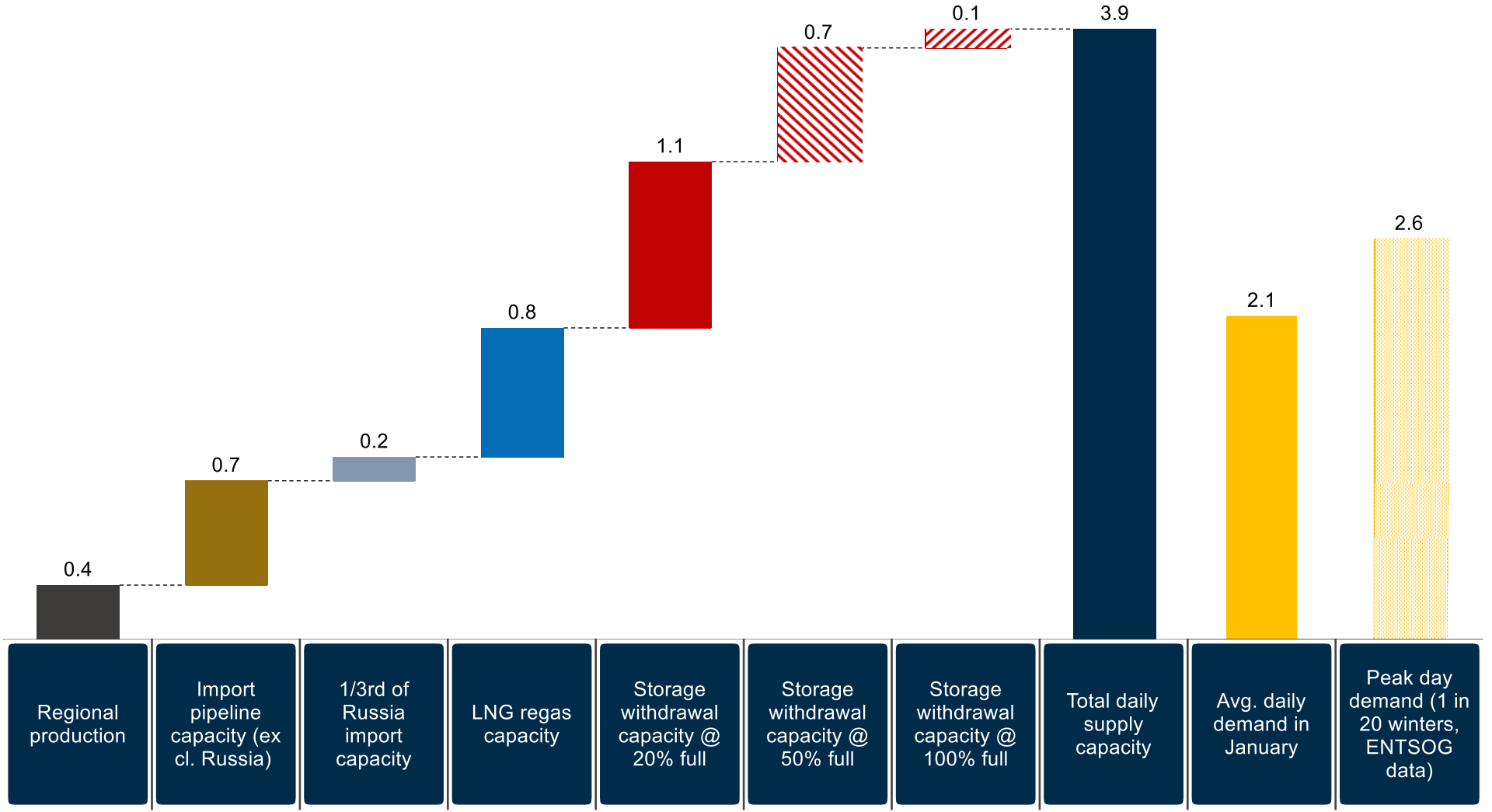
Region	Regional production	Piped gas	LNG	Total supply	Demand EU pre-FF55 + UK	Gap	Remaining supply capacities (unused due to lack of affordable supplies): Unused LNG Capacity	Remaining supply capacities (unused due to lack of affordable supplies): Interconnector
N&C Europe*,**	79	95	72	245	285	- 40	15	92
British Isles**	37	22	23	82	82		34	45
Italy***	3	37	20	61	72	- 11	0	88
Iberia***	0	9	28	36	36		40	7
Southeast***	9	4	10	23	25	- 2	0	23
The Baltics	0	0	5	5	5		8	2
Europe	127	167	159	453	506	- 53	97	0

*N&C Europe treated as a region of residual uncontracted LNG **Norwegian exports assumed flexible and maximized up to capacity ***Contractual obligations respected
Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy, ENTSOG

Europe has significant gas infrastructure capacity to supply peak day demand

Max infrastructure capacity

Peak day supply capacity build-up, Jan 2023 (unit: bcm/day)

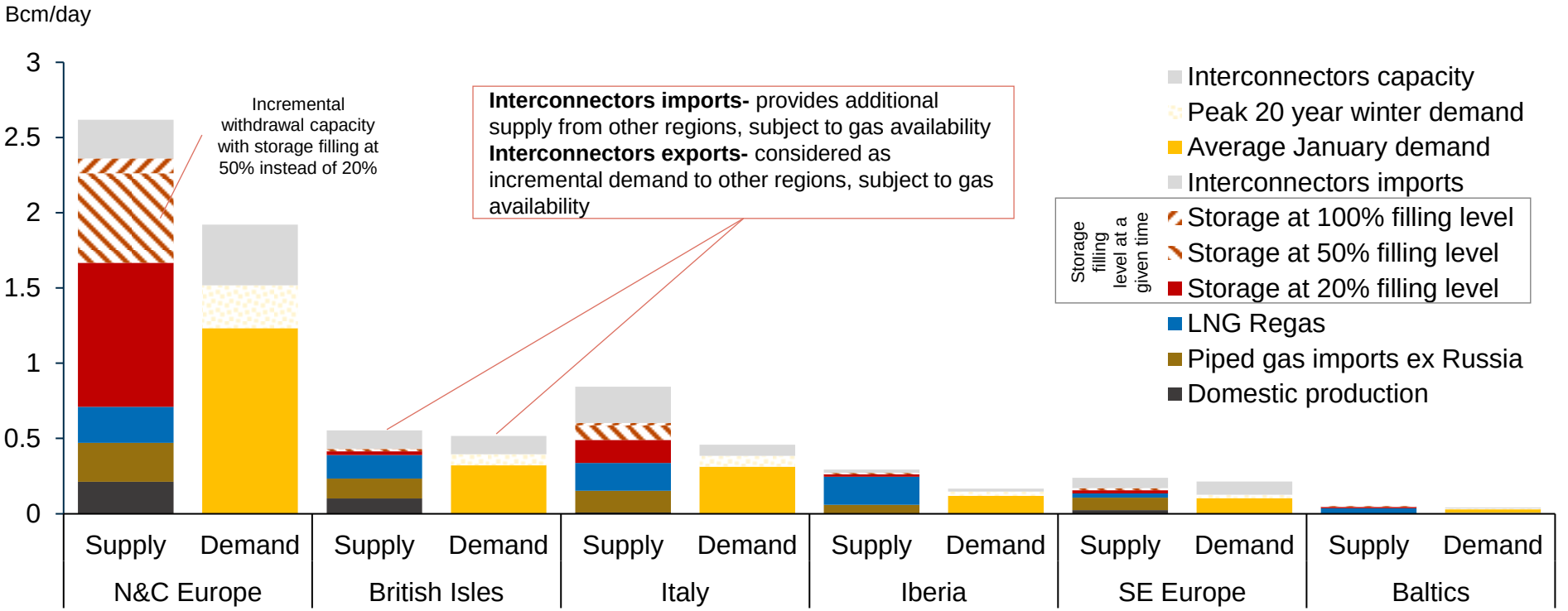


Source: Rystad Energy research and analysis

European infrastructure is sufficient to manage peak demand loads across regions

Max infrastructure capacity

Regional balances with peak day supply capacity of infrastructure, 2023



Assumptions

- Supply based on what can exclusively be provided to the region (domestic production, pipelines) as well as maximum regas, storage and interconnectors
- Ukraine storage included according to AGSI data (up to 0.11bcm/d withdrawal capacity)
- Piped gas capped by export country supply availability
- Bottlenecks within regions not considered
- Demand based on ENTSOG TYNDP Scenarios; peak demand- peak day that can occur once every 20 years (123% of average winter demand)

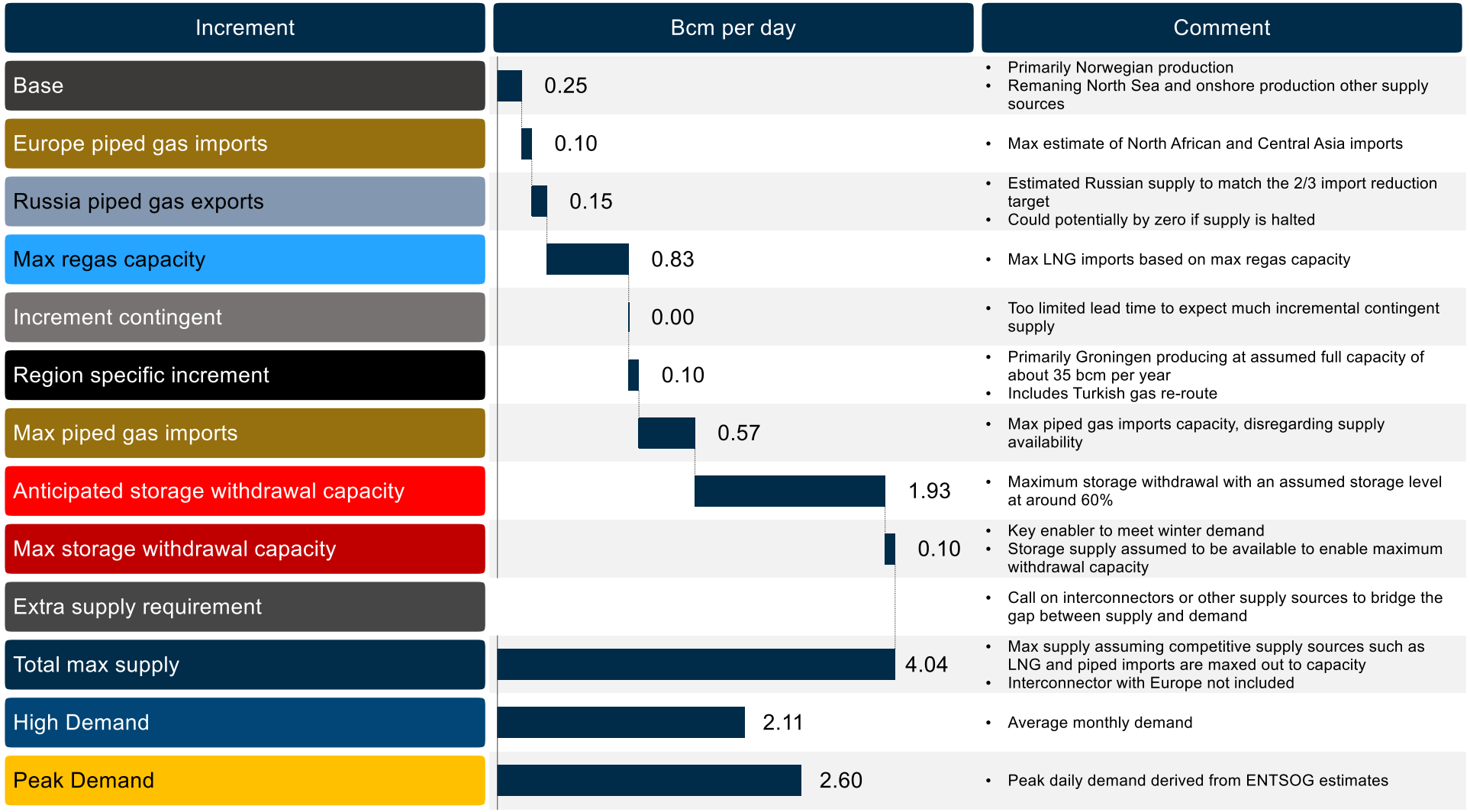
Results

- On a regional level, Europe has sufficient gas imports infrastructure
- Storage and interconnectors are the ultimate balancing factors
- Storage filling level crucial to supply on peak days

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

European view– if competition for volumes disregarded, Europe has sufficient gas infrastructure capacity to secure the market in peak demand

Daily peak supply build-up, Jan 2023 ignoring interconnectors with other regions



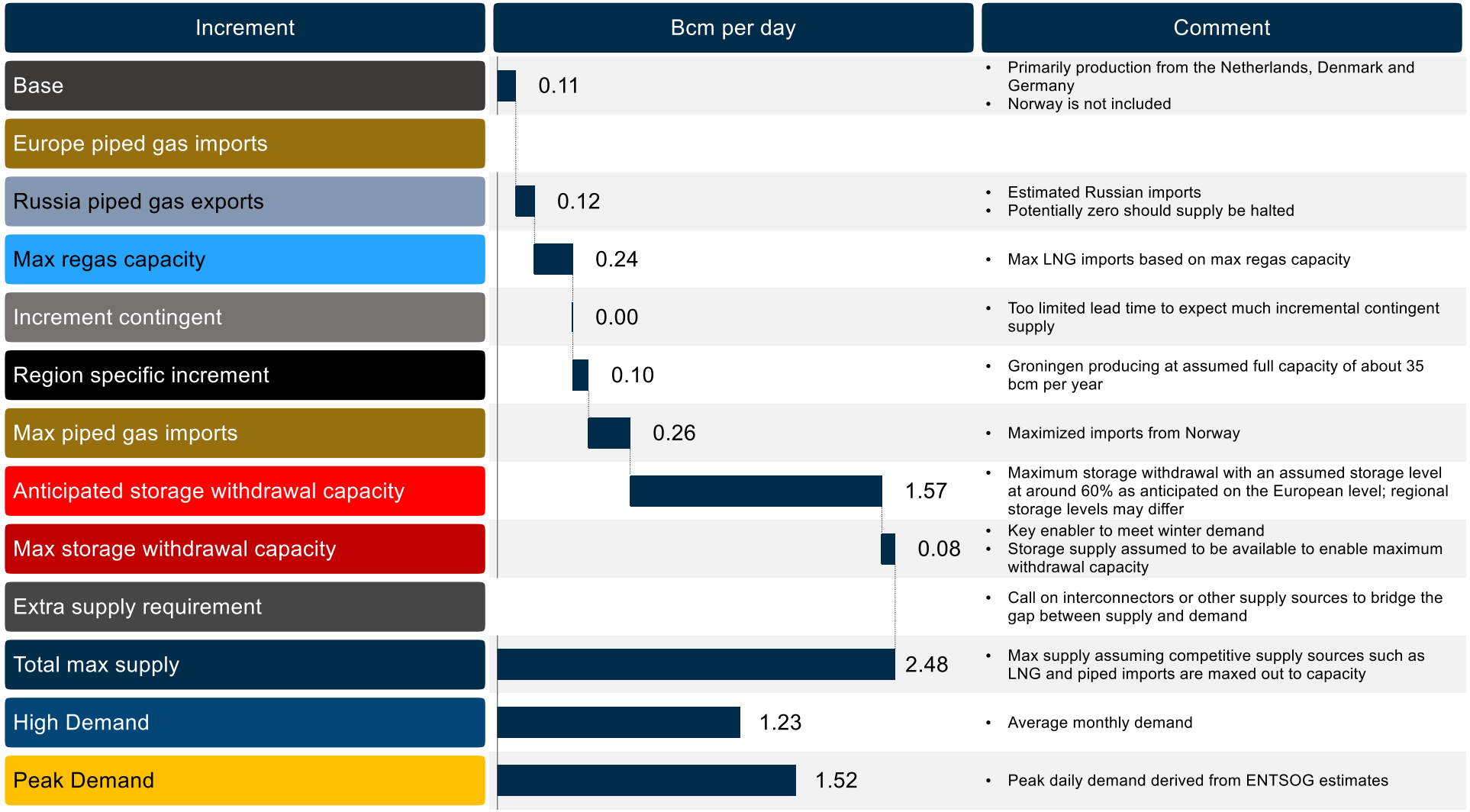
Source: Rystad Energy research and analysis

Content

North and Central Europe – infrastructure capacity large enough to meet demand even in case of Russian gas disruption

Max infrastructure capacity

Daily peak supply build-up, Jan 2023 ignoring interconnectors with other regions

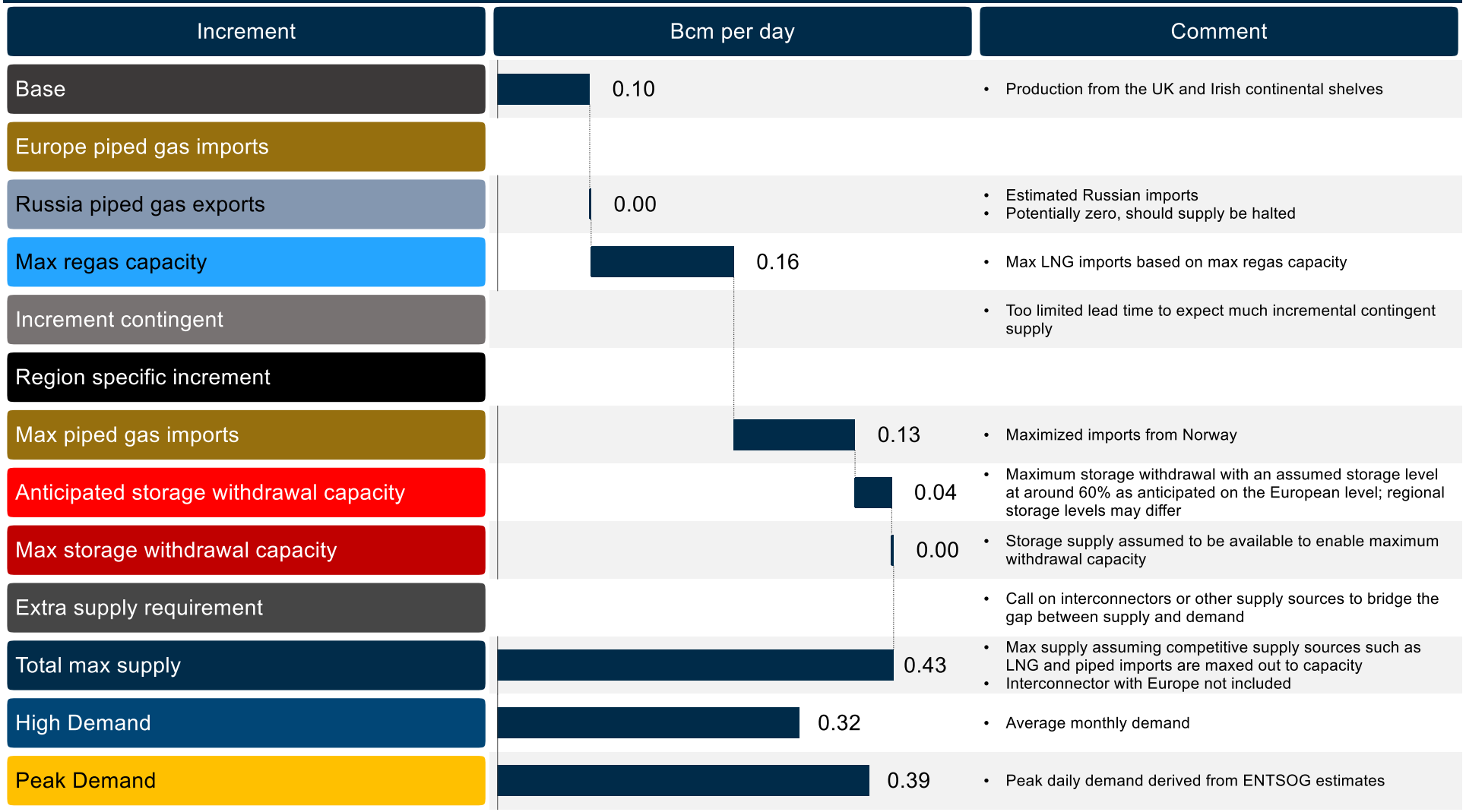


Source: Rystad Energy research and analysis

British Isles– Without maximized imports from Norway and regas capacity, the region may struggle to meet peak demand

Max infrastructure capacity

Daily peak supply build-up, Jan 2023 ignoring interconnectors with other regions

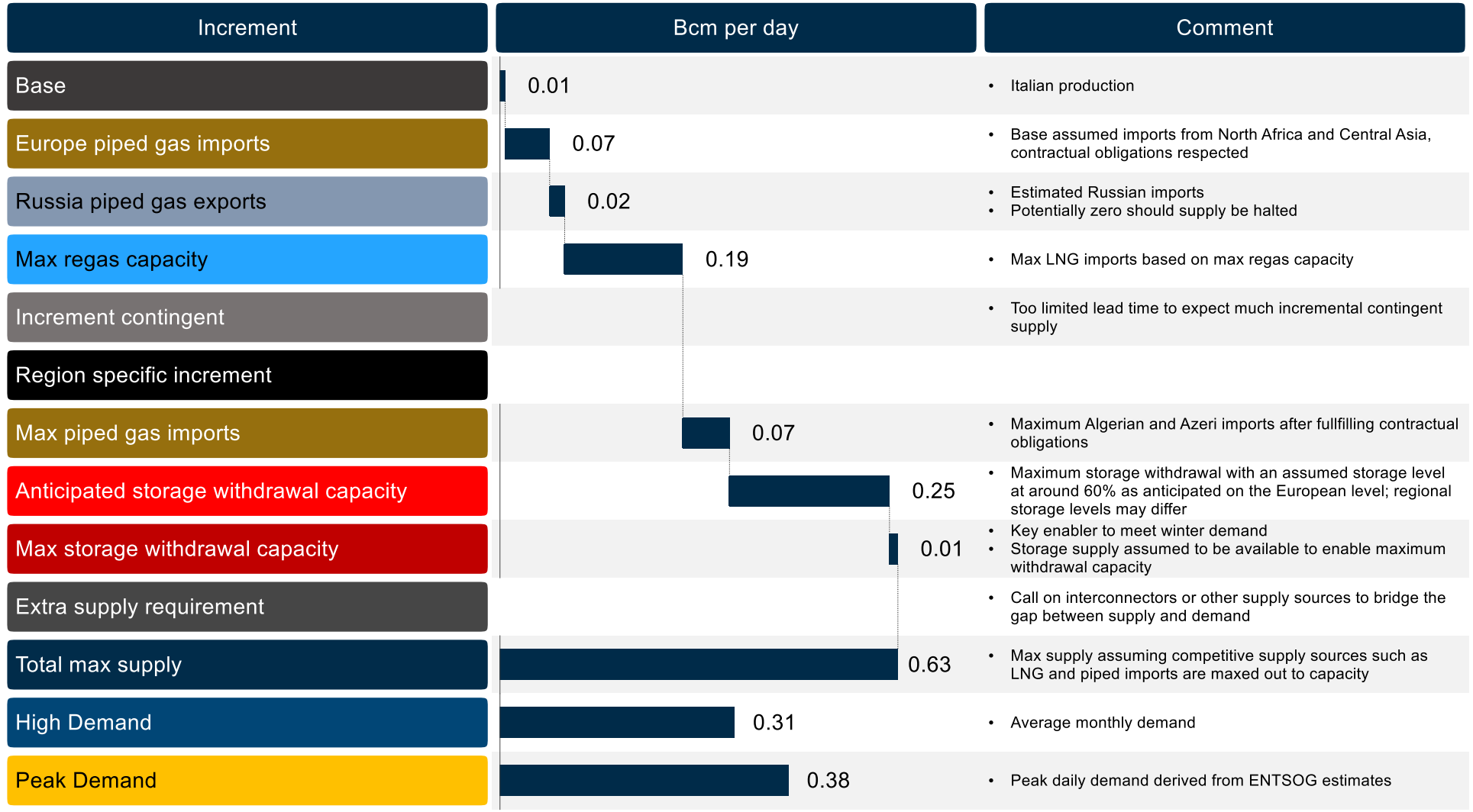


Source: Rystad Energy research and analysis

Italy– Storage is the key peak demand enabler

Max infrastructure capacity

Daily peak supply build-up, Jan 2023 ignoring interconnectors with other regions

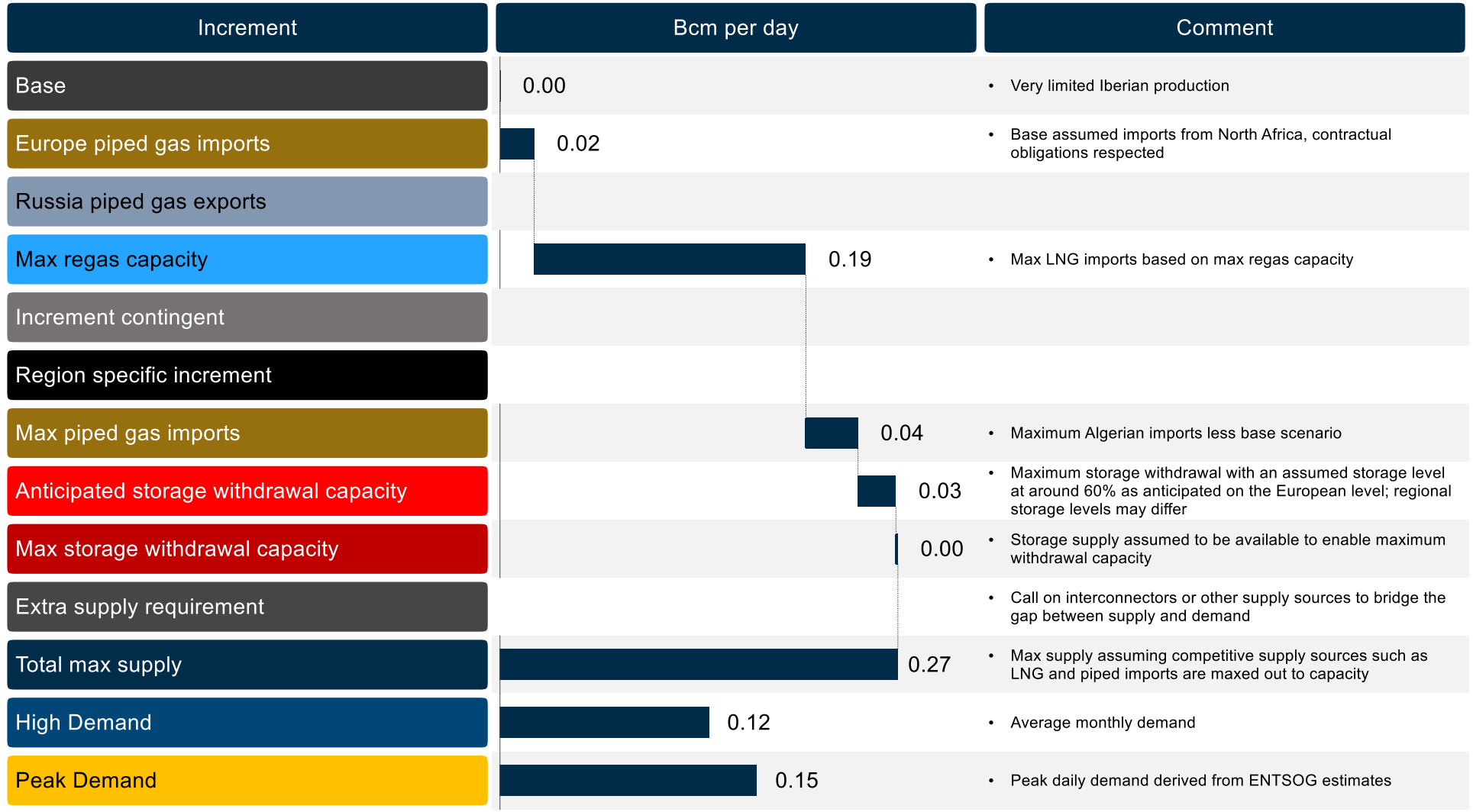


Source: Rystad Energy research and analysis

Iberia– With extensive regas capacity, the region is well placed to meet peak demand

Max infrastructure capacity

Daily peak supply build-up, Jan 2023 ignoring interconnectors with other regions

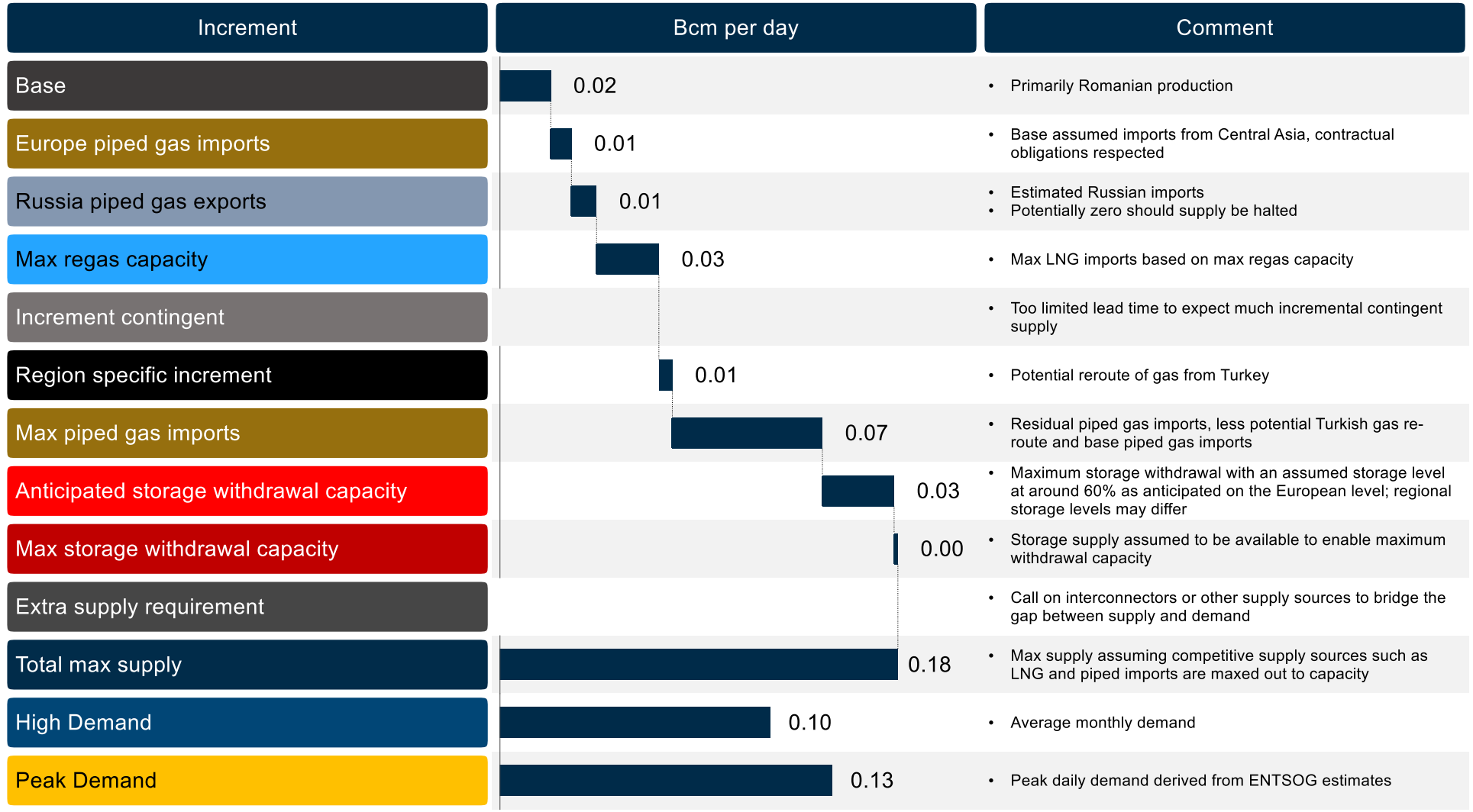


Source: Rystad Energy research and analysis

Southeast Europe– Without maximized piped gas imports, the region will likely to be short

Max infrastructure capacity

Daily peak supply build-up, Jan 2023 ignoring interconnectors with other regions

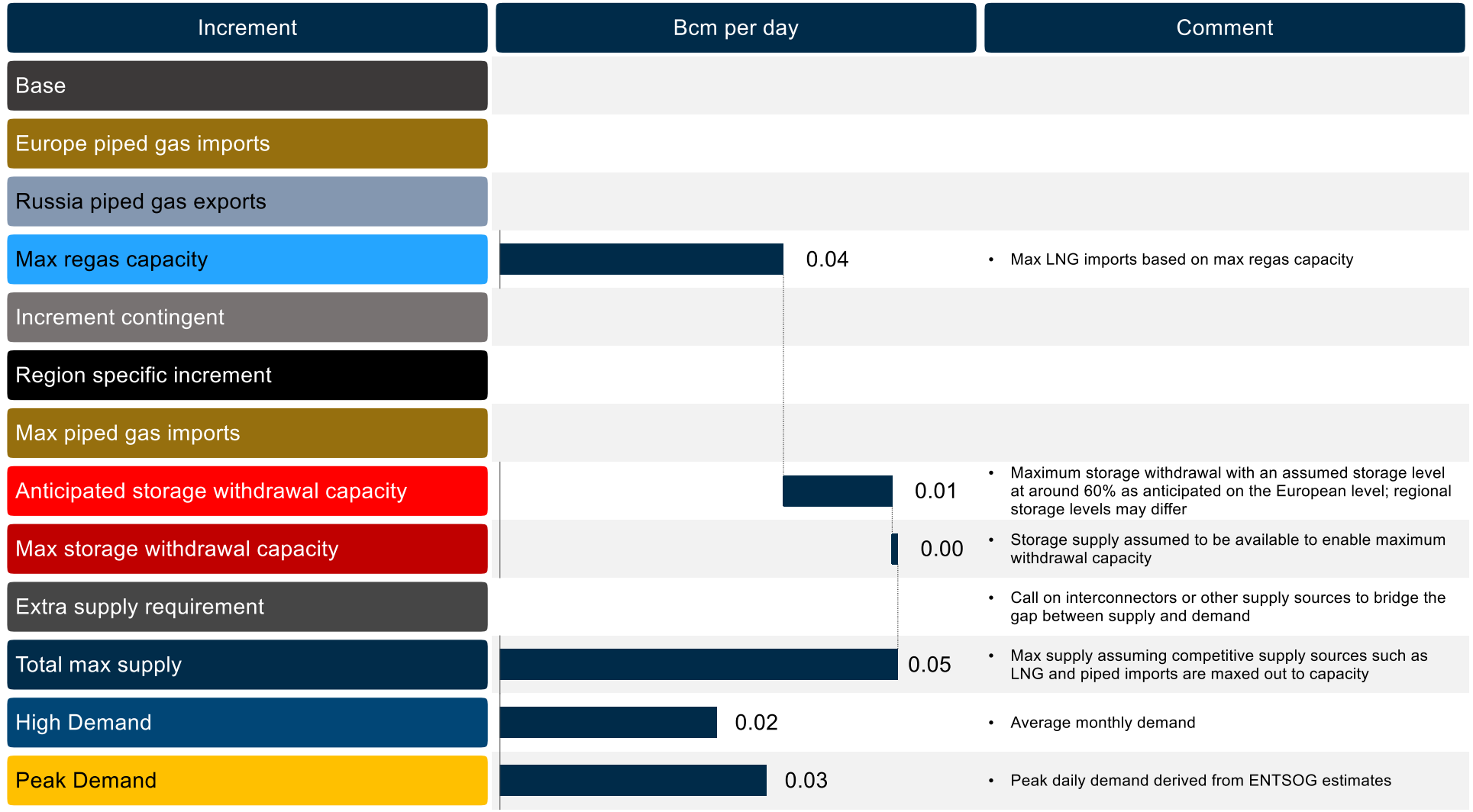


Source: Rystad Energy research and analysis

The Baltics and Finland– the region has sufficient regas capacity to meet peak demand

Max infrastructure capacity

Daily peak supply build-up, Jan 2023 ignoring interconnectors with other regions



Source: Rystad Energy research and analysis

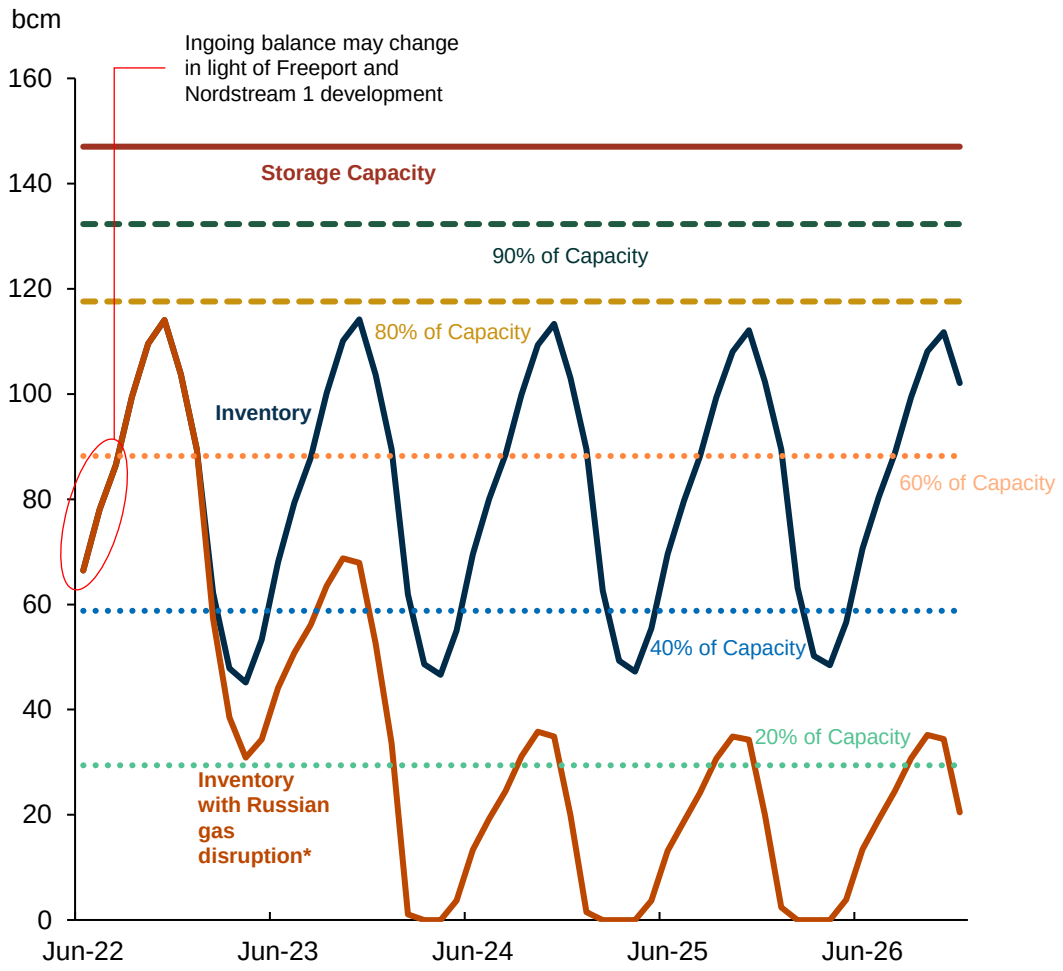
Storage inventory must be over a certain level to provide sufficient withdrawal capacity – may be challenging with low storage from missing Russian supply

Constrained supply

Storage analysis

Region	Estimated storage requirement (*bcm/day*)	Min required inventory level to balance peak demand**
N&C Europe	0.79	10%
British Isles	0.04	100%
Italy	0.23	40%
Iberia	0.00	0%
SE Europe	0.03	100%
The Baltics	0.00	0%
Total storage	1.10	20%
Without Russian gas	1.24	25%

Implied European Storage Inventories*** – no constraint on storage use applied



*Russian gas disruption assumes no Russian gas imports from January 2023 ** Before interconnector capacity is considered ***Assumes pre fit 55 demand scenario and full Groningen production
Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy, ENTSOG TYNDP 2022

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Storage withdrawal capacities are sufficient for short term peak demand provided inventories are above the threshold

Sensitivity analysis of storage inventory level on a peak demand day (unit: *bcm/day*)

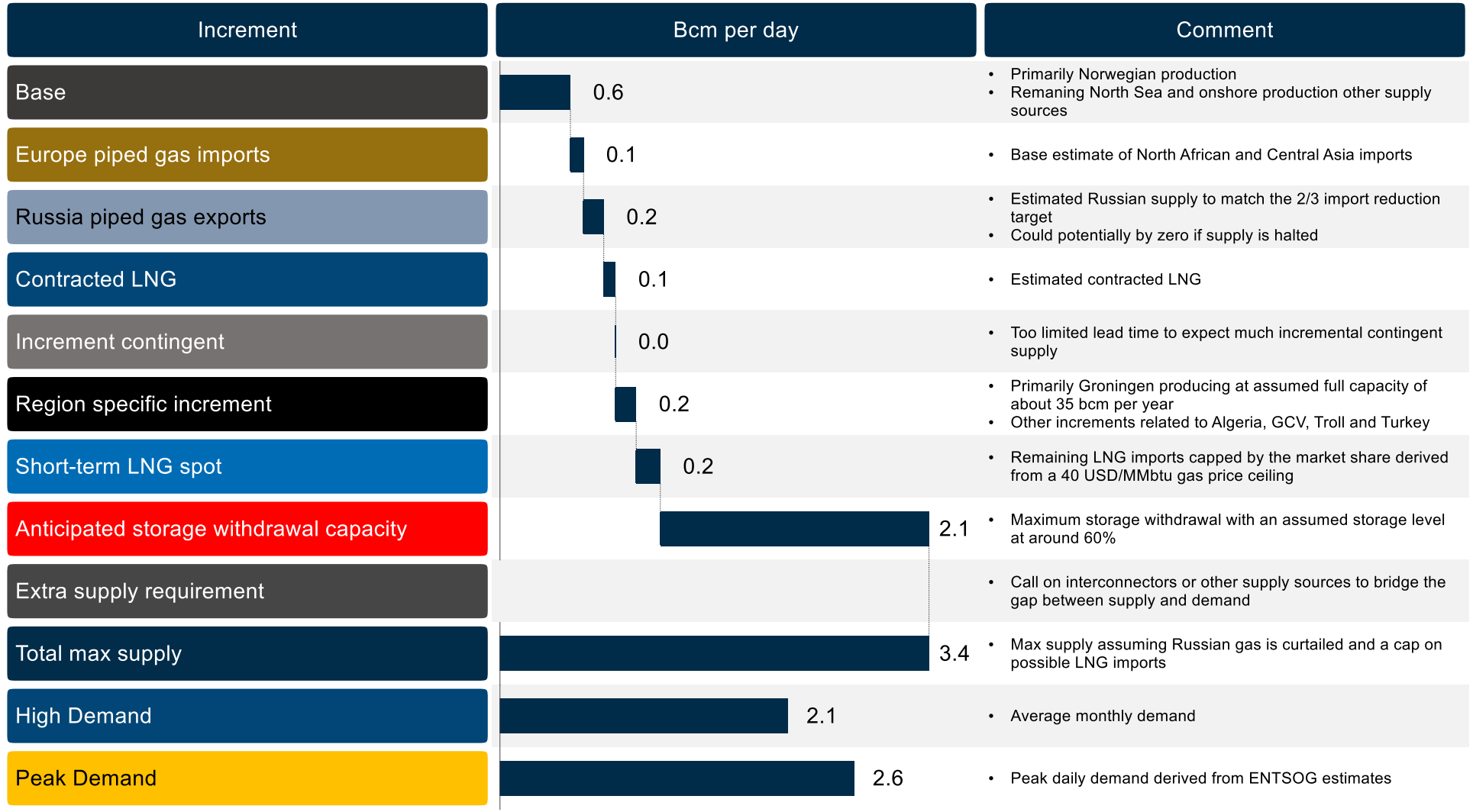
Region	Impact of inventory level on region's S/D balance*					Comment
	60% inventory	50% inventory	40% inventory	30% inventory	20% inventory	
N&C Europe	0.78	0.76	0.53	0.33	0.17	• Based on assumed gas flows, N&C Europe will be able to meet peak demand even with low storage levels • Excess up to **0.3bcm/d** can be exported to othe regions via interconnectors
British Isles	(0.04)	(0.04)	(0.04)	(0.05)	(0.05)	• Gas deficit in the UK and Ireland can be met via the interconnector with N&C Europe (up to 0.12bcm/d)
Italy	0.02	0.02	(0.01)	(0.05)	(0.07)	• Italian will become in deficit of gas if storage levels fall below 50% • The deficit can be met by interconnectors (up to 0.24bcm/d)
Iberia	0.03	0.03	0.02	0.02	0.02	• Iberia's supply&demand balance does not rely on storage • Up to **0.02bcm**/d of surplus can be sent to N&C Europe
SE Europe	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	• Southeast Europe's deficit will grow with falling storage levels, but can be met by its interconnectors
The Baltics	0.01	0.01	0.01	0.01	0.01	• The regions expected not to be affected by any reduced storage withdrawal • Limited potential to export the surplus to N&C Europe (up to 0.01bcm/d)

*Positive balance indicates that supply exceeds demand (surplus); negative balance indicates that demand exceeds supply (deficit), zero would imply balance
Source: Rystad Energy research and analysis

European wide balances can be met assuming storage is available - Ignores any nuance on more granular geographical level

Constrained supply

Daily peak supply build-up, Jan 2023

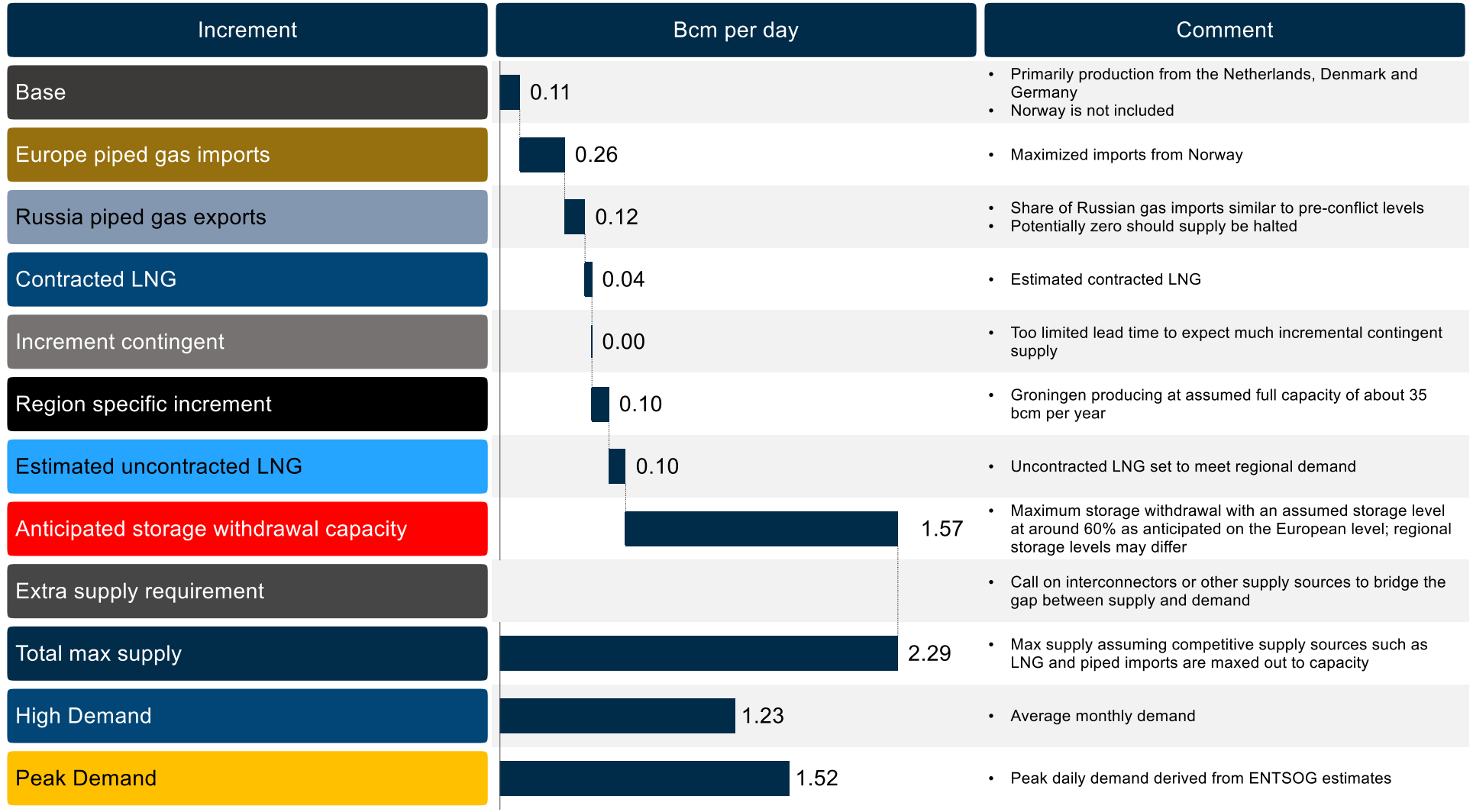


Source: Rystad Energy research and analysis

North and Central Europe has a critical dependence on storage to meet demand potential

Constrained supply

Daily peak supply build-up, Jan 2023 ignoring interconnectors with other regions

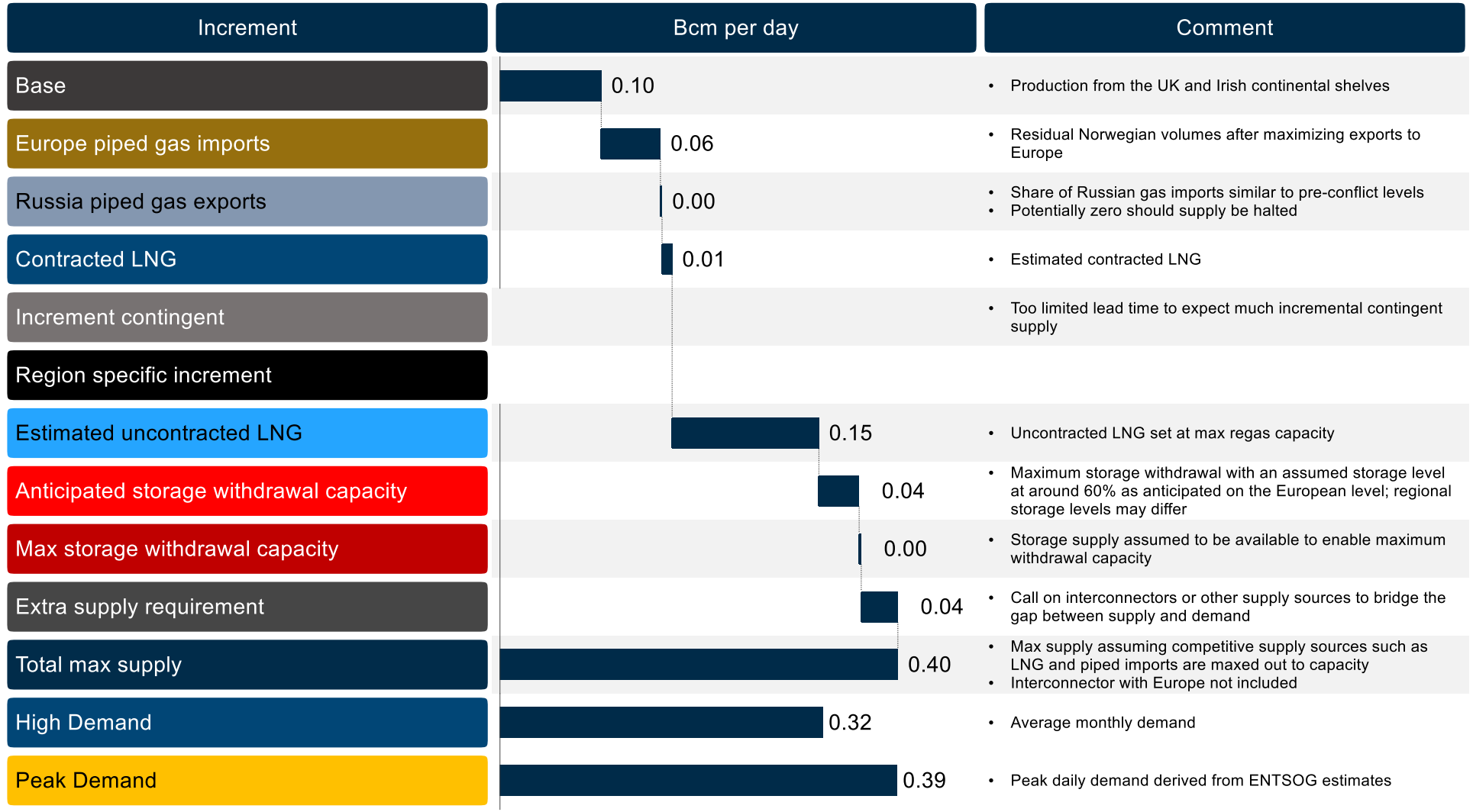


Source: Rystad Energy research and analysis

UK and Ireland may see supply deficit and be dependent on interconnector with North and Central Europe

Constrained supply

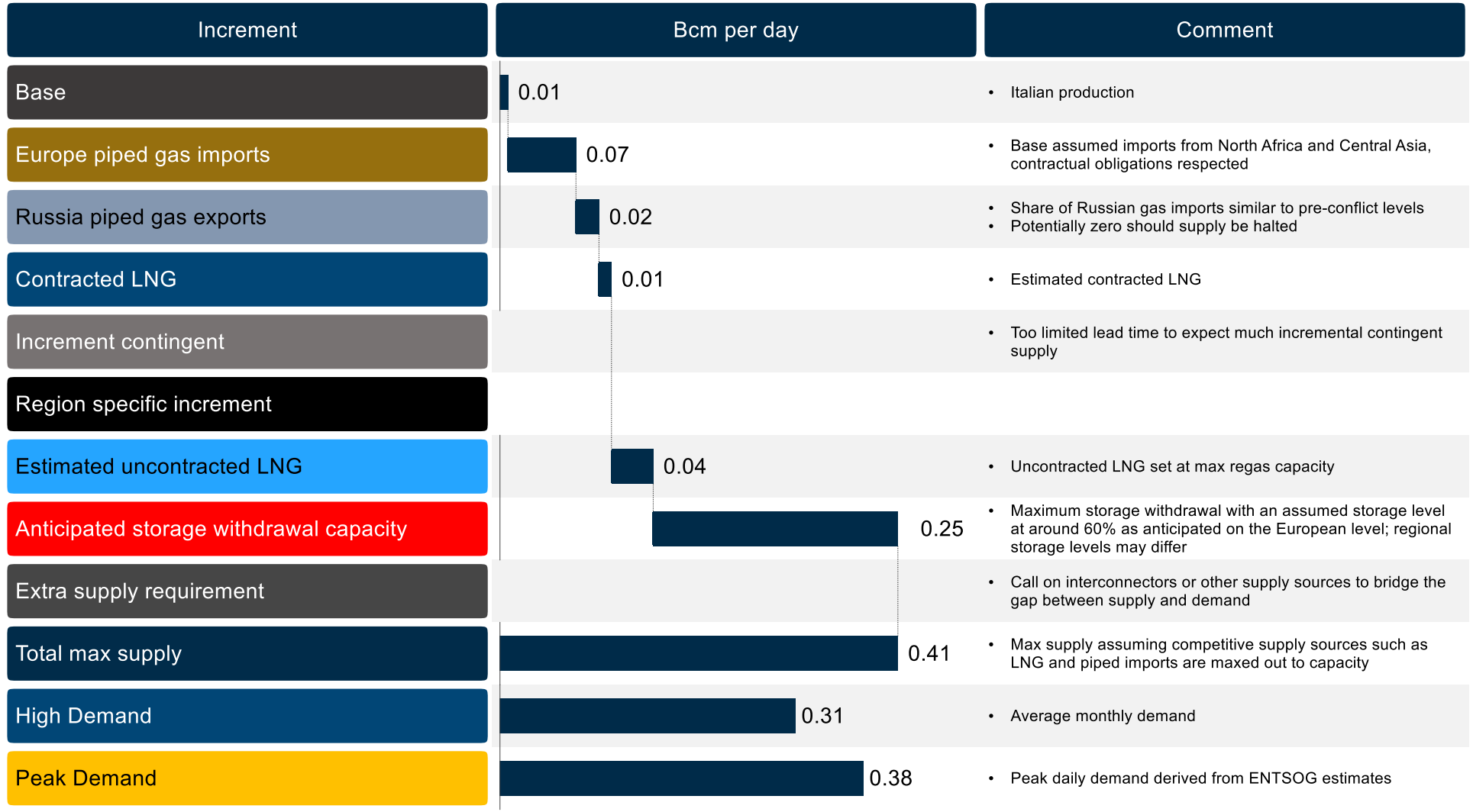
Daily peak supply build-up, Jan 2023 ignoring interconnectors with other regions



Source: Rystad Energy research and analysis

Italy may see tight balances if storage is not available

Daily peak supply build-up, Jan 2023 ignoring interconnectors with other regions

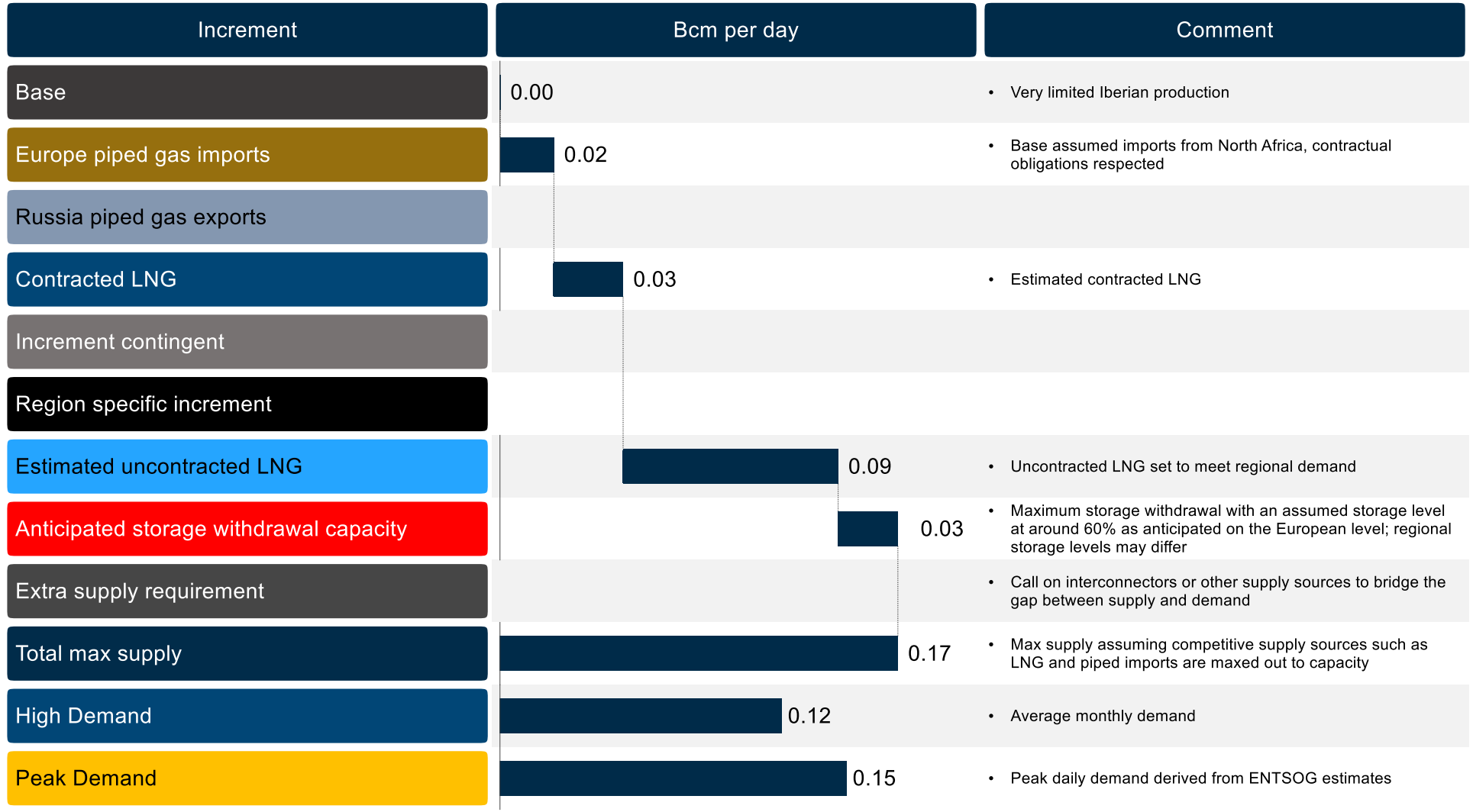


Source: Rystad Energy research and analysis

Iberia has significant regas capacity to help meet demand potential

Constrained supply

Daily peak supply build-up, Jan 2023 ignoring interconnectors with other regions

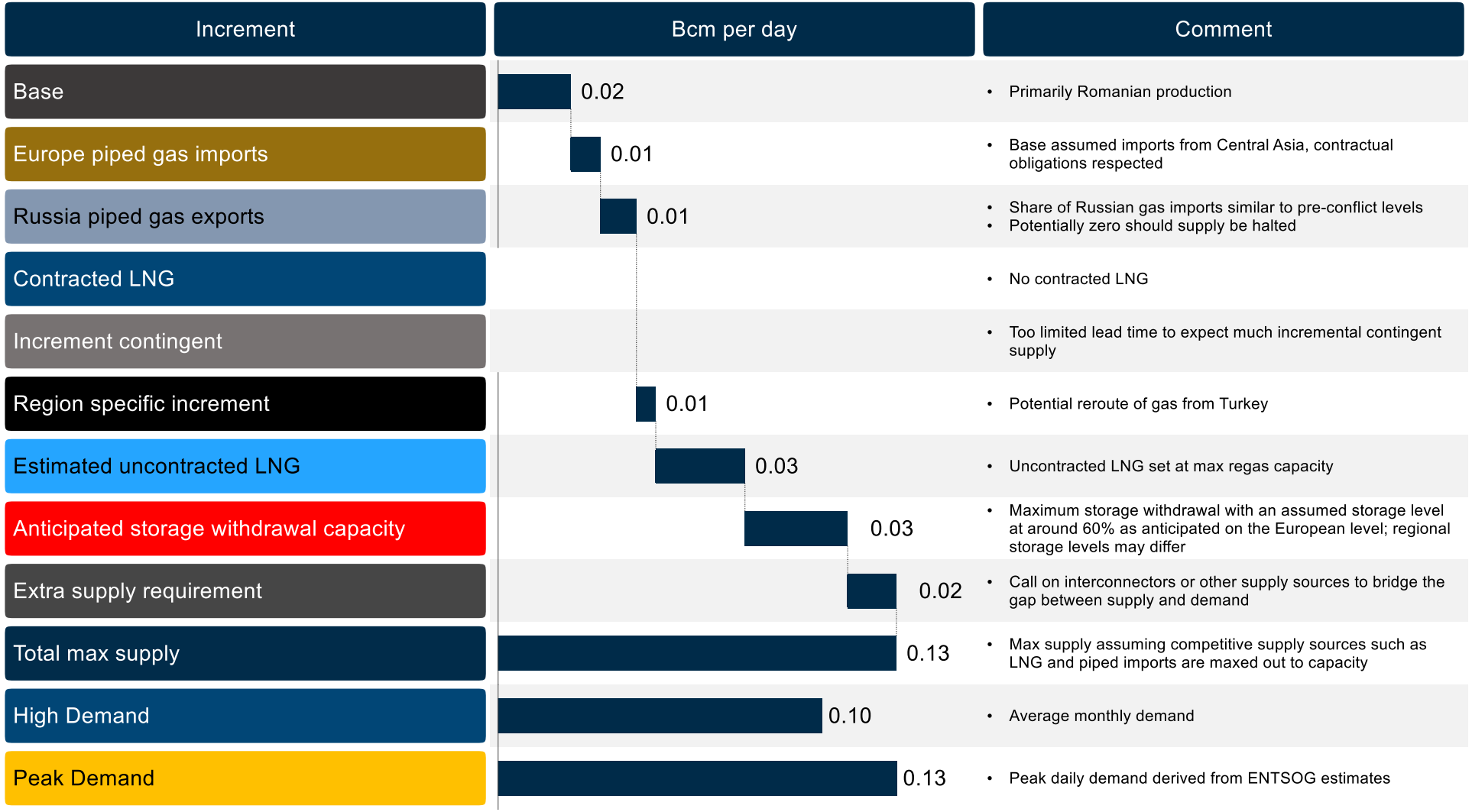


Source: Rystad Energy research and analysis

Southeast Europe may be short of gas despite maxed out regas capacity
- The region is likely to be dependent on interconnectors to balance demand

Constrained supply

Daily peak supply build-up, Jan 2023 ignoring interconnectors with other regions

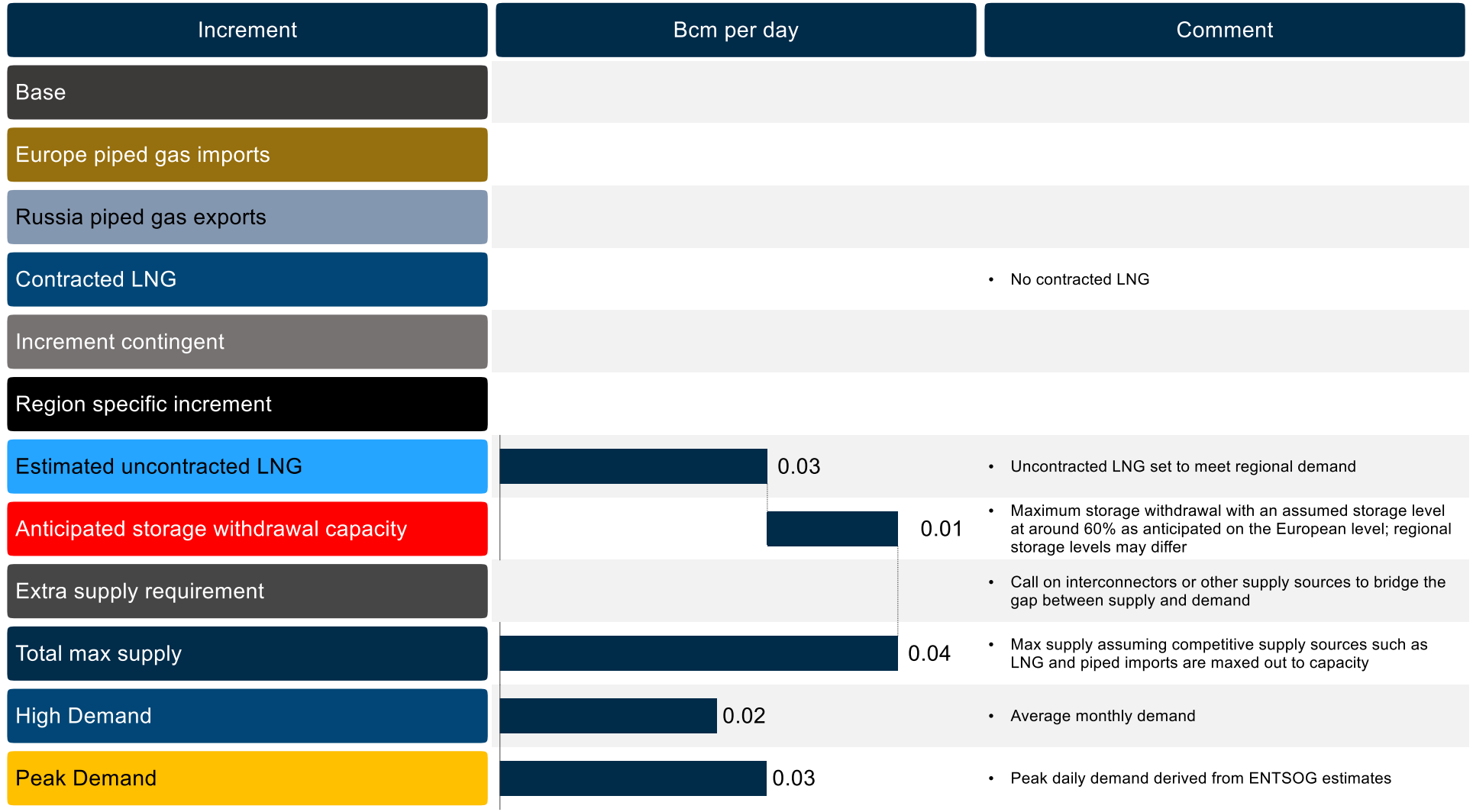


Source: Rystad Energy research and analysis

The Baltics and Finland should manage with available regas capacity

Constrained supply

Daily peak supply build-up, Jan 2023 ignoring interconnectors with other regions



Source: Rystad Energy research and analysis

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

Recommendations from European Transmission System Operators and European Commission

- **Some new LNG regas terminals and related transmission system connections needed to replace Russian supplies, increase system resilience**
  - LNG regas in Northern Germany; Baltics / Poland (Gdansk), Croatia (Krk)

- **Some interconnector expansions / extensions further increase regional supply options:**
  - Spain to France: increase N/C Europe access to Spain's LNG regas as alternative to cargo redirections
  - Poland, Slovakia, Hungary, towards Greece
  - Turkey to Bulgaria and Bulgaria to Greece

- **Some intra-regional transmission bottlenecks to be addressed to enable / support new flow patterns**
  - France to Germany transmission capacity debottlenecking needed including addressing issue of odorized gas preempting gas flows due to German industry consumer concerns about sulfur content
  - Reinforce Italian transmission system for increased South to North flows from TAP and N Africa

- **Increase storage capacity in Latvia (Incukalns) to enhance supply capacity for peak demand**

Source: European TSOs, European Commission RePowerEU

Content

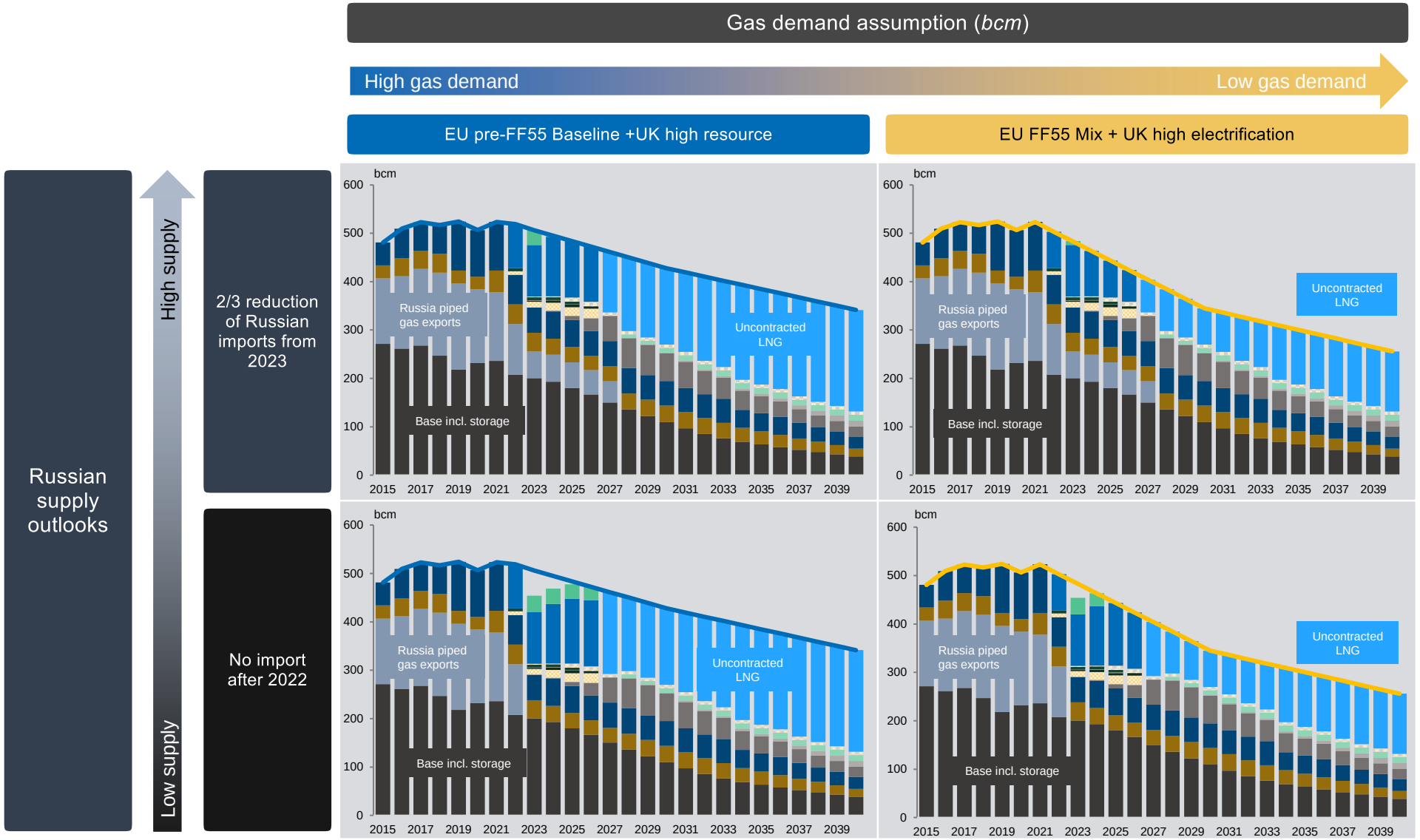
Russian supply and gas demand produce four different world views

Source: Rystad Energy research and analysis

Content

RYSTAD ENERGY

Interaction in the supply stack will alter quantity and nature of resources called upon



Countries included in the scope are: EU, UK, Norway, Albania, Moldova, Montenegro, North Macedonia, Serbia, Switzerland, Ukraine
Source: Rystad Energy research and analysis

Content

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Some key considerations stay constant throughout all permutations calling upon difficult trade offs to be made

Gas demand assumption

High gas demand → Low gas demand

Russian supply outlooks: High supply → Low supply

EU pre-FF55 Baseline +UK high resource

2/3 reduction of Russian imports from 2023

Timing	Consideration	Condition met
Short term	Groningen called upon	✓
	Sufficient supply to meet demand	✓
Long term	Long term gas capacity expansion required	✓
Both	Infrastructure requirement met	✓

No import after 2022

Timing	Consideration	Condition met
Short term	Groningen called upon	✓
	Sufficient supply to meet demand	✗
Long term	Long term gas capacity expansion required	✓
Both	Infrastructure requirement met	✓

EU FF55 Mix + UK high electrification

Timing	Consideration	Condition met
Short term	Groningen called upon	✓
	Sufficient supply to meet demand	✓
Long term	Long term gas capacity expansion required	✓
Both	Infrastructure requirement met	✓

Timing	Consideration	Condition met
Short term	Groningen called upon	✓
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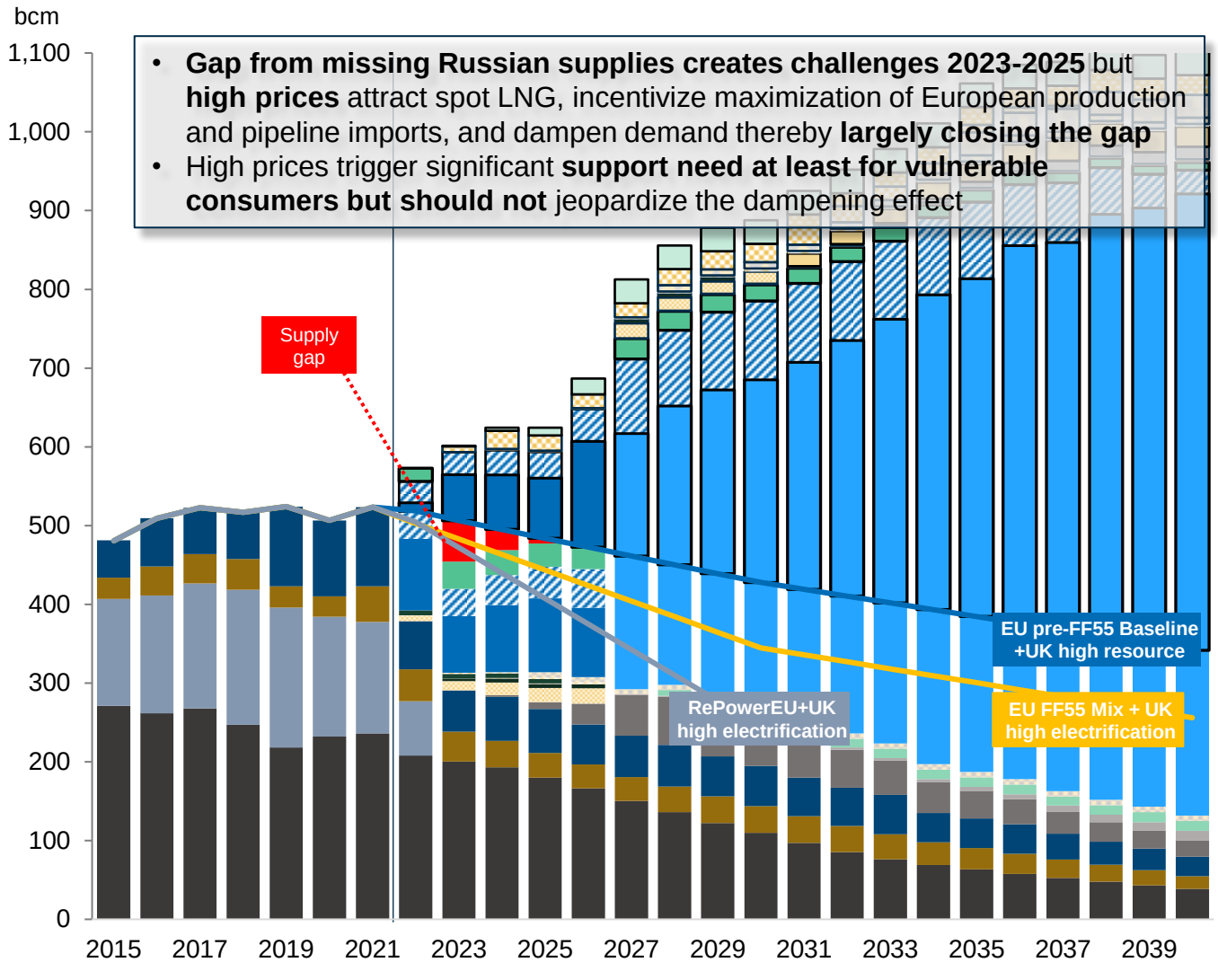
Long term	Long term gas capacity expansion required	✓
Both	Infrastructure requirement met	✓

Source: Rystad Energy research and analysis

No Russian supplies as of 2023 creates supply gap in 2023 - 2025

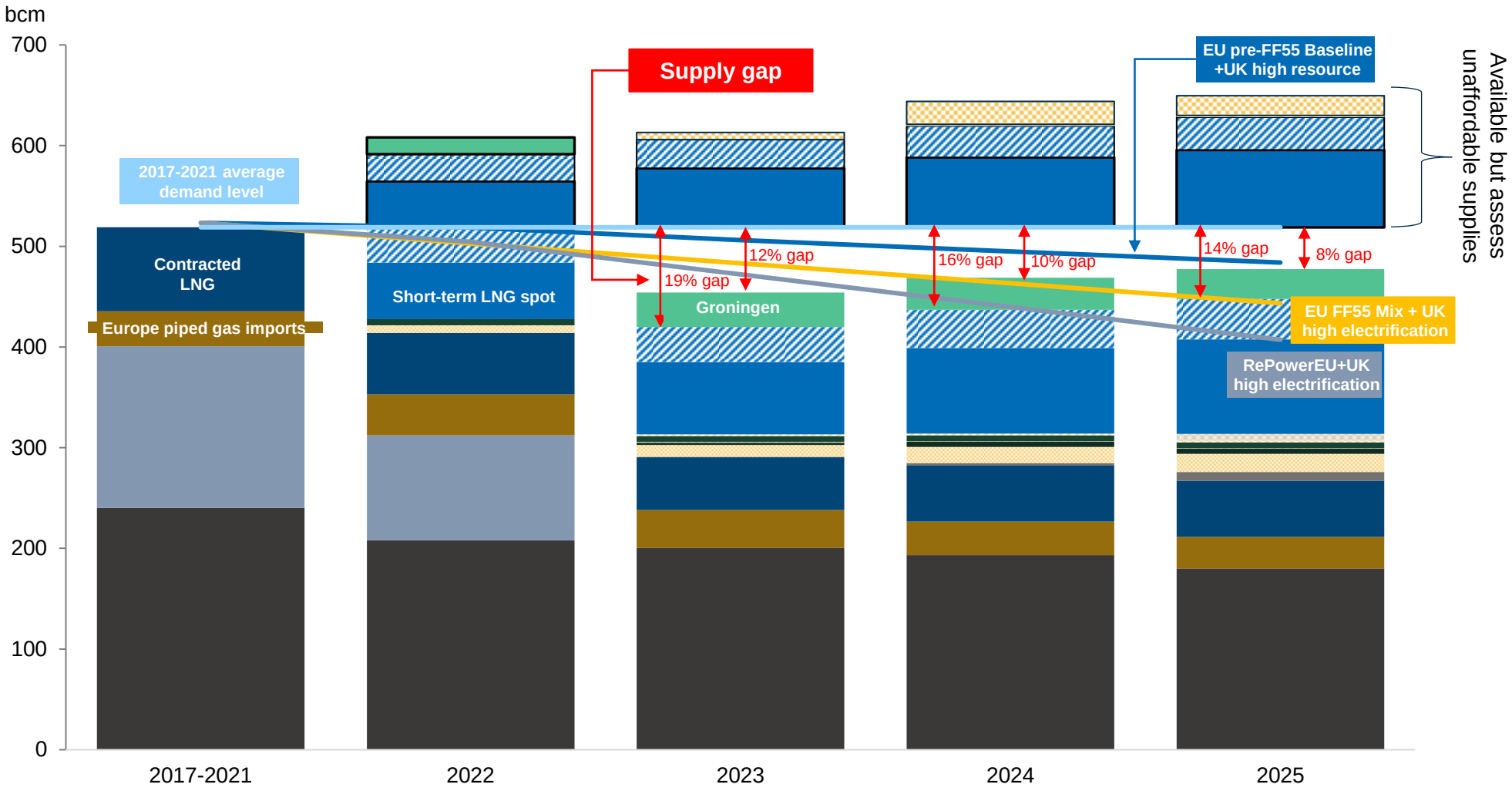
Gas source	Increment group	Timing
Domestic	Base	Both
	Increment contingent	Long term
	Increment exploration	
Special domestic increment	Troll max	Short term
	Higher GCV	
	Groningen	
	Barents pipe	Long term
	European shale	
Russia	Russian piped gas	Short term
Piped gas	Europe piped gas imports	Both
	Algeria increase	Short term
	Turkey pass-through	
	TR/Azerbaijan expansion	Long term
LNG	LT Contracted	Both
	Spot/FOB LNG	Short term
	Available for LT contracts	Long term



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

Supply gap versus 2017-2021 average demand: gap of up to 19%

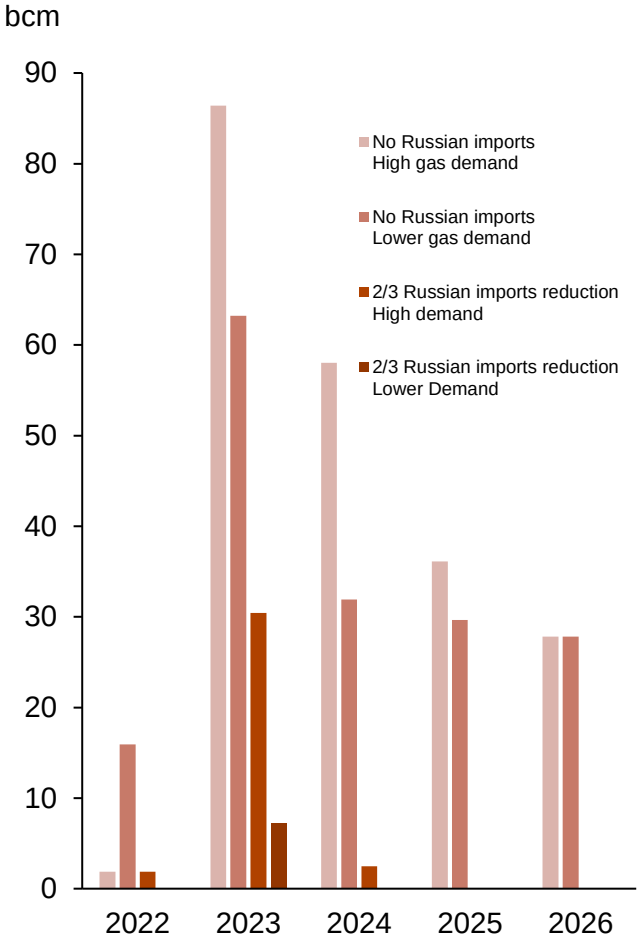
Short-term supply with high-cost / non-affordable gas filtered out, and without Russia from 2023



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

Disrupted Russian supply will create a short-term supply deficit with difficult choices

Implied supply deficit from various permutations without Groningen production



Assessment

Short-term supply and demand balances are very difficult and will call on difficult decisions

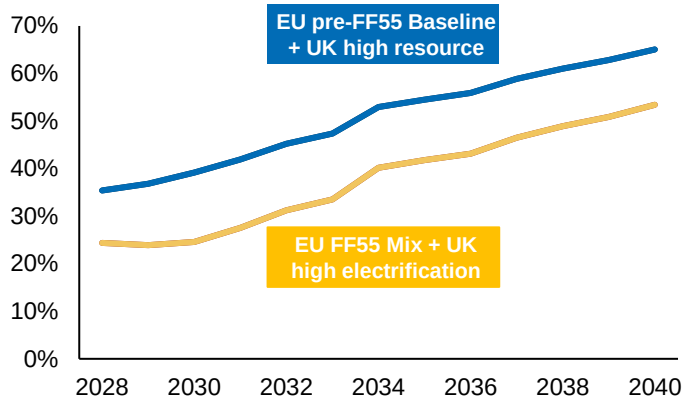
There are three key options either alone or as a combination that can help bridge short term supply and demand balance

- Demand management with negative impact on standard of living and economic output
- Net storage withdrawal although supply security for winter 2023/2024 will deteriorate
- Increase LNG market share through increased price and/or restart Groningen production

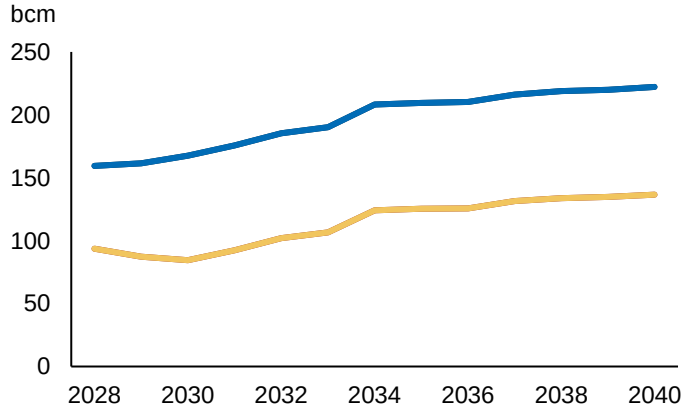
Source: Rystad Energy research and analysis

Long term new capacity expansion is required and could act as a future insurance policy

Call on capacity expansion* market share



Call on capacity expansion* absolute volume



Assessment

Increased long term gas export capacity is required with implications on undesired fossil fuel investments

However, it is arguably sensible to risk over investment in gas acting as insurance policy versus a possible new energy crunch

Emissions go up with coal used as energy supply of last resort

High energy prices result in energy poverty and its regressive tax nature impacts the least fortunate most

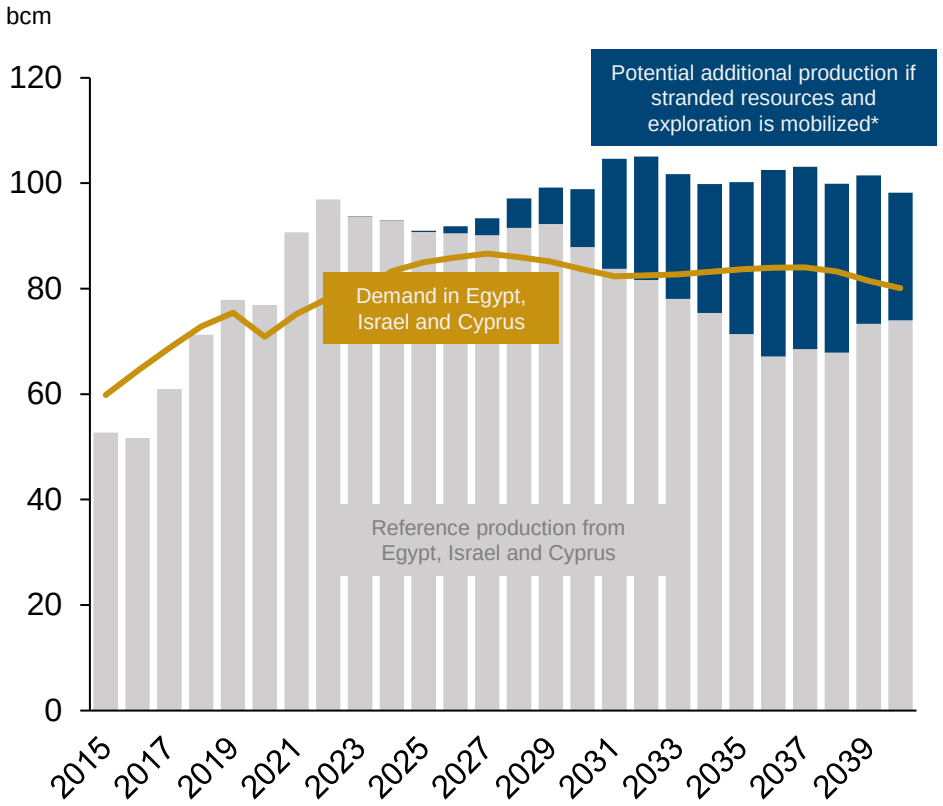
Investments, business and consumers desire stability

* Capacity expansion represents future projects and their volumes which are not yet in place, including TANAP expansion, Barents pipe and uncontracted LNG
Source: Rystad Energy research and analysis

Content

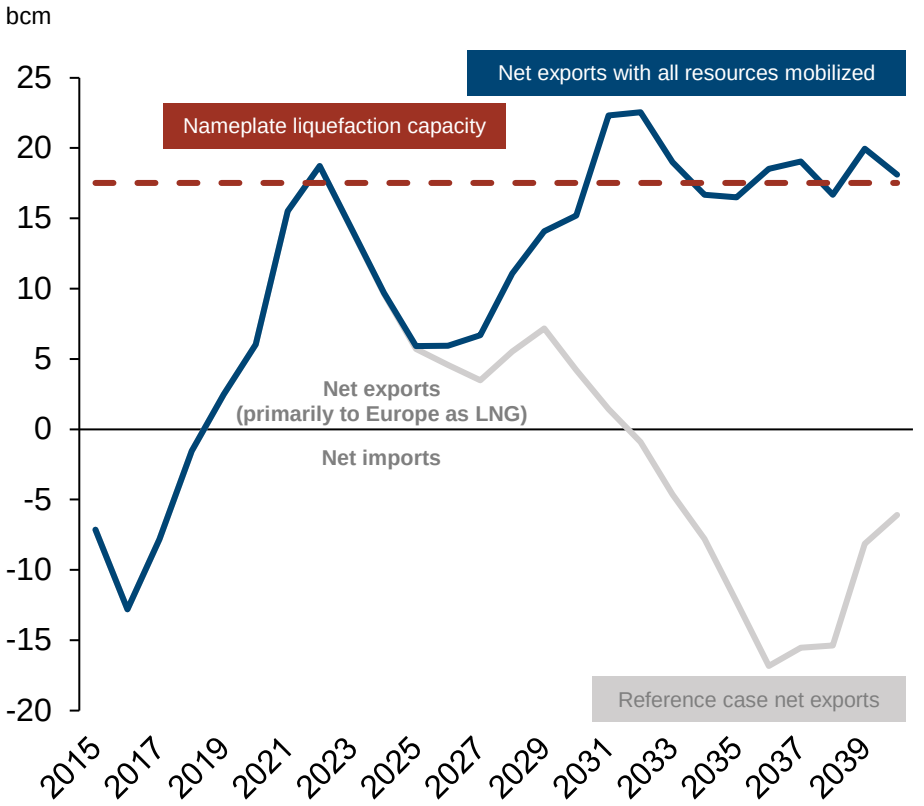
Maintaining net exports out of East Med will require full mobilization of available resources

Reference and maximum production potential from East Med



- Production in the East Med region including Egypt, Israel and Cyprus is expected tot reach almost 100 bcm per year on the back of new discoveries made
- Demand, in particular Egyptian, is increasing which reduces export ability
- Significant potential in currently stranded resources can maintain production levels towards 2040

Net export ability from East Med

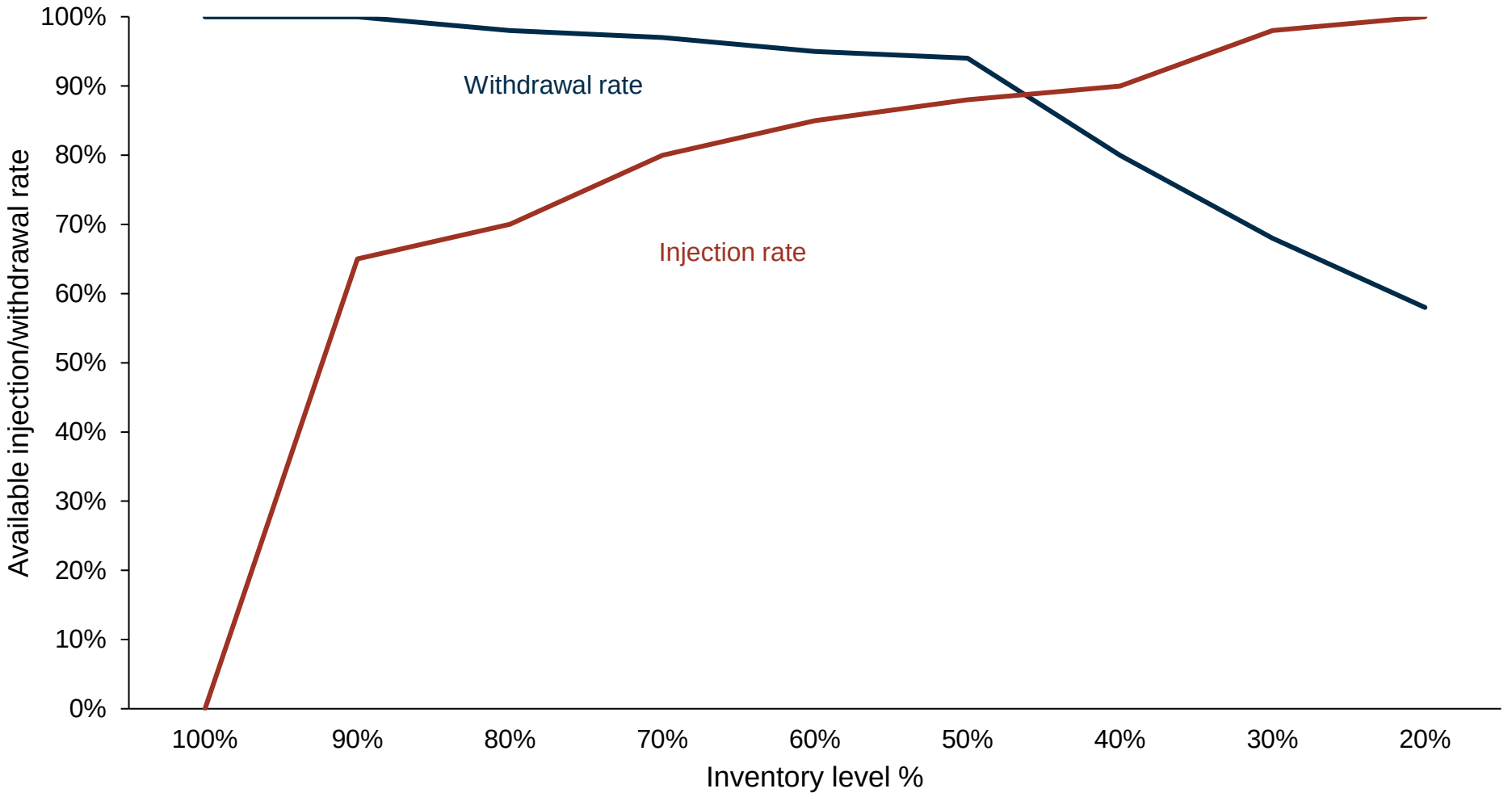


- In the reference case the region will exhaust its net export potential by the early 2030s on the back of declining production and flat demand
- If all resources can be mobilized it may be possible to maintain export levels around 15 to 20 bcm per year towards 2040
- This long-term potential will have to compete with US and Middle East LNG in the supply stack

*Key considered stranded resources includes Aphrodite, Gaza Marine and Notus
Source: Rystad Energy research and analyses; Rystad Energy GasMarketCube

Available injection and withdrawal rates depend on inventory level

Available injection and withdrawal rates depending on inventory level



Source: ENTSOG

Content

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Rystad Energy is an independent energy consulting services and business intelligence data firm offering global databases, strategy advisory and research products for E&P and oil service companies, investors, investment banks and governments. Rystad Energy is headquartered in Oslo, Norway.

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