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

Presentation overview

- **Needed background information**
- **Key results**
  - Annual European demand / supply balances until 2040 with and without Russia
  - Regionalization of Europe’s demand / supply balances
  - Infrastructure capabilities
- **LNG deep dive**
- **Conclusions**
- **Policy recommendations**

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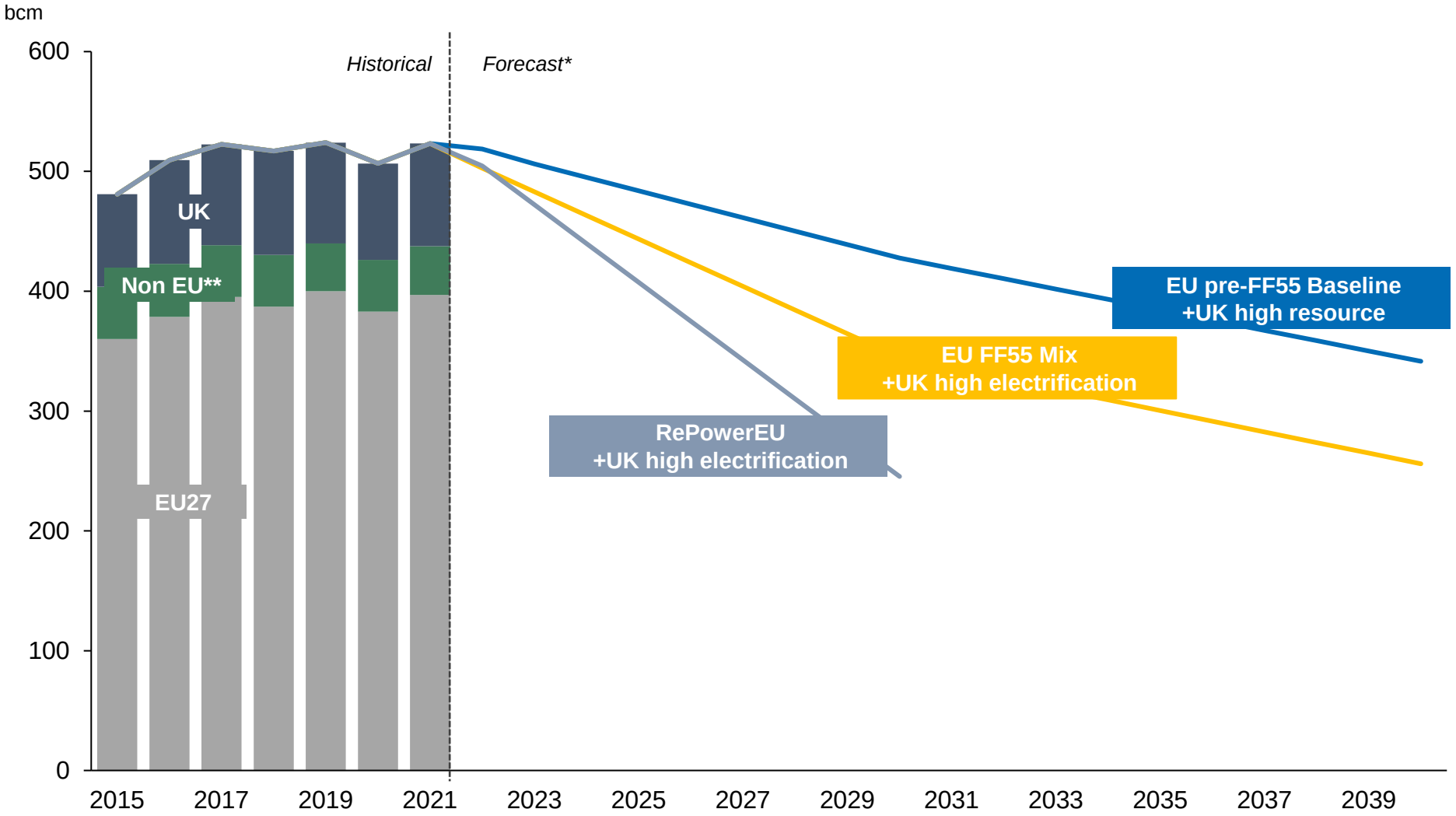
NEEDED BACKGROUND INFORMATION

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

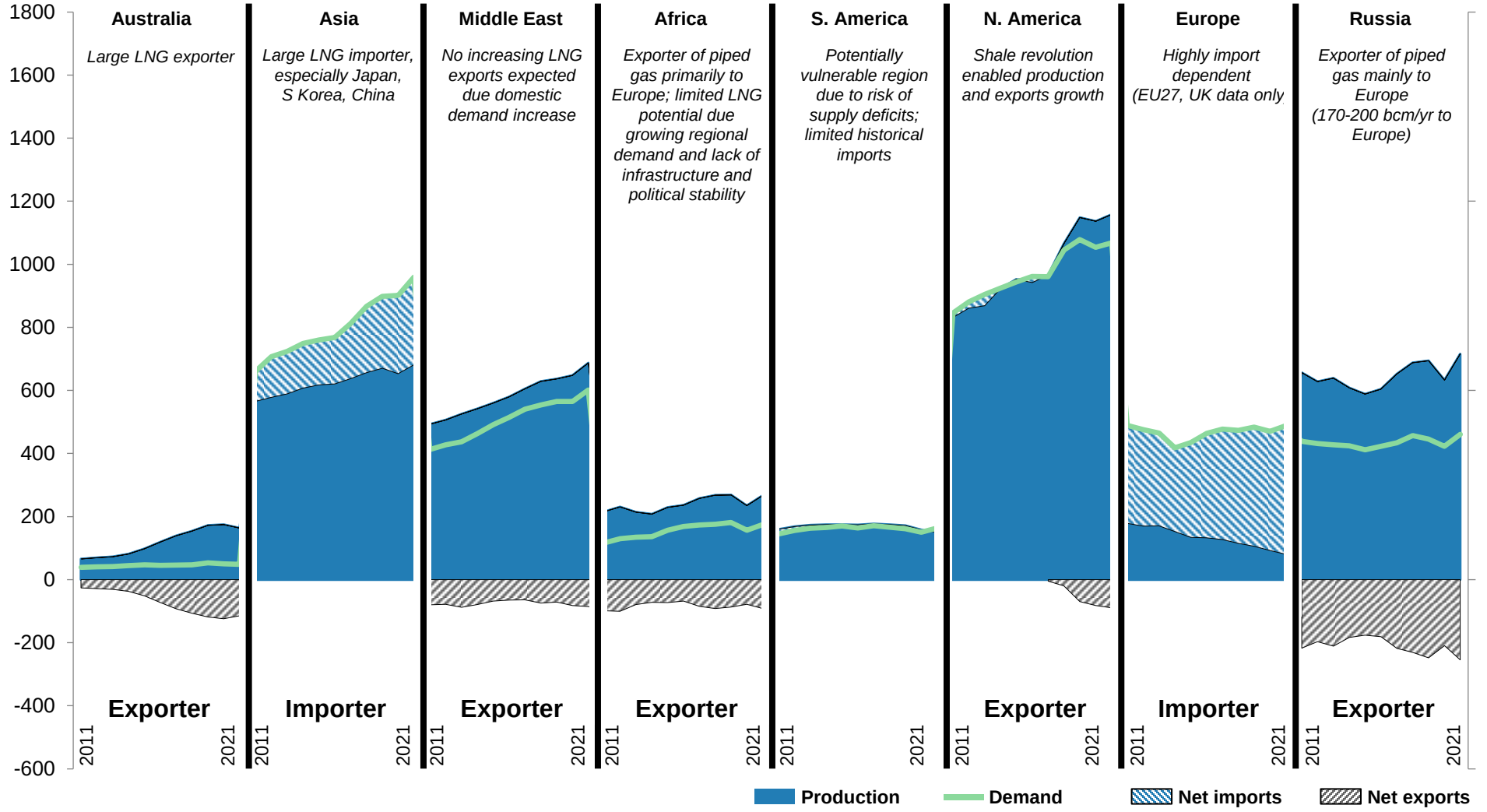
European natural gas demand forecasts



*EU and UK forecasts have 2030 and 2050 data points only; linear extrapolation used between data points **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

Europe and Asia compete for LNG supplies from global sources

Global natural gas balances 2011-2021



Source: Rystad Energy research and analysis; Rystad Energy GasMarketCube

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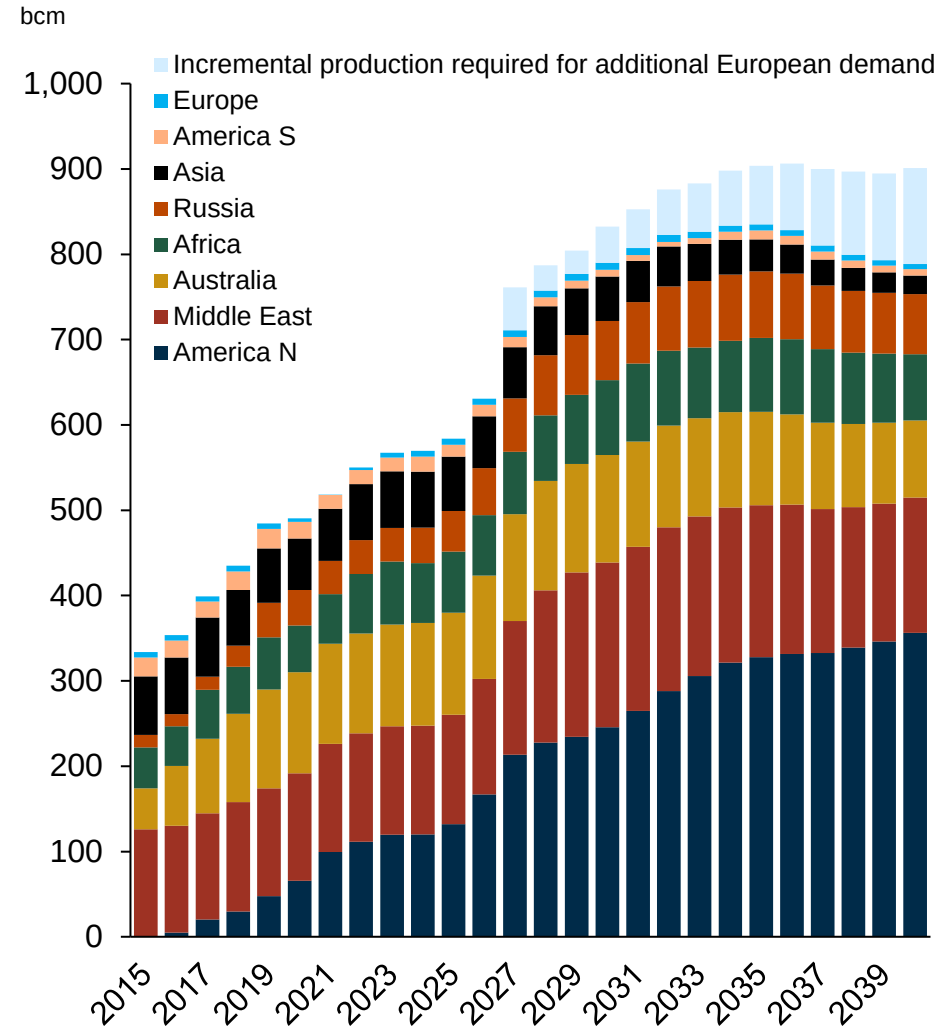
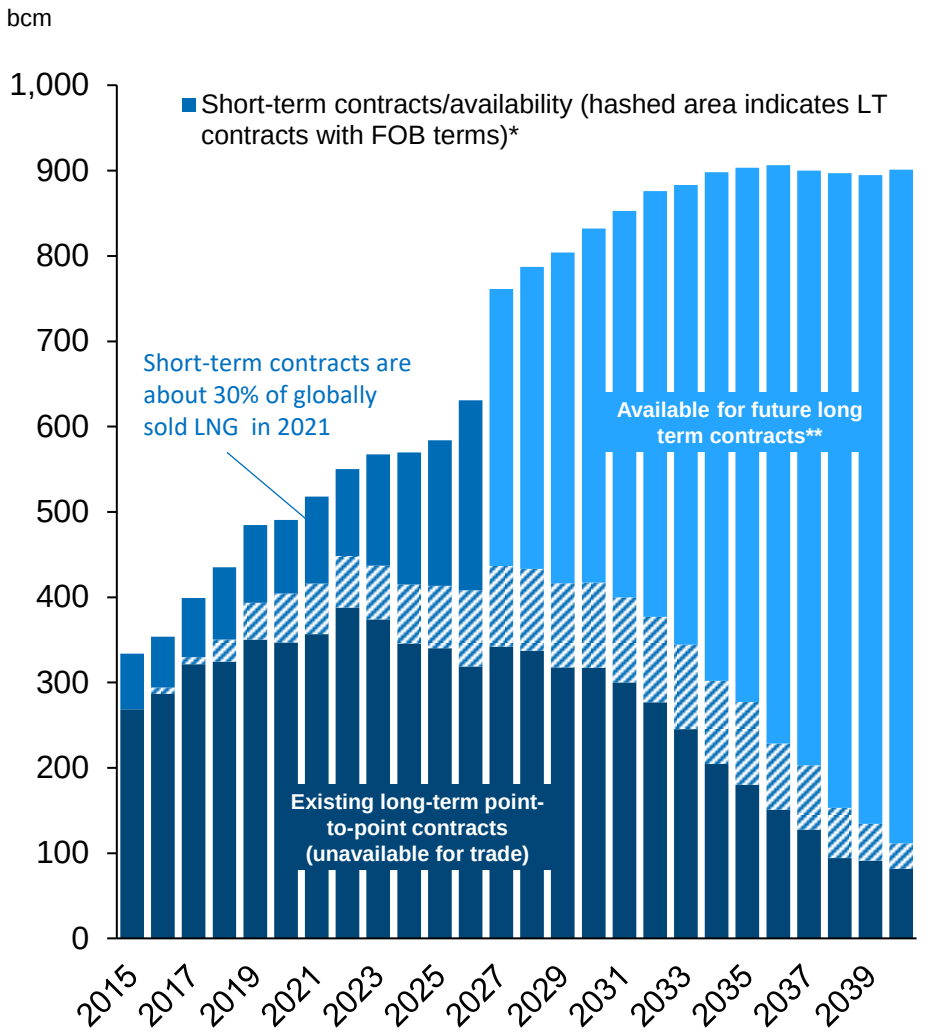
Global LNG market growing to 900 bcm/a with N America becoming largest supplier; limited volumes (~200 bcm) available for short-term (spot) contracting

Global LNG production by region



Global LNG production by availability/types of contracting



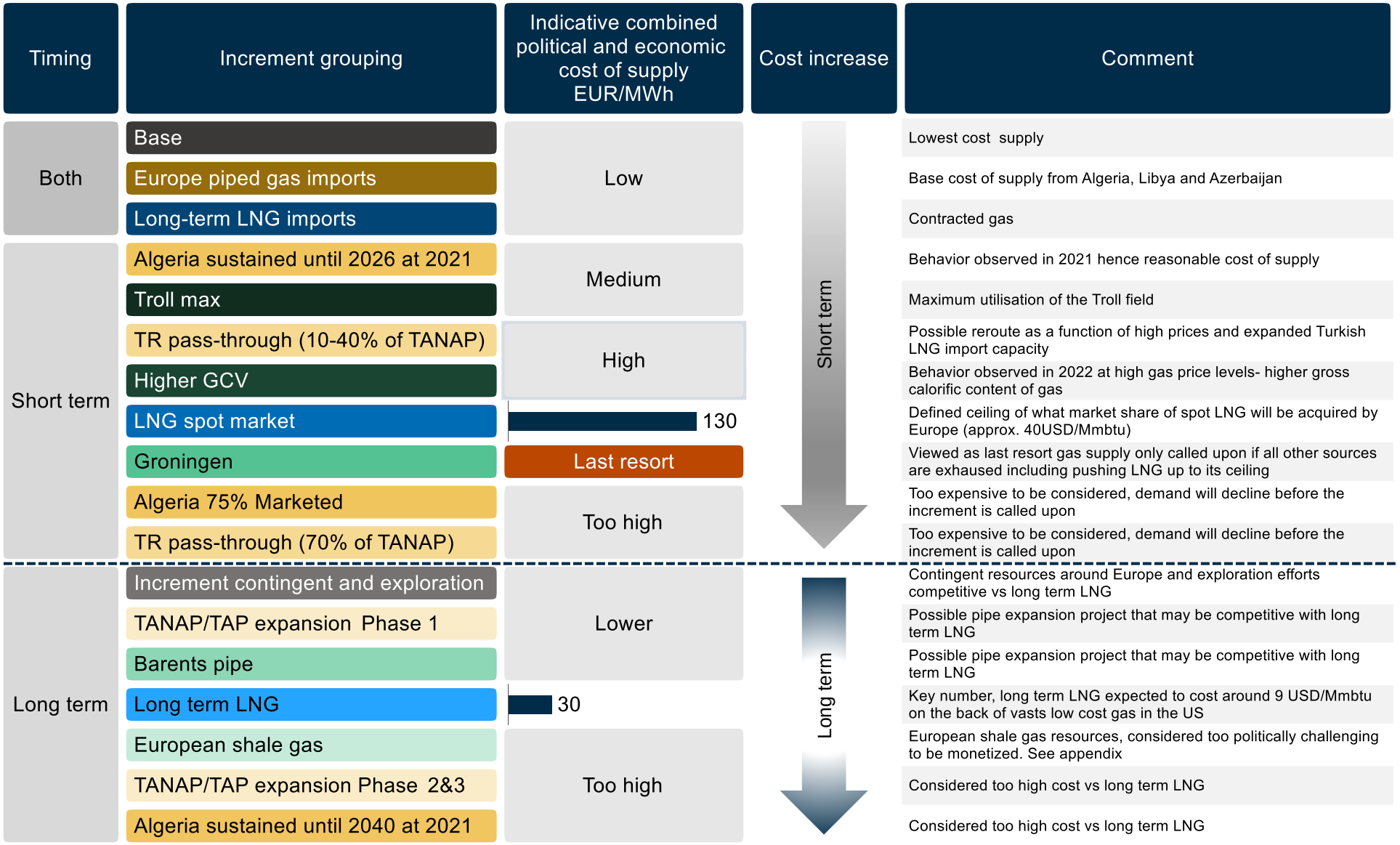
*US LNG FOB potential treated as spot LNG under a high gas regime – treated as long term contracts and therefore unavailable upon assumed stabilizing market prices from 2027 onwards. **Includes incremental European demand. Source: GasMarketCube, Rystad Energy research and analyses

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

The study ranks supplies by earliest availability and cost of supply



Source: Rystad Energy research and analysis

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KEY RESULTS

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
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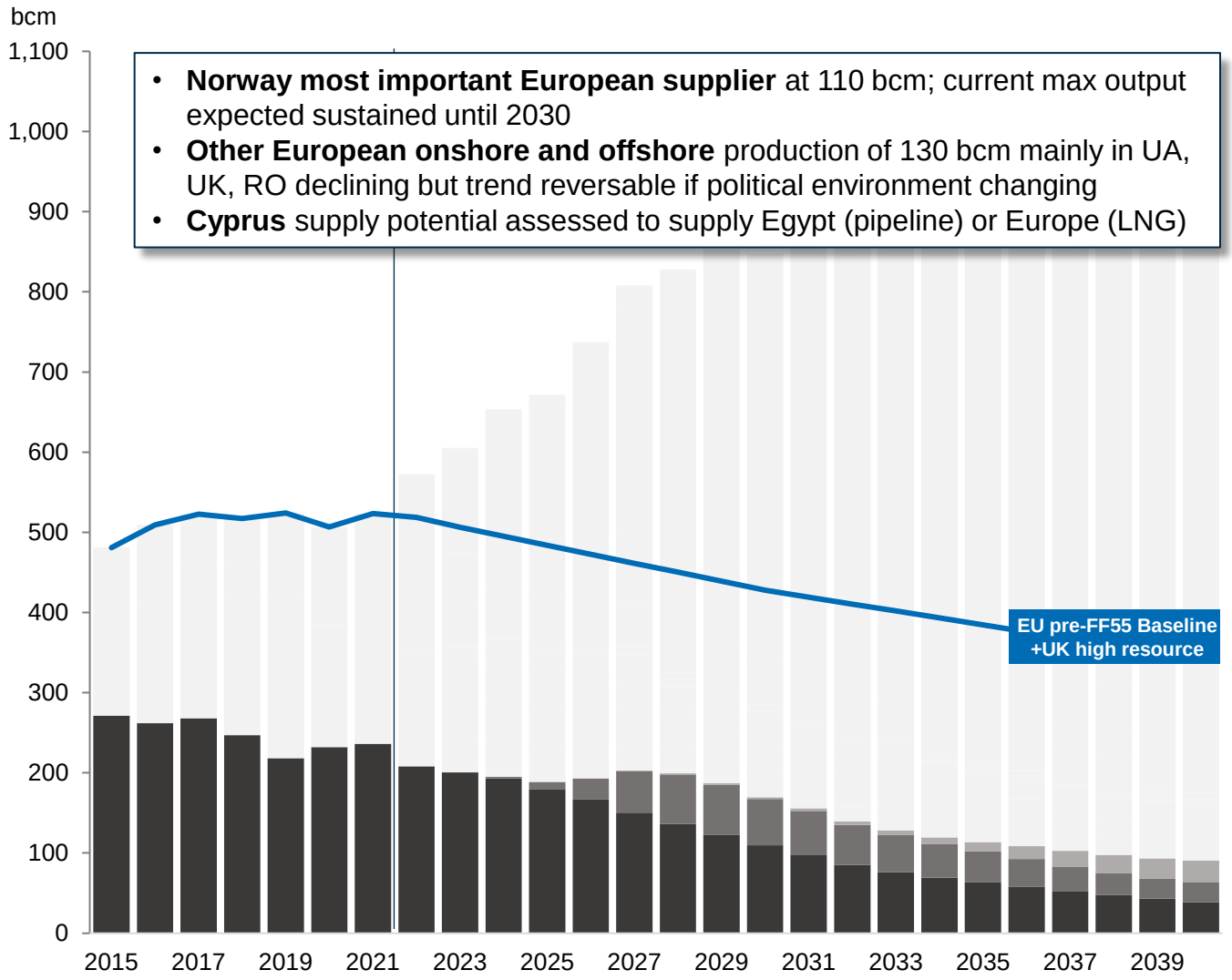
LNG	LT Contracted	Both
	Spot/FOB LNG	Short term
	Available for LT contracts	Long term

Production by increment group



Source: Rystad Energy research and analysis

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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
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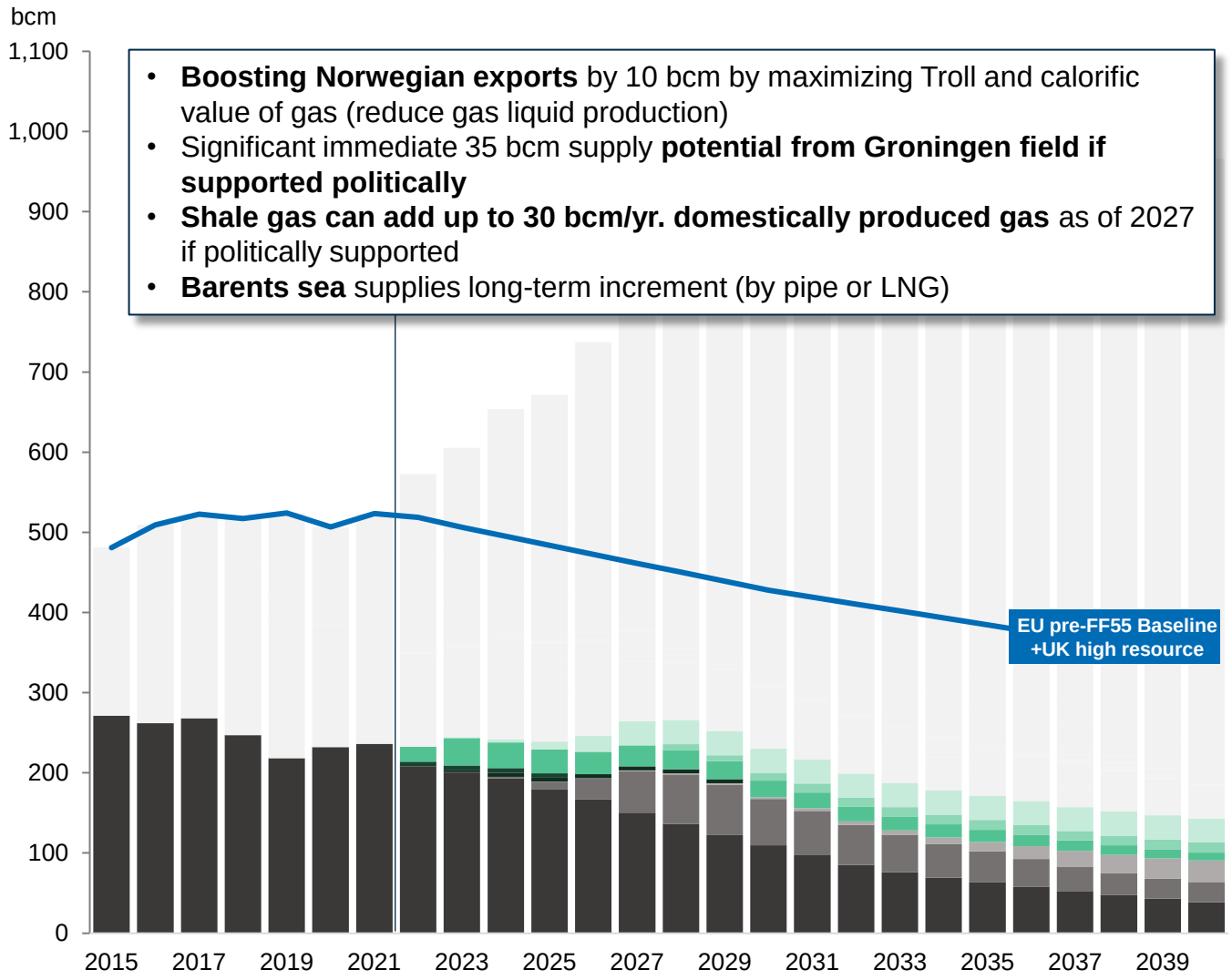
Production by increment group



- **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

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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	
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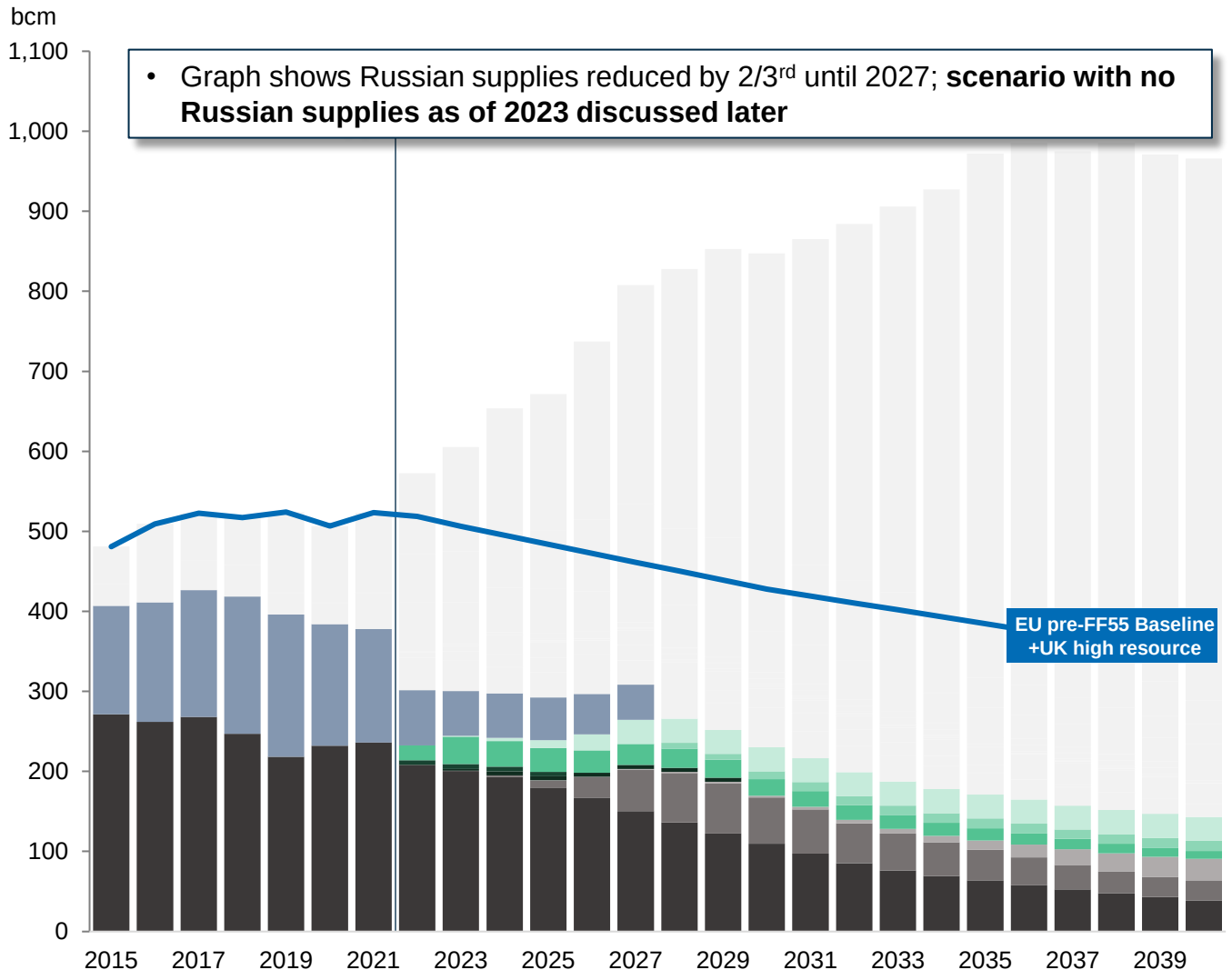

Source: Rystad Energy research and analysis

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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
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	Groningen	
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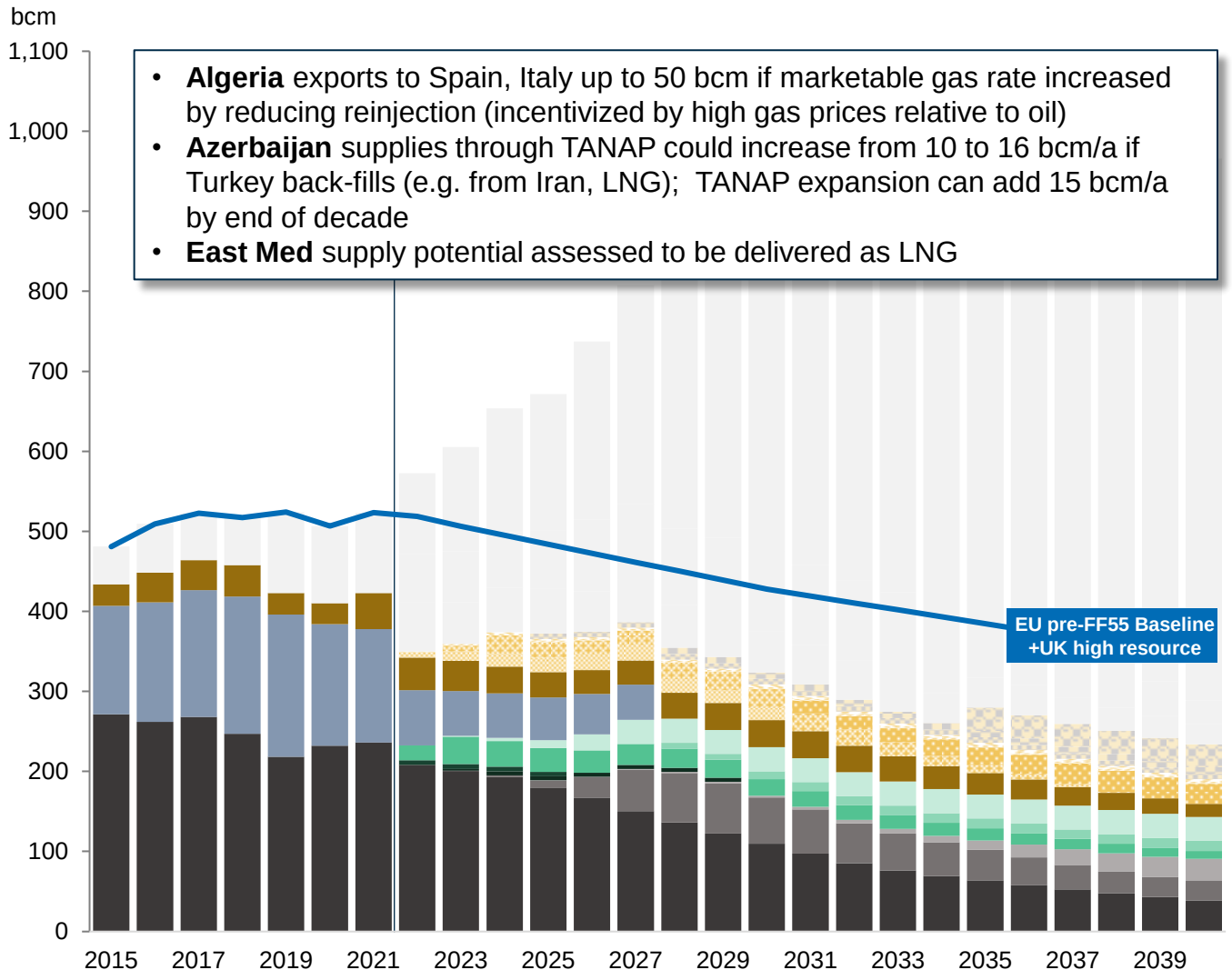

Source: Rystad Energy research and analysis

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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	
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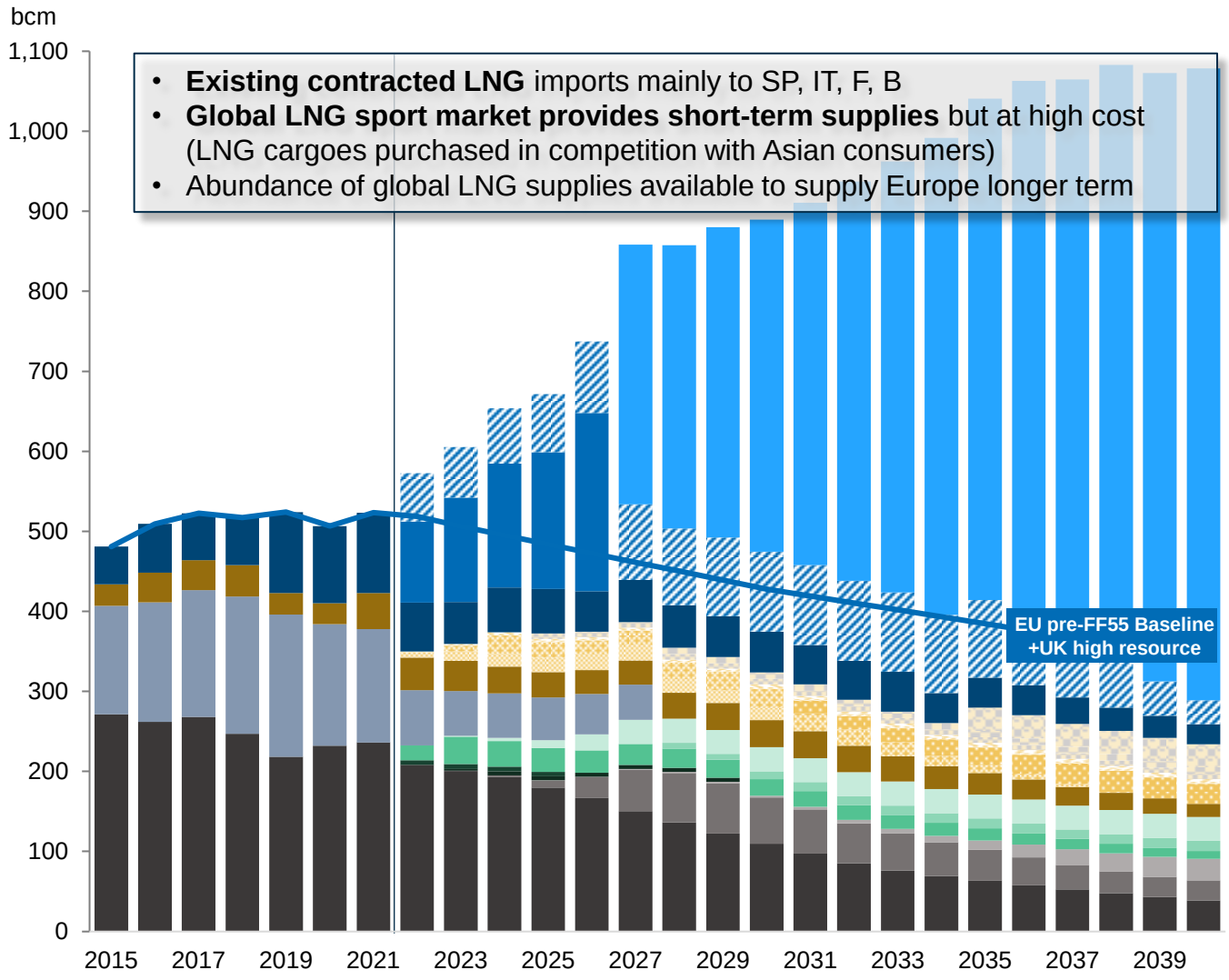
Production by increment group



Source: Rystad Energy research and analysis

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Ranking supplies by cost of supply filters out high-cost LNG, pipeline imports, politically challenged gas

Gas source	Increment group	Timing
Domestic	Base	Both
	Increment contingent	Long term
	Increment exploration	
Special domestic increment	Troll max	Short term
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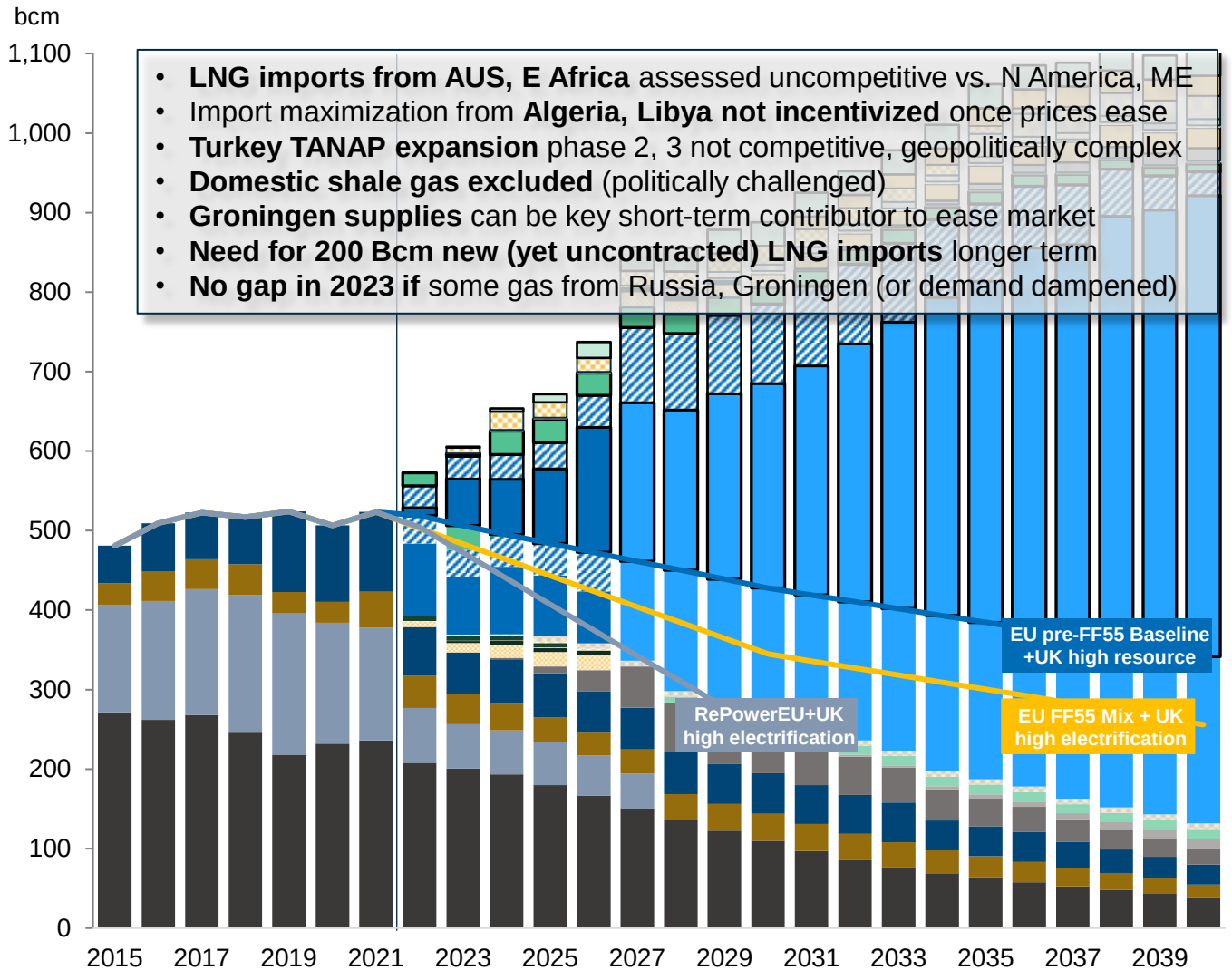

Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy

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WHAT IS THE SUPPLY GAP IF RUSSIA STOPS SUPPLIES?

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

Gas source	Increment group	Timing
Domestic	Base	Both
	Increment contingent	Long term
	Increment exploration	
Special domestic increment	Troll max	Short term
	Higher GCV	
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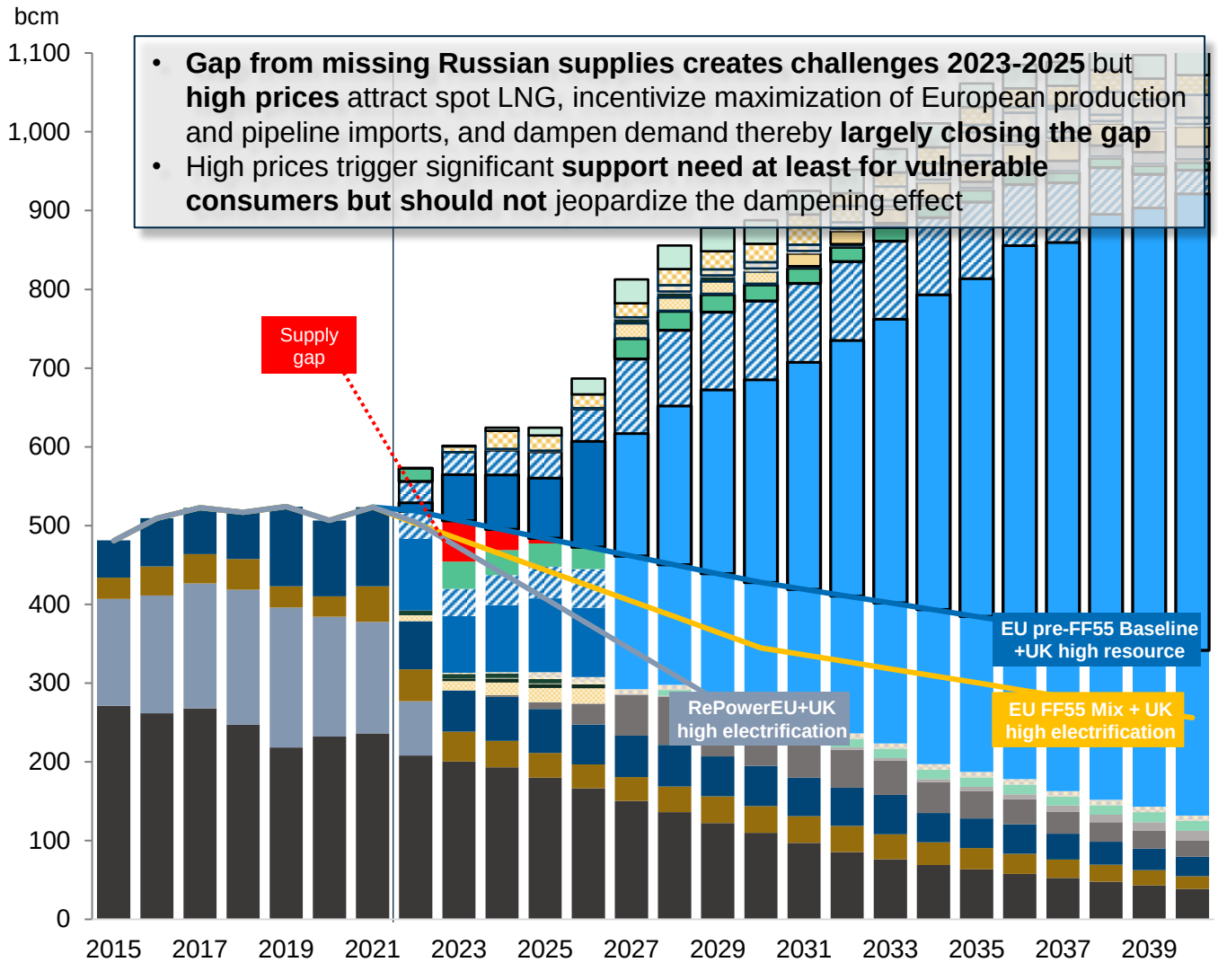

Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy

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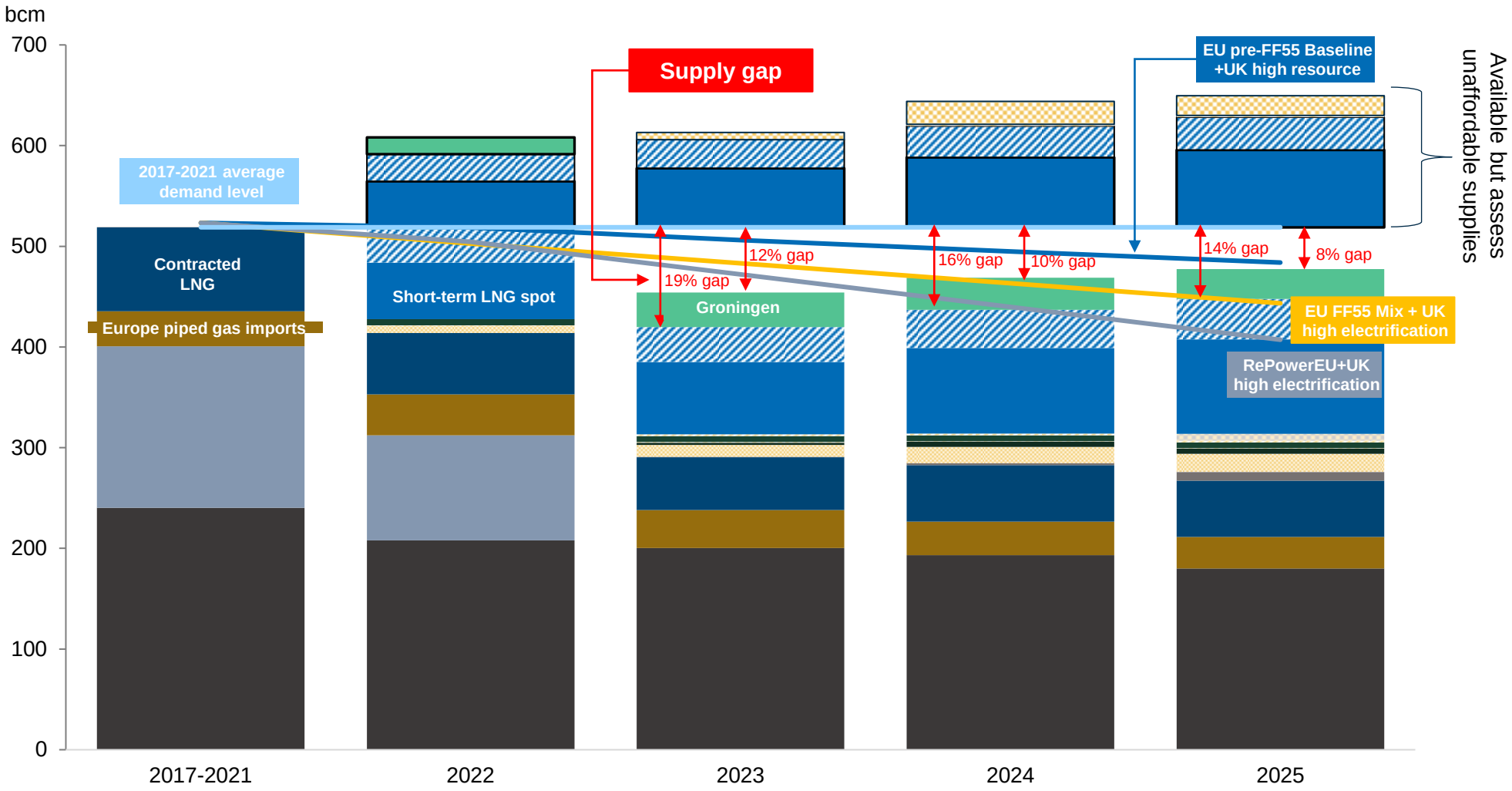
Supply gap versus 2017-2021 average demand: gap of up to 19%

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

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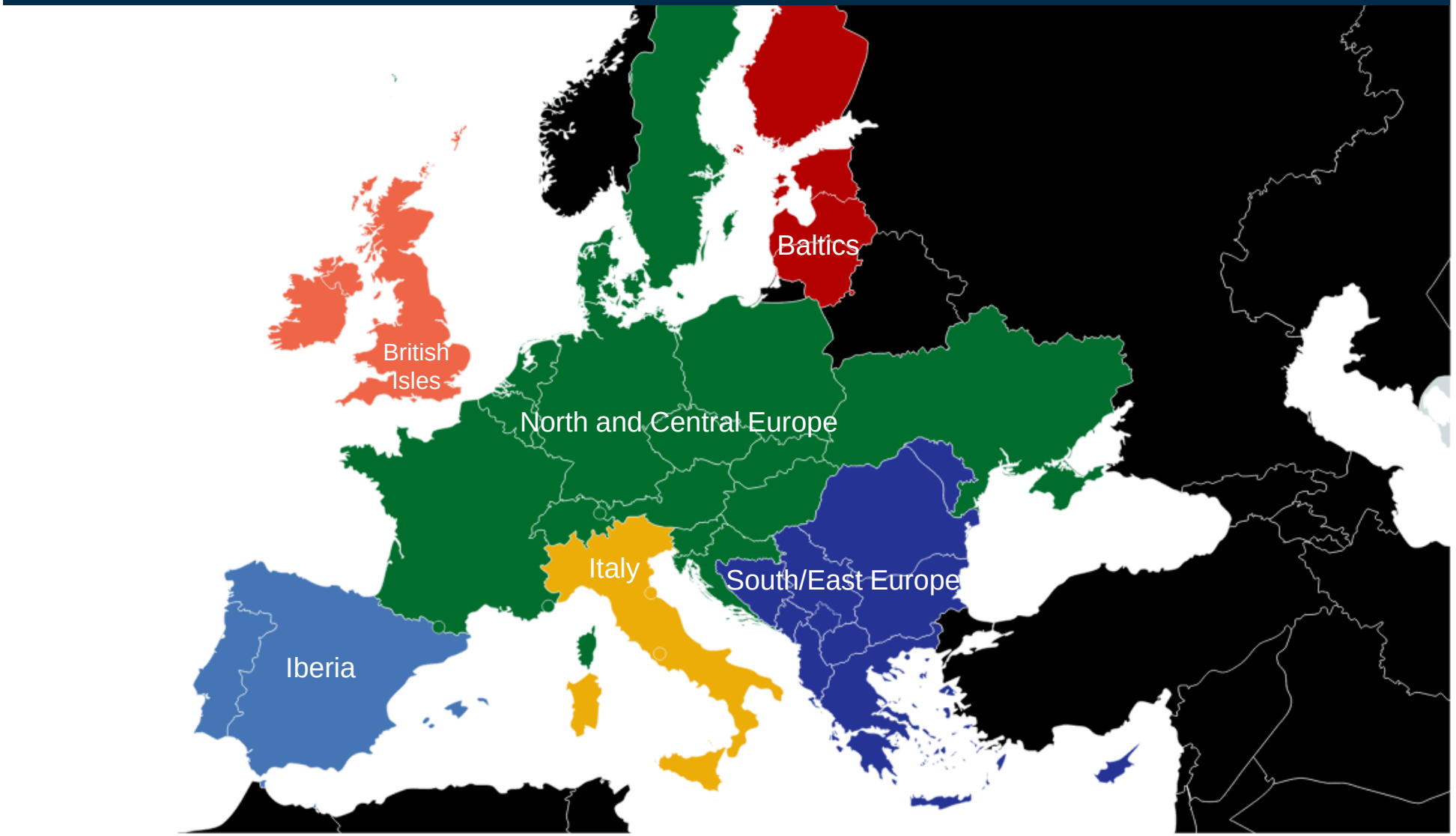
REGIONALIZATION

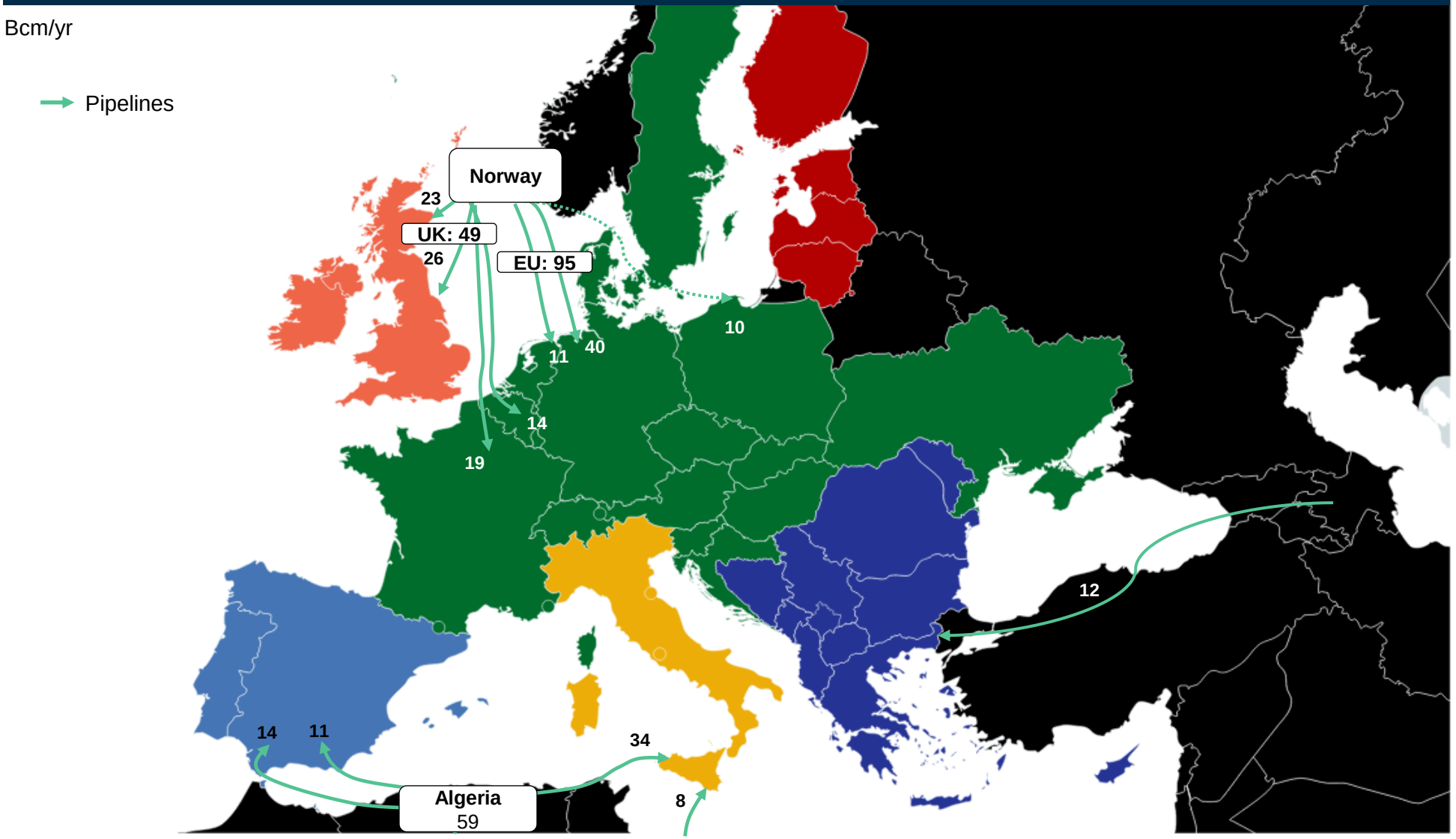
Regional grouping of countries which are relatively well connected by infrastructure

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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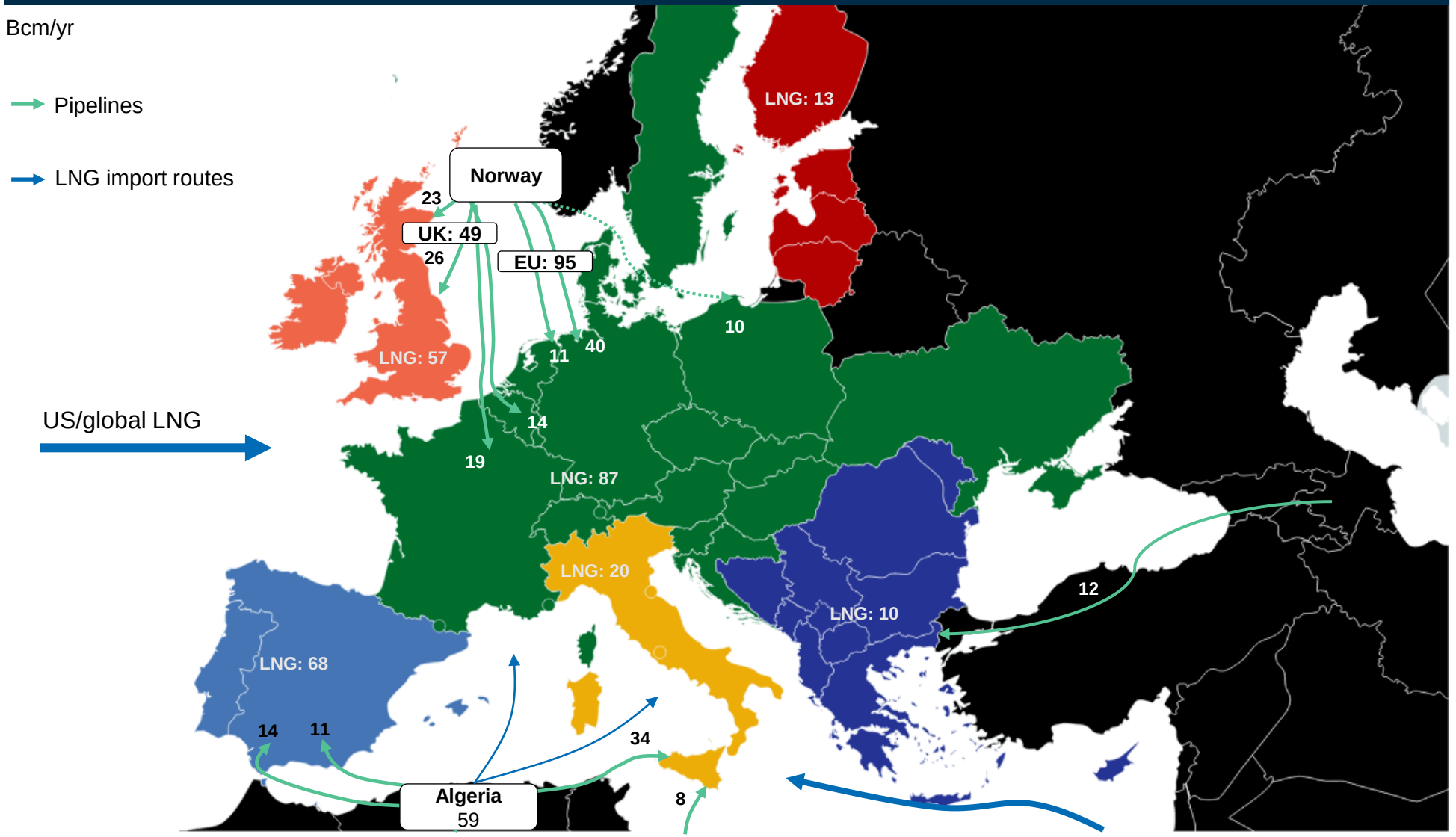
Significant LNG regas capacity into Europe; interconnecting regions through rerouting

LNG and non-Russian pipeline import capacities by region



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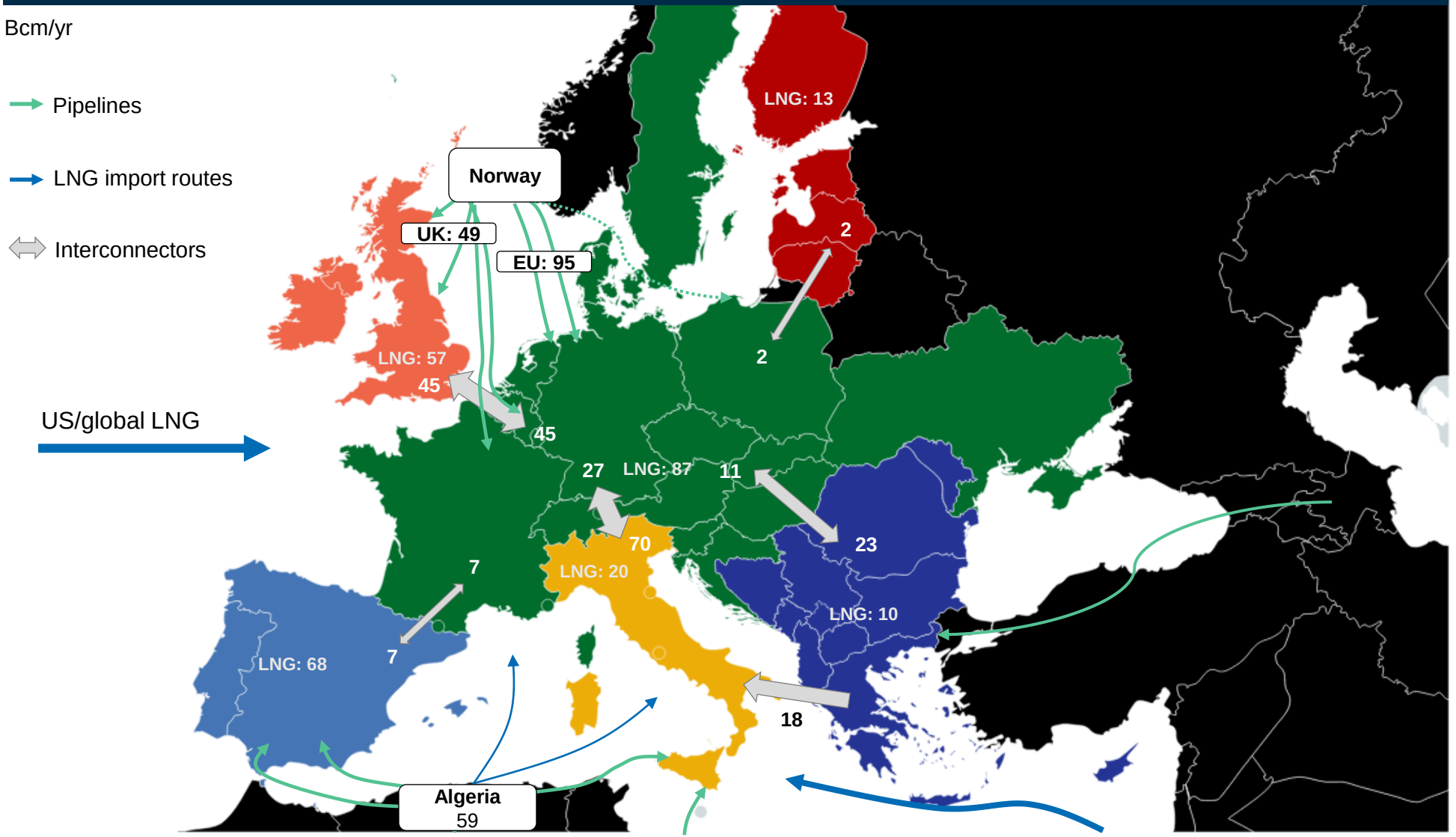
Connectivity between regions varies with significant bottlenecks between Spain and France; Poland and Lithuania and no capacity for reverse flows from Italy to Greece

Regions and the interconnectivity between them, 2023



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Without Russian gas in 2023: while interconnectors/LNG reroute can shift supplies, N&C Europe, Italy, S/E Europe compete for globally remaining affordable supplies

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	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 maximised 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

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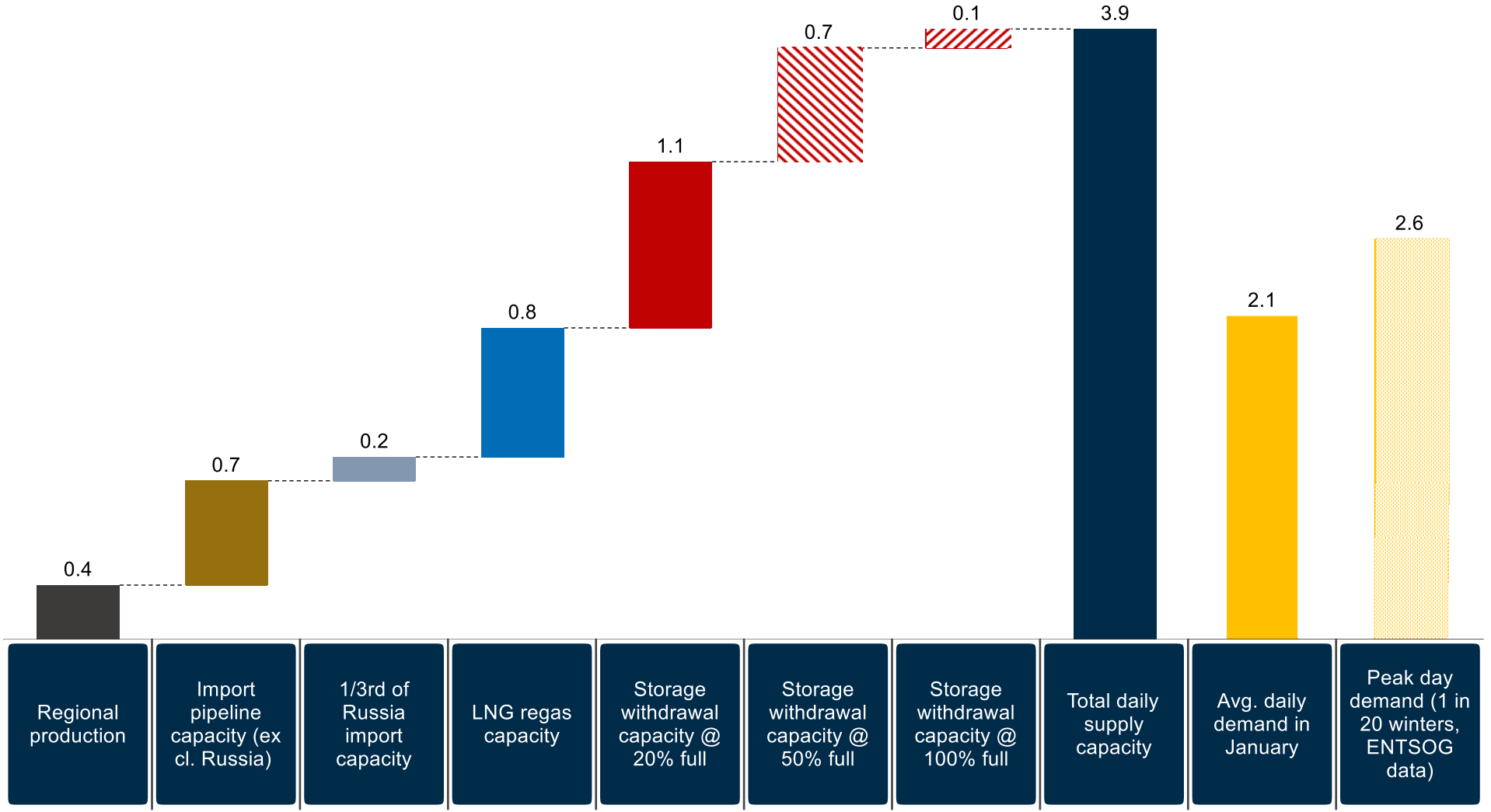
INFRASTRUCTURE CAPABILITIES

Europe has significant gas infrastructure capacity to supply peak day demand

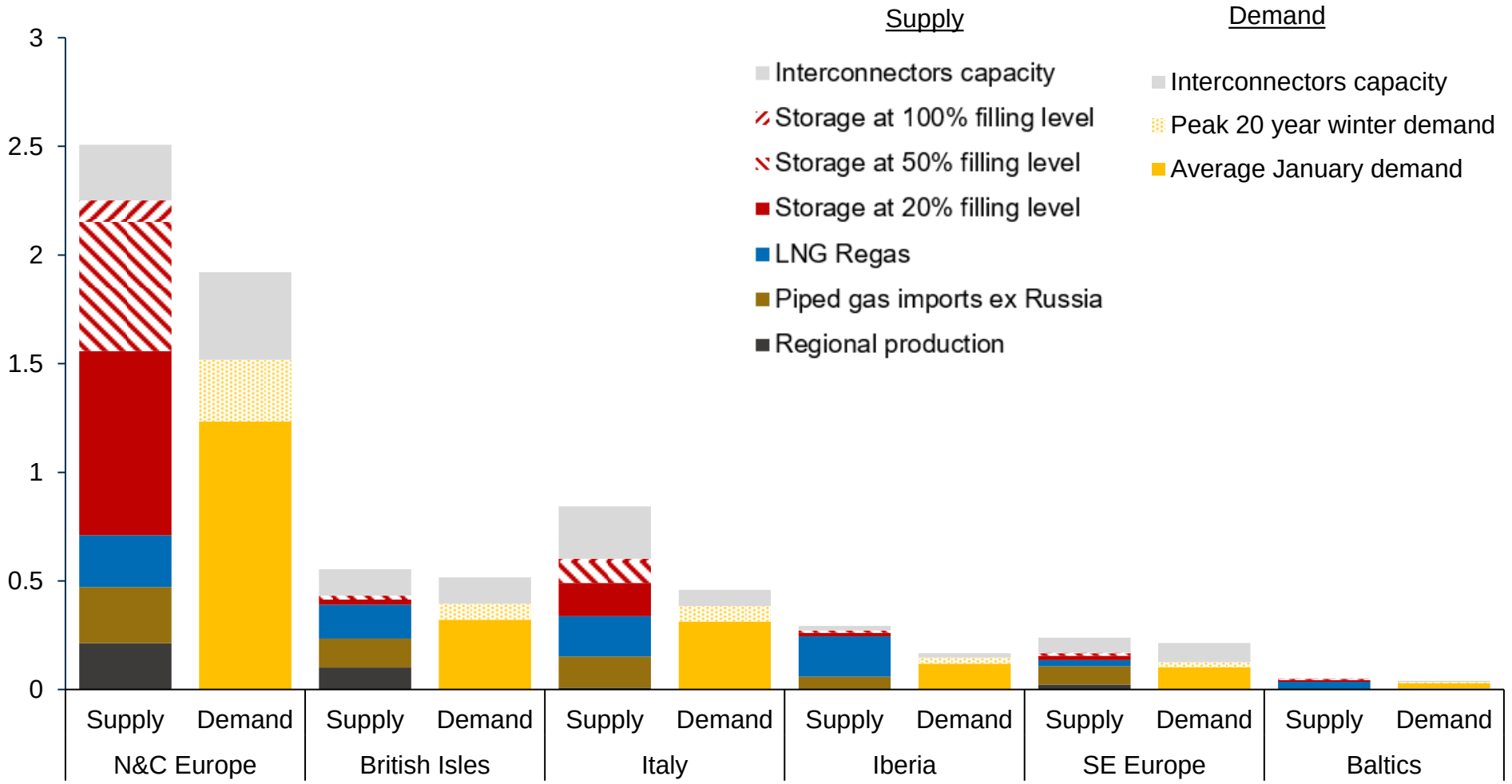
Peak day supply capacity build-up, Jan 2023 (unit: bcm/day)



Source: Rystad Energy research and analysis

Regional infrastructures sufficient to supply peak day demand but storages need to be appropriately filled (some bottlenecks within regions to be addressed)

Regional balances with peak day supply capacity of infrastructure, 2023 (unit: bcm/day)



Assumptions: pipeline import capacities capped by export country supply availability; Bottlenecks within regions not considered; Ukraine storage excluded.
Source: Rystad Energy research and analysis, Rystad Energy GasMarketCube, European Commission, UK Department for Business, Energy & Industrial Strategy, ENTSOG

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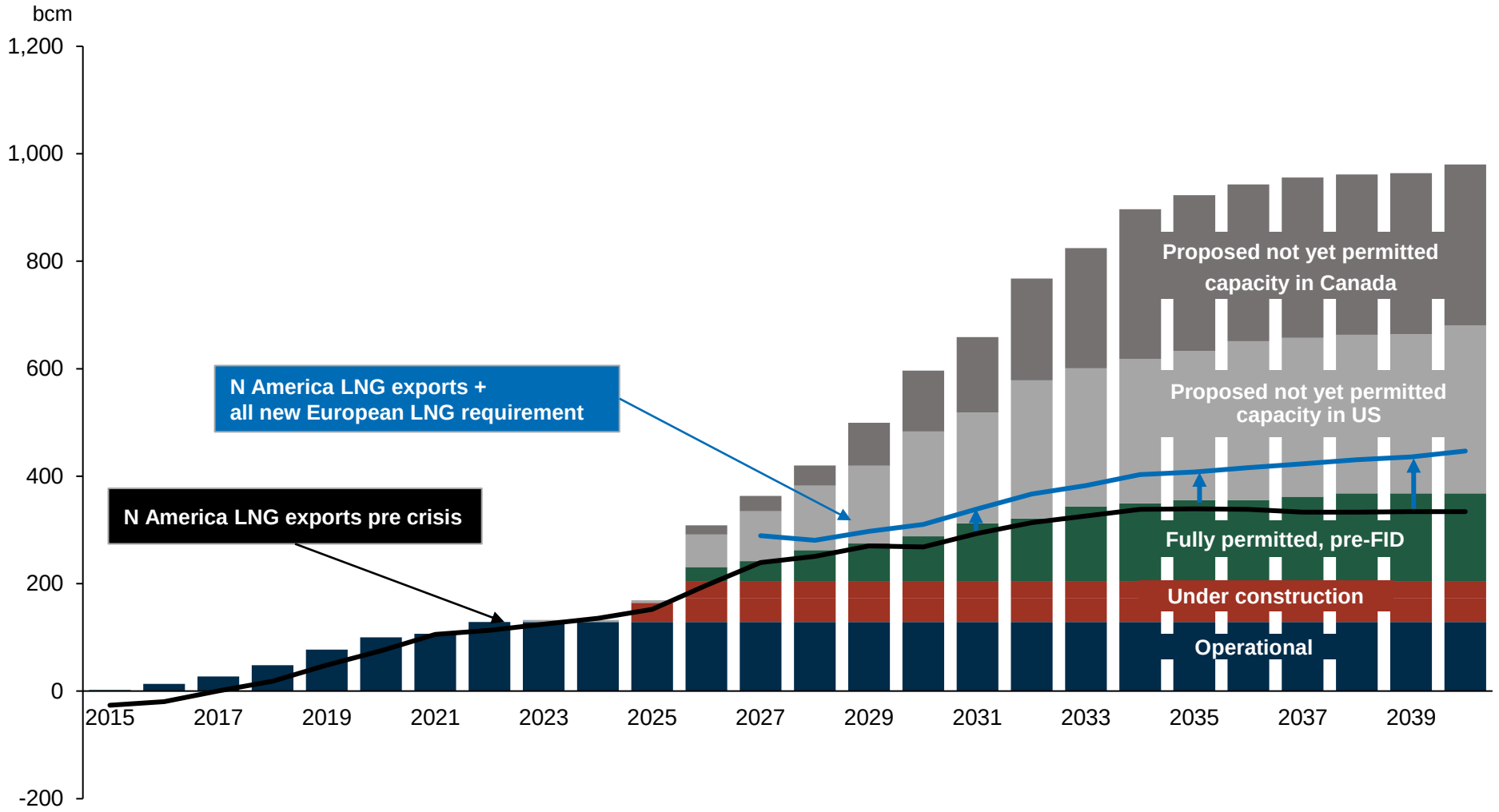
DEEP DIVE ON LNG

N America could supply new European LNG long-term requirements

North American LNG exports capacity vs European LNG imports requirement



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

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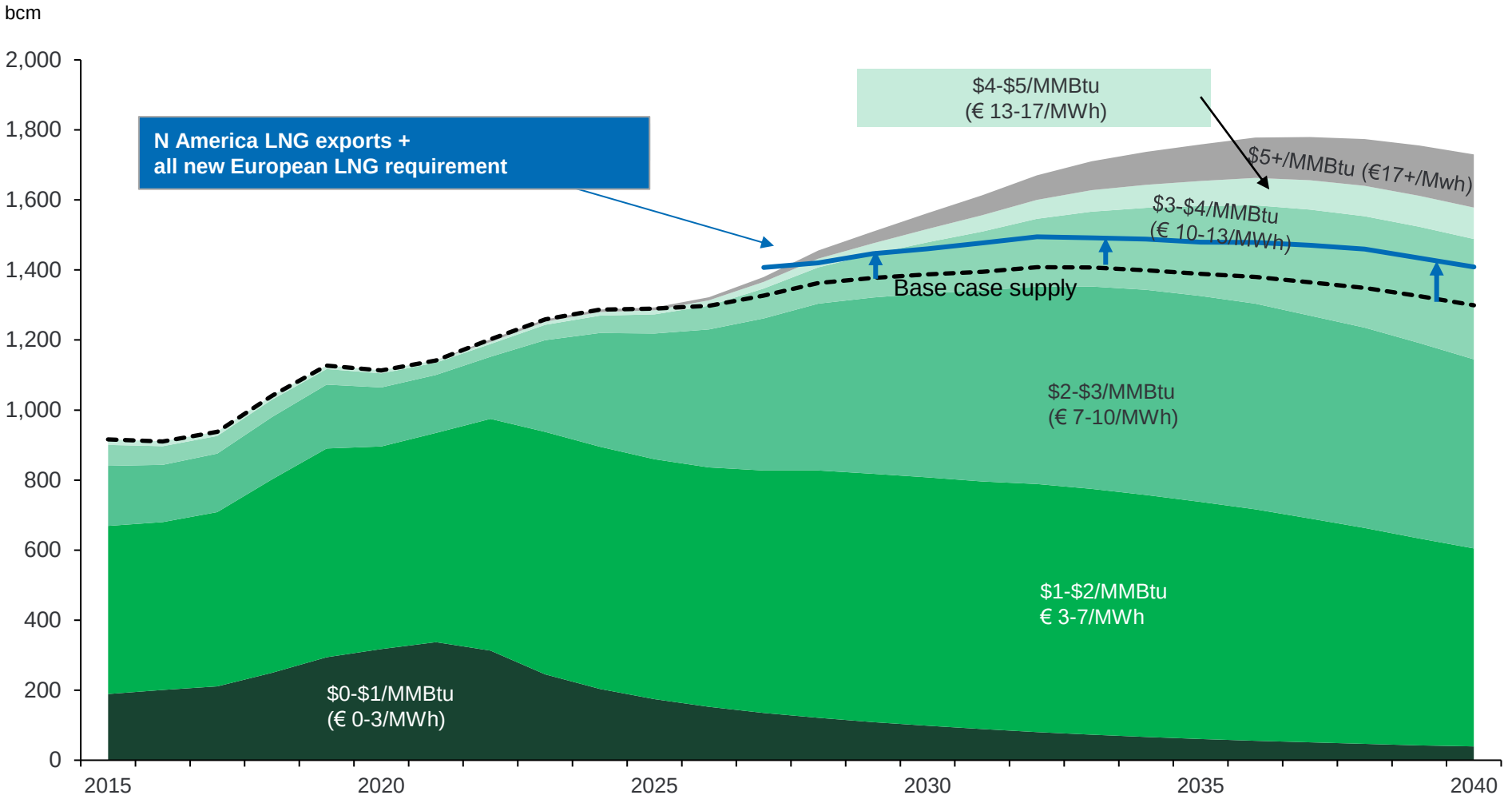
Low-cost supplies in N America; new European demand ~7% production increase

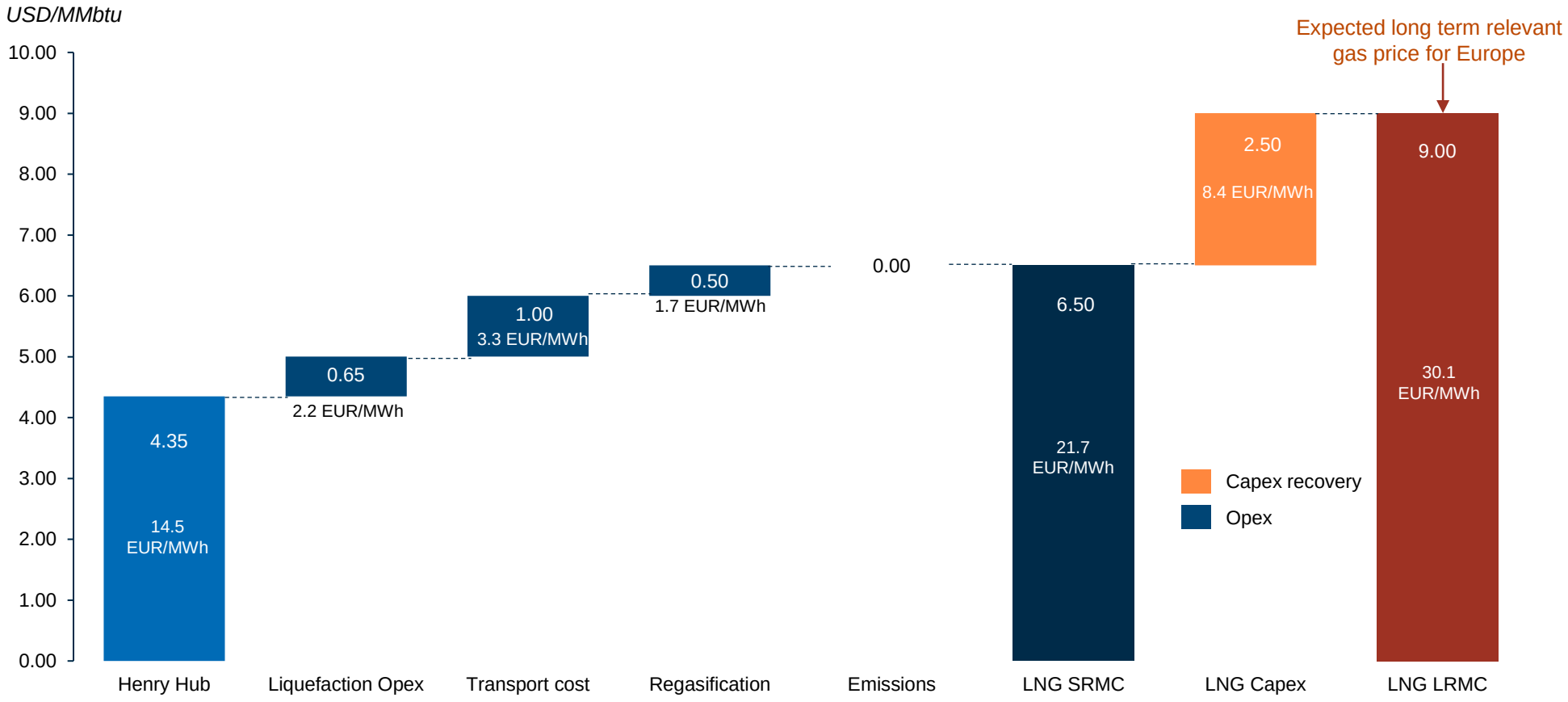
US and Canada natural gas supply potential by lifecycle and breakeven price



Note: Breakeven based on a 7.5% real hurdle rate. Prices are in real terms. Assumed exchange rate: 1 EUR = 1.02 USD
Source: Rystad Energy GasMarketCube

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



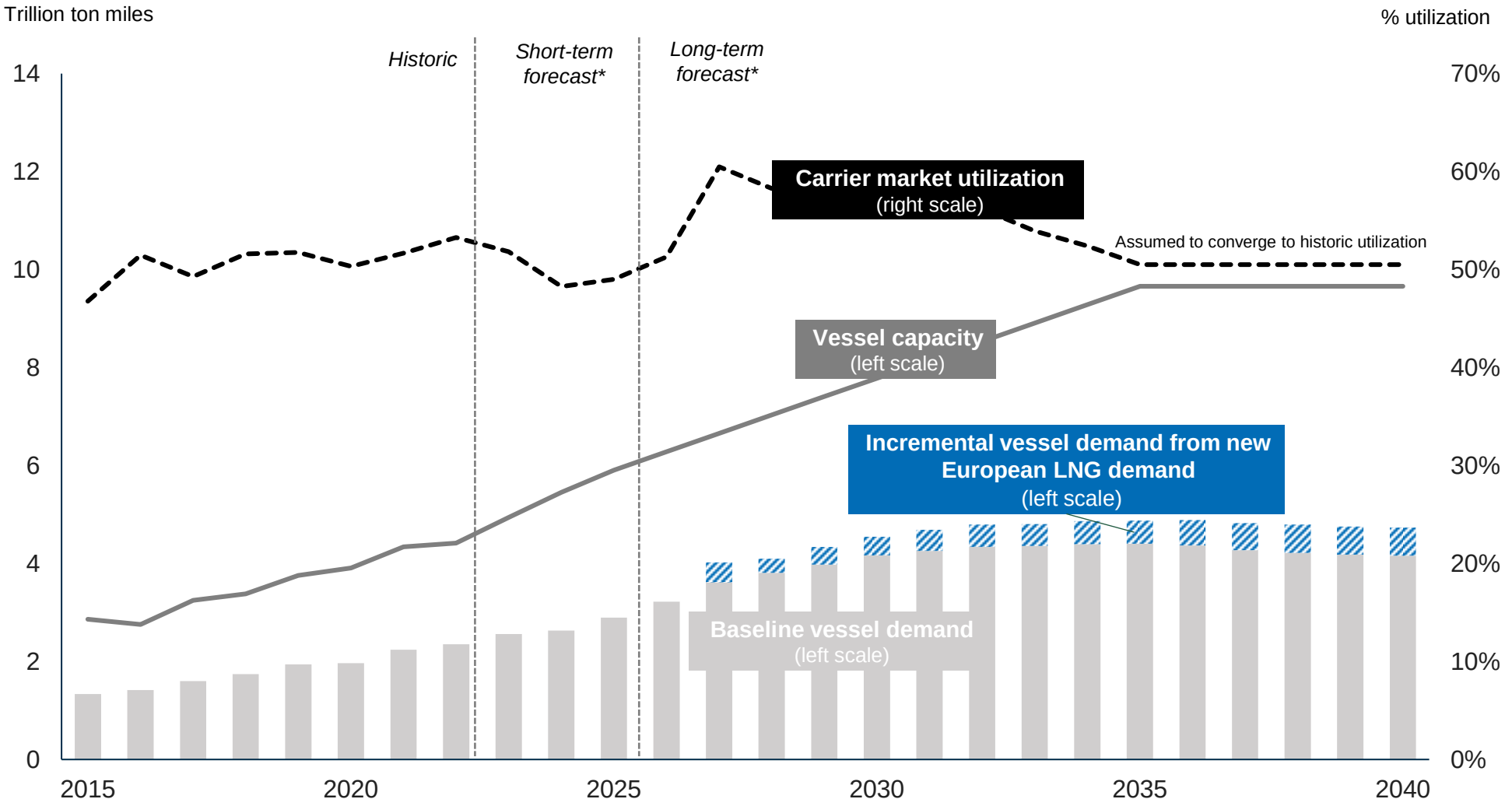
Assumptions

US trading point '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*

Prices are in real terms. Assumed exchange rate: 1 EUR = 1.02 USD Source: Rystad Energy research and analysis

LNG carrier fleet expected to handle more LNG trade

Forecast of the global LNG carrier market



*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

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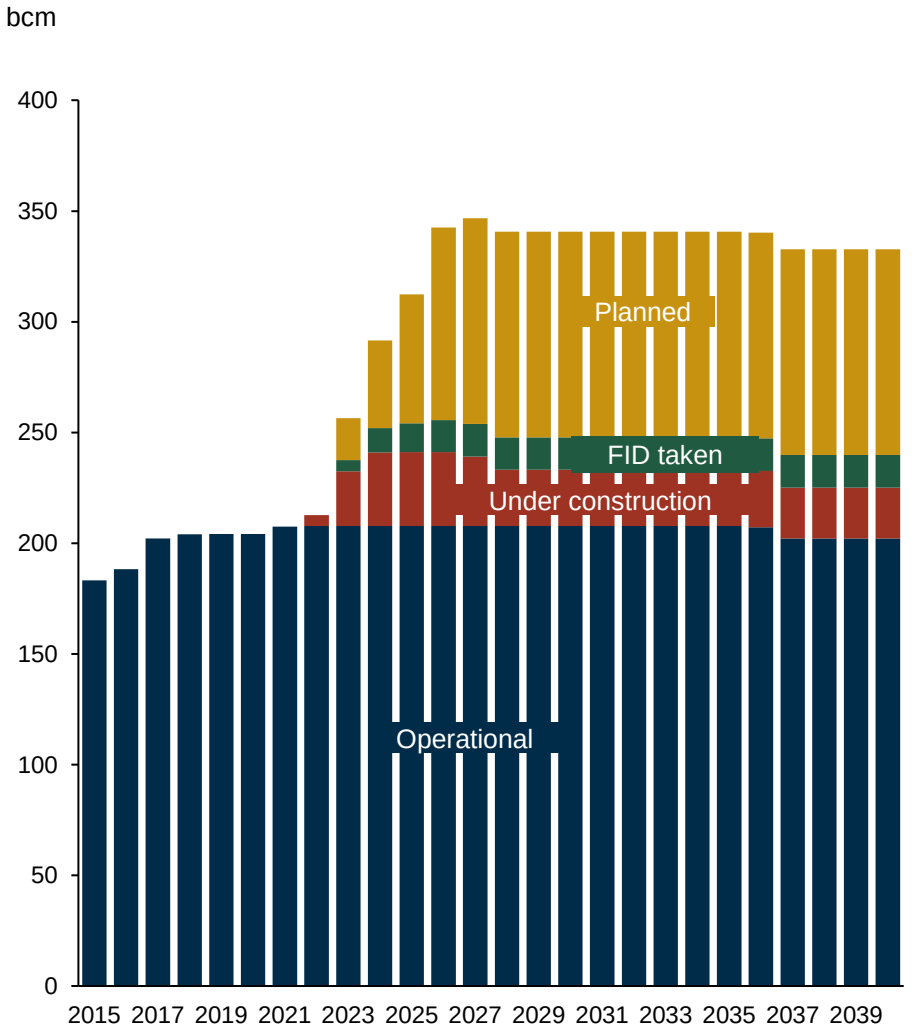
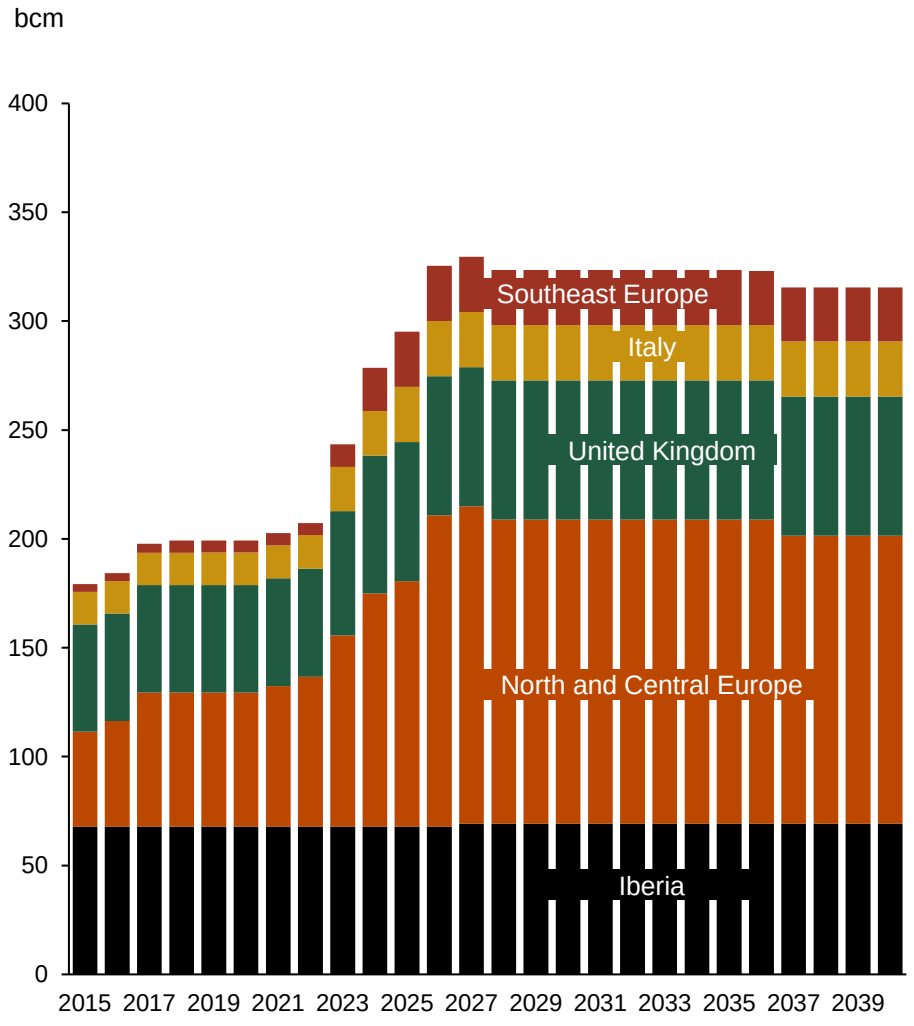
European LNG regas/import capacity can grow by 120 bcm to 330 bcm per year

Infrastructure status on European regas capacity



European regas capacity split by geography

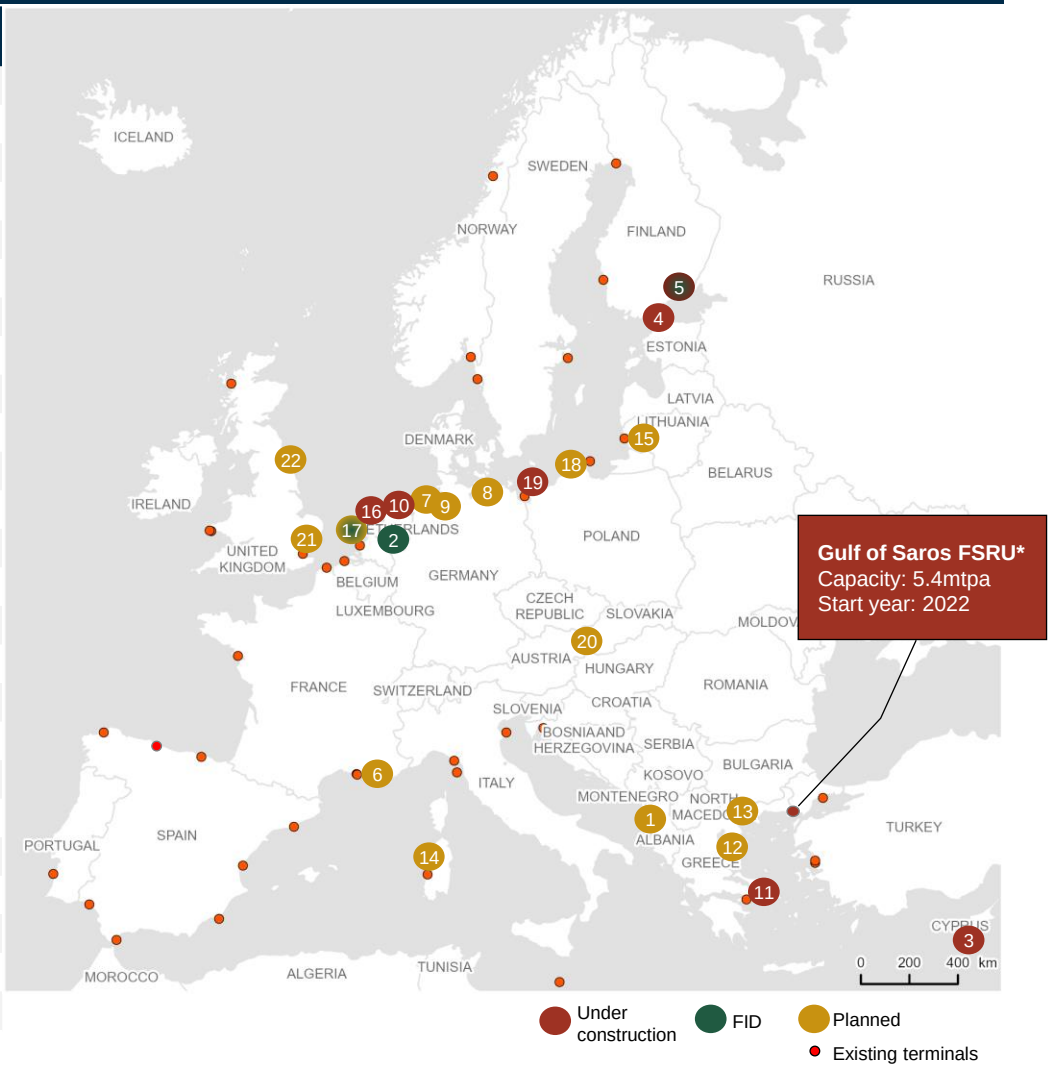


Source: Rystad Energy research and analysis; Rystad Energy GasMarketCube

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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CONCLUSIONS

Conclusions

- **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 neighbouring 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**

- **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 neighbours 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

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POLICY CONSIDERATIONS

Policy considerations – European production

- **Reassess potential of natural gas production in Europe including from shale gas resources with the aim to maximize domestic production in compatibility with Green Deal; production in Europe …**
  - supports Europe's gas supply diversity and energy security,
  - creates economic activity, significant fiscal revenues, job opportunities in a highly skilled sector**,**
  - has comparably low GHG emissions footprint (produced based on mature framework near the market),
  - can be produced while achieving net-zero objectives without lock-in effects (replaces imported gas and reforming it into hydrogen with CCUS enables it to fuel Europe's energy needs with near zero emissions at relatively low cost)

- **Member States should review their contribution to increasing domestic production and include production plans in the revisions to National Energy and Climate Plans (NECPs)**
  - Reconsider bans, moratoria or limitations on E&P activities and the deployment of fracking technology
  - Review designated no-go areas under existing mining laws
  - Accelerate permitting procedures and related impact assessments

- **Recognize significant role of Norway as reliable supplier and further deepen EU's partnership**
  - Possibly exempt Barents Sea resource developments from Arctic Resources Directive (environmental conditions in Barents Sea are similar with the North Sea rather than with other Arctic areas)

Policy considerations – New imports

- **EU partnerships with producer countries can support new supplies but contracts should be concluded between market parties in competition with each other**
  - Imports via pipelines from other EU neighbouring regions can benefit from targeted policy support (e.g. TANAP/TAP expansions)

- **Long-term LNG purchase and infrastructure-use contracts need to be supported by an appropriate legal framework** underpinning the financing and de-risking of the significant investments needed
  - TPA rule exemptions facilitate investments into new/incremental infrastructure
  - Accelerate LNG FSRU permitting procedures
  - Reassess sunset clause for long-term natural gas contracts

- **Missing North America midstream infrastructure (pipeline capacity, liquefaction) is a bottleneck to fully enable LNG exports to Europe**
  - Permitting issues to be addressed in US and Canada; EU awareness and support important
  - Ongoing API study on need for expansion of midstream pipelines to transport gas to LNG liquefaction

- **Recognize relevance of demand forecasts / energy policy objectives for investors into new supplies**

Policy considerations – Infrastructure

- **Integrated market with well interconnected infrastructure significantly contributing to resilience of European gas market and should be preserved being a key enabler of its fast rebalancing**
- **With East-West flows disappearing, former transit countries have spare capacities while new bottlenecks for new West-East flows need to be addressed to increase system resilience**
  - Gas projects in REPowerEU chapters of the Recovery and Resilience Plans address key infrastructure needs (without leading to lock-in effects and stranded assets)
  - Coordination role for Commission for transmission corridors across several member states
  - Gas de-odorization of flows from France to Germany is key issues to be addressed
- **Nearly sufficient alternative natural gas import capacities exist**
  - Selected infrastructure expansions and new LNG regas terminals especially in N/Central and S/E Europe create additional system resilience
  - Consider establishing a short-term / emergency Projects of Common Interest instrument to support necessary EU network, LNG regas, and storage reinforcements
- **Policy makers to carefully reassess forecast gas demand reductions and infrastructure downsizing with aim to ensure security of supply**
  - Hydrogen-ready infrastructure contributes to diversify gas supply in the internal market and help tap into the long-term potential for hydrogen

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

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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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