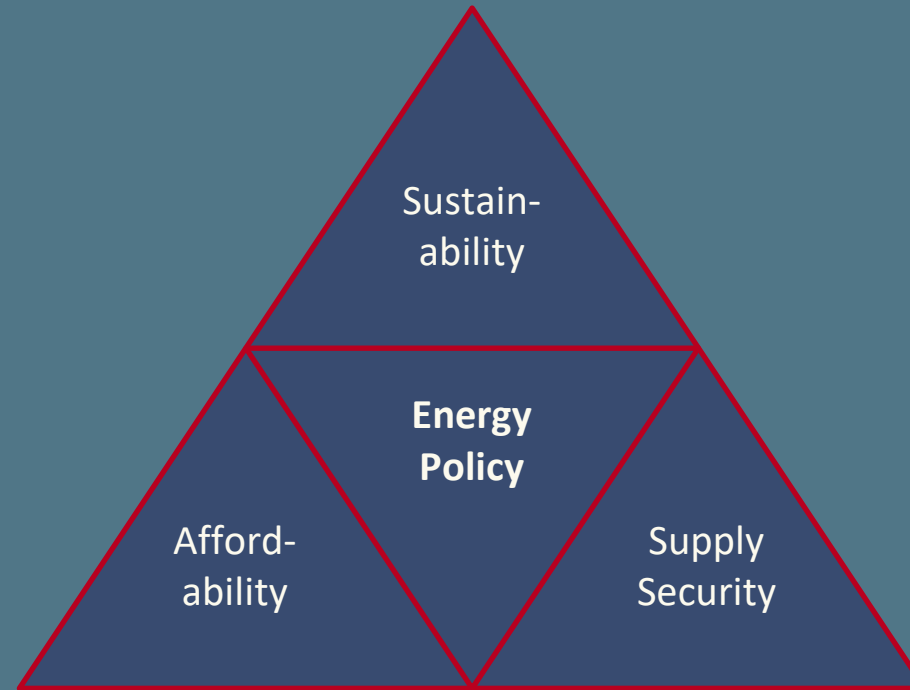


Modeling Europe's role in the global LNG market 2040

Dr. Sebastian Zwickl-Bernhard, Prof. Dr. Anne Neumann

LNG's role in the clean energy transition

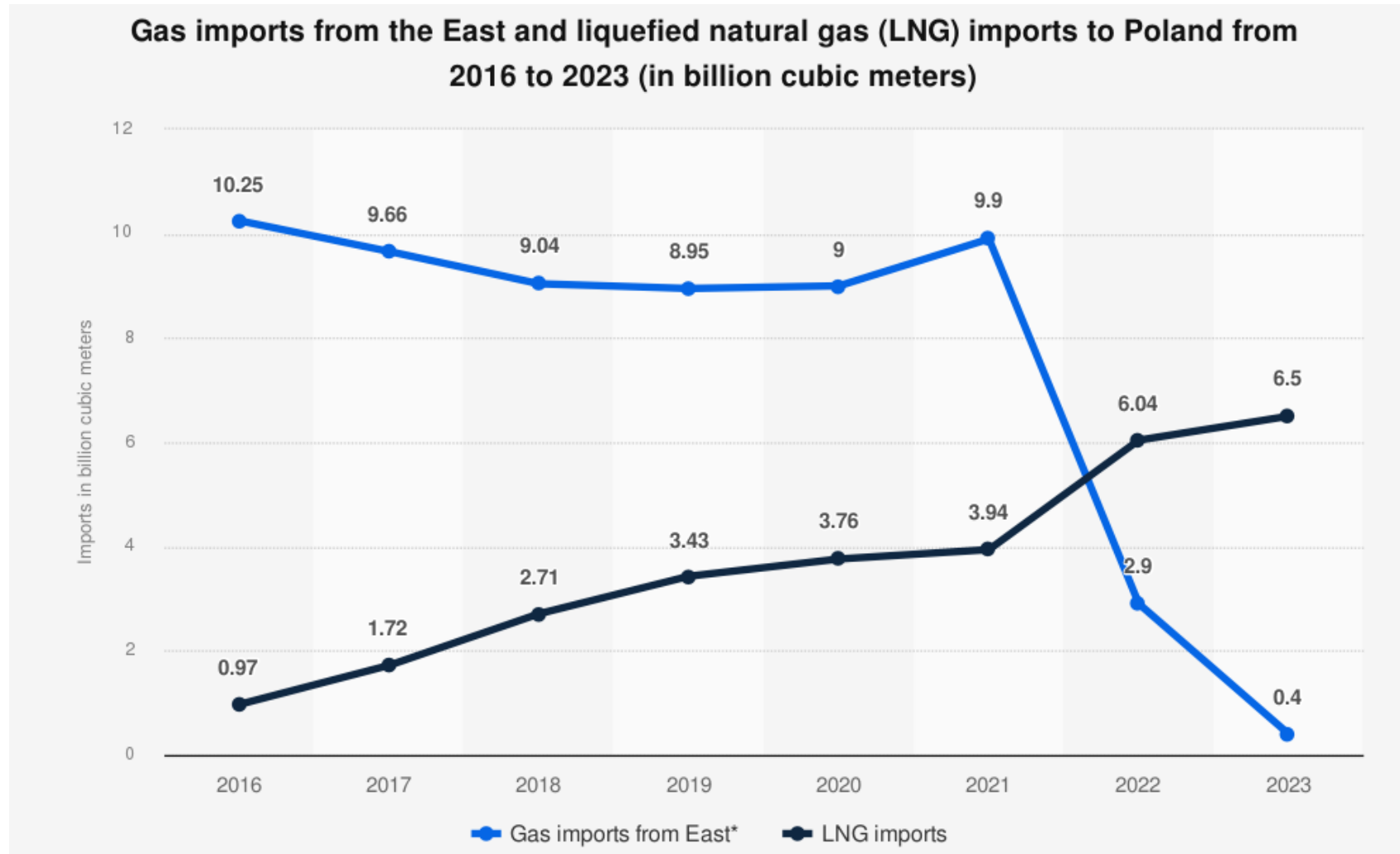
A bridging technology to...



European LNG infrastructure



- U.S. LNG, along with supplies from other exporters, presents a viable **alternative** to pipeline-based gas imports from Russia in both the short and medium term
- LNG contracts are frequently associated with **more flexible pricing mechanisms**, in contrast to the traditional oil-indexed gas agreements that have dominated the market.
- Beyond cost, **environmental concerns**, including methane emissions from LNG production and shipping, have raised concerns.



**Which impact will geopolitical tensions between
importing and exporting regions have on
European LNG supply if global LNG trade were to
be used as a political weapon?**

Method (I)

- focus on European supply and associated costs in 2040 under two scenarios
- the impact of political tensions -> detailed analysis of LNG flows and supply costs for five cases
- specifically looking at Europe

$q_{e,i}$... Quantity of LNG exchanged between exporter e and import i

$DES_{e,i}$... Delivered ex-ship costs between e and i

Method (II)

- tailor-made (and simplified) optimization model
 - minimizing DES costs + alternative supply
 - considering increasing LNG demand in developing countries

$$\min_x \underbrace{\sum_e \sum_i DES_{e,i} \times q_{e,i}}_{\text{Global LNG trade with minimum supply cost}} + \underbrace{\sum_{i'} (EDP + CCS) \times q_{i'}^{EDP}}_{\text{European domestic production equipped with CCS}}$$

- subject to six (standard) constraints

Method (III)

■ baseline assumptions for future demand

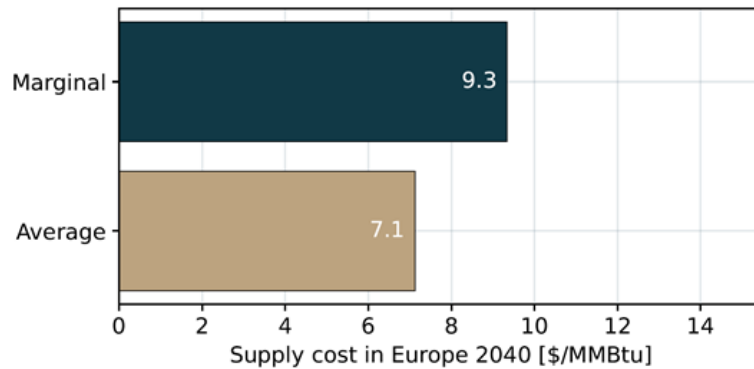
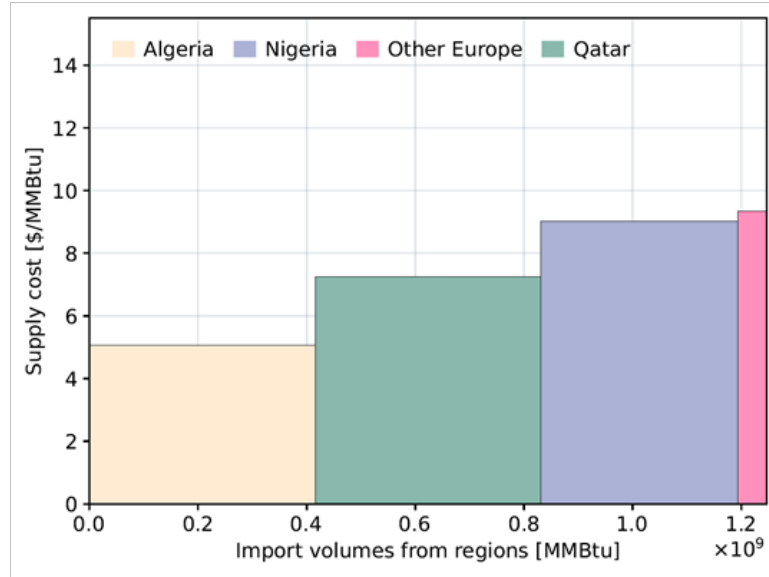
Demand [billions of MMBtu]	Net Zero	Persisting Fossil Demand
Global	16.7	35.0
Europe	2.1	6.9
- Share of global	13%	20%

Table 1: Assumptions on the LNG demand in 2040. Based on [58] and [59].

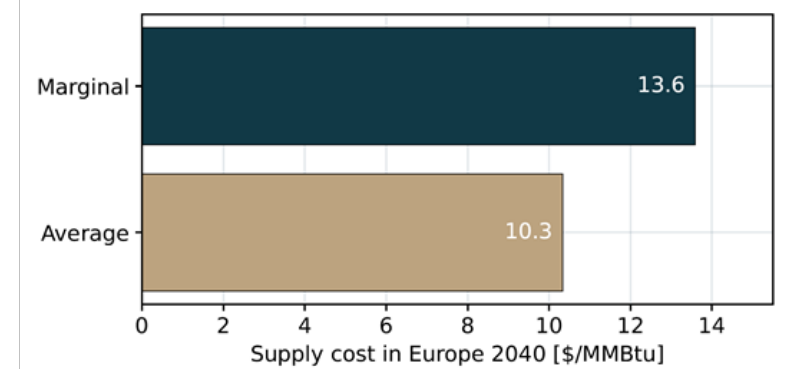
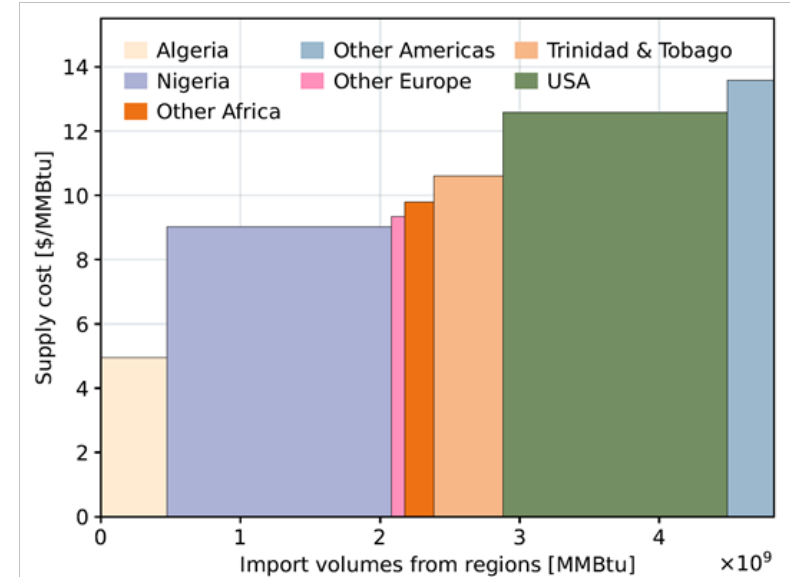
**How will Europe meet its expected LNG demand
in 2040 given increased global LNG demand
driven primarily by developing countries?**

Two possible futures.

Net Zero



Persistent

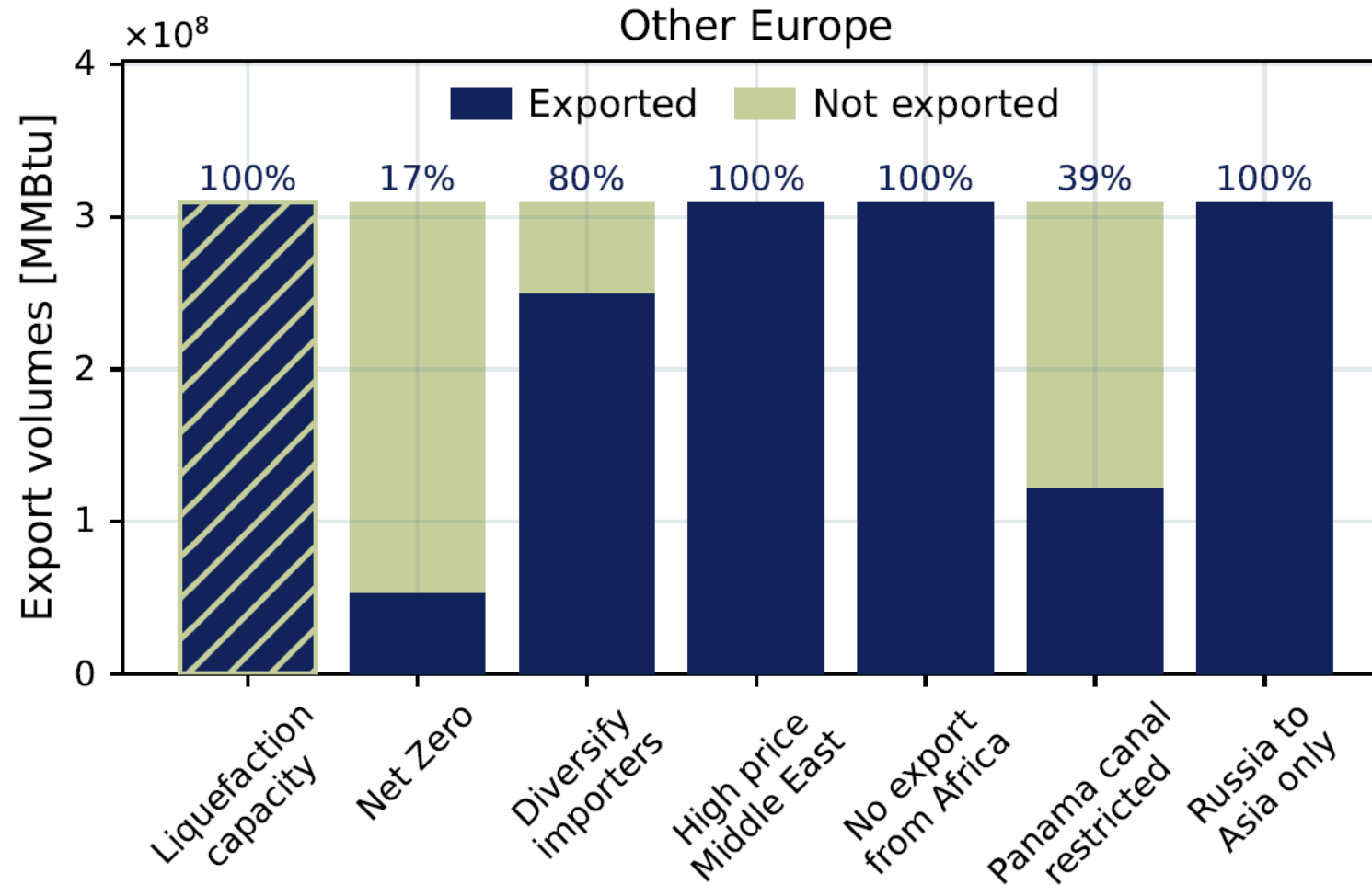


Which impact will geopolitical tensions between importing and exporting regions have on the European LNG supply if global LNG trade were to be used as a political weapon?

Five cases

Case	Extension	Input parameter	Example
(1) <i>Diversify importers</i>	Increase in the number of regions importing LNG to Europe	$n_i = 5$	Belgium, France, Italy
(2) <i>High price Middle East</i>	Increase in the delivered ex-ship costs of the Middle East	$1.25 * DES_{e,i}$	Qatar, Oman, Other ME
(3) <i>No export from Africa</i>	Nonparticipation of African LNG exporters in the global LNG trade	$q_{e,i} = 0$	Nigeria, Other Africa
(4) <i>Panama canal restricted</i>	Increase in the delivered ex-ship costs of all LNG flows	$1.33/1.15 * DES_{e,i}$	USA to Japan
(5) <i>Russia to Asia only</i>	LNG sent from Russia to Asian regions only	$q_{e,i} \neq 0$	Russia to China

Net Zero, scenario results



Scenario effects, net zero

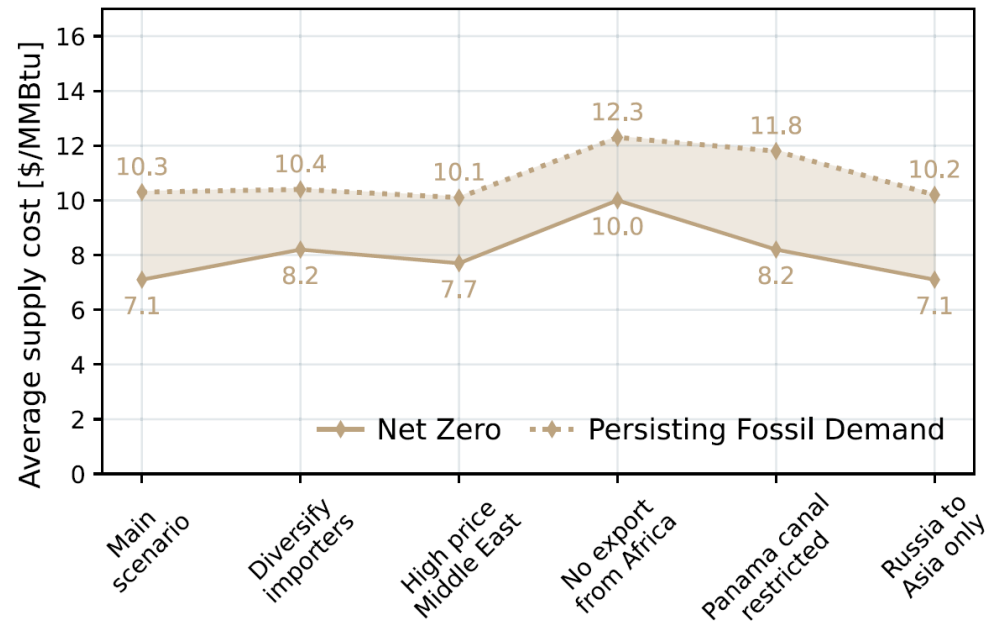
LNG import volumes from regions to Europe 2040 in the *Net Zero* scenario and cases in billions of MMBtu.

Exporter	Net Zero	Diversify importers	High price Middle East	No export from Africa	Panama canal restricted	Russia to Asia only
Algeria	0.415	0.249 (↘)	0.415 (~)	– (↓)	0.415 (~)	0.415 (~)
Nigeria	0.362	0.249 (↘)	0.415 (↗)	– (↓)	0.415 (↗)	0.285 (↘)
Other Africa	–	0.249 (↑)	– (~)	– (~)	– (~)	– (~)
Other Europe	0.053	0.249 (↑)	0.130 (↑)	0.130 (↑)	– (↓)	0.130 (↑)
Qatar	0.415	0.249 (↘)	0.285 (↘)	0.415 (~)	0.415 (~)	0.415 (~)
Trinidad & Tobago	–	– (~)	– (~)	0.285 (↑)	– (~)	– (~)
USA	–	– (~)	– (~)	0.415 (↑)	– (~)	– (~)

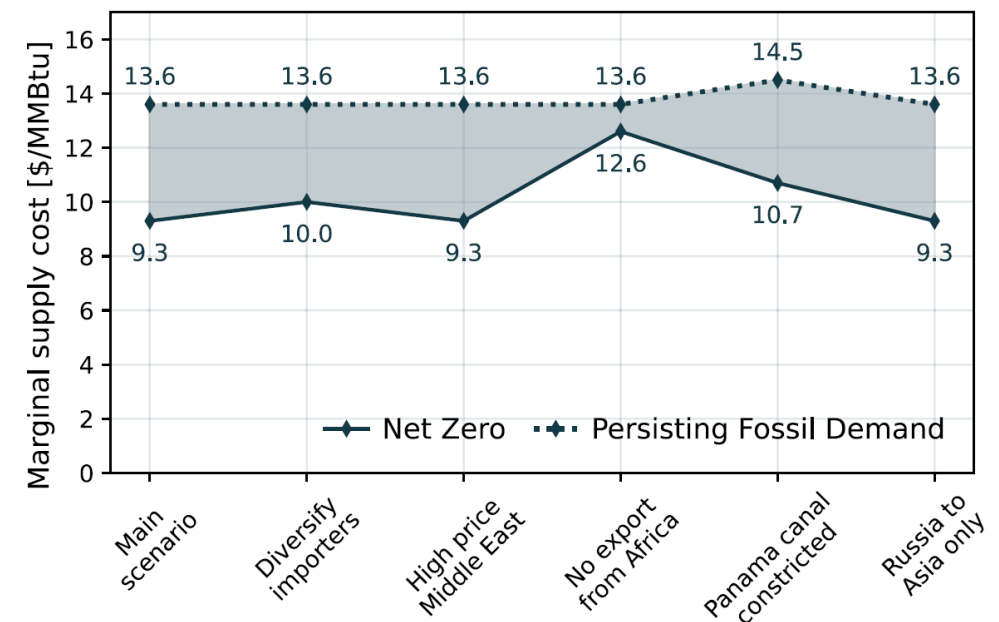
¹ The symbols in the brackets qualitatively indicate the change between the case and the scenario. Legend: strong decrease (↓), slight decrease (↘), constant (~), increase (↗), strong increase (↑).

Effect on supply costs

Average supply costs to Europe in 2040

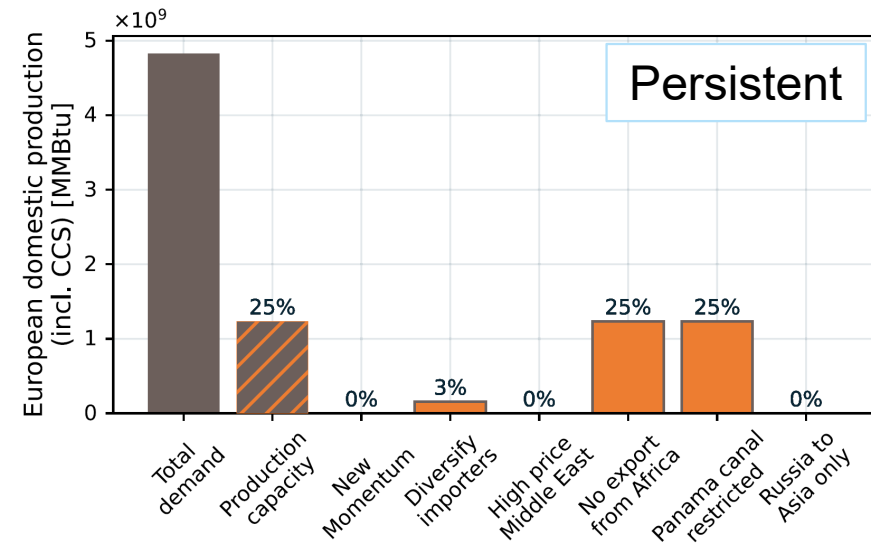
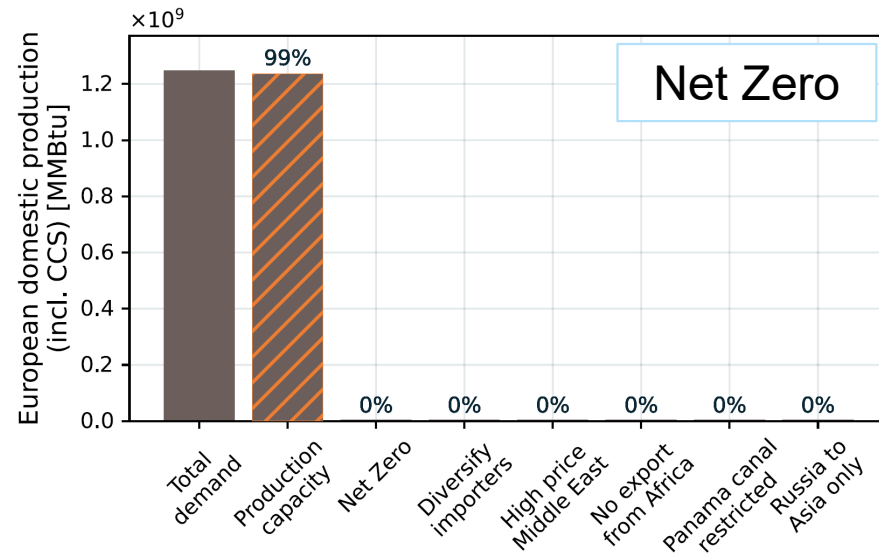


Marginal supply costs to Europe in 2040



Can European domestic fossil gas production combined with CCS be part of the solution for covering the demand in a decarbonized European energy system?

European domestic production with CCS



Conclusions

- Complexity of Europe's strategy to simultaneously meet decarbonization targets and address energy security concerns
- Provide insights into the economic feasibility and implications of prioritizing domestic production over external LNG imports (CCS)
- Europe has a role in the global LNG market only in an ambitious sustainable scenario
- African exporters become crucial stabilizers
- As global LNG demand increases, truly stable trends or patterns in trade are diminishing

Contact

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Back up

Natural gas price benchmarks –May 2024 (\$/mmbtu)



Cost function

$$DES_{e,i} = BEP_e + TC_{e,i} \quad (8)$$

$$TC_{e,i} = (CC_{e,i} + FC_{e,i} + BC_{e,i} + FEE_{e,i} + PC) \times \frac{1}{1 - HeelRate} \quad (9)$$

$$Time_{e,i} = \frac{Distance_{e,i} \times 2}{Speed} \times \frac{1}{24} \quad (10)$$

$$CC_{e,i} = \frac{Time_{e,i}}{CharterRate} + \underbrace{\frac{3}{CharterRate}}_{\text{Gasification at the port}} \quad (11)$$

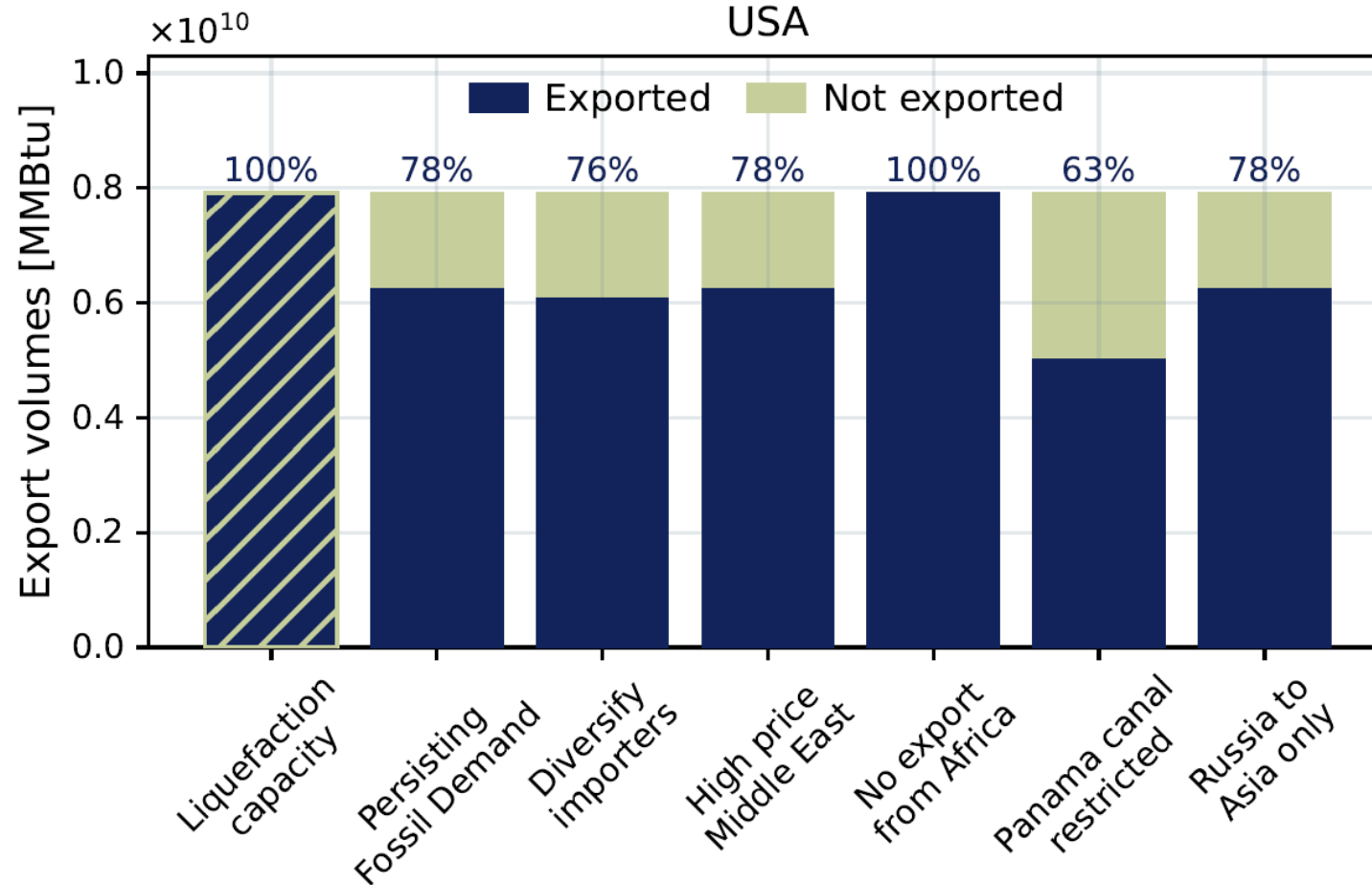
$$FC_{e,i} = Time_{e,i} \times (Bunker \times BunkerPrice) + \underbrace{3 \times 25 \times BunkerPrice}_{\text{Empty LNG carrier}} \quad (12)$$

$$BC_{e,i} = Time_{e,i} \times BoilOff \times Capacity \times BoilOffCostRate \quad (13)$$

$$FEE_{e,i} = Time_{e,i} \times FeeRate + RouteFee_{e,i} \quad (14)$$

$$PC = 3 \times PortRate \quad (15)$$

Persistent, scenario results



Scenario effect, Net Zero

	Diversify imports	High price ME	No exports from Africa	Panama canal closed	Russia to Asia only
Algeria	↓		↓↓↓		
Nigeria	↓	↑	↓↓↓	↑	↓
Other Africa	↑↑↑				
Other Europe	↑↑↑	↑↑↑	↑↑↑	↓↓↓	↑↑↑
Qatar	↓	↓			
T & T			↑↑↑		
USA			↑↑↑		

Scenario effects, net zero

LNG import volumes from regions to Europe 2040 in the *Net Zero* scenario and cases in billions of MMBtu.

Exporter	Net Zero	Diversify importers	High price Middle East	No export from Africa	Panama canal restricted	Russia to Asia only
Algeria	0.415	0.249 (\)	0.415 (~)	– (↓)	0.415 (~)	0.415 (~)
Nigeria	0.362	0.249 (\)	0.415 (↗)	– (↓)	0.415 (↗)	0.285 (\)
Other Africa	–	0.249 (↑)	– (~)	– (~)	– (~)	– (~)
Other Europe	0.053	0.249 (↑)	0.130 (↑)	0.130 (↑)	– (↓)	0.130 (↑)
Qatar	0.415	0.249 (\)	0.285 (\)	0.415 (~)	0.415 (~)	0.415 (~)
Trinidad & Tobago	–	– (~)	– (~)	0.285 (↑)	– (~)	– (~)
USA	–	– (~)	– (~)	0.415 (↑)	– (~)	– (~)

¹ The symbols in the brackets qualitatively indicate the change between the case and the scenario. Legend: strong decrease (↓), slight decrease (\), constant (~), increase (↗), strong increase (↑).

Scenario effects, Persistent

	Diversify imports	High price ME	No exports from Africa	Panama canal closed	Russia to Asia only
Algeria	↓		↓↓↓		
Nigeria	↓	↑	↓↓↓	↑	↓
Other Africa	↑↑↑				
Other Europe	↑↑↑	↑↑↑	↑↑↑	↓↓↓	↑↑↑
Qatar	↓	↓			
T & T			↑↑↑		
USA			↑↑↑		

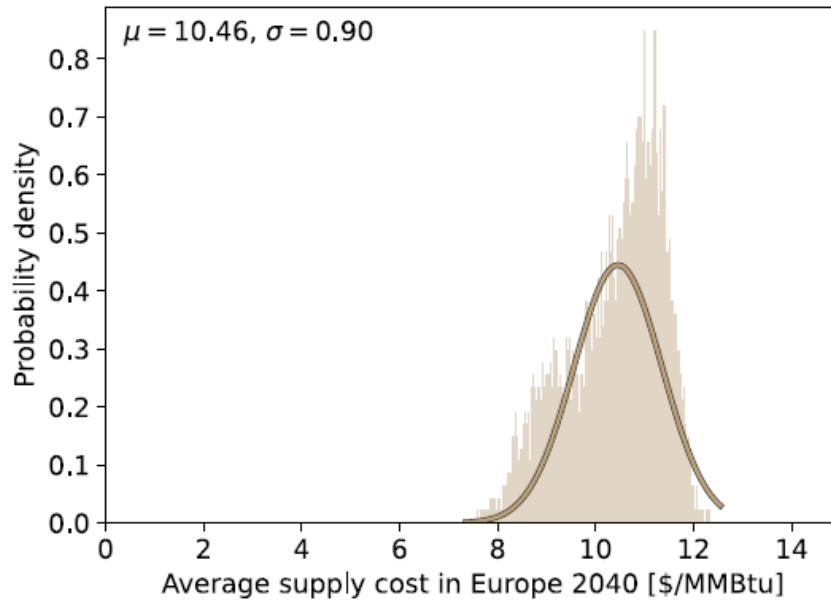
Scenario effects, persistent

LNG import volumes from regions to Europe 2040 in the *Persisting Fossil Demand* scenario and cases in billion of MMBtu.

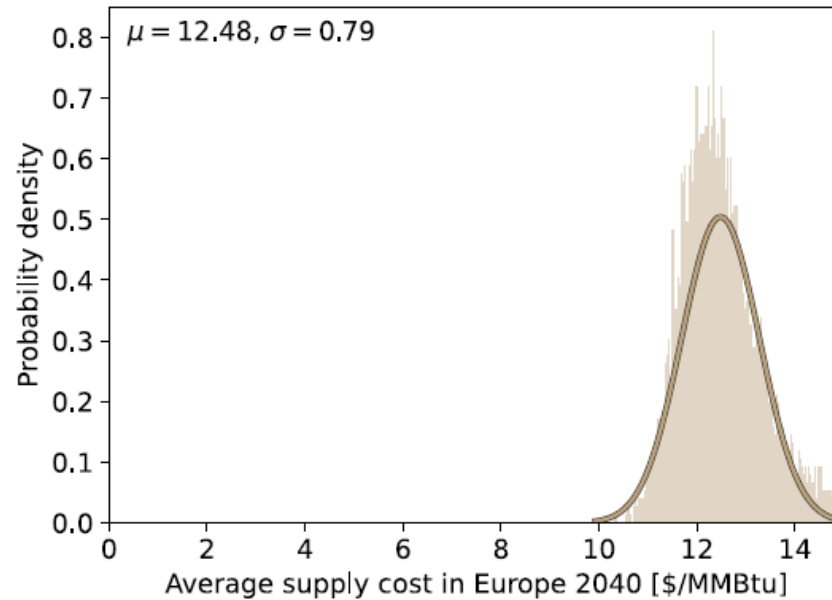
Exporter	Persisting Fossil Demand	Diversify importers	High price Middle East	No export from Africa	Panama canal restricted	Russia to Asia only
Algeria	0.472	0.472 (~)	0.682 (↗)	– (↓)	0.472 (~)	0.472 (~)
Nigeria	1.608	0.965 (↘)	1.608 (~)	– (↓)	0.897 (↘)	1.608 (~)
Other Africa	0.210	0.756 (↗)	– (↓)	– (↓)	– (↓)	0.541 (↗)
Other Americas	0.337	0.707 (↗)	0.337 (~)	1.348 (↗)	– (↓)	0.101 (↘)
Other Europe	0.094	0.310 (↗)	0.094 (~)	0.125 (↗)	– (↓)	– (↓)
Qatar	–	– (~)	– (~)	0.260 (↑)	– (~)	– (~)
Trinidad & Tobago	0.494	0.494 (~)	0.494 (~)	0.184 (↘)	0.612 (↗)	0.494 (~)
USA	1.608	0.965 (↘)	1.608 (~)	1.608 (~)	1.608 (~)	1.608 (~)

¹ Symbols in the brackets qualitatively indicate the change between the case and the scenario. Legend: strong decrease (↓), slight decrease (↘), constant (~), increase (↗), strong increase (↑).

Monte Carlo, average costs



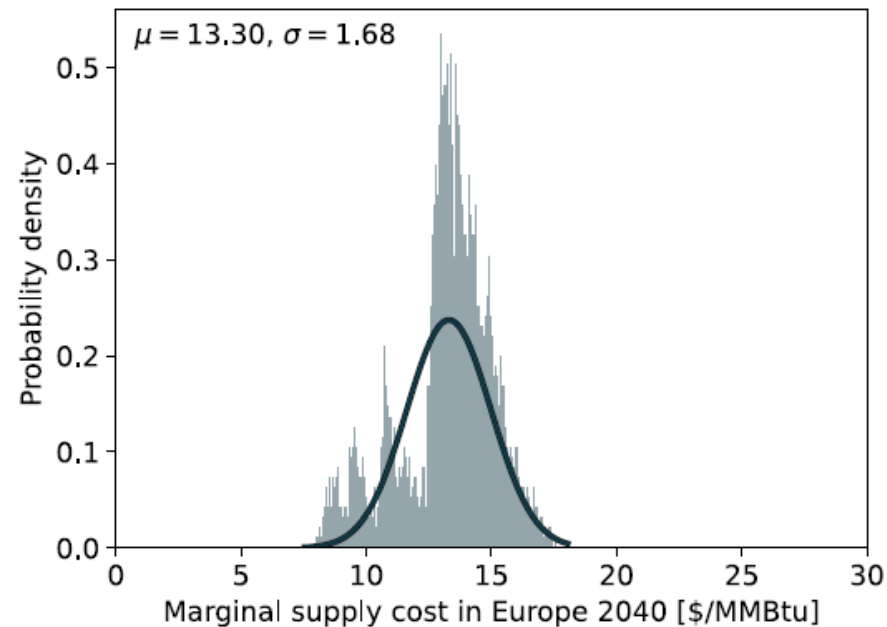
(a) *Net Zero*



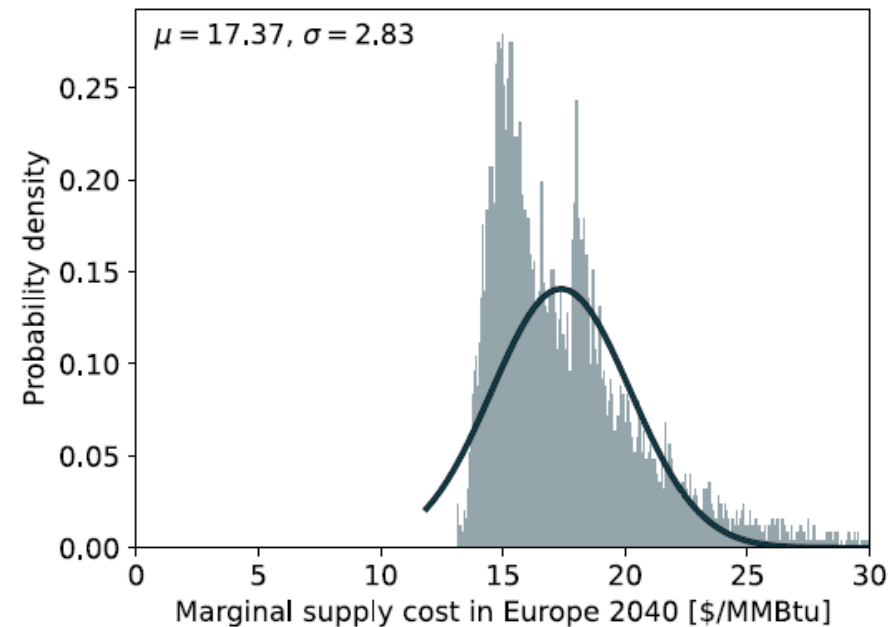
(b) *Persisting Fossil Demand*

Fig. 10. Distribution of Monte Carlo simulated average supply cost to Europe 2040.

Monte Carlo, marginal costs



(a) *Net Zero*



(b) *Persisting Fossil Demand*

Fig. 11. Distribution of Monte Carlo simulated marginal supply cost to Europe 2040.

Monte Carlo, domestic with CCS

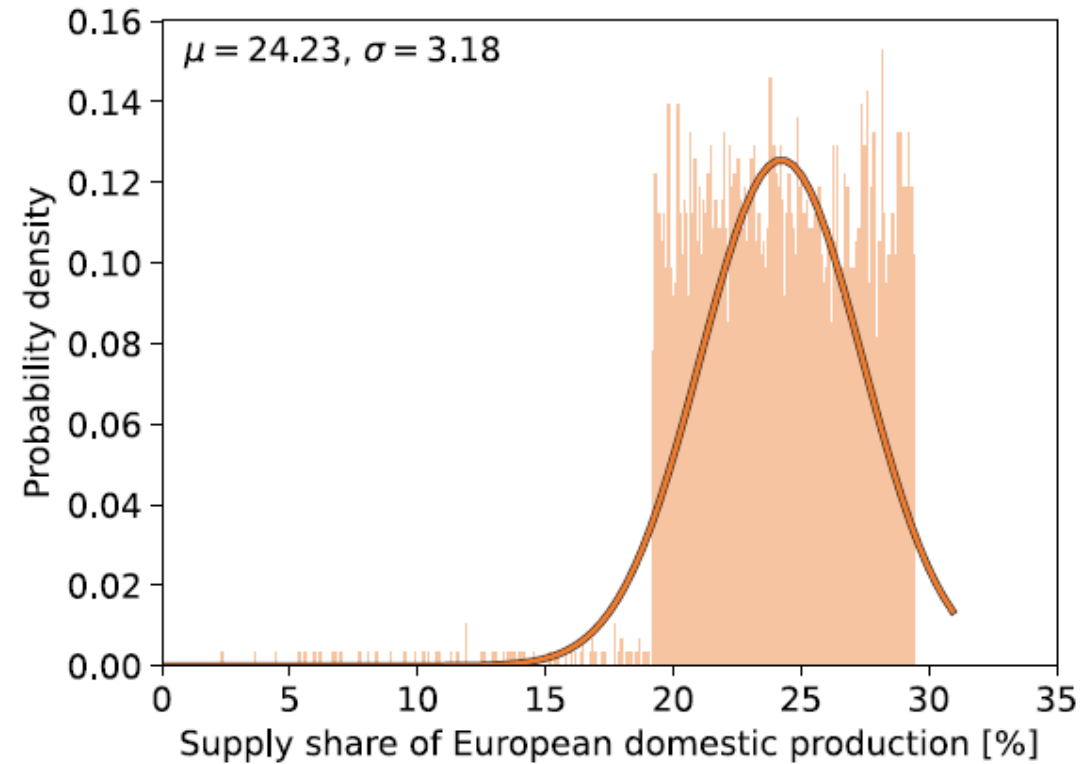
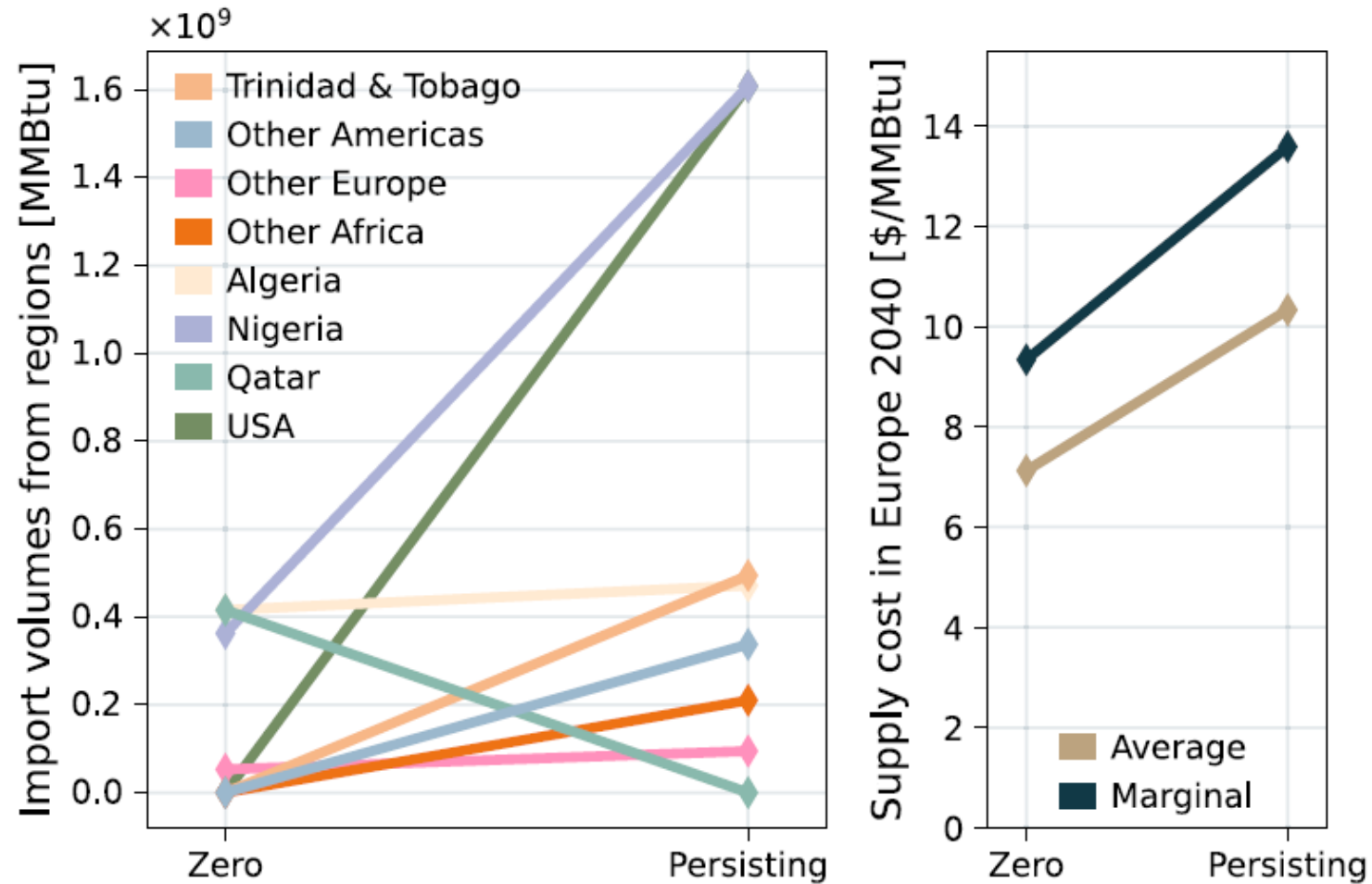
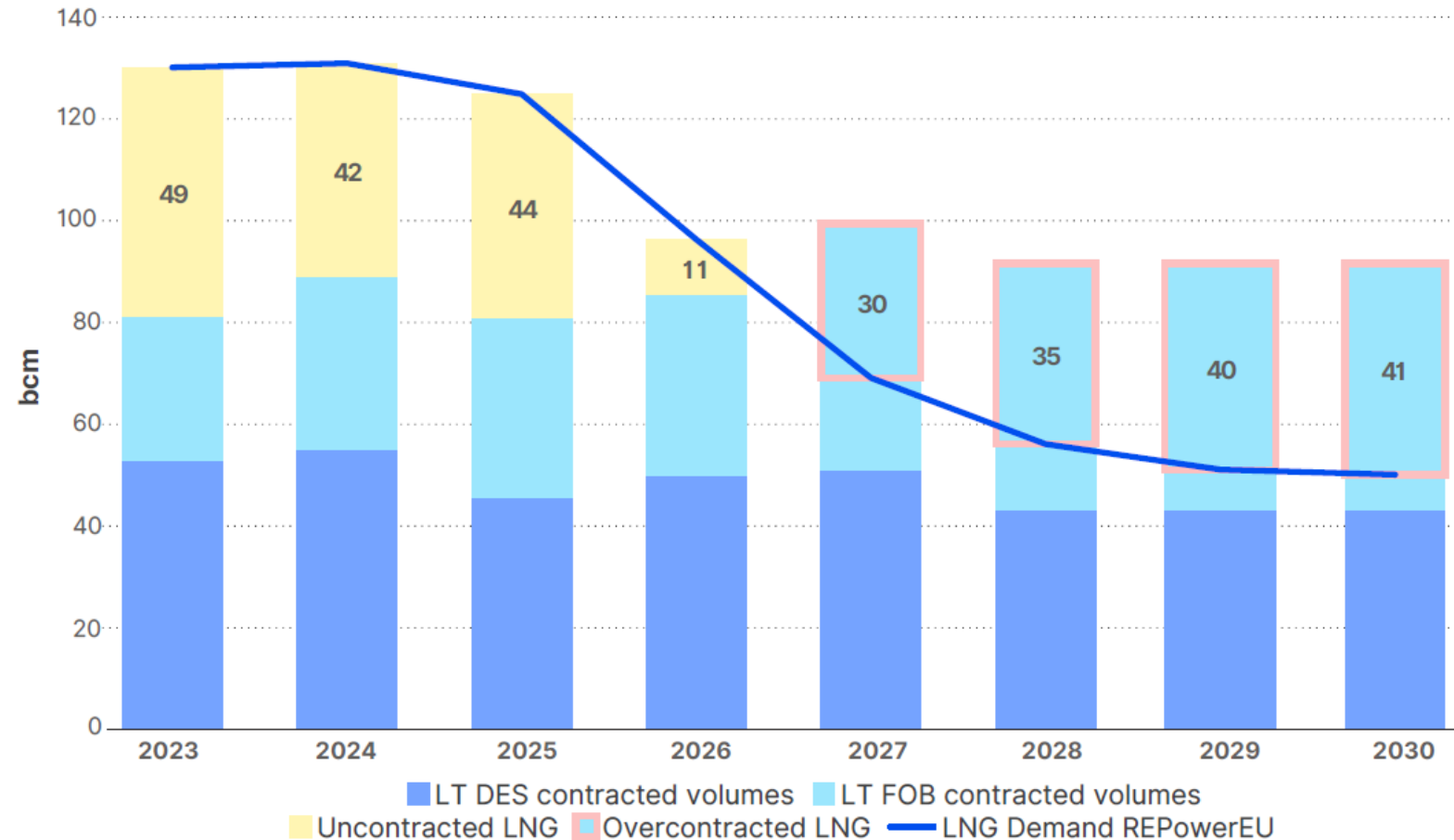


Fig. 12. Distribution of the Monte Carlo simulated supply share of European domestic production.

Summary of findings



Exposure to the LNG spot market under the REPowerEU scenario by 2030 (bcm)



Source: ACER based on data from REPowerEU and ACER's proprietary database of long-term LNG contracts.