

# RBAC's Global Gas and LNG Forecast 2018-2040: where will China get its future LNG and why?

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Robert Brooks, PhD  
Founder, RBAC, Inc.



**Dr. Robert Brooks**  
**Founder**  
**RBAC, Inc.**

## RBAC's Purpose

"Our purpose is to contribute to the prosperity of mankind through improvements in the quality and ethics of economic decisions made by the energy industry. This, in turn, will increase the availability of affordable energy throughout the world, while still allowing for profitability of those projects to deliver shareholder value to the investors as well as the interests of other stakeholders." Robert E Brooks Ph.D.

## Success

Since 1997 RBAC has become the industry leader in natural gas forecasting systems used by industry, consulting companies, government and electric utilities to determine forward looking price and flows as well as control risk or seek new opportunities in the markets.

## Solutions

G2M2<sup>®</sup> Global Gas Market Modeling System

GPCM<sup>®</sup> Natural Gas Market Forecasting System<sup>™</sup>

Gas4Power<sup>™</sup> Essentials (with Power Model Interface)

NGL-NA<sup>®</sup> Natural Gas Liquids Market Forecasting System for North America

# Dominant Analytics Platform in North America

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Multinational  
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**Major  
Exploration &  
Production  
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**Regional Utilities**

**Government &  
Regulatory  
Agencies**

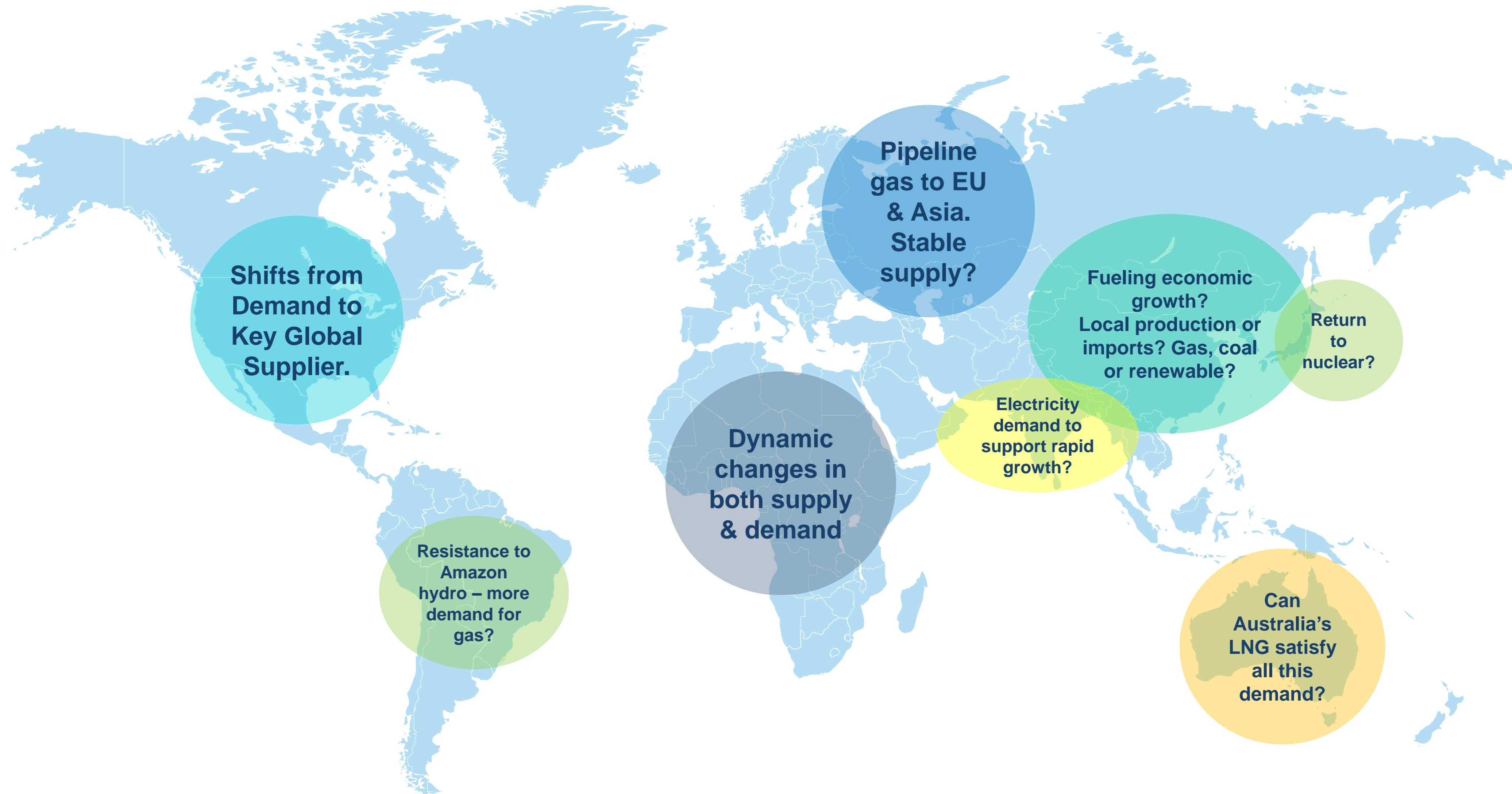
**Energy Marketers  
& Traders**

**Major Energy  
Consulting Firms**

GPCM<sup>®</sup>, RBAC's North American gas market simulator, is used by most of the major players and consultants in the North America natural gas and LNG market, as well as the US Federal Energy Regulatory Commission (FERC) and the Canadian National Energy Board (NEB).

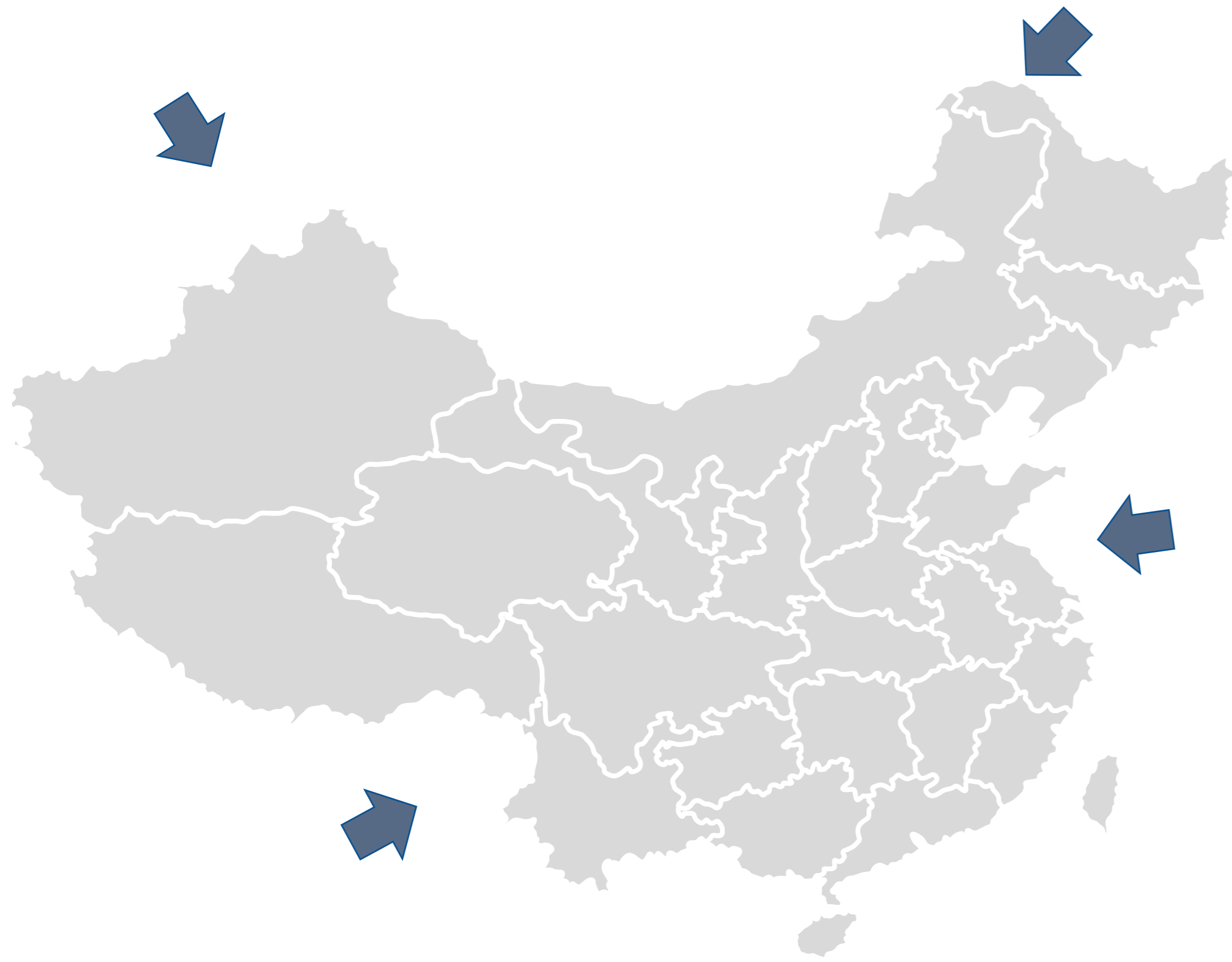
# Looming Questions: LNG Demand / Supply Balance

A global perspective on price, product flow and capacity is vital  
but firms also need enough detail to show local implications



# China's Challenges: Balance, Supply, and Modern Market 5

## The Vital Role of the Global LNG Market



### Short term gas demand and supply balance

- a. What are the optimal strategy supply reliable and cost effective natural gas for seasonal peaks in the winter months?
- b. What are the sensitivity of gas demand against weather?
- c. Where are the likely bottlenecks of gas supplies in the system in the next 2-3 years?

### Medium & long-term procurement strategy

- a. Who would be the preferred choices for China's LNG supplies, and when should China lock in these contracts?
- b. Long term investment choices of oversea gas assets under various policy and geopolitical scenarios

### Projection of market price of natural gas

- a. What is the market fair value of natural gas to a market? What is the fair price of LNG into China market?
- b. How would one consider the pricing structure for a pipeline project or a LNG contract?
- c. What market price shall the service company of natural gas charge their industrial/commercial customers that would be aligned with their risk profile and positions of supply portfolio (including both imports and domestic production)?

# Global Pipeline Gas Trade Has Been Growing

*Average annual growth rate 2011-2017: 1.1%*

**Natural Gas: Trade movements 2011 by pipeline**

Billion cubic metres

To \ From	North America	South America	Europe	Russia & C. Asia	Middle East	Africa	Asia Pacific	Total imports	% Imports
North America	128.8	-	-	-	-	-	-	128.8	19%
S. & Cent. America	-	15.6	-	-	-	-	-	15.6	2%
Europe and Eurasia	-	-	180.8	244.7	9.1	35.2	-	469.7	68%
Middle East	-	-	-	10.6	19.2	1.8	-	31.6	5%
Africa	-	-	-	-	-	5.7	-	5.7	1%
Asia Pacific	-	-	-	14.3	-	-	29.0	43.2	6%
<b>Total exports</b>	<b>128.8</b>	<b>15.6</b>	<b>180.8</b>	<b>269.5</b>	<b>28.3</b>	<b>42.6</b>	<b>29.0</b>	<b>694.6</b>	<b>100%</b>
<b>% Exports</b>	<b>19%</b>	<b>2%</b>	<b>26%</b>	<b>39%</b>	<b>4%</b>	<b>6%</b>	<b>4%</b>	<b>100%</b>	

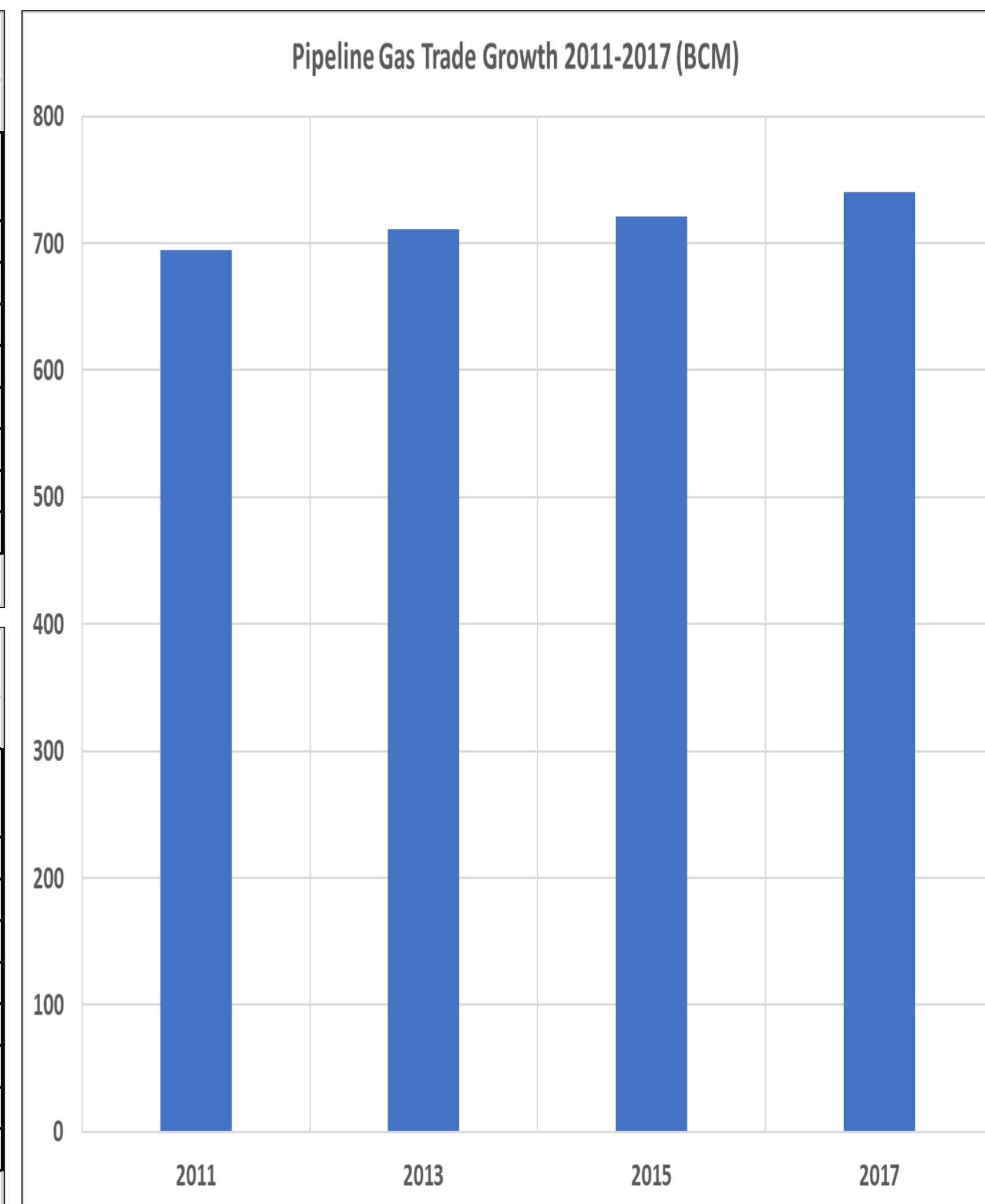
Source: Cedigaz for all flow s, except intra-CIS trade; CISStat.

**Natural Gas: Trade movements 2017 by pipeline**

Billion cubic metres

To \ From	North America	South America	Europe	Russia & C. Asia	Middle East	Africa	Asia Pacific	Total imports	% Imports
North America	146.7	-	-	-	-	-	-	146.8	20%
S. & Cent. America	-	15.4	-	-	-	-	-	15.4	2%
Europe and Eurasia	-	-	192.7	244.6	10.9	37.4	-	485.7	66%
Middle East	-	-	-	2.2	20.0	-	-	22.2	3%
Africa	-	-	-	-	-	7.6	-	7.6	1%
Asia Pacific	-	-	-	36.1	-	-	26.8	62.9	8%
<b>Total exports</b>	<b>146.7</b>	<b>15.4</b>	<b>192.7</b>	<b>283.0</b>	<b>30.9</b>	<b>45.1</b>	<b>26.8</b>	<b>740.7</b>	<b>100%</b>
<b>% Exports</b>	<b>20%</b>	<b>2%</b>	<b>26%</b>	<b>38%</b>	<b>4%</b>	<b>6%</b>	<b>4%</b>	<b>100%</b>	

Source: Includes data from FGE MENA gas service, IHS.



# Global LNG Trade Has Been Growing *FASTER*

Average annual growth rate 2011-2017: 10.4%

**Natural Gas: Trade movements 2011- liquefied natural gas**

Billion cubic metres

To \ From	US	S & Cent America	Europe	Russian Federation	Middle East	Africa	Asia Pacific	Total imports
North America	-	6.1	-	-	8.4	2.2	0.3	17.4
S. & Cent. America	0.4	6.1	0.1	-	2.2	1.9	0.1	10.9
Europe and Eurasia	0.3	5.8	-	-	44.7	36.8	-	90.7
Middle East	-	0.3	0.1	-	2.5	1.0	0.8	4.6
Africa								
Asia Pacific	1.3	5.8	0.2	14.4	72.7	15.0	96.6	207.3
<b>Total exports</b>	<b>2.0</b>	<b>24.0</b>	<b>-</b>	<b>14.4</b>	<b>130.4</b>	<b>56.9</b>	<b>97.7</b>	<b>330.8</b>

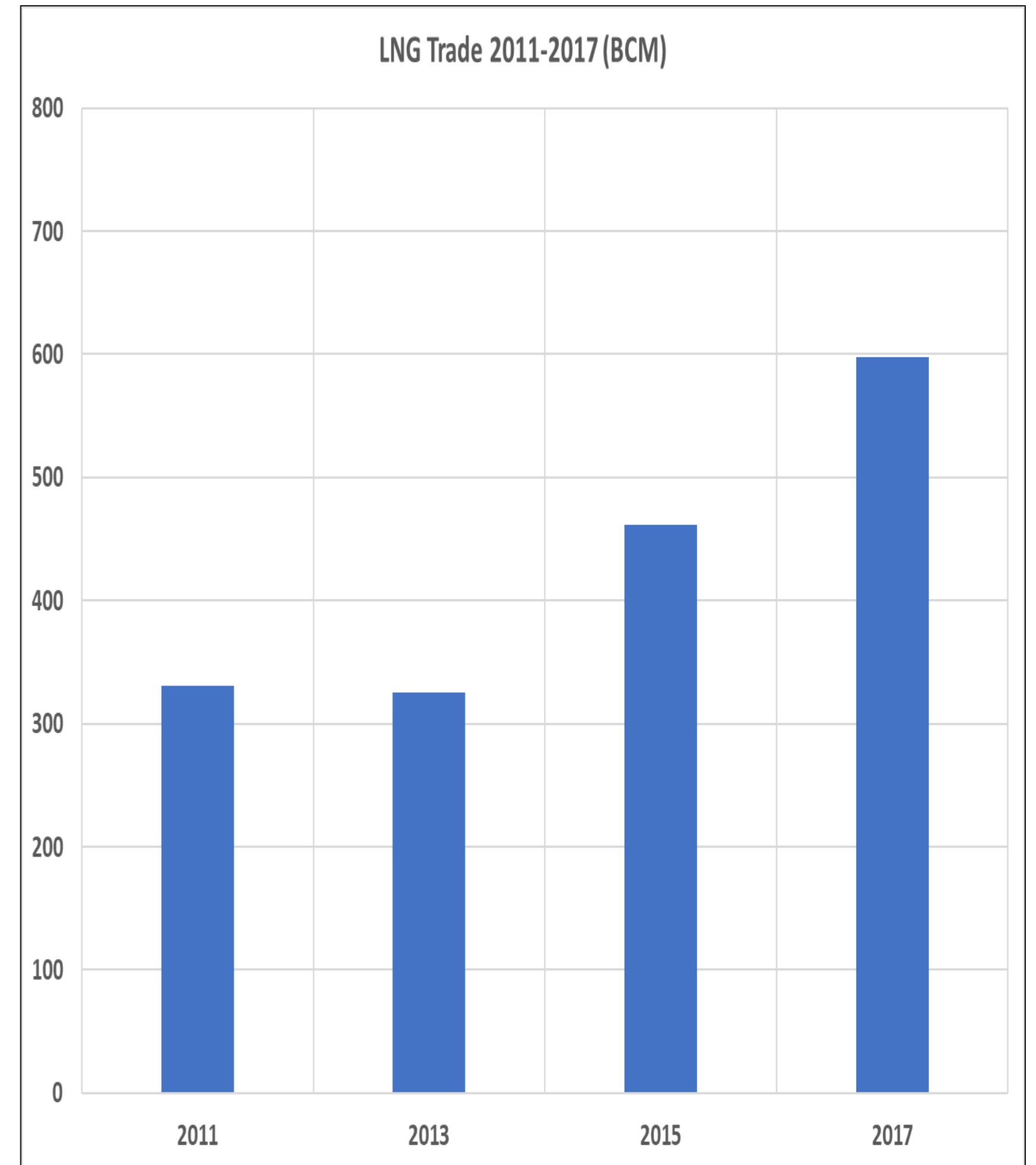
Source: Includes data from GIGNL, Poten, Waterborne.

Note: A billion cubic meters is equivalent to about 0.78 metric tons.

**Natural Gas: Trade movements 2017 as liquefied natural gas\***

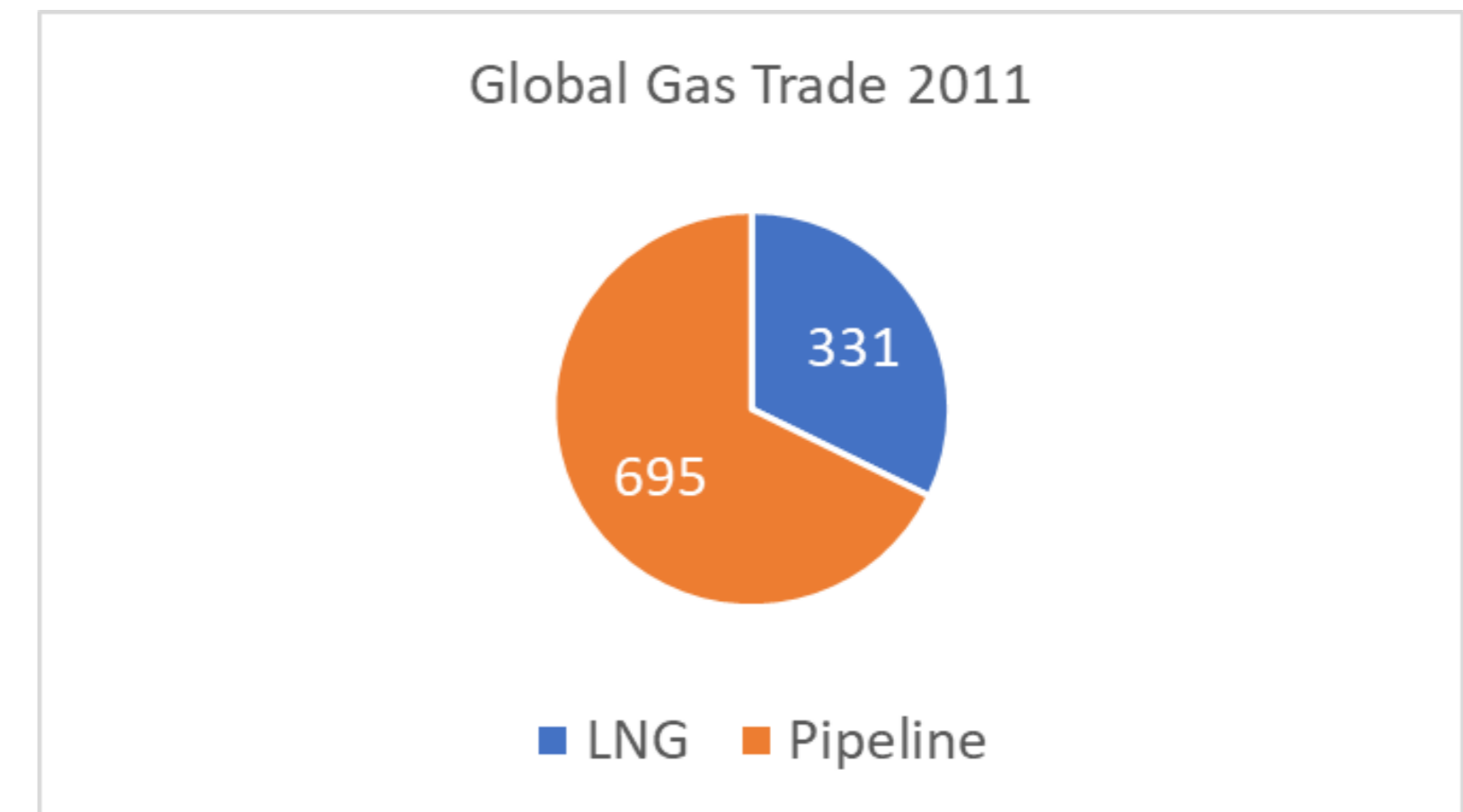
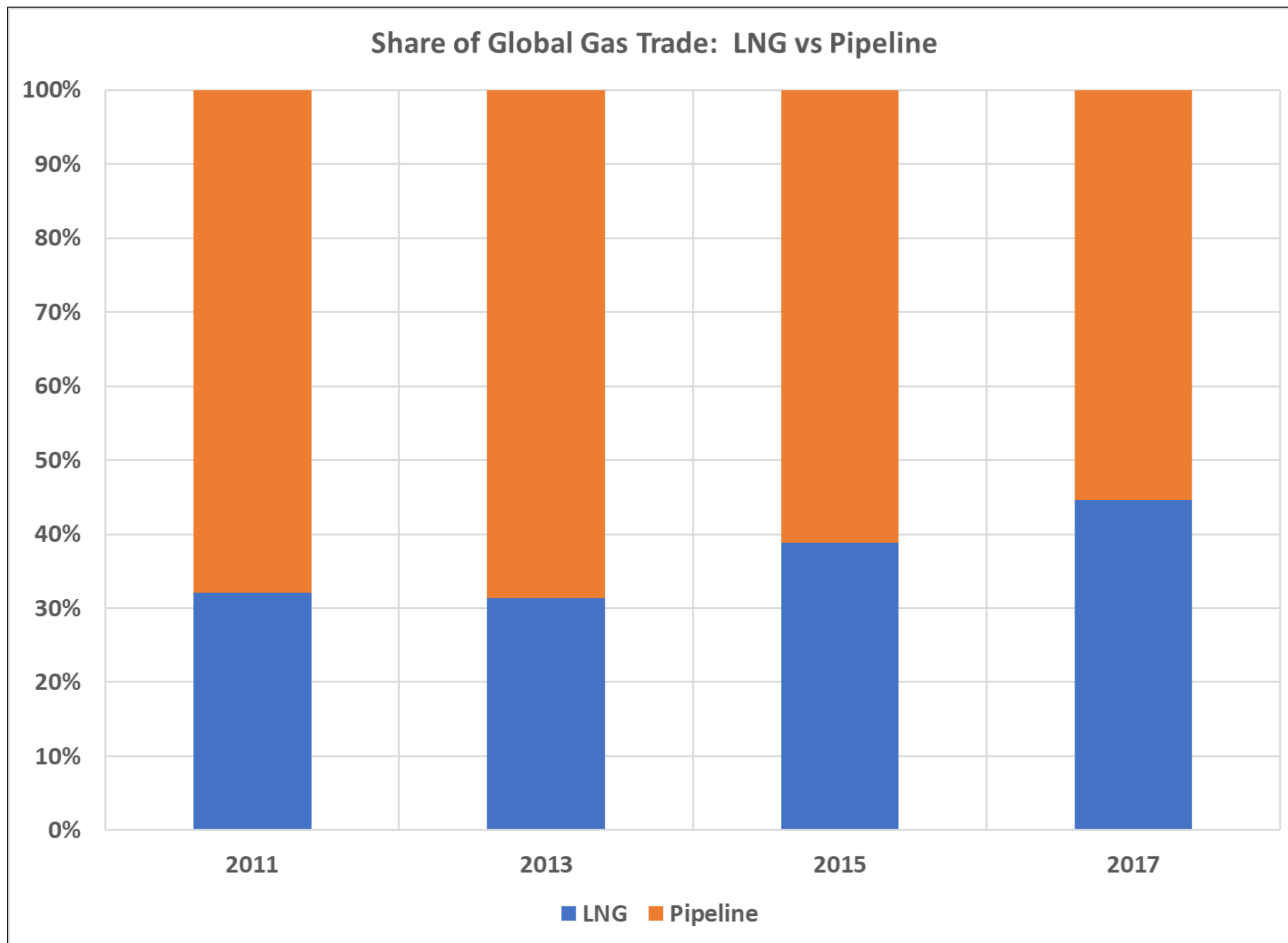
Billion cubic metres

To \ From	US	S & Cent America	Europe	Russian Federation	Middle East	Africa	Asia Pacific	Total Imports
North America	3.8	3.2	0.1	-	-	1.8	0.3	14.2
S. & Cent. America	1.8	6.9	0.1	-	2.2	2.5	-	25.4
Europe	2.6	5.8	5.5	0.1	24.1	27.4	-	128.4
Middle East	1.9	1.0	0.6	-	3.1	6.2	0.3	23.9
Africa	0.2	-	0.4	-	5.5	2.1	-	16.3
Asia Pacific	7.1	2.2	1.6	15.4	87.5	15.4	153.7	389.5
<b>Total exports</b>	<b>17.4</b>	<b>19.1</b>	<b>8.3</b>	<b>15.5</b>	<b>122.5</b>	<b>55.4</b>	<b>154.2</b>	<b>597.7</b>



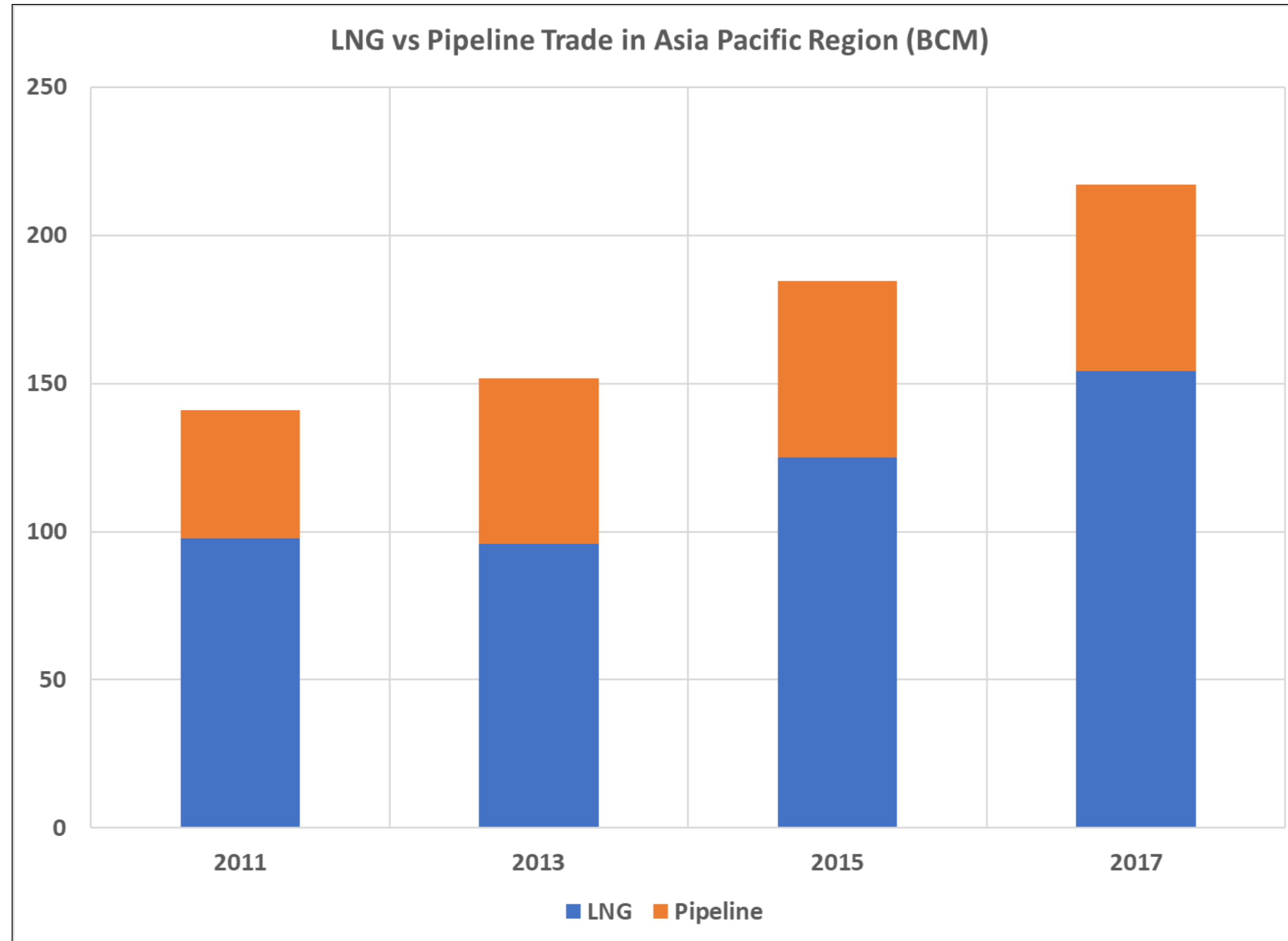
# LNG has become more important in world gas trade

*LNG's share of global gas trade has grown from 32% in 2011 to 45% in 2017*



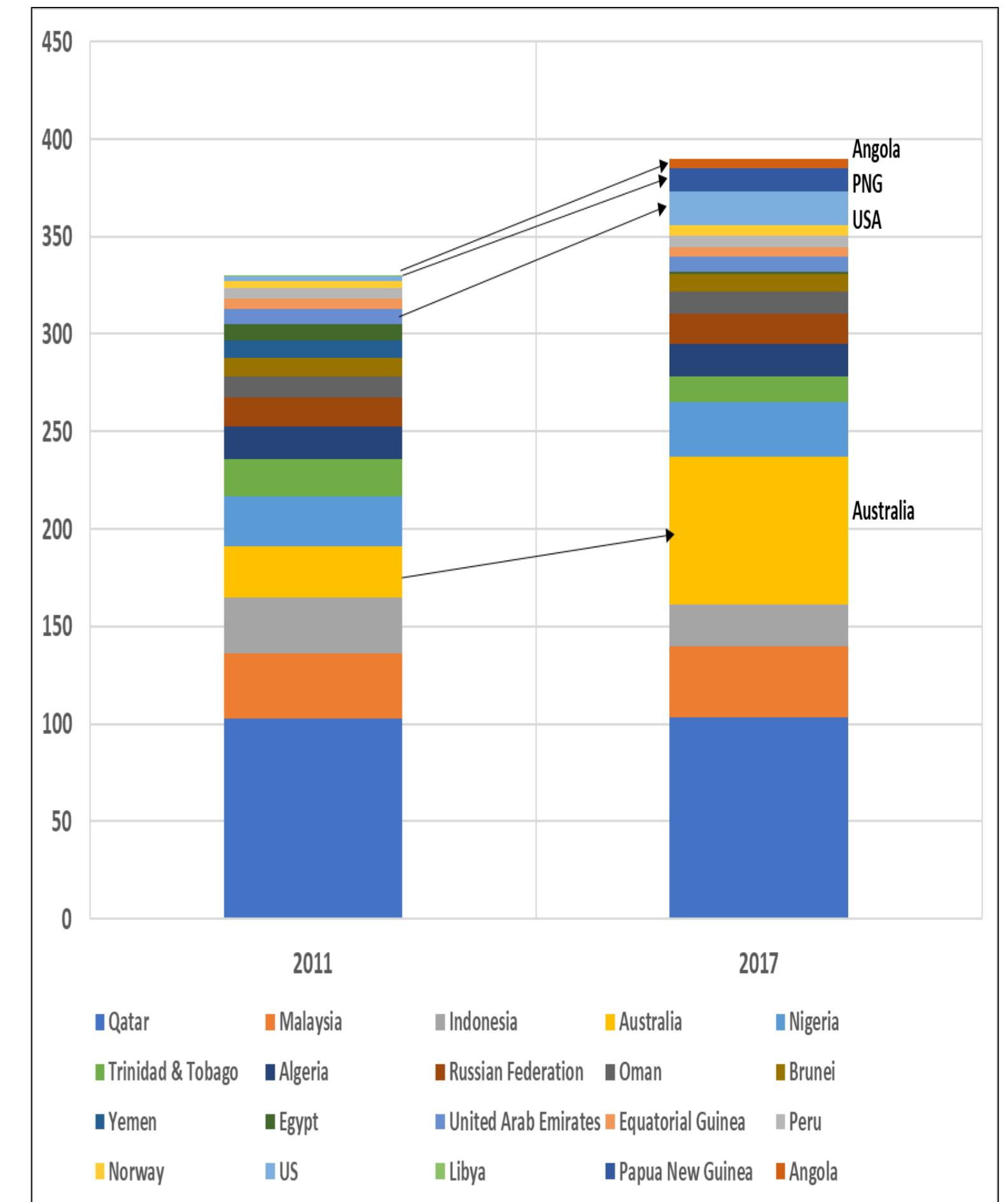


# Especially in the Asia Pacific region



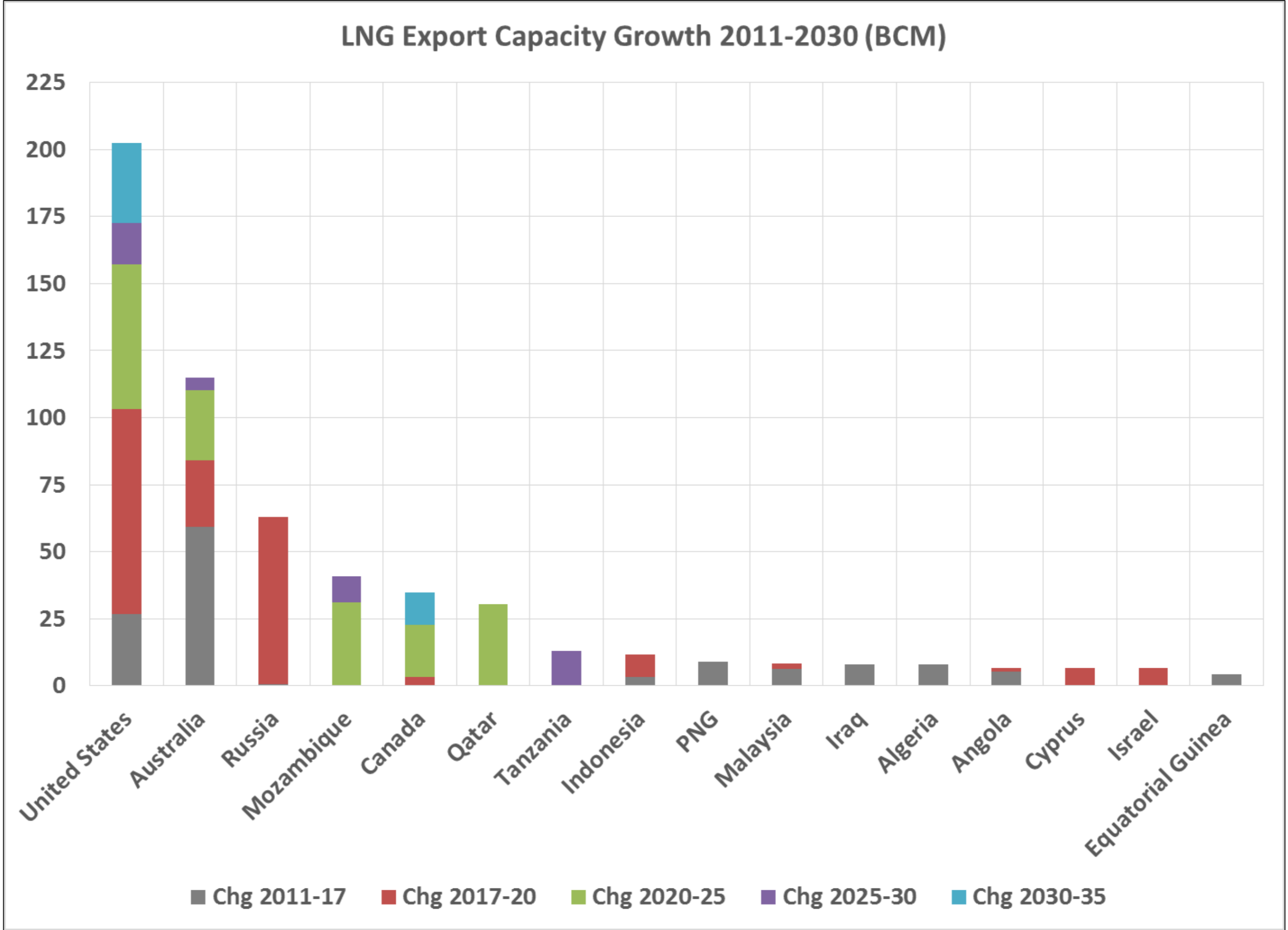
# New LNG projects have brought major market changes

Billion Cubic Meters	2011			2017			Change		
	Country	LNG Exports	Market Share	Rank	LNG Exports	Market Share	Rank	LNG Exports	Market Share
Qatar	102.60	31.0%	1	103.37	26.3%	1	0.77	-4.7%	--
Malaysia	33.26	10.1%	2	36.07	9.2%	3	2.81	-0.9%	DN 1
Indonesia	29.15	8.8%	3	21.71	5.5%	5	-7.44	-3.3%	DN 2
Australia	25.93	7.8%	4	75.93	19.3%	2	49.99	11.5%	UP 2
Nigeria	25.89	7.8%	5	27.76	7.1%	4	1.88	-0.8%	UP 1
Trinidad & Tobago	18.88	5.7%	6	13.42	3.4%	9	-5.46	-2.3%	DN 3
Algeria	17.12	5.2%	7	16.63	4.2%	7	-0.48	-0.9%	--
Russian Federation	14.39	4.3%	8	15.54	3.9%	8	1.15	-0.4%	--
Oman	10.92	3.3%	9	11.40	2.9%	11	0.48	-0.4%	DN 2
Brunei	9.39	2.8%	10	9.06	2.3%	12	-0.32	-0.5%	DN 2
Yemen	8.94	2.7%	11	0.00	0.0%	19	-8.94	-2.7%	DN 8
Egypt	8.58	2.6%	12	1.19	0.3%	18	-7.40	-2.3%	DN 6
United Arab Emirates	7.96	2.4%	13	7.70	2.0%	13	-0.25	-0.4%	--
Equatorial Guinea	5.27	1.6%	14	4.81	1.2%	17	-0.45	-0.4%	DN 3
Peru	5.12	1.5%	15	5.57	1.4%	15	0.45	-0.1%	--
Norway	3.97	1.2%	16	5.76	1.5%	14	1.79	0.3%	UP 2
US	2.02	0.6%	17	17.37	4.4%	6	15.35	3.8%	UP 11
Libya	0.08	0.0%	18	0.00	0.0%	20	-0.08	0.0%	DN 2
Papua New Guinea	0.00	0.0%	19	11.46	2.9%	10	11.46	2.9%	UP 9
Angola	0.00	0.0%	20	5.01	1.3%	16	5.01	1.3%	UP 4
<b>Total Exports</b>	<b>330.83</b>	<b>100.0%</b>		<b>393.40</b>	<b>100.0%</b>		<b>62.57</b>	<b>0.0%</b>	



Traditional suppliers such as Indonesia, Trinidad, Yemen, and Egypt have lost ground to new players such as Angola, Papua New Guinea, and the United States. Australia, however, has continued to grow.

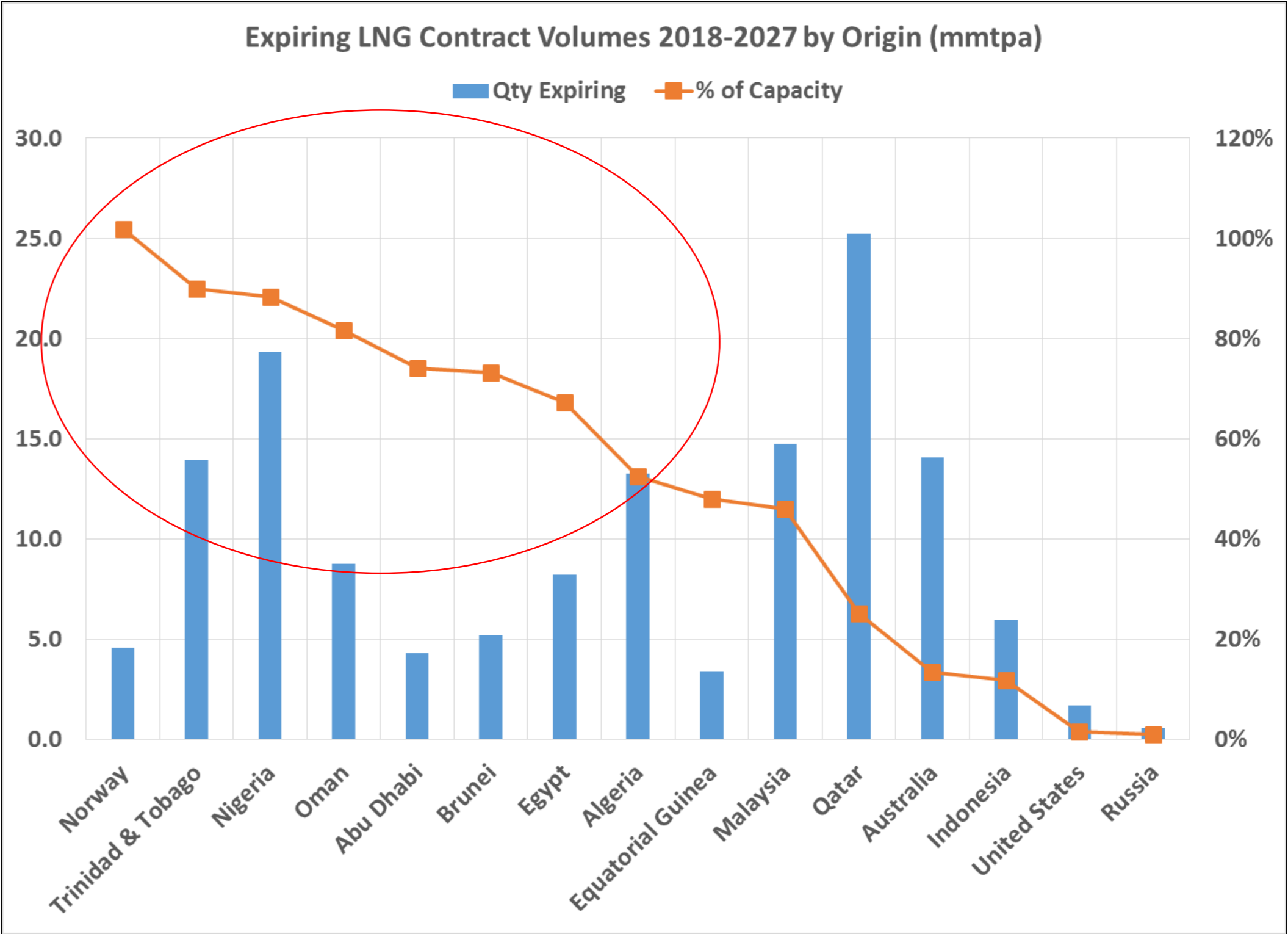
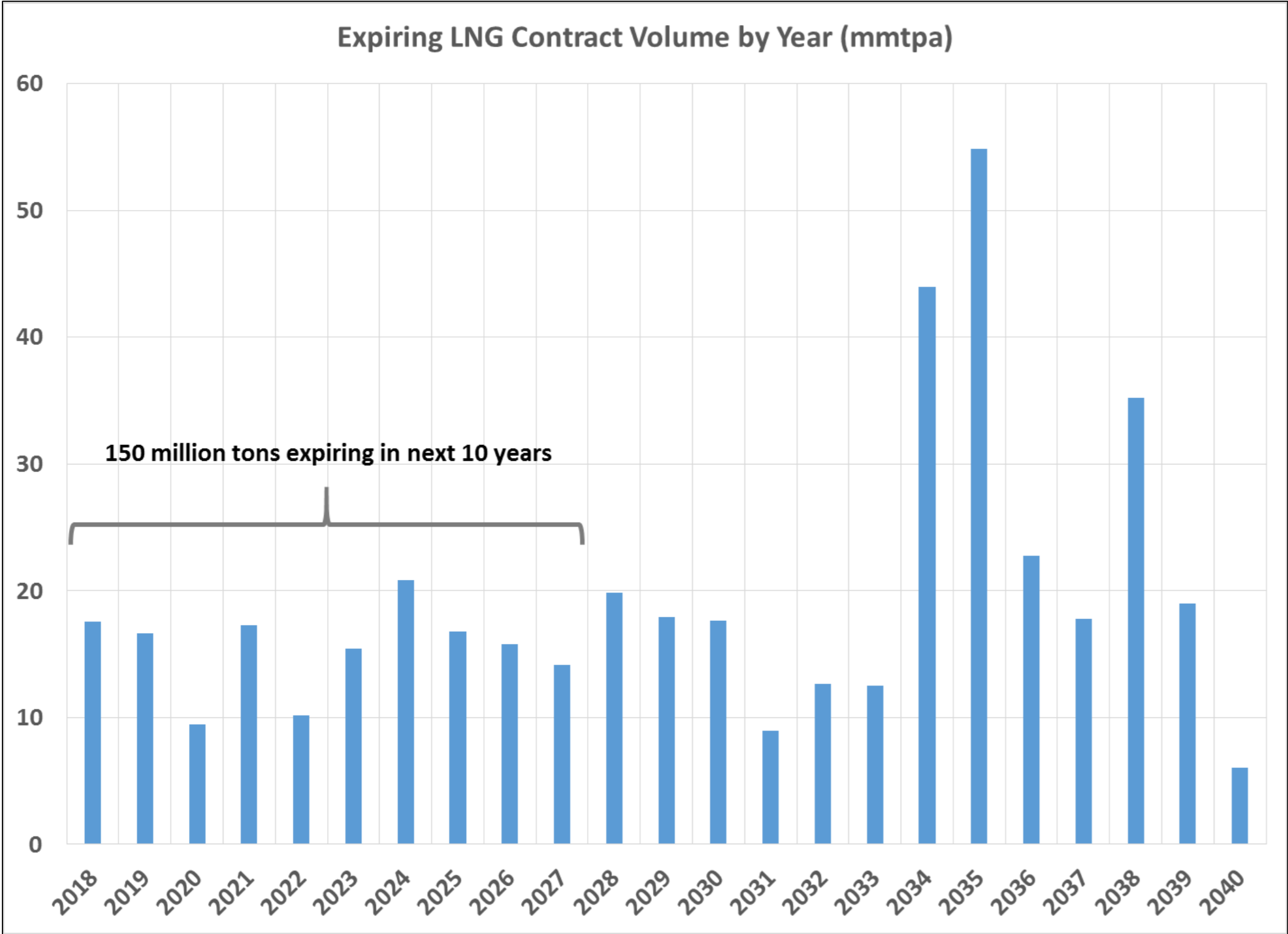
# Even bigger changes are coming ... soon



67% of LNG capacity growth is expected from just 3 countries: the United States, Australia, and Russia.

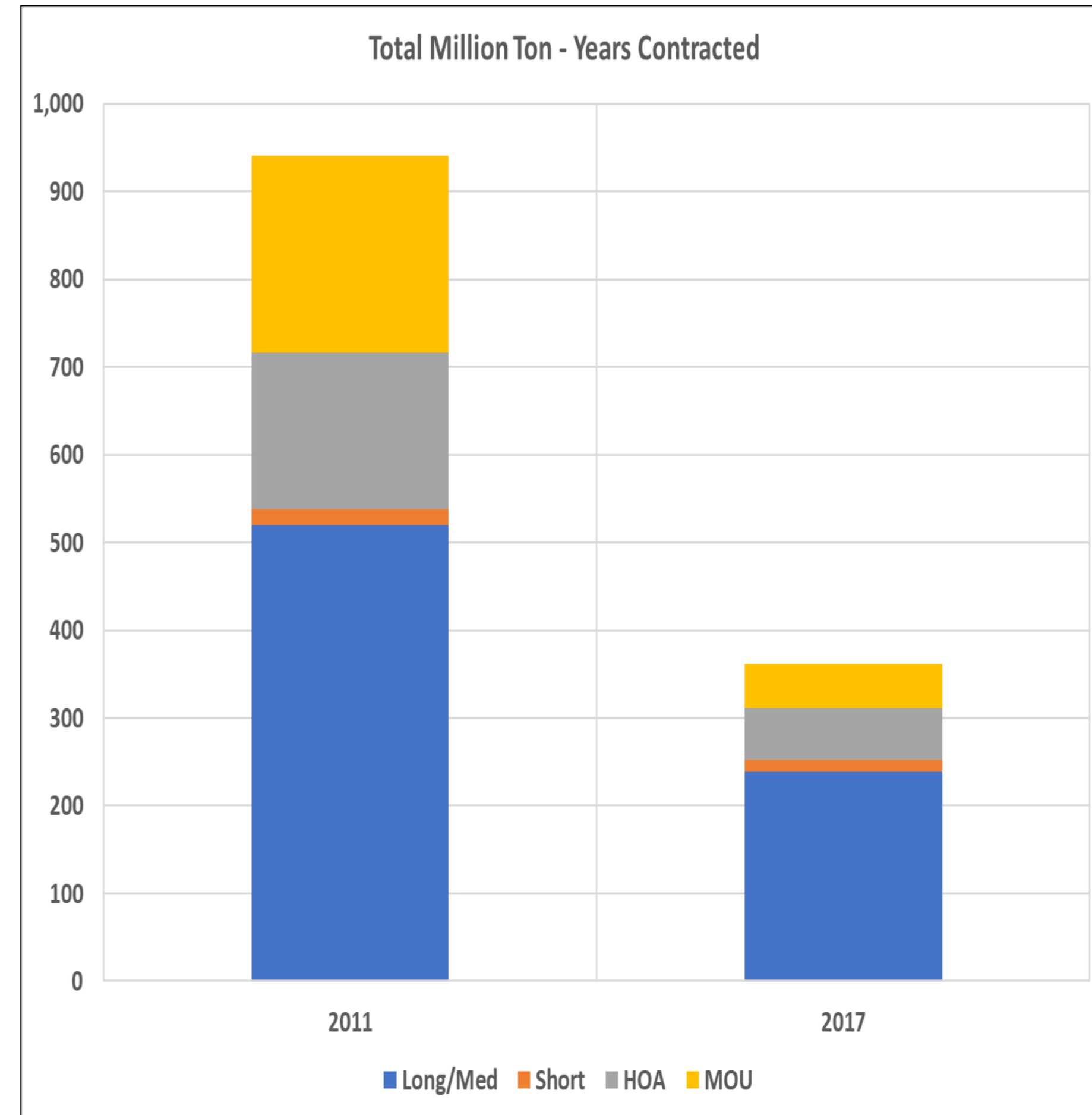
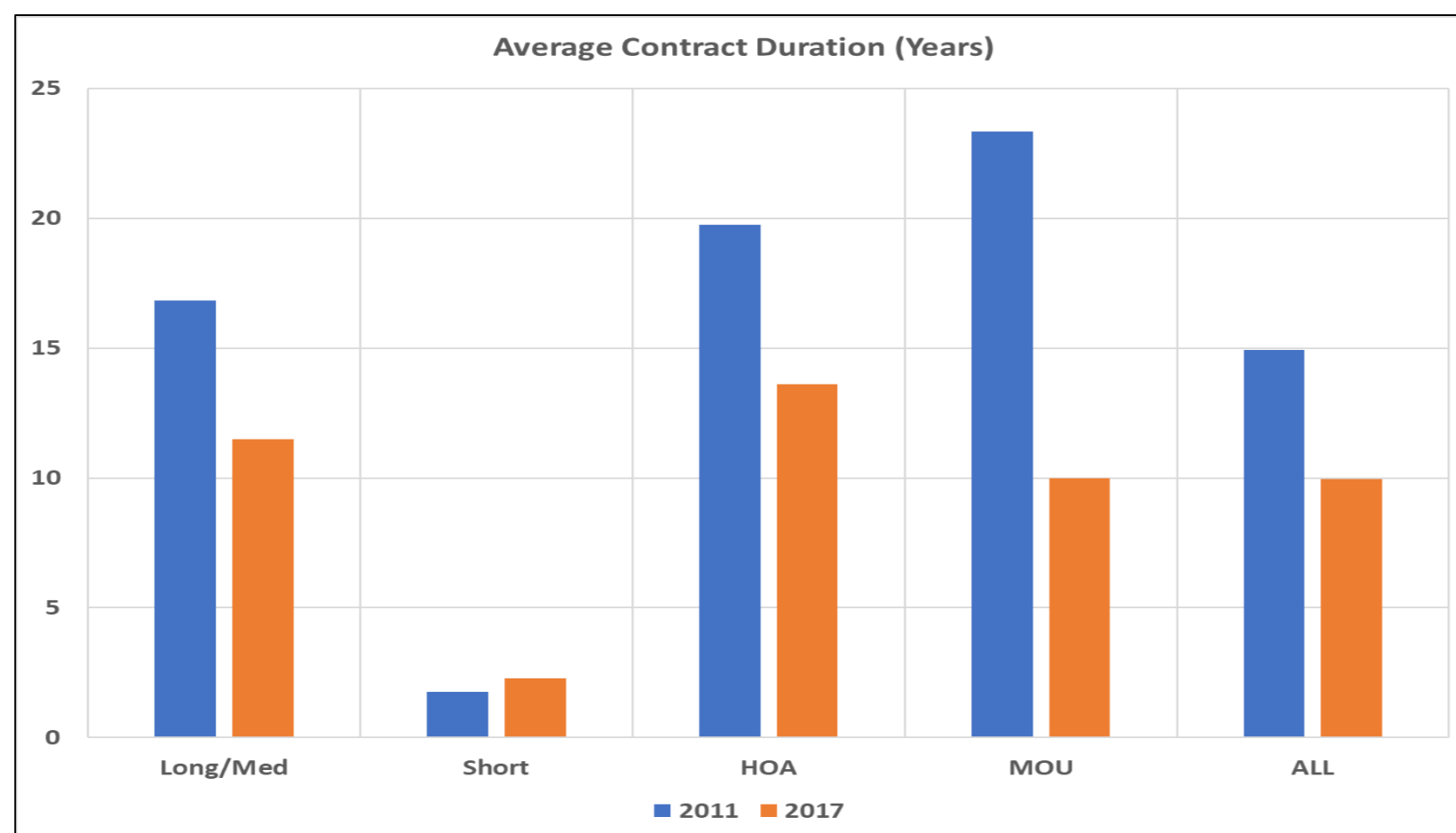
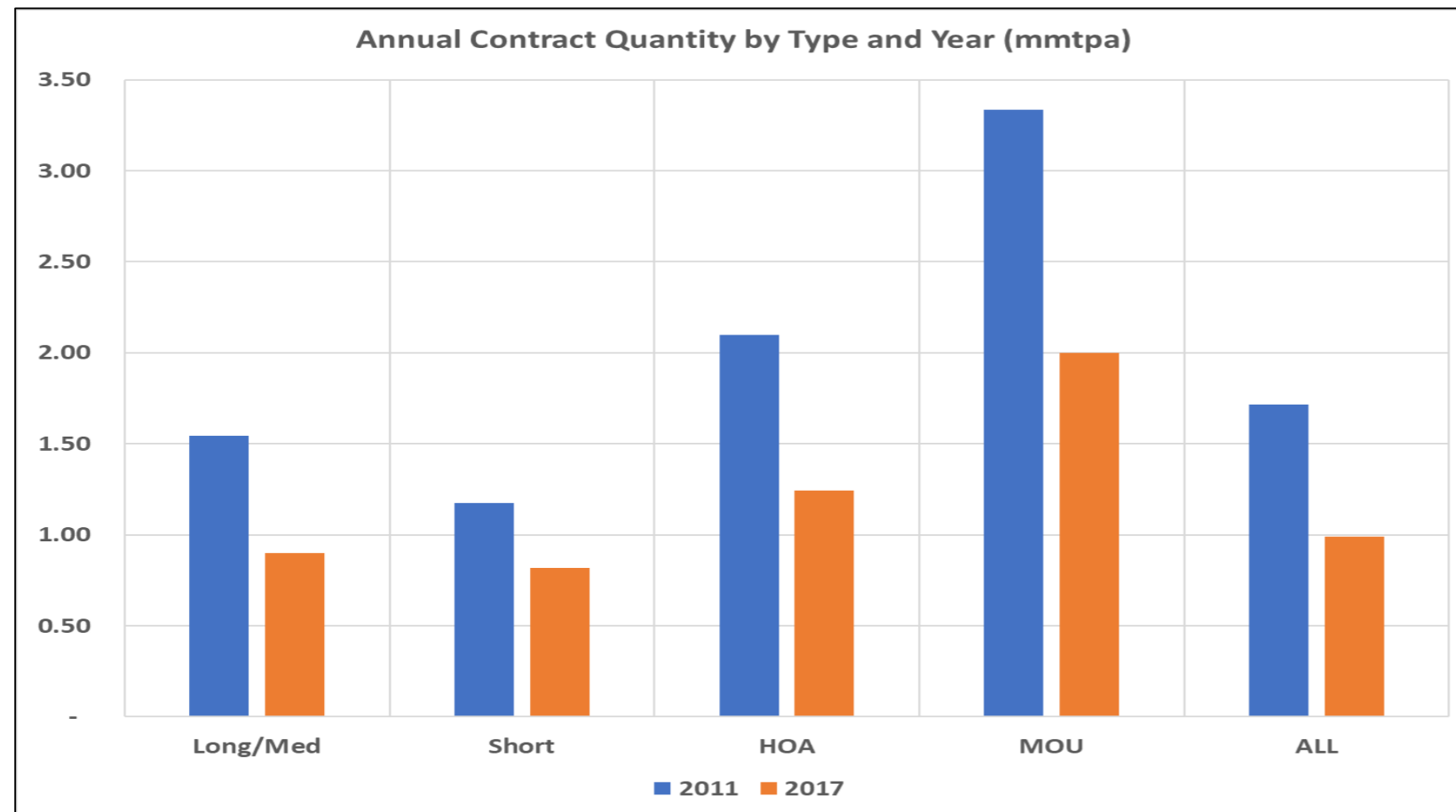
# 150 million tons expiring between now and 2027

## Some producers much more exposed than others



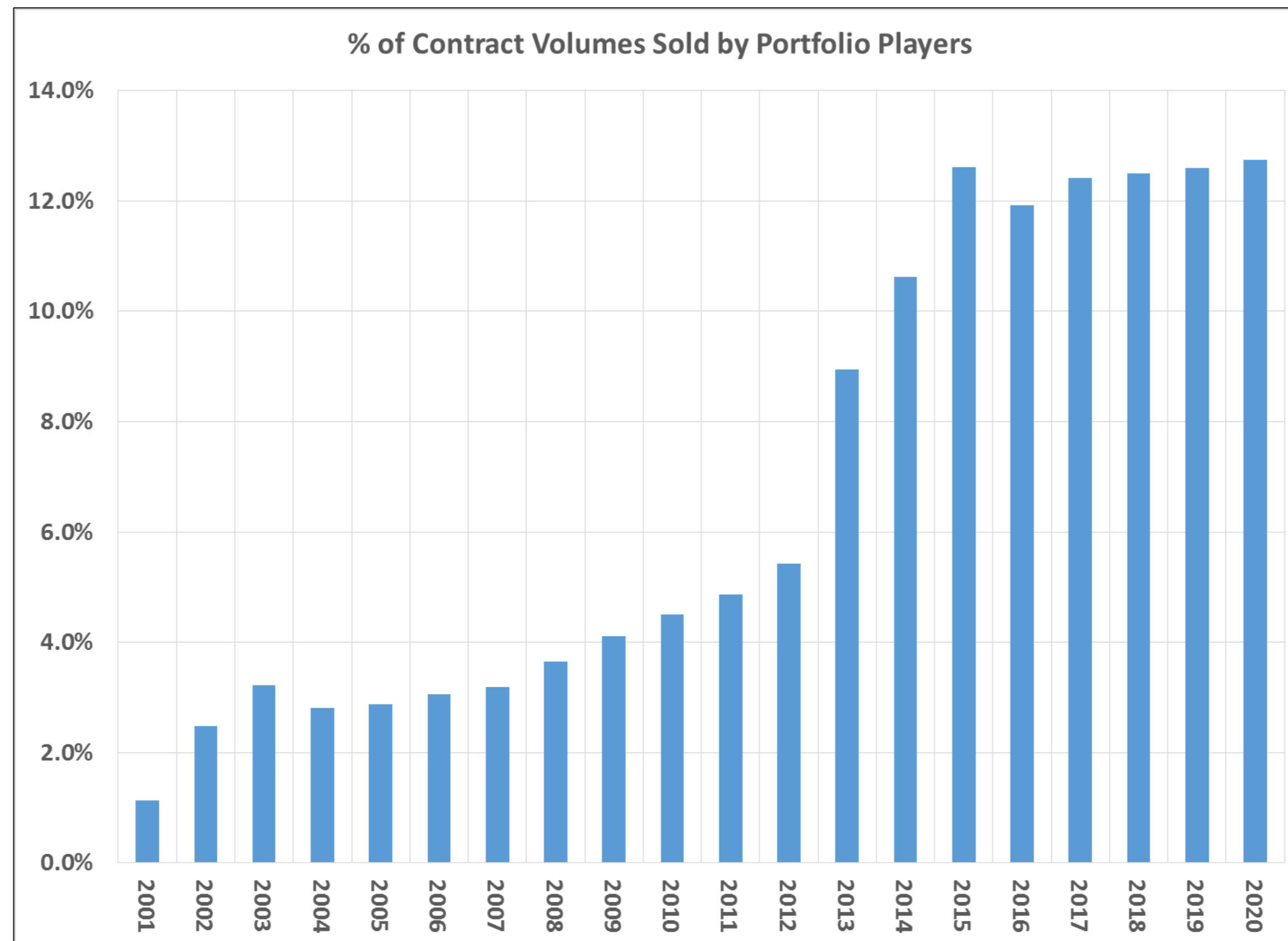
Eight countries will have 50% or more of their contract tonnage expire in the next 10 years.

# LNG Contracts are getting smaller and shorter



Source: GIIGNL Annual Reports 2012 and 2018 and RBAC calculations

# Portfolio players are playing a bigger role

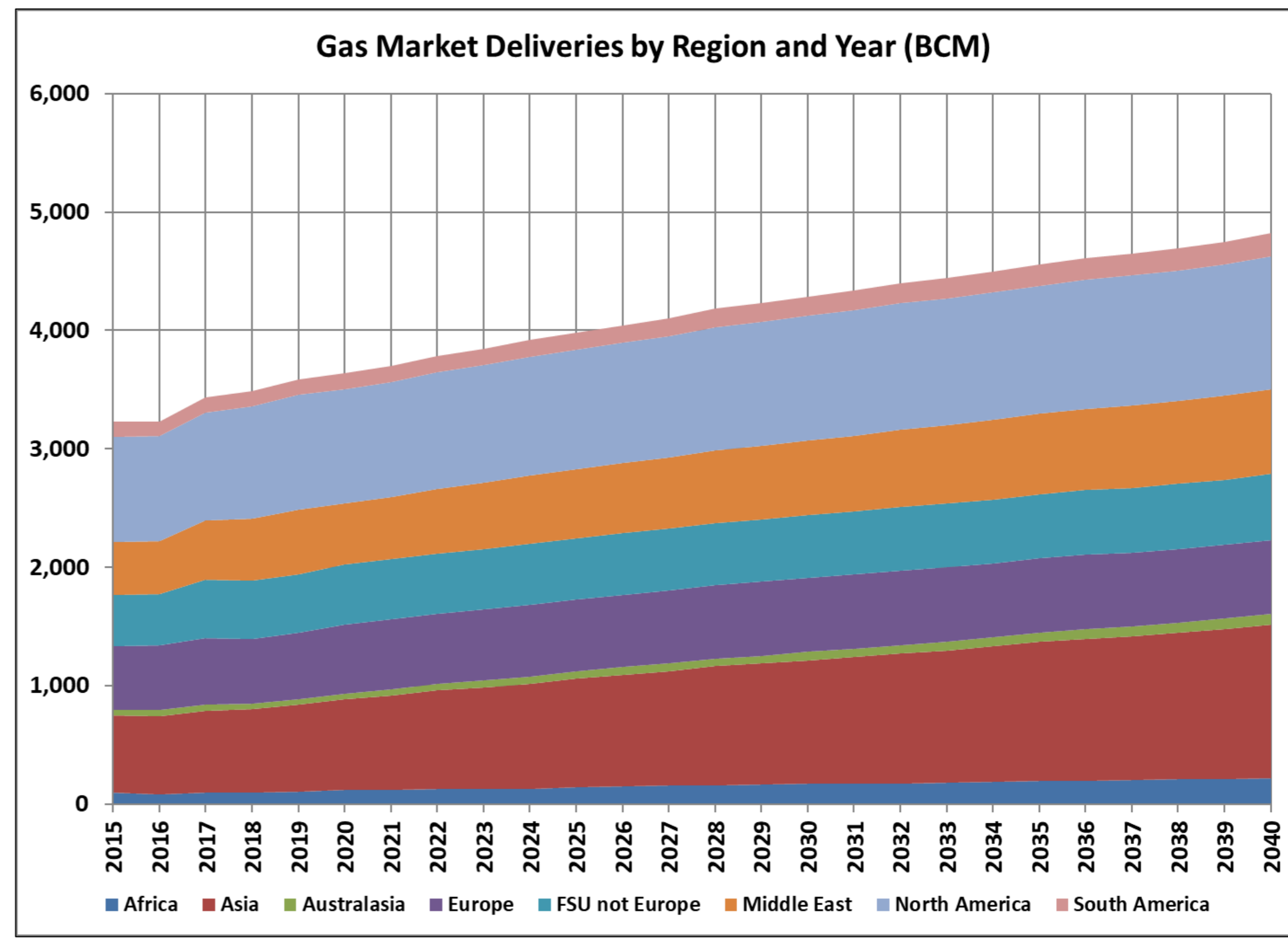
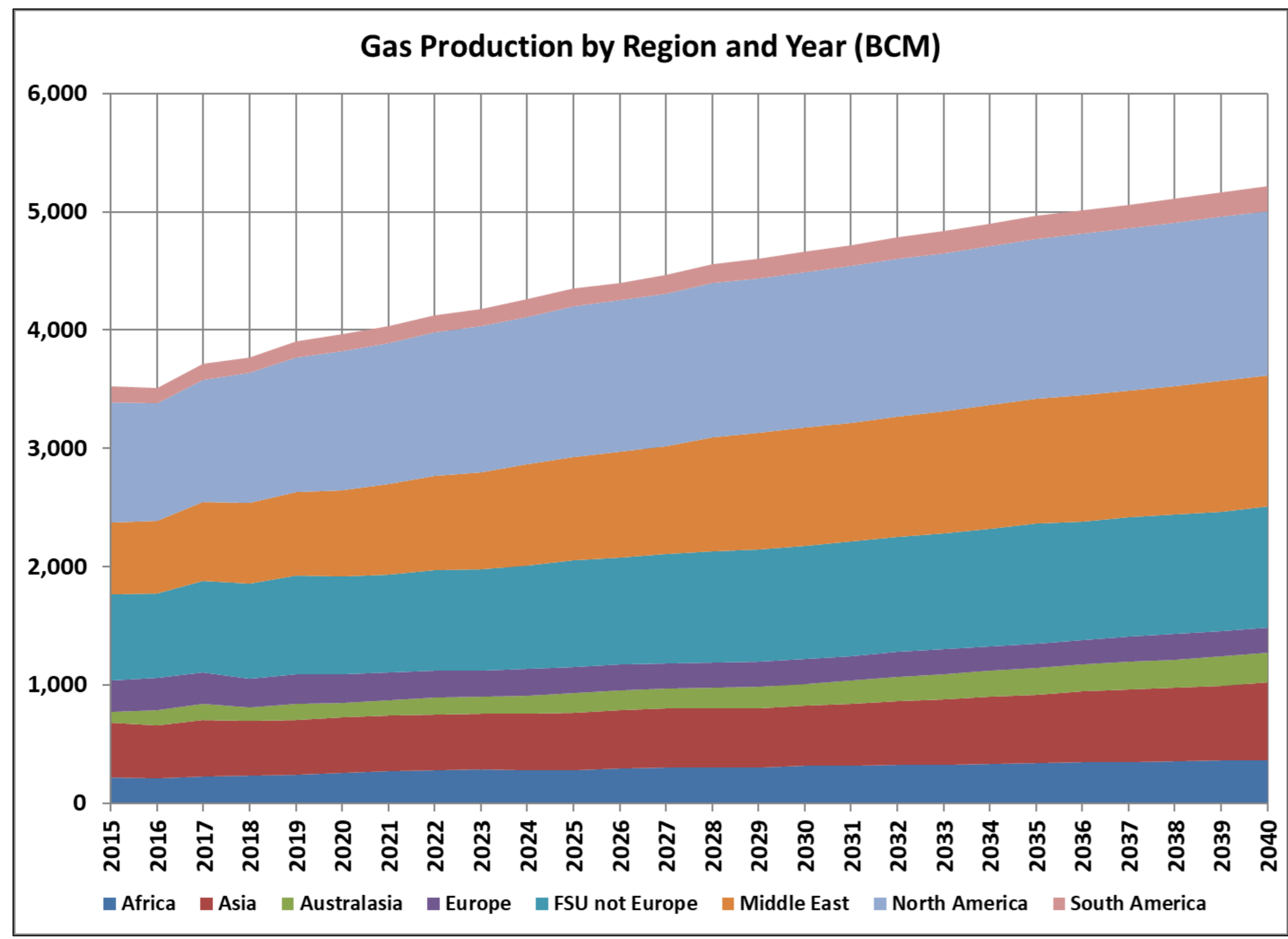


They make the market more efficient by delivering LNG where it is needed most.

# RBAC Global Gas Forecast 2018: Scenario Design

- Gas demand
  - Multiple sources including BP, IEA, China's National Plan, etc.
- Gas supply
  - Curves based on low, base, and high projections from Rystad Energy
- Pipeline capacity
  - Existing plus a number of new projects such as Power of Siberia, Turk Stream, Nord Stream 2, etc.
- LNG supply
  - Include existing plus those being built and a selection of proposed projects
- LNG import terminals
  - Existing plus a selection of proposed facilities

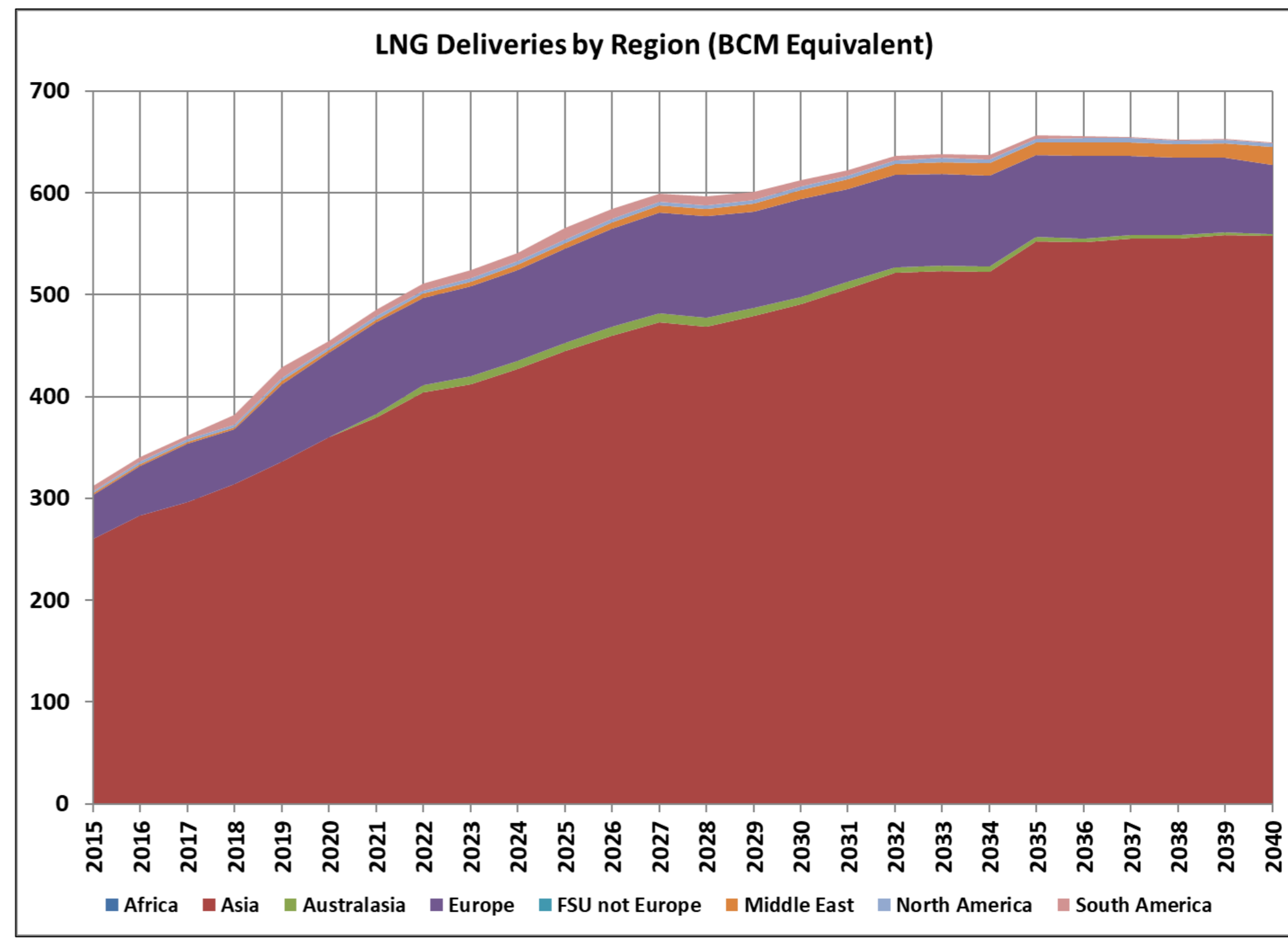
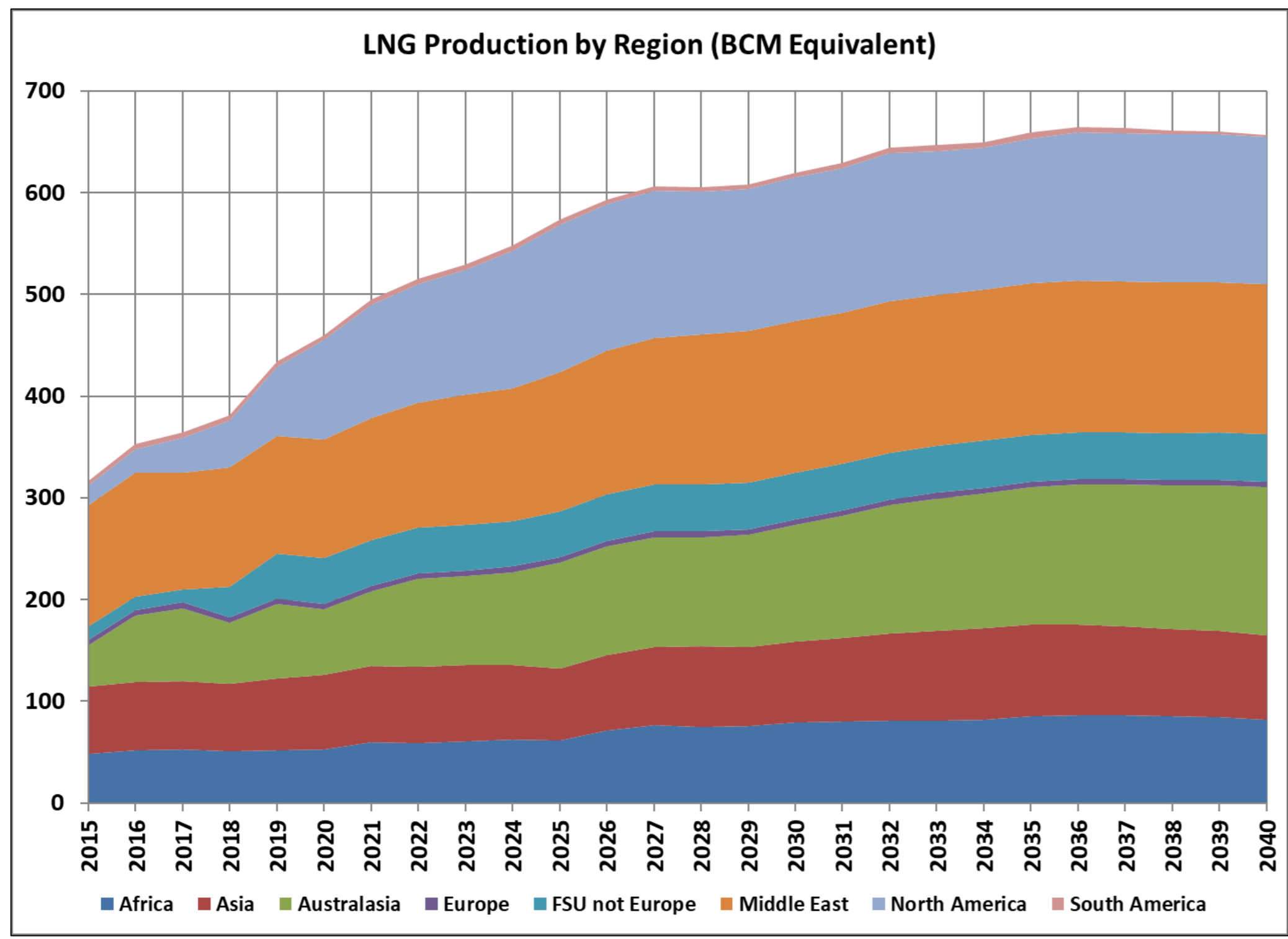
# RBAC Base Scenario Forecast: Global gas balance by region (BCM)



Production and deliveries grow by 48% between 2015 and 2040.  
Deliveries are about 8% lower than production due to fuel use and losses.

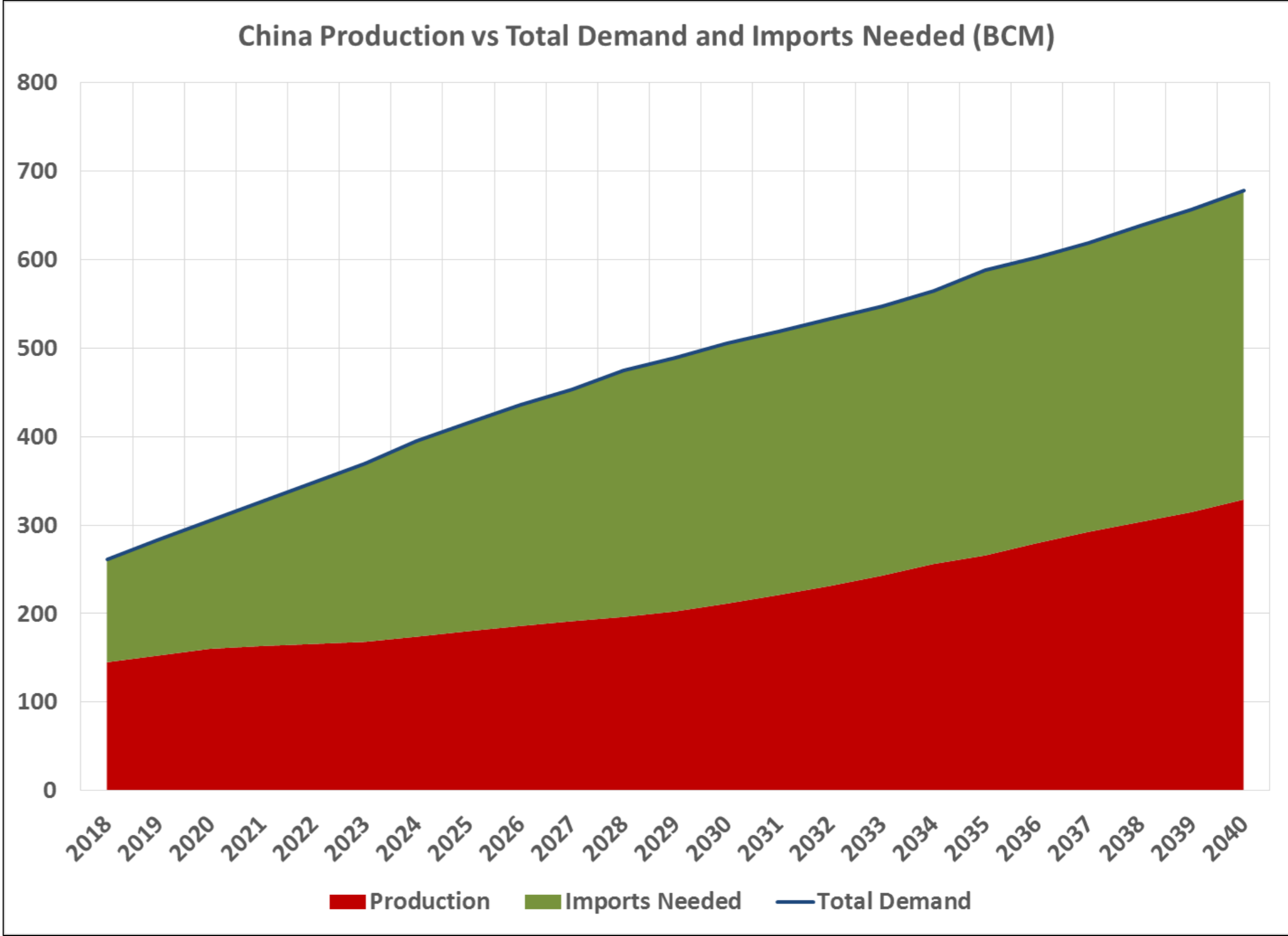
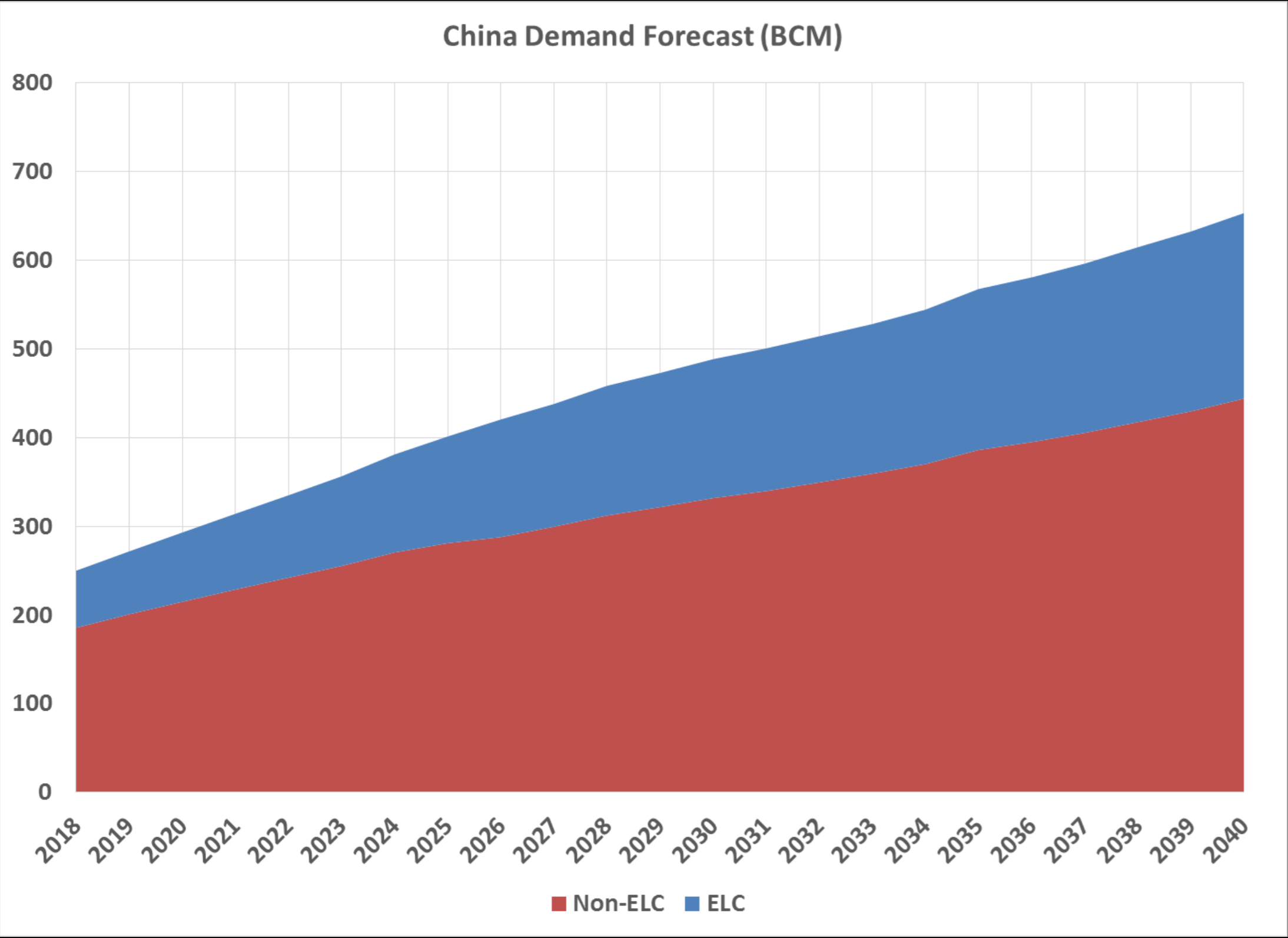


# RBAC Base Case Forecast: Global LNG balance by region (BCM)



LNG production and deliveries grow by 108% between 2015 and 2040. Deliveries are about 1% lower than production due to boil-off in transit. While production is distributed among all regions, 96% of deliveries are concentrated in Asia (81%) and Europe (15%).

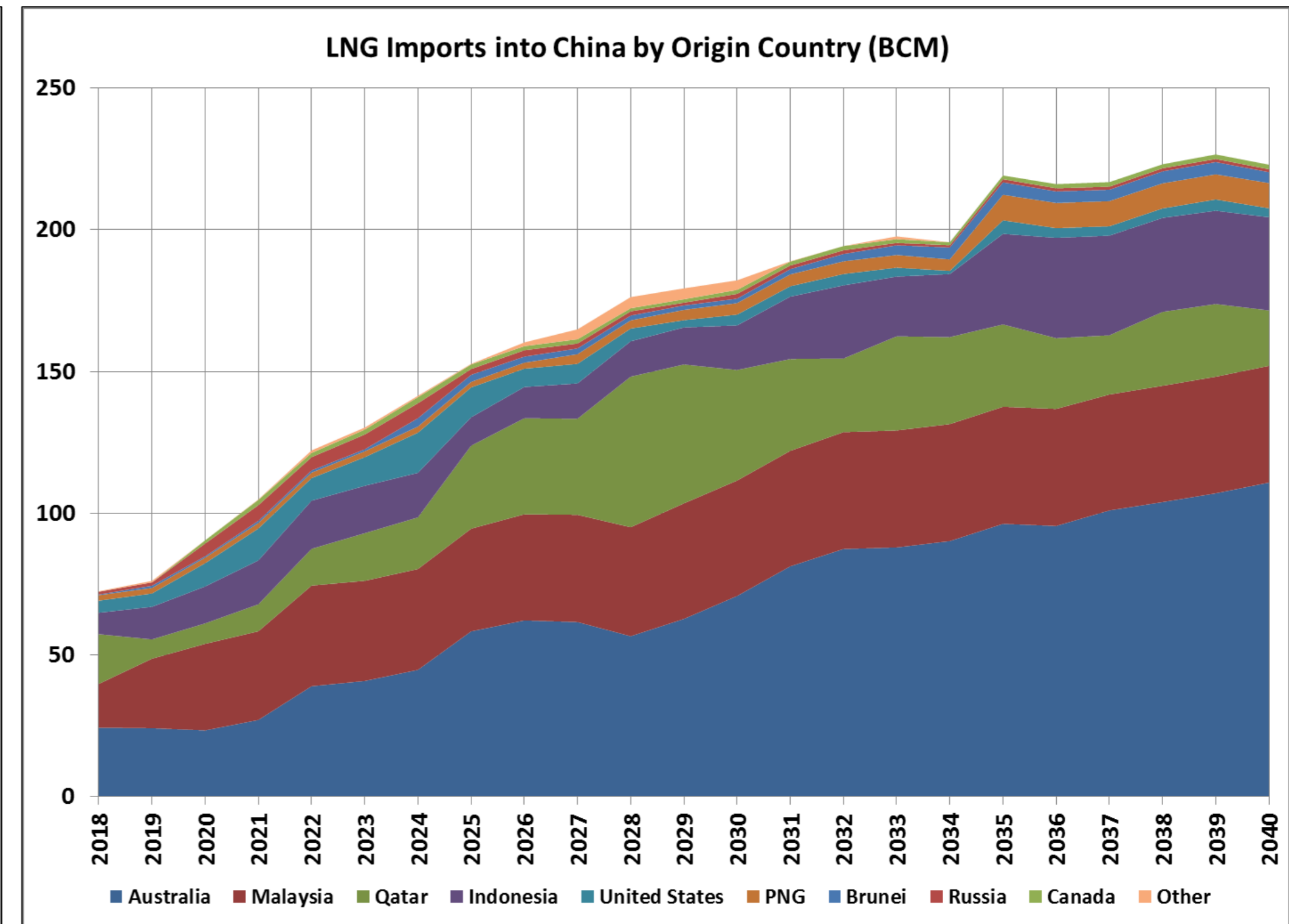
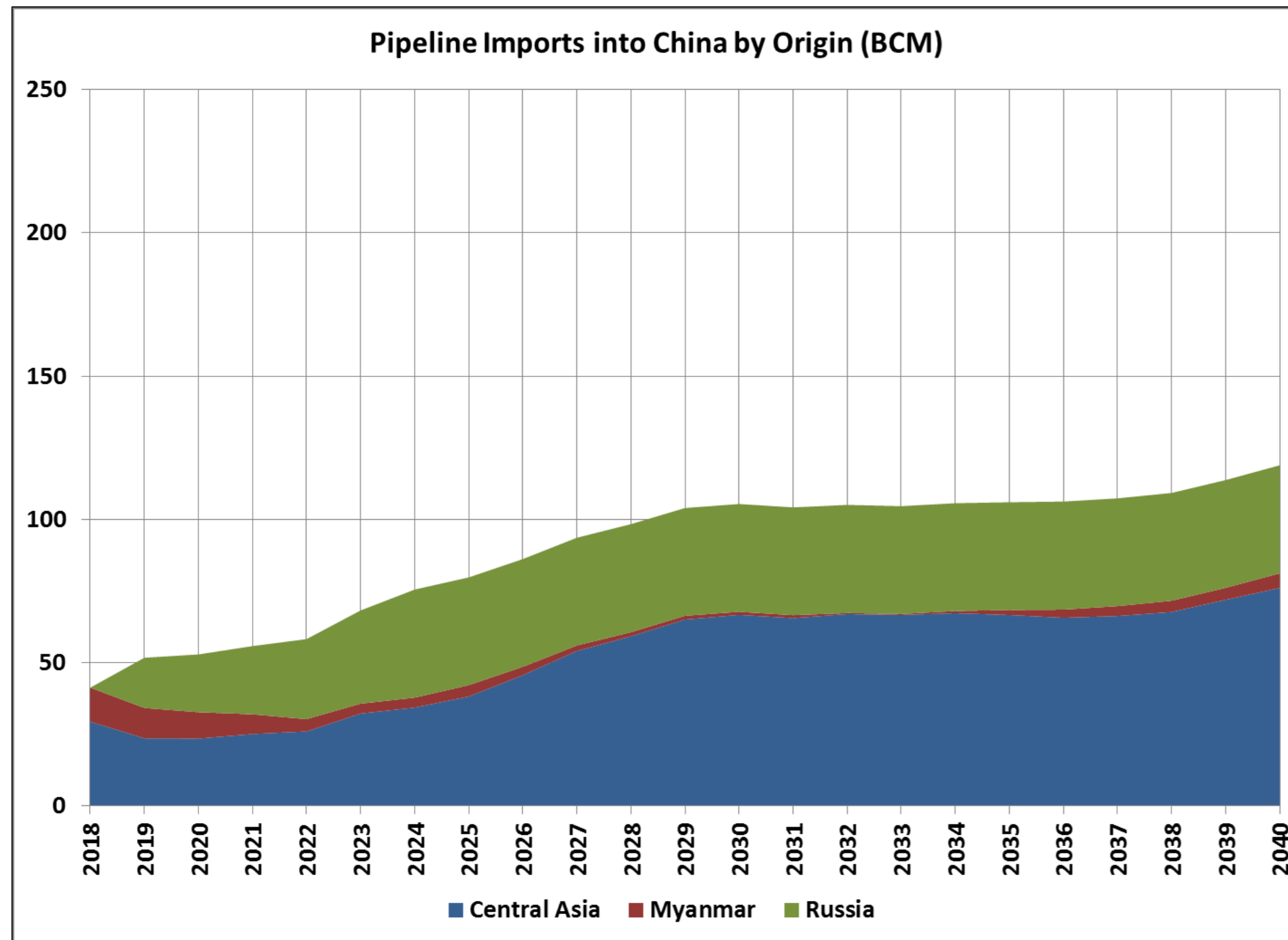
# RBAC Base Case Forecast: China's rapid demand growth needs growing imports



With the base case forecast natural gas demand and production growth, China will need over 300 BCM of pipeline gas and LNG imports by 2040.

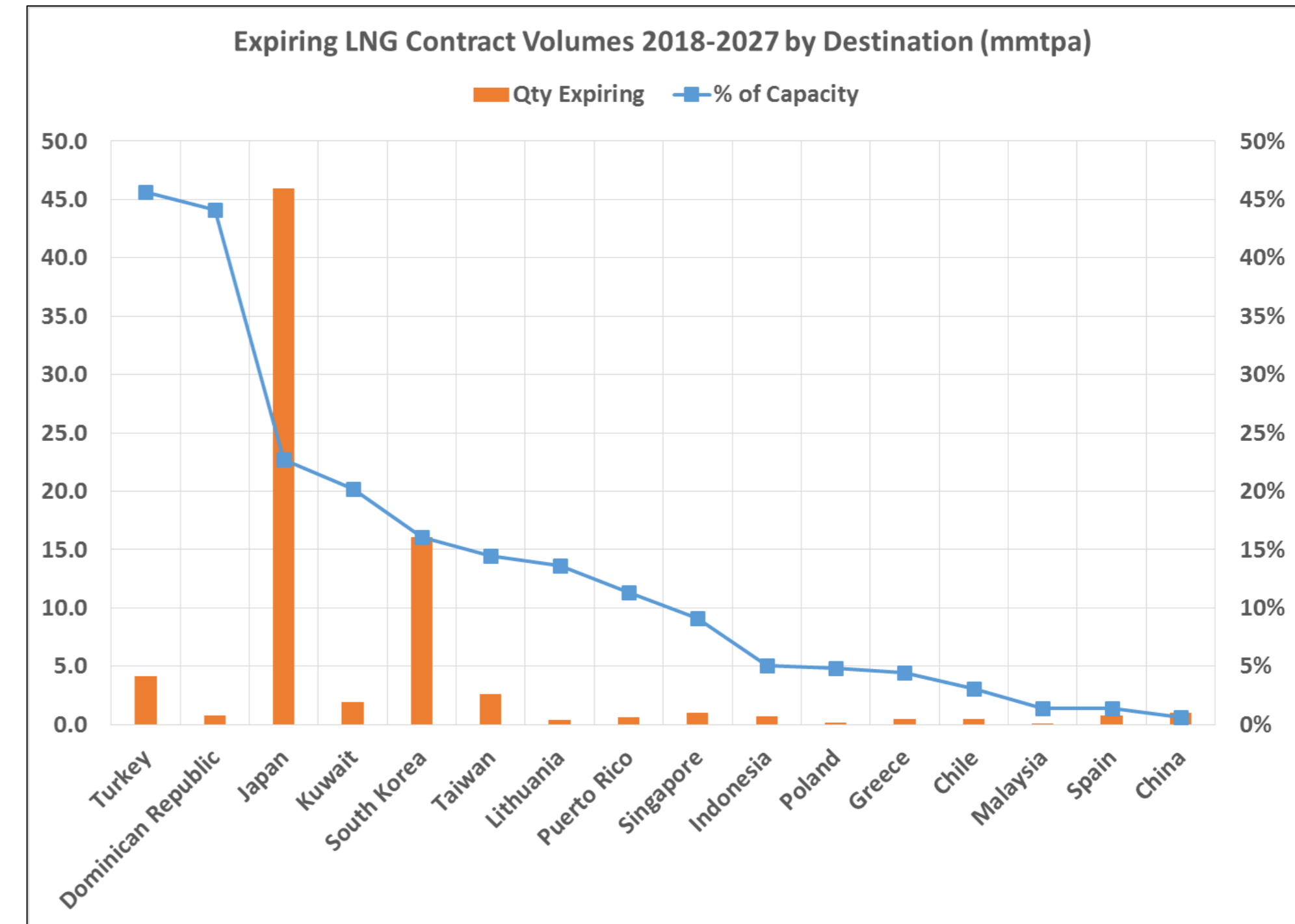
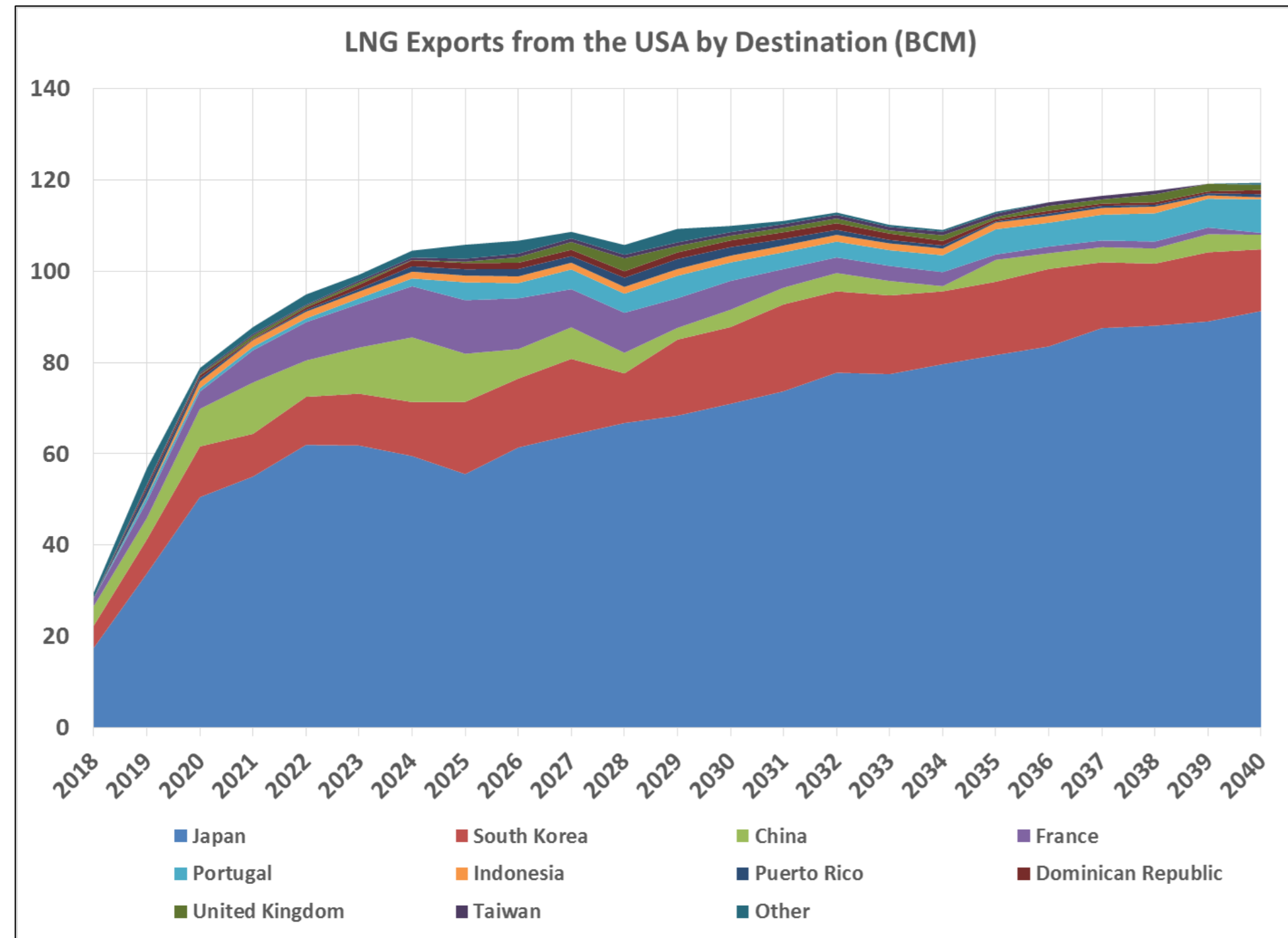
# China will need 250% growth in imports, 67% of that from LNG - and 90% of that from just four nations

Australia (40%), Malaysia (20%), Qatar (15%), Indonesia (12%)



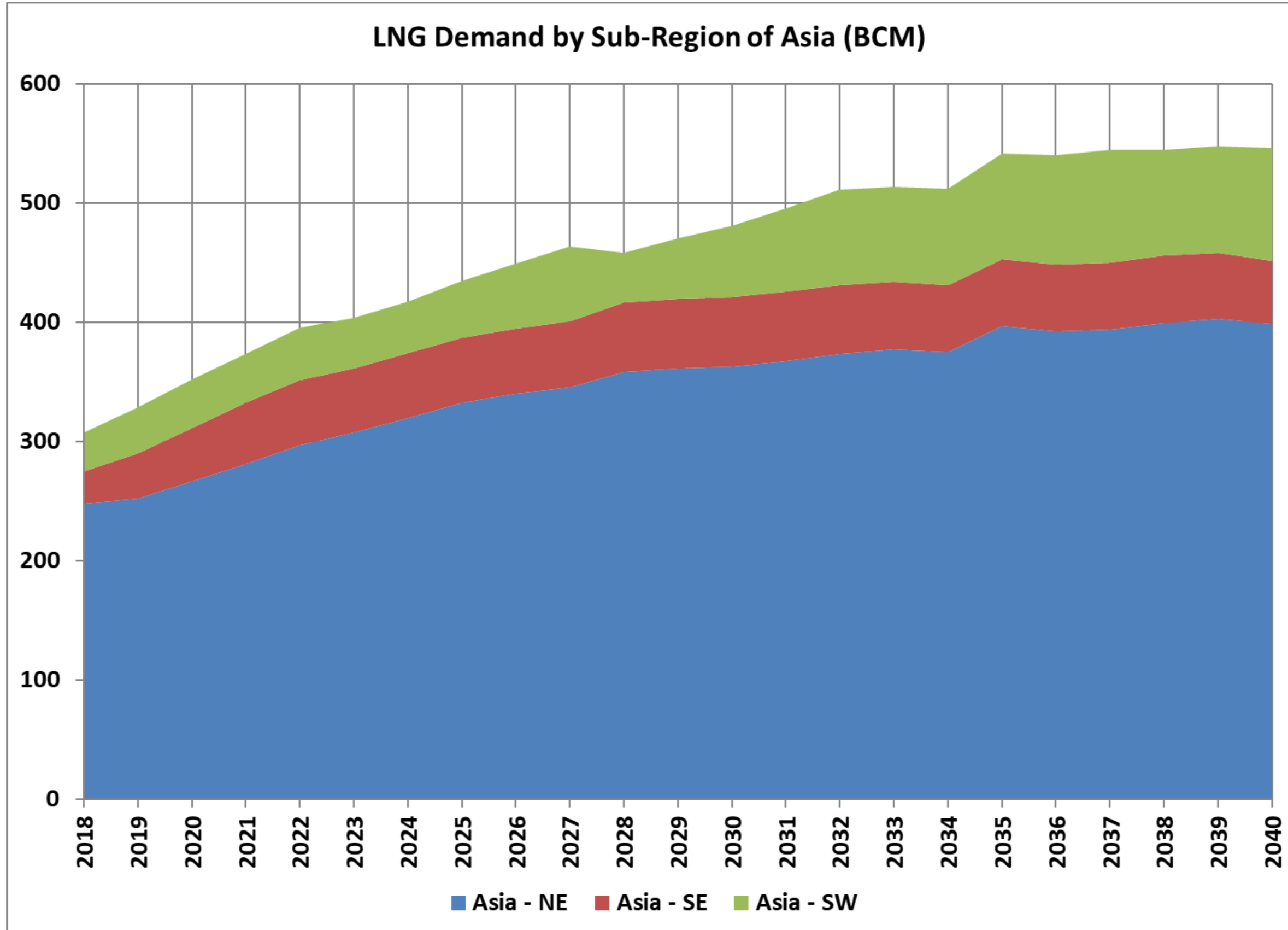
Australia, Central Asia, Russia, Malaysia, Qatar and Indonesia provide most of China's natural gas import needs. Only a small percent is expected to come from North America.

# If US LNG does not come to China, where will it go?



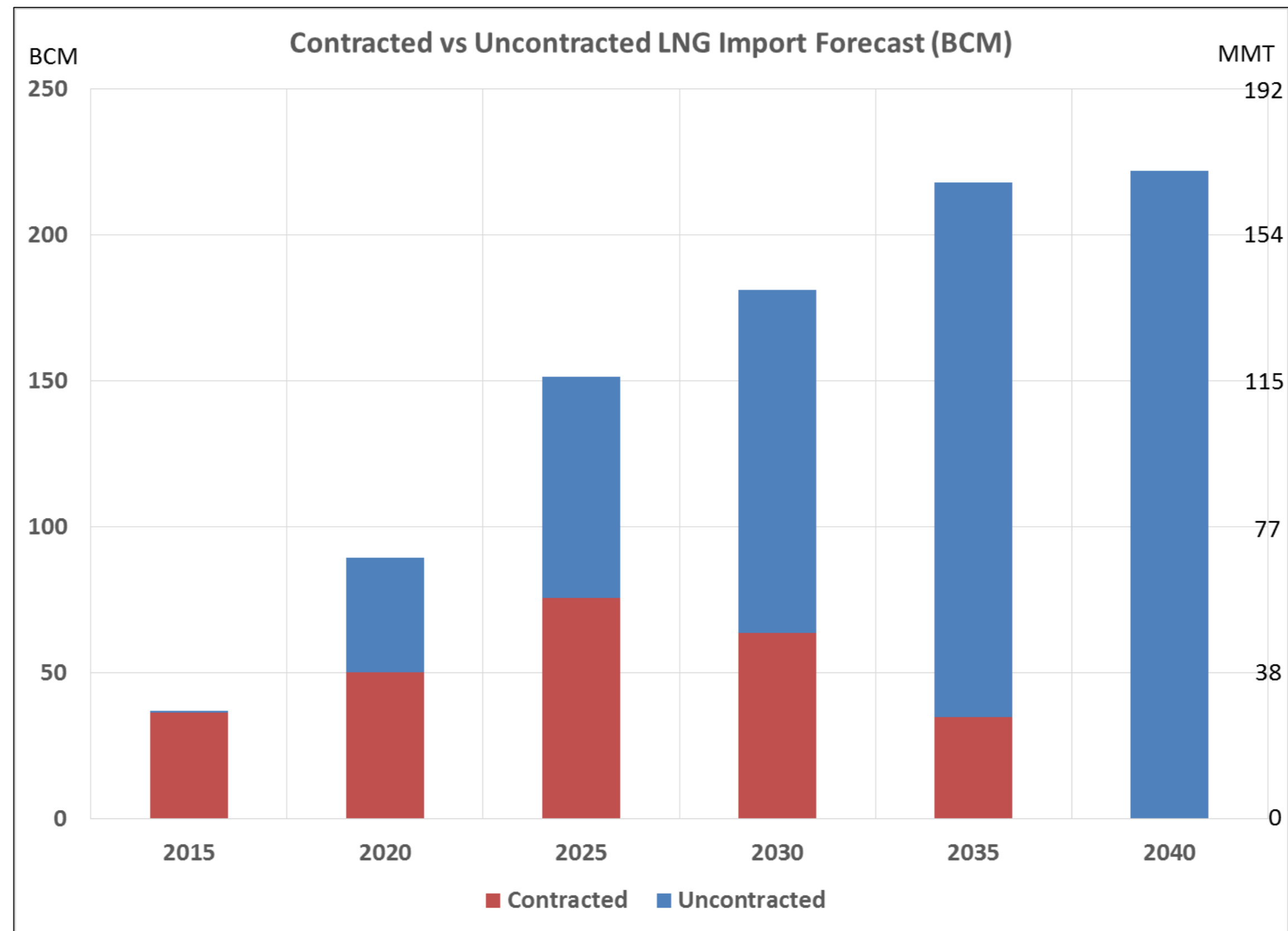
Global geography dictates that LNG will flow most economically from the USA to Japan rather than to China. Japan has a great deal of contract expirations in the near term. It is likely to select the USA to source much of its LNG needs.

# Demand in other Asian countries is also growing



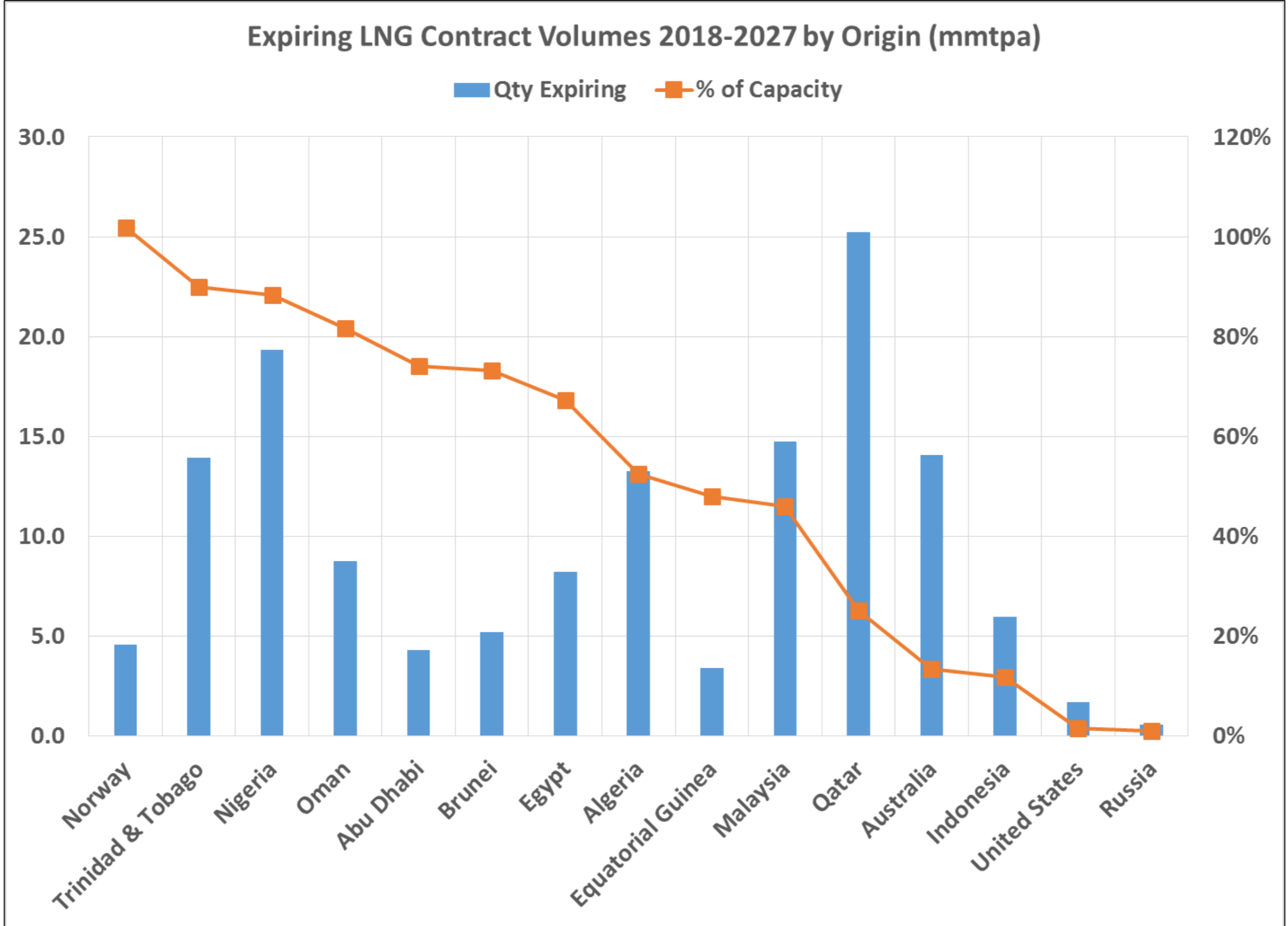
Asia NE demand is expected to grow by 62% between 2018 and 2040; the remainder of Asia, including India, Pakistan, Bangladesh, and Southeast Asia grows by 218% in the same period.

# China LNG: Most future imports not yet contracted: More risk or opportunity?



After surpassing Korea to be the no. 2 largest LNG importer in the world, China continues to grow its need for LNG. But it has only contracted for about 1/2 of 2025's expected demand and about 1/3 of what it will need in 2030. There are two approaches for China LNG procurement: existing supplier or participation in new projects.

# 150 million tons expiring between now and 2027 with some producers much more exposed than others



The degree of exposure for expiring contracts would determine the risk appetite of LNG suppliers when renegotiating.

# And many proposed projects are looking for investors to help them make FID

Name	Country	Start-Up	MMTPA	BCM
Cameron LNG	United States	2019	5.79	7.53
Corpus Christi LNG	United States	2019	5.22	6.79
Freeport LNG	United States	2019	5.80	7.54
PFLNG 2 Rotan	Malaysia	2020	1.50	1.95
Woodfibre LNG	Canada	2020	2.43	3.16
Coral South FLNG	Mozambique	2022	3.40	4.42
Port Arthur LNG	United States	2023	7.60	9.88
Mozambique LNG	Mozambique	2024	12.88	16.74
Jordan Cove LNG	United States	2024	4.53	5.89
LNG Canada	Canada	2024	15.08	19.60
Browse Basin	Australia	2025	12.00	15.60
Scarborough LNG	Australia	2025	6.00	7.80
Mamba FLNG	Mozambique	2025	15.20	19.76
Greater Sunrise	Australia	2028	3.50	4.55
Tanzania LNG	Tanzania	2029	10.00	13.00
Nikiski LNG	United States	2030	23.85	31.01
Bear Head LNG	Canada	2030	9.29	12.07
Magnolia LNG	United States	2030	11.13	14.47
Total			155.20	201.77

Most of these projects are in North America, East Africa and Australia.



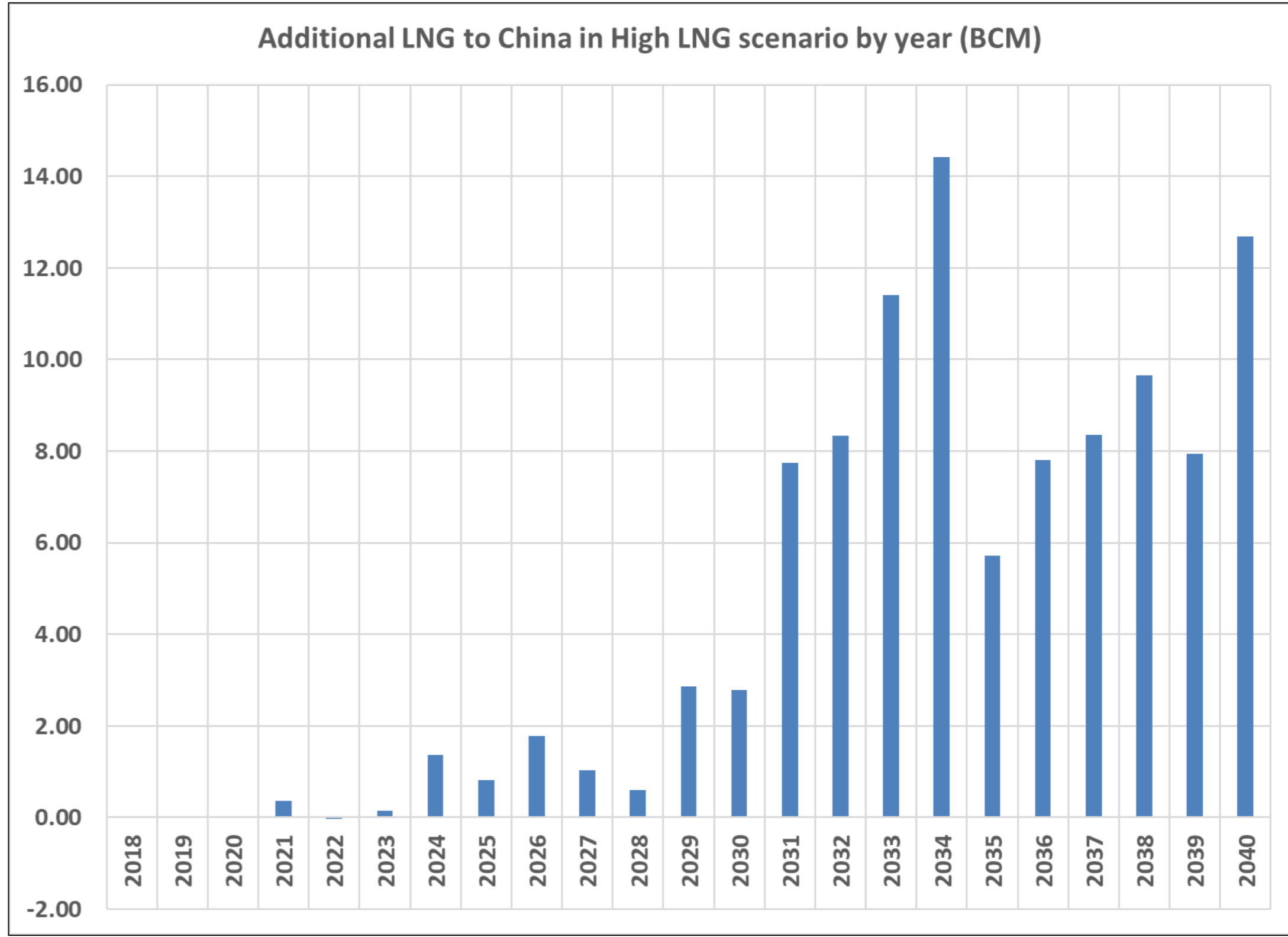
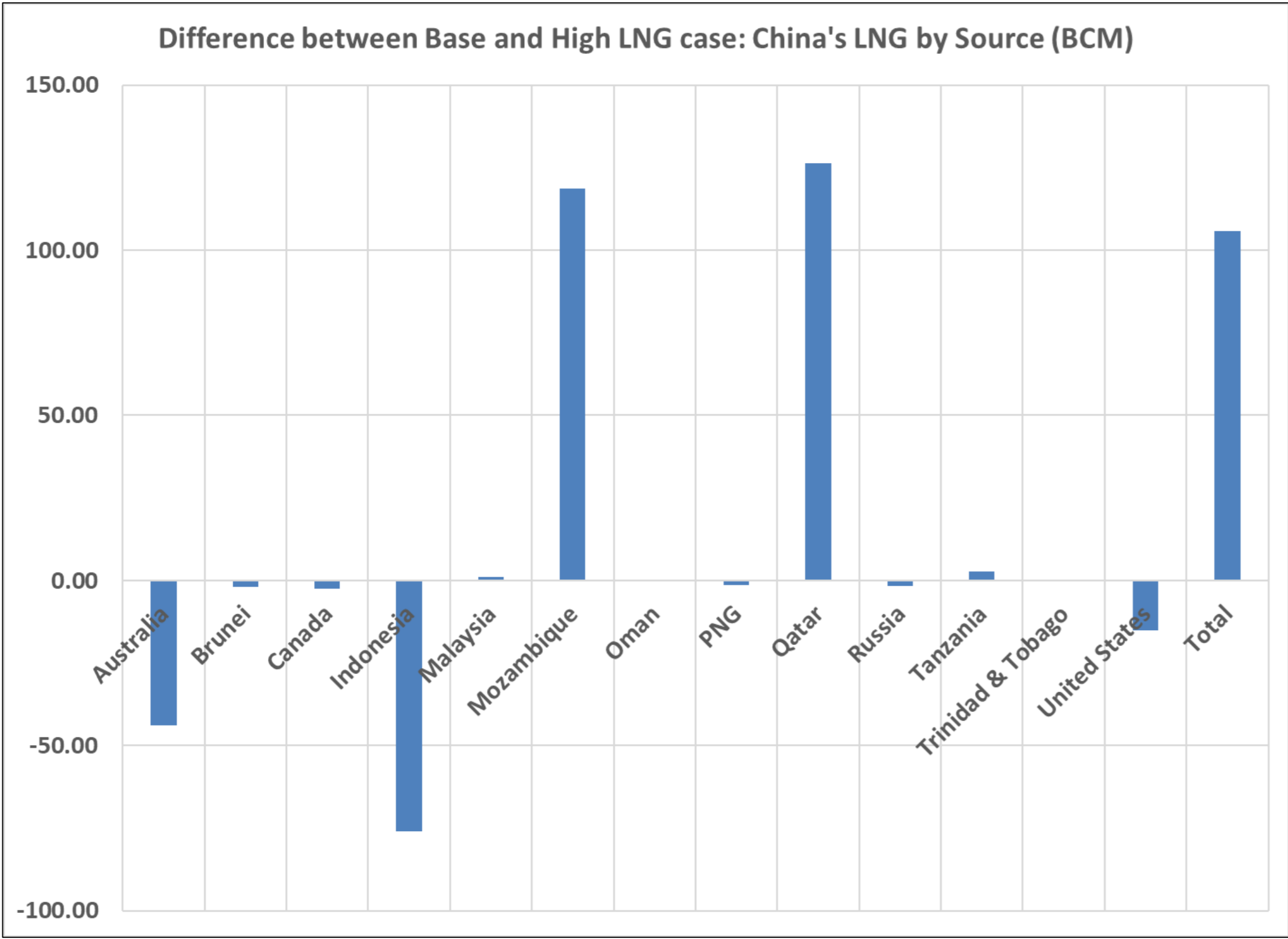
# “High LNG” Scenario assumes additional liquefaction and regasification capacity

LNG Origin	Cap (BCM)
Mozambique LNG	16.7
Port Arthur LNG	19.8
Tanzania LNG	13.0
Nikiski LNG	31.0
Magnolia LNG	14.5
Total	95.0

LNG Destination	Cap (BCM)
Caofeidian BEIH	3.0
Chaozhou Huaying	13.3
Chengmai	17.8
Huizhou	35.6
Lianyuangang	4.4
Linhai GCL	4.4
Qinzhou	4.4
Rizhao PO&G	3.0
Rudong GCL	4.0
Tianjin FSRU	3.3
Zhuhai Hanas	8.9
Total	102.1

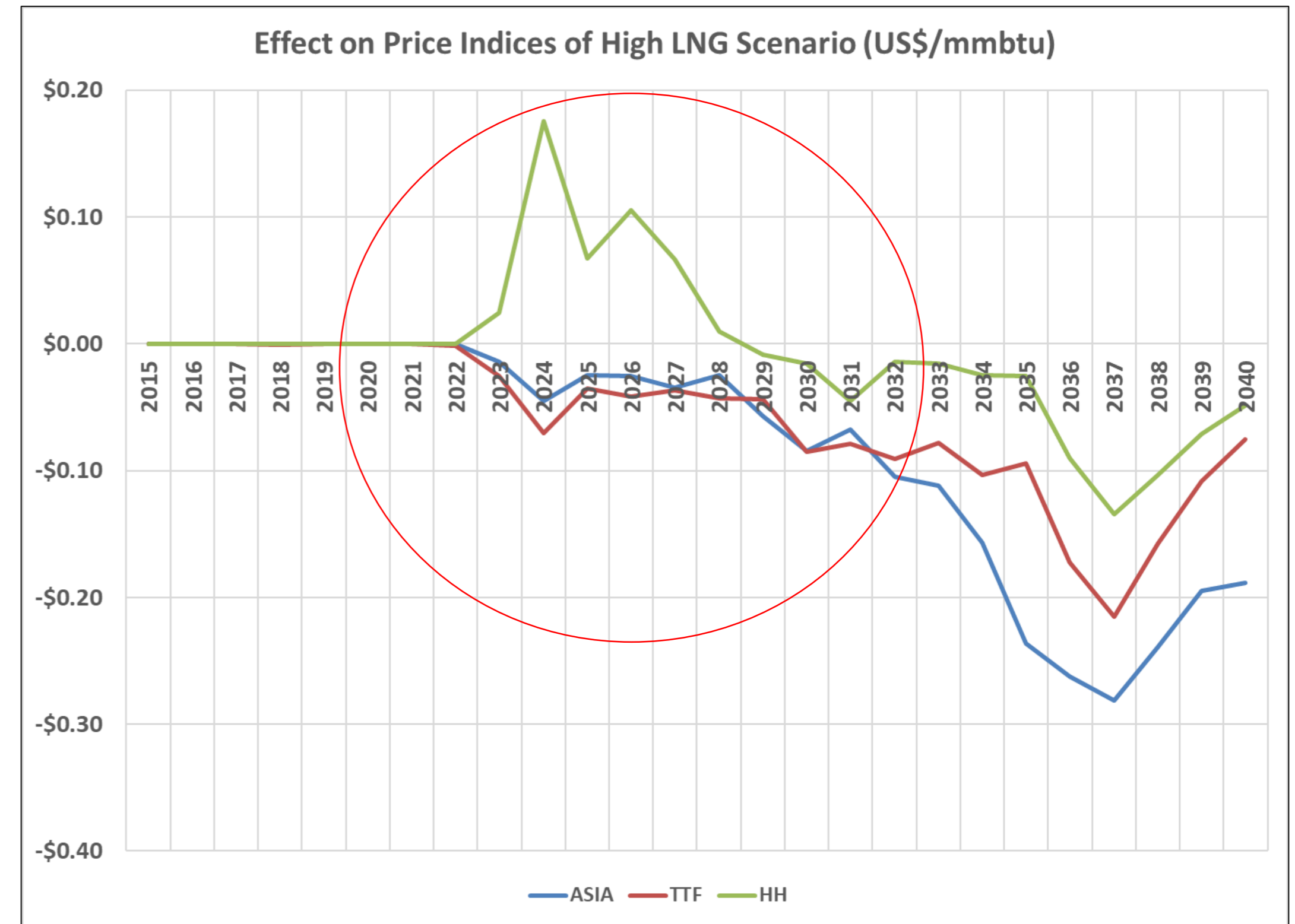
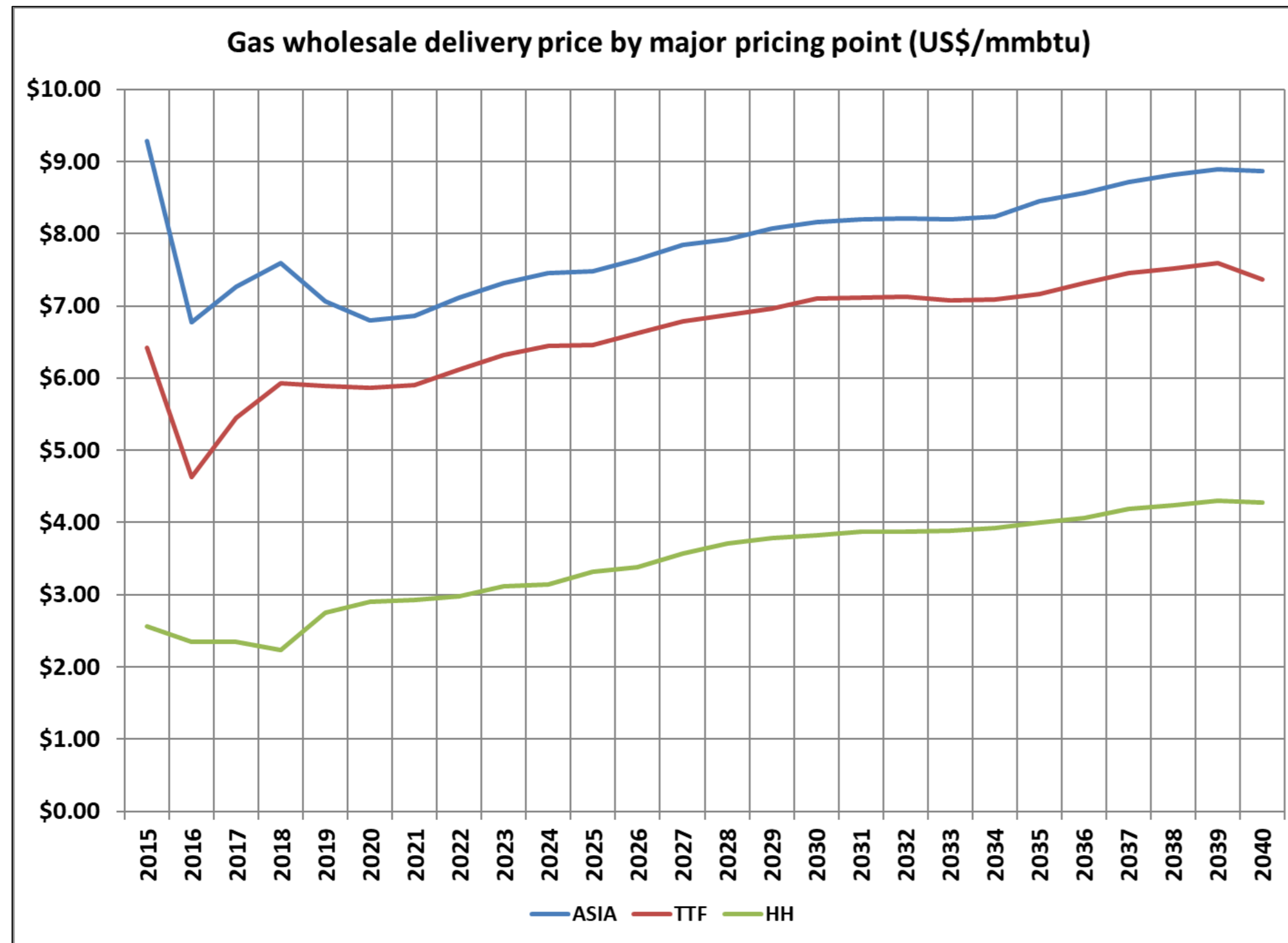
In the “High LNG” scenario, approximately 100 BCM of additional LNG supply and demand are turned on. The new export capacity is located in East Africa and the United States. The new import capacity consists of proposed terminals in China.

# How does the “High LNG” scenario affect China?



New developments in East Africa, and additions from the Middle East, provide 100 BCM more LNG to China. Australia and Malaysia lose the most Chinese market share.

# Base case regional price index forecast

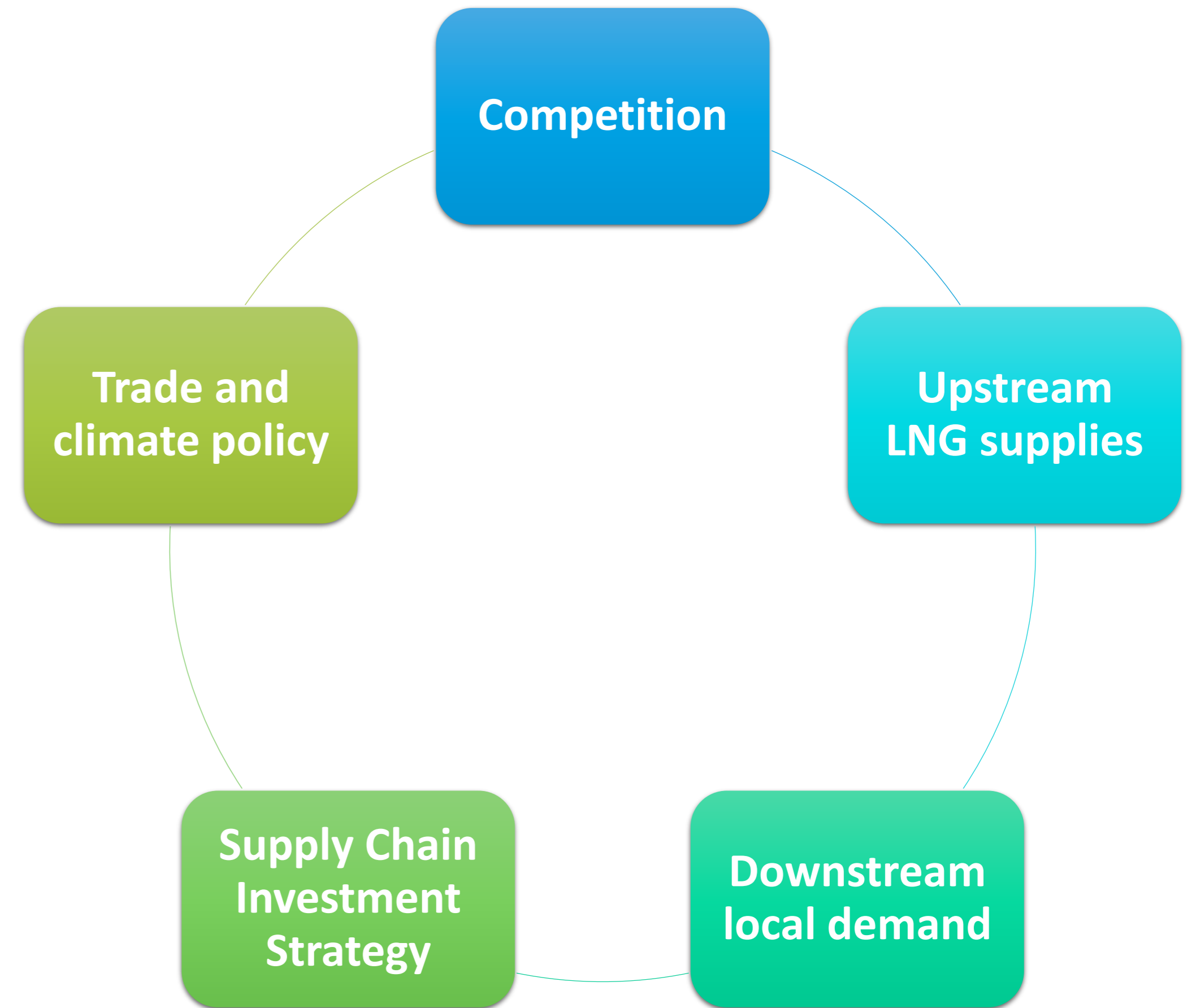


In the near-term, LNG export expansion in North America raises prices there but helps to lower prices in Asia. Longer term, prices rise but not to levels seen before 2015. Adding more LNG to the market has a minor but logical effect on prices. Note that even Henry Hub price falls after 2030. This is due to competition from Alaskan LNG which comes on-line at that time.

# Summary:

## Five key factors of considerations of optimal long term LNG strategy

- Upstream LNG supply is forecast to double by 2040**  
New LNG suppliers arise portfolio players introduces new alternatives with flexibility.  
Expiring LNG contracts create opportunities for buyers, especially with highly exposed producing countries
- China's demand** continues grow with strong momentum and which would be supported by imports in form of LNG.  
China's demand in peak seasons differs from traditional ratable profile, which requires new and more flexible term of supply contracts.
- Competition among LNG buyers and strategic positioning**  
Besides traditional buyers like Korea and Japan, fast growing developing market, like India and Thailand would also compete for LNG demand in Asia. Europe's demand of LNG is a balancing act for the global market.
- Impact of trade and climate policy**  
impact from trade policy may impact medium term project progress.  
Low carbon future adds incremental demand for natural gas
- Plenty of **investment opportunities** for China to participate in various segment of LNG supply chain to creates additional energy security with quality return: including upstream E&P, LNG trading and transportations.



Even with much uncertainty and risk in the global gas market ... there remains great opportunity for achievement and success.

# Robert Brooks, Ph. D.

Founder

## Biography

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Dr. Brooks is the Founder of RBAC Inc. He is an applied mathematician, energy economist, and software systems designer with over thirty-five years of experience in developing decision support systems for business and government.

Dr. Brooks has earned degrees from the University of California at Berkeley, the University of Texas at Austin, and MIT. His doctoral research involved development of the first large-scale linear programming model of the North American natural gas pipeline grid.

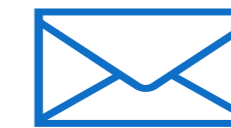
After receiving his PhD from MIT, Dr. Brooks developed specialized natural gas grid models for use by DOE, FERC, and EPRI. He led technical development of President Carter's National Energy Transportation Study, identifying probable bottlenecks in US energy transportation infrastructure over the next 20 years.

Dr. Brooks designed the gas network model for Logistic Solutions' GRIDNET nominations management system. This system employs an extensive database of pipeline receipt and delivery points throughout the North American gas grid to compute optimal daily routings from production, storage, and market points to customer delivery points, customized for the firm's specific supply, transportation, and delivery contracts.

For RBAC, Dr. Brooks developed the GPCM® Natural Gas Market Forecasting System™, the first pipeline-specific monthly, long-term model of the entire North American natural gas transportation and storage system. Since its introduction in 1997, GPCM has become the industry standard modeling software for natural gas market analysis in North America, licensed to North America's largest and most prominent energy producers, infrastructure developers, utilities, and consultants. In 2015 he completed development of the GPCM Power Model Interface, a reliable and efficient system for integrating highly granular power market models with the GPCM natural gas market model.

Dr. Brooks has also designed and developed a similar modeling system for the North American natural gas liquids market. The NGL-NA® model database comprises virtually all existing and planned NGL infrastructure in the US, Canada, and Mexico, from gas processing plants to fractionators, terminals, storage facilities, ethylene and propylene plants, and refineries. It also includes virtually all NGL mix and purity pipelines with their origins and destinations, as well as truck, rail, and barge links between the various facilities. Development was supported by major energy industry players to assure model realism and usefulness.

More recently Dr. Brooks has extended these successful concepts to global natural gas and LNG in RBAC's G2M2® Global Gas Market Modeling System. This extension also includes development of the G2M2 Power Model Interface for Europe. G2M2 has been employed to study the evolution of gas and LNG markets in Asia as well as the connection between prolific gas supplies in Eurasia and security of supply in Europe.



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# Liam Leahy

## CEO

### Biography

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Liam Leahy consistently achieves results in creating and executing strategy, financial management, marketing, and business development. His range of experience is concentrated in energy, technology, professional services as well as publishing. He retains a lifelong passion and study in global economics and policy.

During his tenure as CEO he has sustained growth and improved net worth of the enterprise during the ups and downs of business cycles while investing in new capabilities and methods that lead the industry in forecasting capability.

Both as a sought after director and within RBAC, Mr. Leahy's corporate governance duties include expansion planning; business development for complex products generally not well understood by marketing and advertising experts: capital formation and allocation, implementing financial controls.

Prior to joining RBAC, Mr. Leahy was a turnaround / interim CEO for 15 years to small & mid-cap companies. He specialized in a variety of roles such as director & trust management, turnaround manager, strategy, planning, marketing, financial planning, business development, professional negotiation, mediation & conflict resolution, mergers & acquisition as well as business analysis.

Mr. Leahy joined RBAC in 1999. In concert with RBAC's founder Dr. Robert Brooks they spearheaded the market penetration of what has become an industry standard, GPCM® Natural Gas Market Forecasting System™. Within a few years RBAC obtained a majority market share.

With the development of RBAC's North American NGL Model (NGL-NA™) and Global Gas Market Model (G2M2™) RBAC supports the energy industry with fast and reliable forecasting tool, which helps companies and their clients develop corporate strategies, evaluate risks and opportunities as well as maximize the value of their assets.



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# Ning Lin, Ph. D.

Executive Director, Global Gas

## Biography

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Dr. Lin is a respected energy industry economist with extensive credentials validated by her direct contribution to assets and profitability of several global businesses. Before joining RBAC, Dr. Lin managed global market analysis capabilities for Shell Trading, KOCH Industries and Tenaska. Her experience in both the chemical and energy industries ranges from natural gas and power, to petrochemical derivatives, intermediate chemicals and polymer, fiber, and engineering plastics. She is also well versed at using GPCM® Natural Gas Forecasting System™ and G2M2® Global Gas Market Modeling System™; the leading tools in this industry.

Both a skilled manager and analyst, she has built and managed multiple successful teams.

Following a long term collegial relationship as a client or colleague, Dr. Lin joined RBAC in 2017 to work directly with Dr. Brooks in leading our international expansion. They have completed the latest release of the G2M2 base case.

As a collaborator on various studies and presentations, their work has further confirmed its wide-ranging approval of Dr. Books' methodologies and G2M2's forecasting capabilities at leading conferences across the globe. Such studies and the model itself demonstrate the implications of major changes in the LNG and Global Gas markets while helping our industry gain greater certainty in an uncertain world and insights to mitigate risk.

Dr. Lin has successfully executed a variety of commercial development projects and established local partnership in overseas regions, including capital investment, technology licensing, market development and product innovations.



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