6TH IEF IGU MINISTERIAL GAS FORUM

Session 3:
Enhancing gas supply and diversification – New sources & markets

IEF-IGU Gas Ministerial

22nd November 2018

INTERNATIONAL ENERGY FORUM

BCG ENERGY

Key messages: Enhancing gas supply and diversification – new sources and markets

Key messages

Global LNG supply is growing rapidly, but further new capacity will be required by the mid-2020s

- Liquefaction capacity growing by 1/3 from 2016-21
- Demand growth likely to outstrip supply growth by 2025 – additional investment of >$110bn may be required

LNG market growth is currently led by China and a small number of new LNG "niche" markets

- China responsible for nearly half of recent global LNG demand growth
- Other LNG demand growth has been led by a small number of new "niche" markets (<15)

To sustain continued gas market growth significant infrastructure investment is required

- Investment of $35-55bn per year is required to enable gas demand growth in emerging market cities

Session objectives

Discuss the role of new sources of LNG supply and how to ensure it is cost competitive

Assess the key drivers of new gas market development and key enablers

Identify how to accelerate gas infrastructure investment in emerging markets

Agenda

LNG supply growth

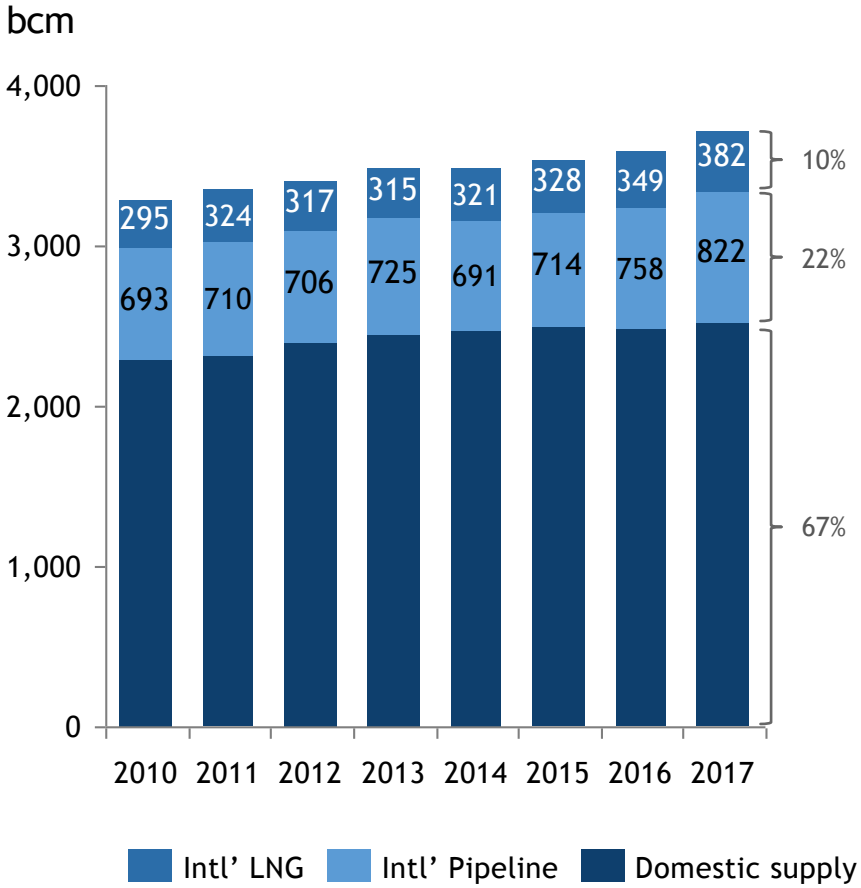
LNG market growth

Gas infrastructure requirements

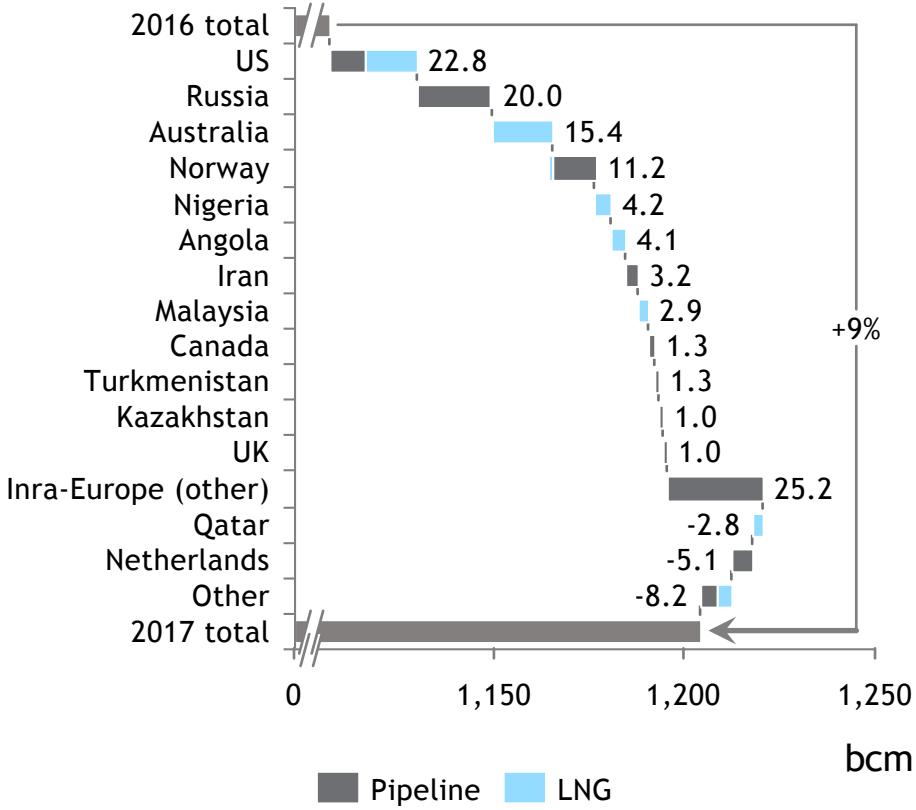
Questions for discussion

Strong global gas trade growth in 2017 led by US, Russia, and Australia exports

Global gas trade by year



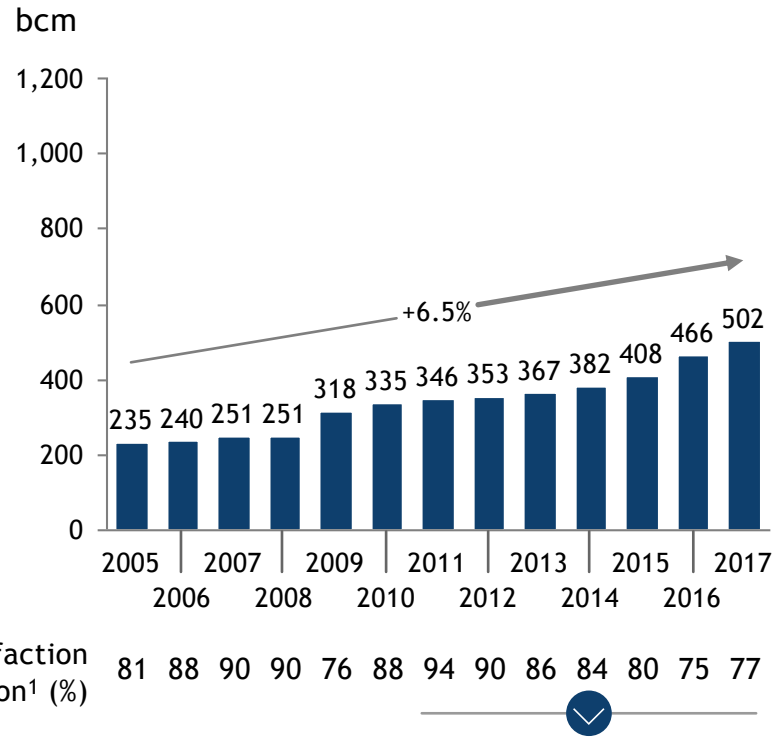
2017 annual change in exports



Source: Cedigaz global trade data, BCG analysis

LNG liquefaction and regasification capacities growing at 6% per year

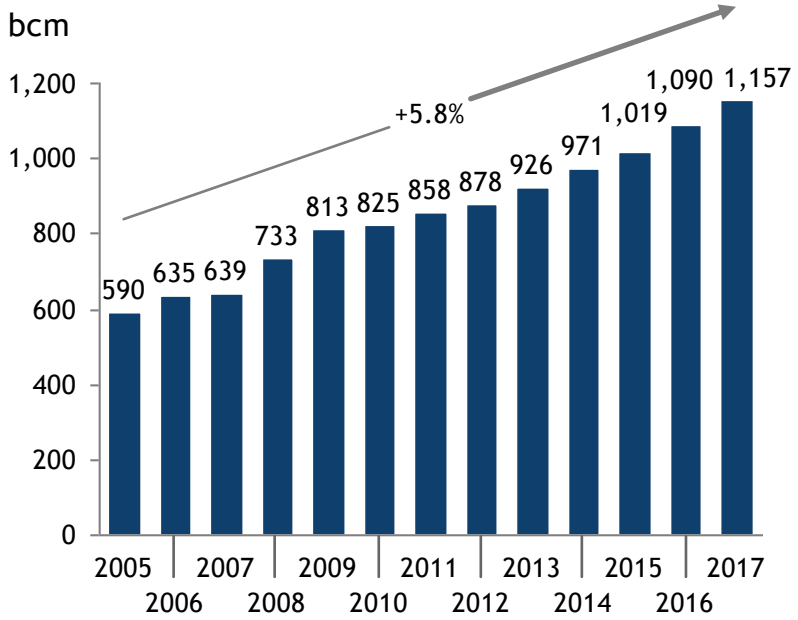
Global liquefaction capacity



Liquefaction Utilization[1] (%)	81	88	90	90	76	88	94	90	86	84	80	75	77

Decline driven by cap. increase in Asia/Oceania and Africa

Global regasification capacity

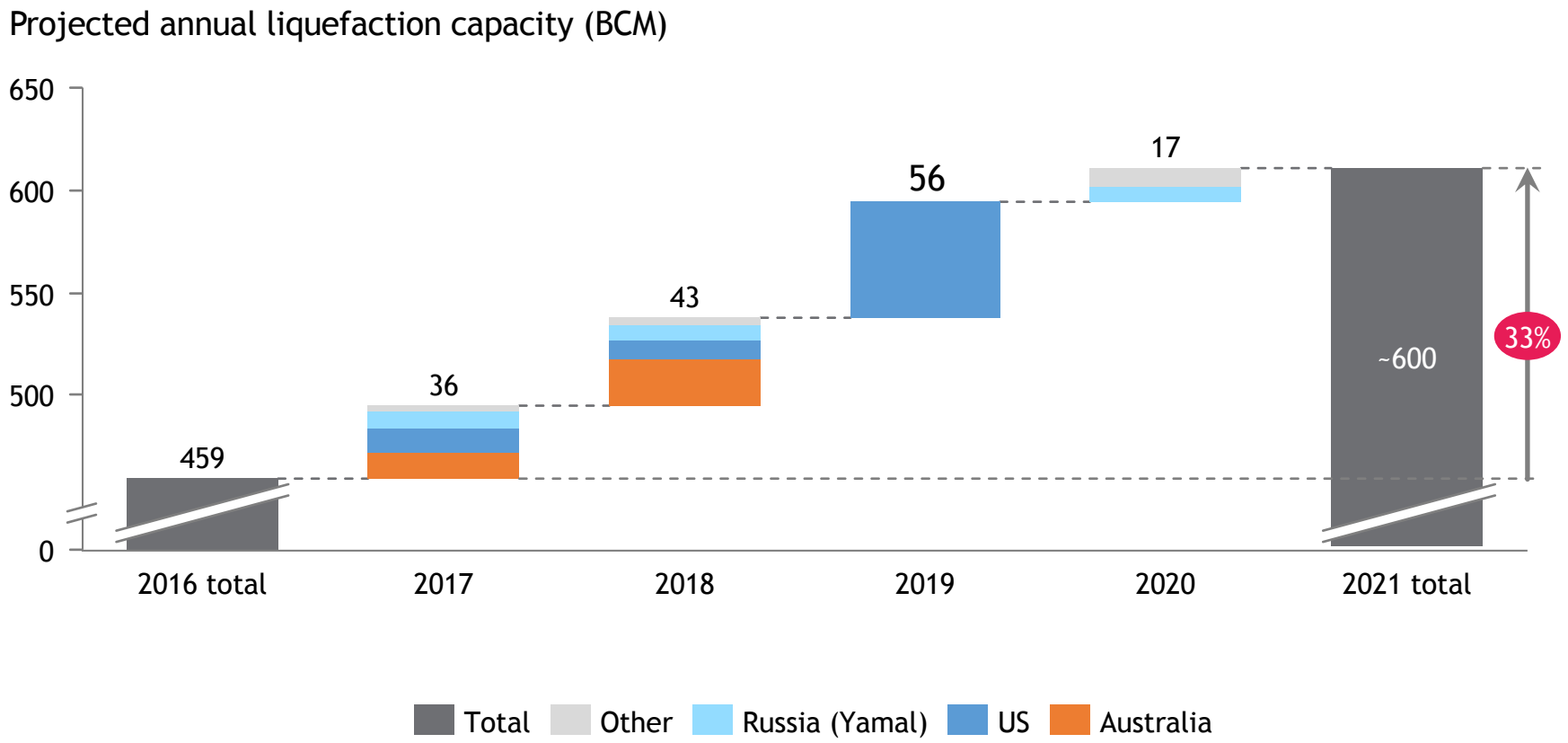


Regasification Utilization[2] (%)	33	33	36	31	30	36	38	36	34	33	32	32	34

Decline driven by Europe and N. America

1. Liquefaction utilization = LNG Exports/Liquefaction capacity * 100 2. Regasification utilization = LNG Imports/Regasification capacity * 100
Source: CEDIGAZ data (Trade, Plants, Terminals), IGU, BCG analysis

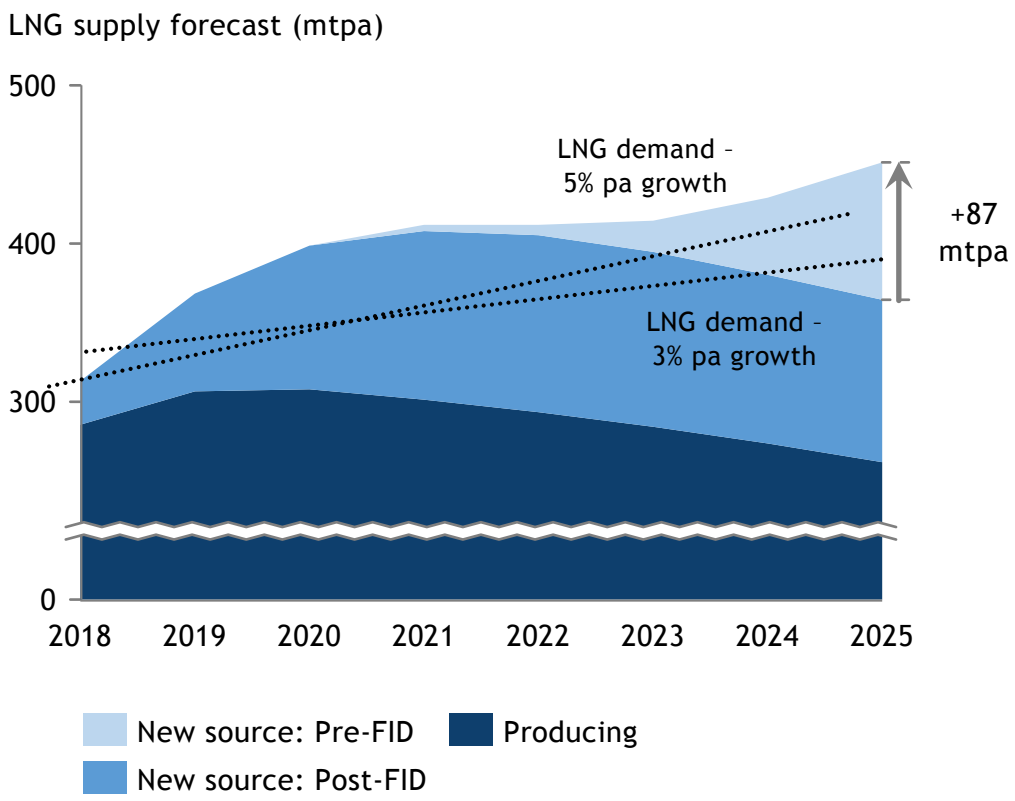
Global liquefaction capacity increasing by 1/3 from 2016-21



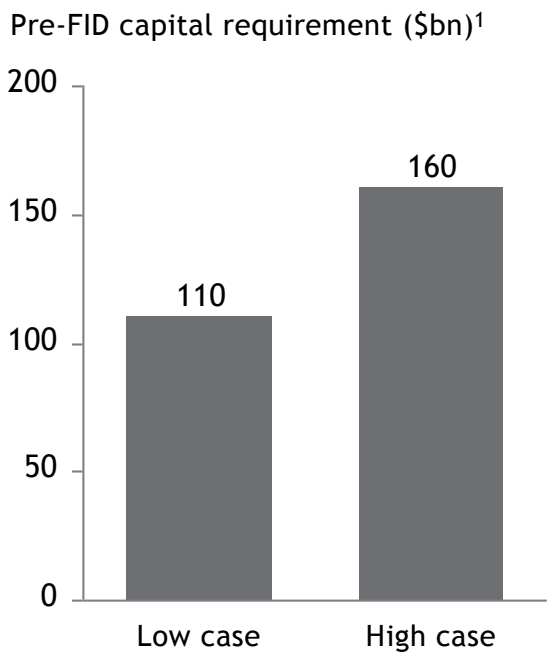
Source: Cedigaz, Platts, BCG analysis

More than $110bn of FIDs required for post-2025 LNG supply

Post-2022 LNG supply growth yet to be sanctioned...



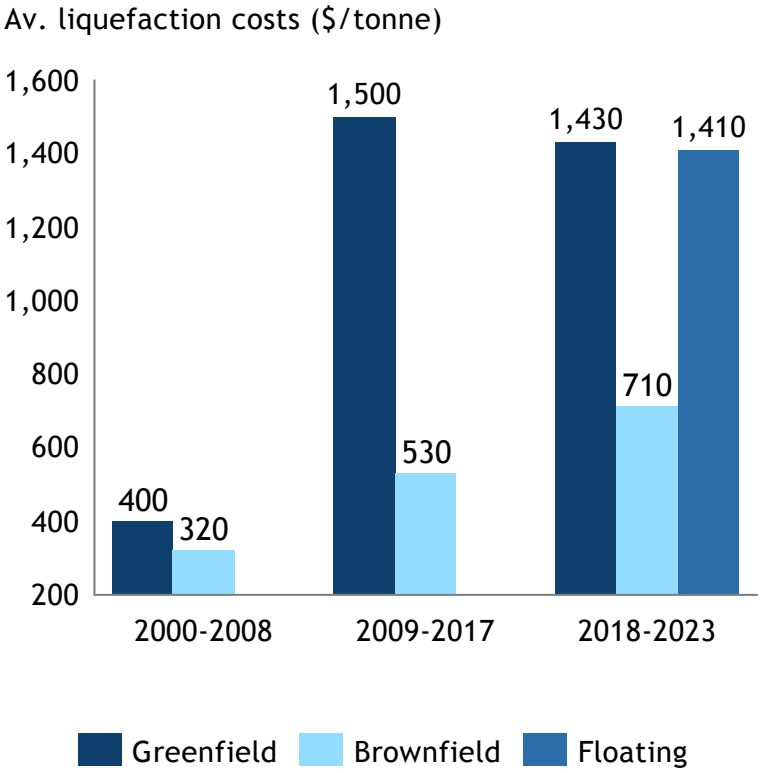
... Requiring $110-160bn capital



1.Only includes capex for liquefaction capacity - based on estimate range of $1,000-1,500/mtpa capacity
Source: Rystad, IHS, BCG analysis

Despite low cost imperative, LNG project costs expected to remain >$1k/tonne

Greenfield liquefaction costs expected to continue exceeding $1,500/tonne...



... Driven by further development of integrated, complex projects

Key drivers of capex escalation include:

- Full, integrated projects (not just liquefaction trains)
  - e.g. upstream costs, pipeline costs (US)
- Remote locations (e.g. Mozambique, Yamal, West Africa)
- Large, technically complex projects
  - Driving supply chain pressures

Note: Liquefaction costs are in real 2016 dollars
Source: IHS, BCG analysis

Agenda

LNG supply growth

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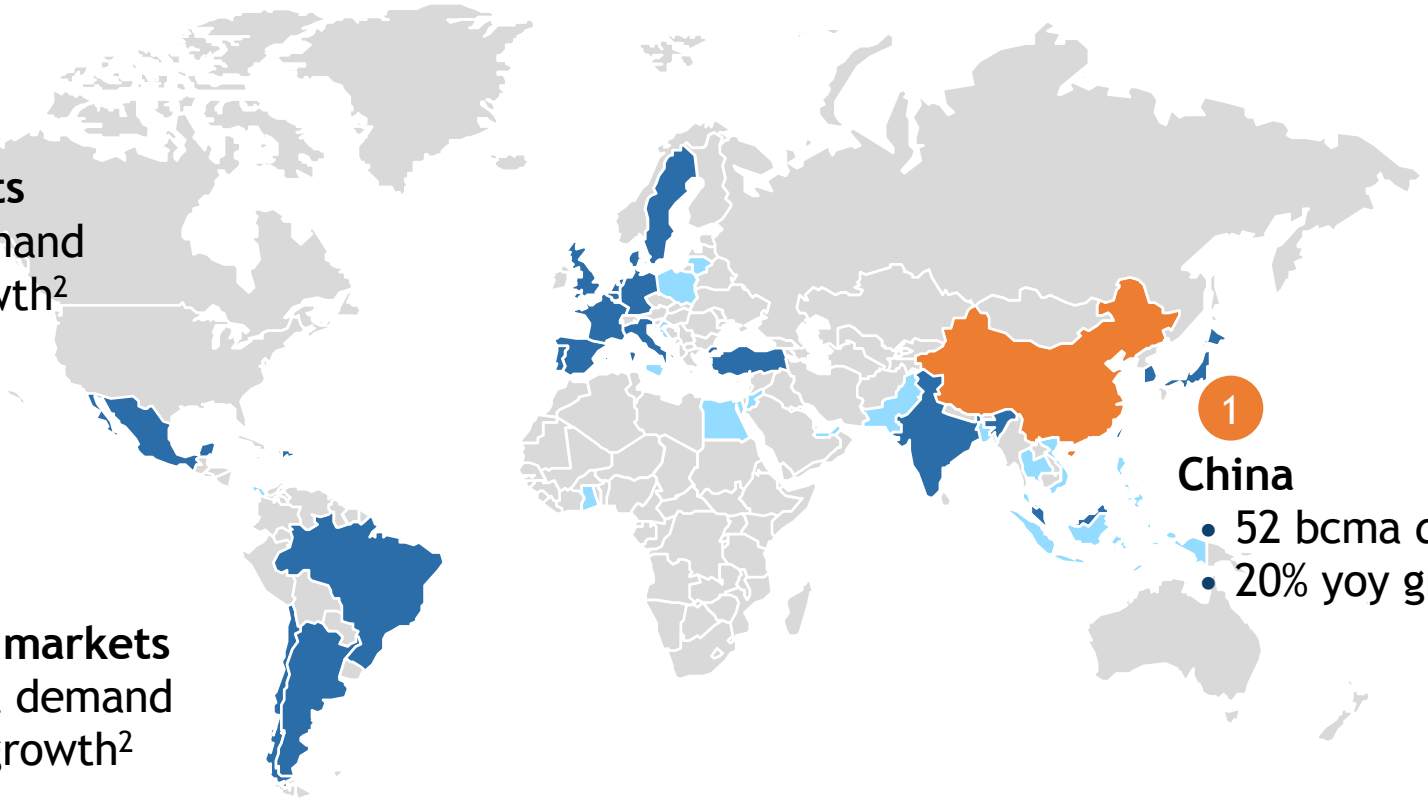
Questions for discussion

Three key sources of global LNG demand, with current growth led by China and "niche" markets



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"Niche"[1] markets

- 44 bcma demand
- 49% yoy growth[2]

1

China

- 52 bcma demand
- 20% yoy growth[2]

3

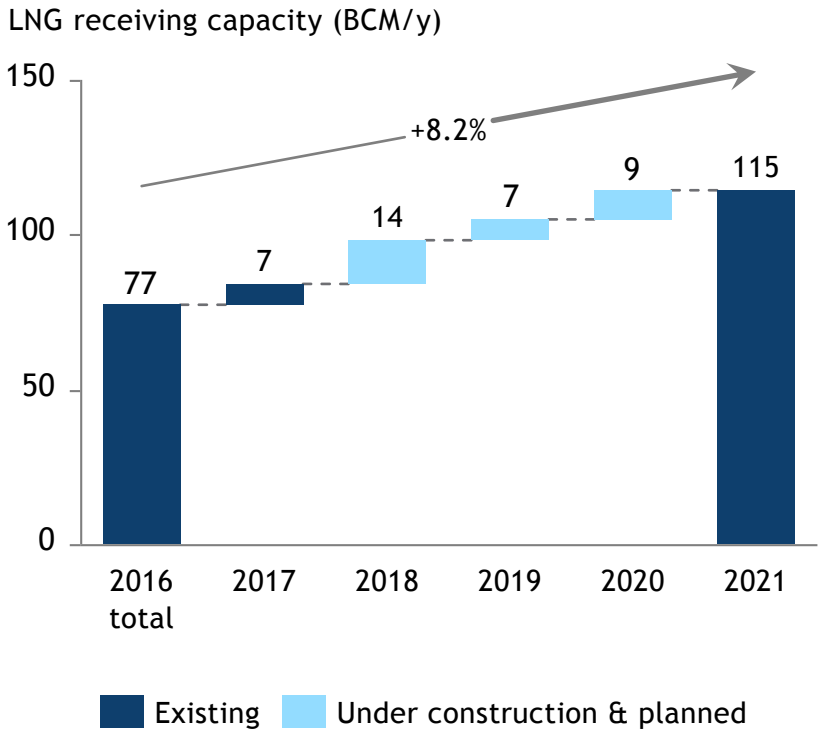
Established markets

- 288 bcma demand
- <1% yoy growth[2]

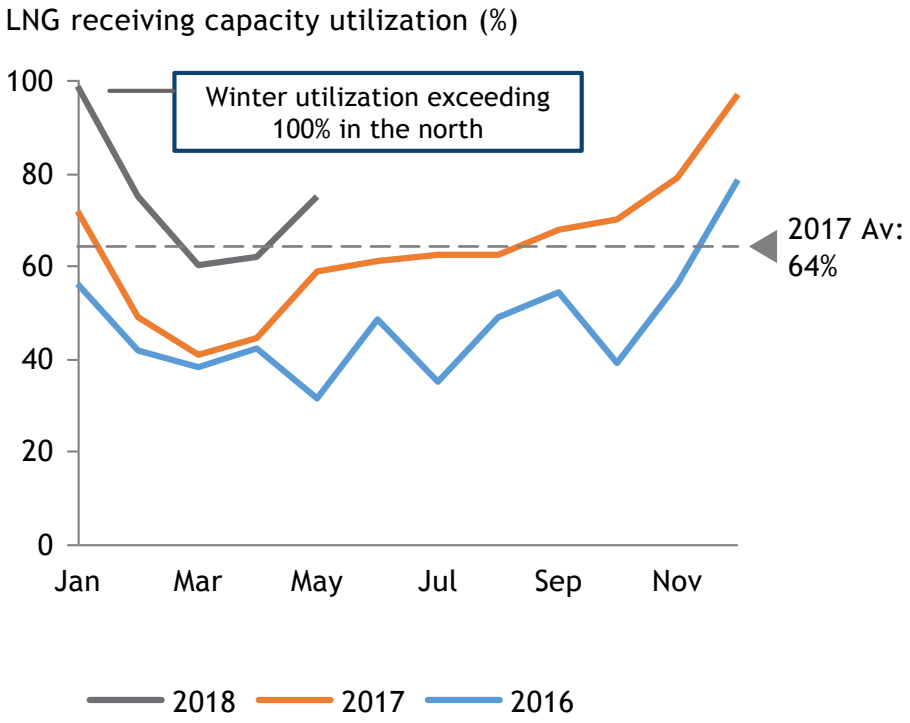
1. "Niche" markets defined as new LNG importers since 2009; 2. Average annual growth in LNG demand from 2013-17
Source: Cedigaz, BCG analysis

Chinese LNG import capacity growing rapidly, but still a constraint in winter

LNG receiving capacity growing 8%/yr to 2021



Capacity utilization increasing, but limited due to seasonality



Source: Cedigaz, China Customs statistics, BCG analysis

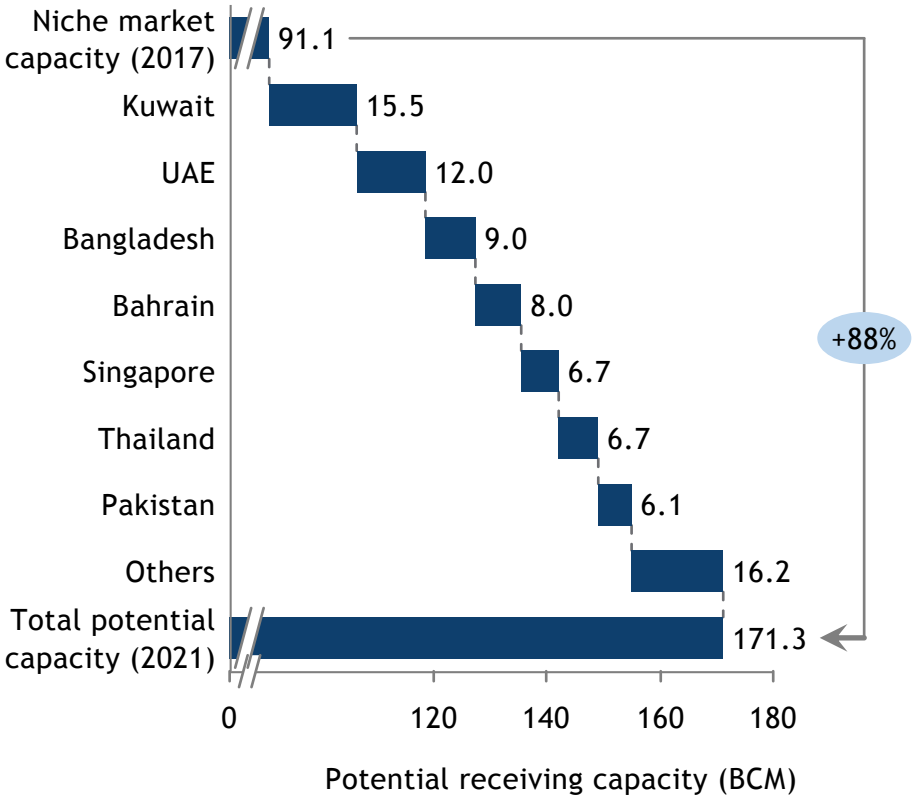
LNG "niche" markets are a key source of growth

Multiple new LNG niche markets since 2009

LNG imports (BCM)

Country	First LNG	2013	2016-17 av.
Kuwait	2009	2.2	4.9
UAE	2010	1.9	3.8
Thailand	2011	1.9	5.1
Indonesia	2012	1.8	3.9
Singapore	2013	1.2	3.5
Lithuania	2014	-	1.2
Pakistan	2015	-	5.4
Egypt	2015	-	9.1
Poland	2015	-	1.6
Jordan	2015	-	4.7
Jamaica	2016	-	0.4
Malta	2017	-	0.3
Bangladesh	2018	-	-
Total		**8.9**	**43.9**

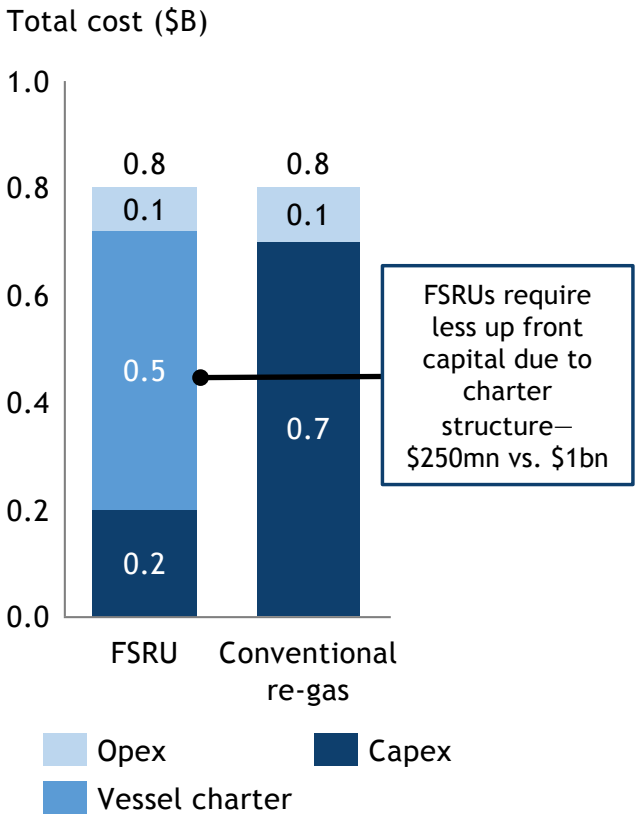
Niche market receiving capacity may nearly double by 2021



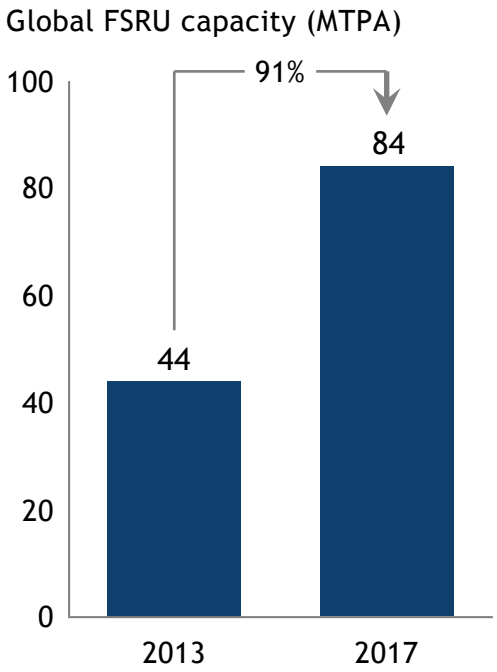
Source: Cedigaz, University of Columbia, BCG analysis

FSRUs are providing a lower cost, flexible way of diversifying gas supply for new LNG markets

FSRUs provide less capital intensive supply...



... FSRU capacity is growing...



... And is helping countries to diversify supply

Argentina: FSRUs quickly added 9bcma capacity to offset domestic production decline

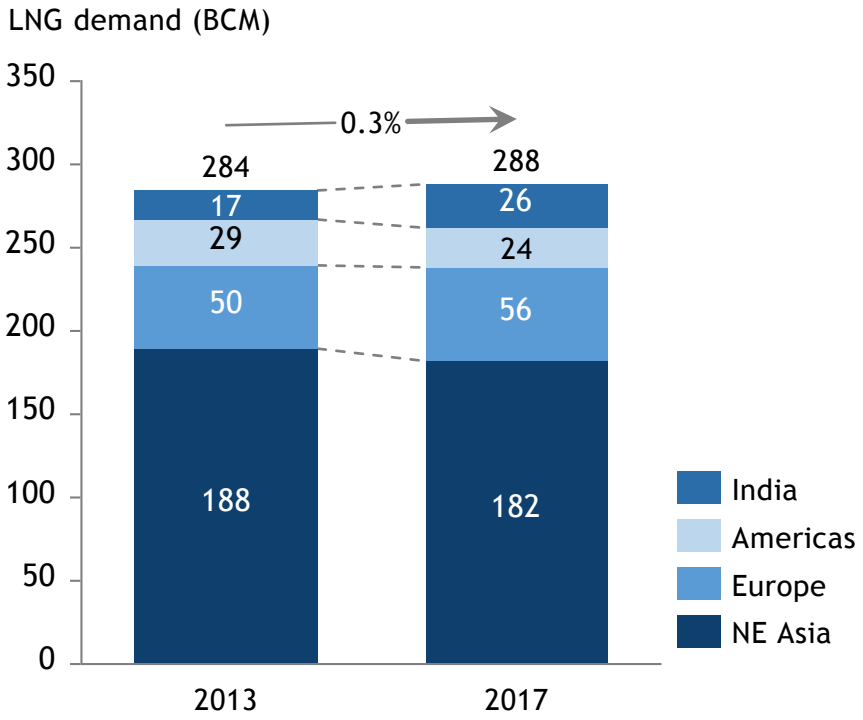
Jordan: FSRU capacity restored gas supplies after Egyptian imports dropped given domestic supply shortages

Bangladesh: Plans currently in place to develop FSRU import aligned with new CCGT plants

Source: IGU, BCG analysis

Growth among "established" LNG markets has been weak and faces headwinds

Established market LNG demand



Future drivers of LNG demand

NE Asia
- Japan: Nuclear restart
- Korea: Shift away from coal and nuclear
- Taiwan: Focus on coal-fired power gen.

India
- Policy-led adoption for cities and industrial use

Europe
- Accelerating shift away from coal
- LNG uncompetitive vs. pipeline supply

Americas
- Growing US pipeline exports
- Growing domestic supply in SA

Upside Neutral Downside

Note: "Established" markets defined as all LNG consumers existing prior to 2009, excluding China
Source: Cedigaz, BCG analysis

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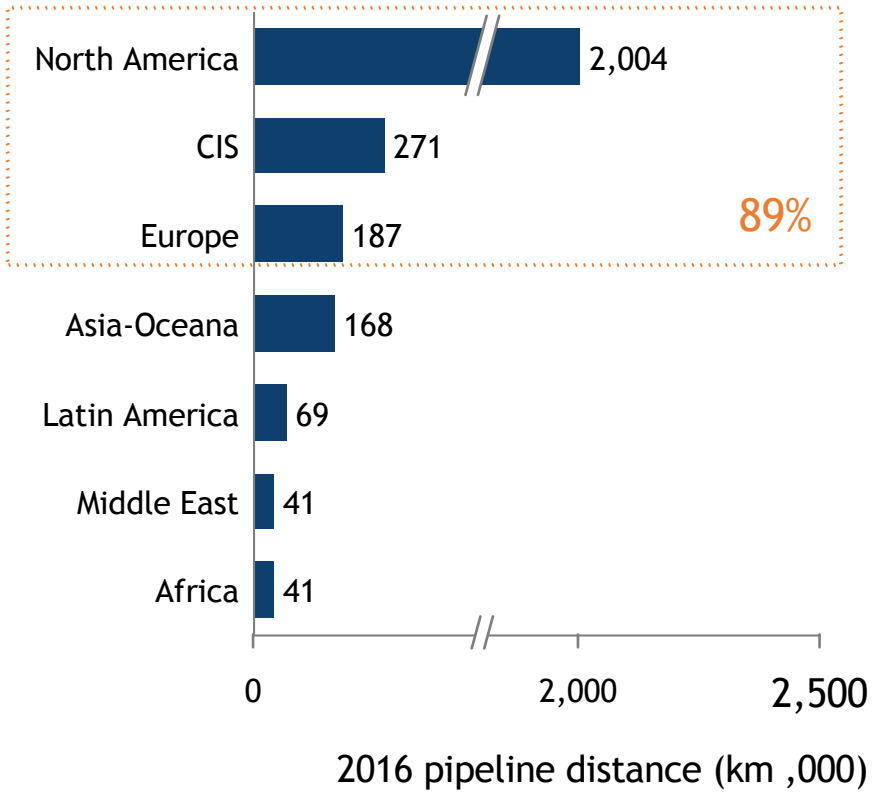
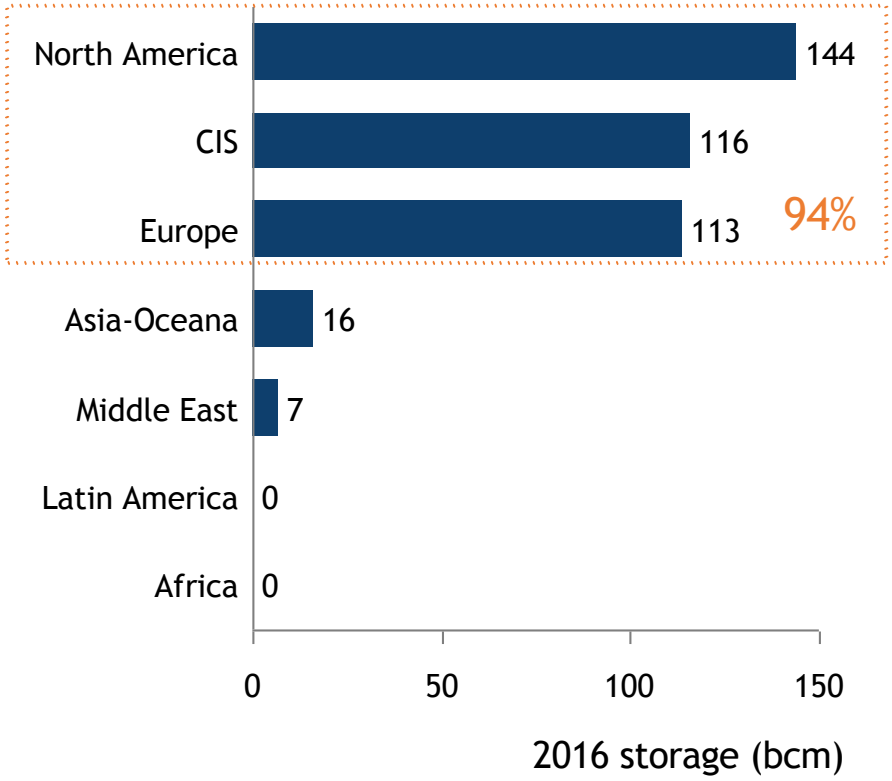
Gas pipeline and storage infrastructure is concentrated in North America & Europe

Total gas pipeline distance by region



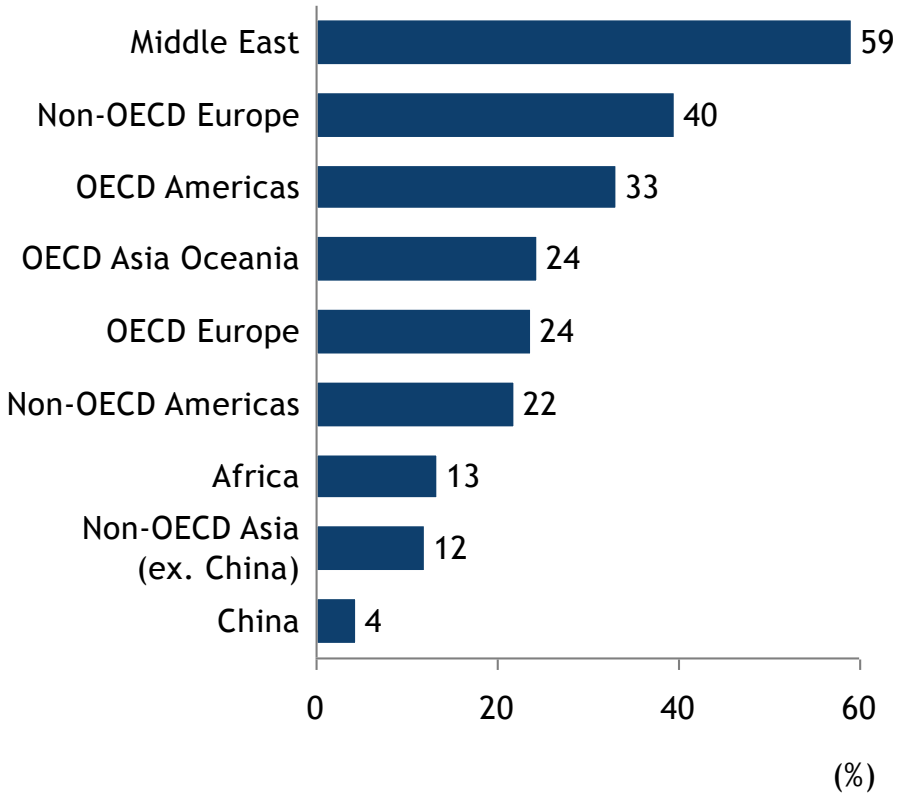
Underground storage capacity by region



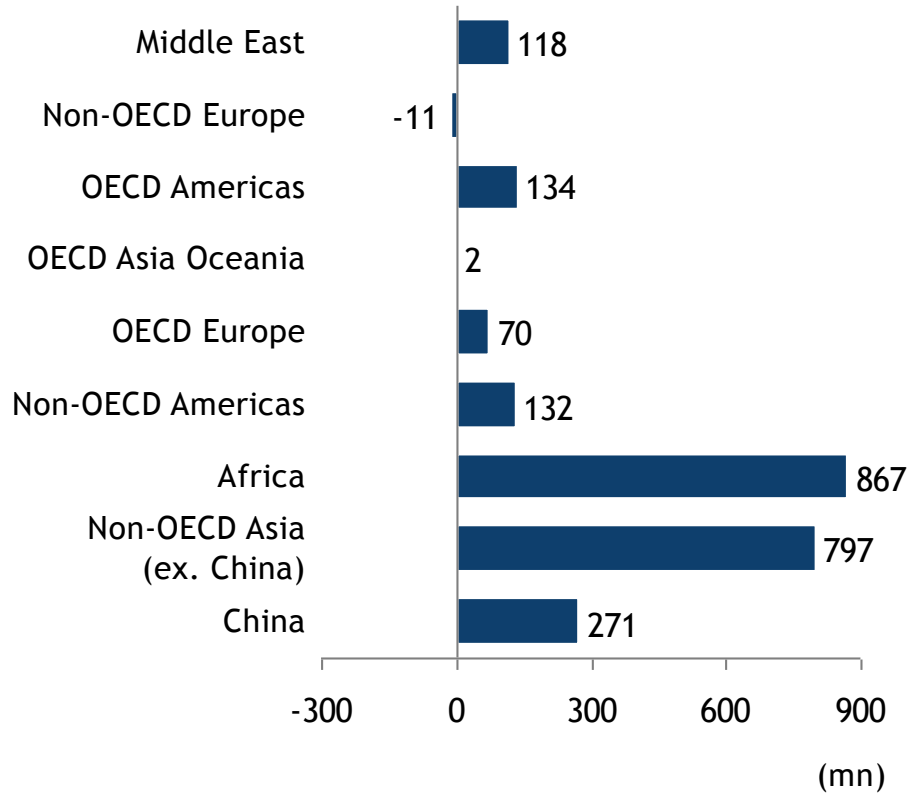
Source: Cedigaz, BCG analysis

Greatest urbanization will occur in regions with lowest gas penetration today

Gas share of energy consumption[1]



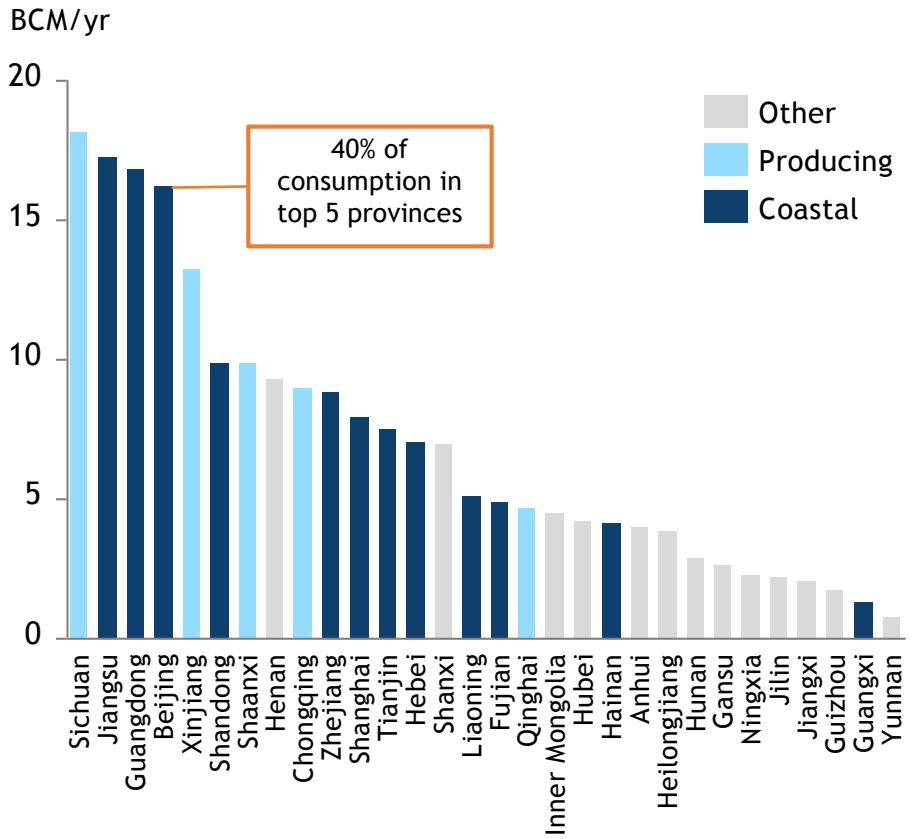
Projected urban population growth (2015-50)



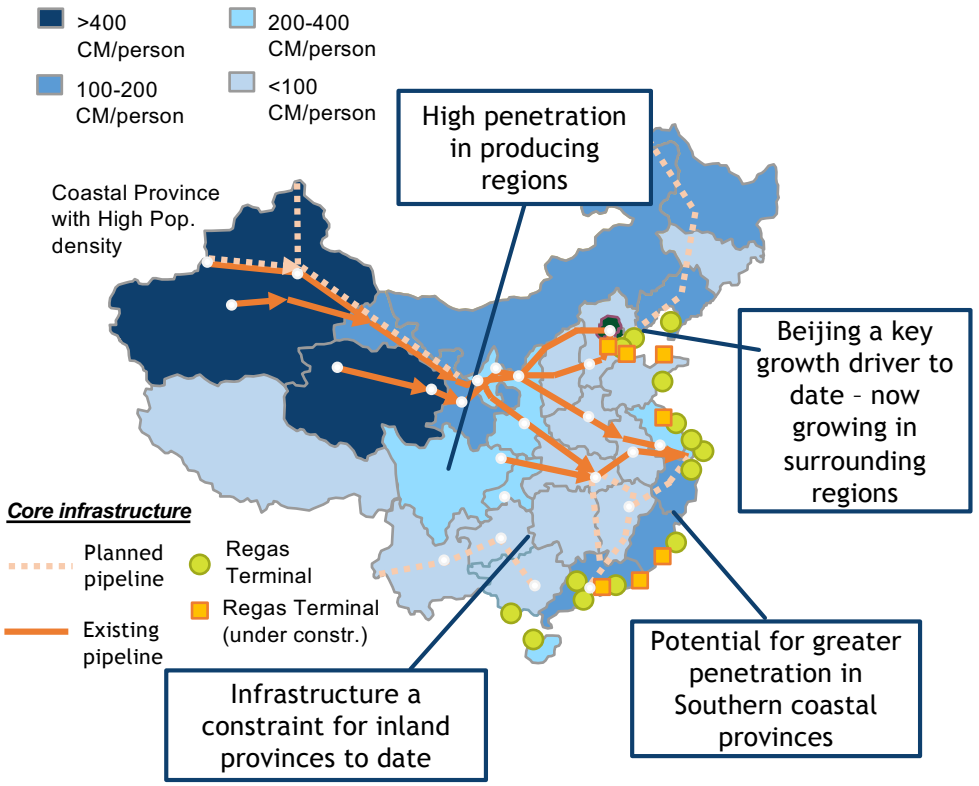
1. Includes weighted average of power generation, buildings, and industry sectors; based on 2015 data
Source: IEA, UN Population Division, BCG analysis

In China, infrastructure constraints limit gas consumption to coastal and gas producing provinces

Gas consumption by province (2016)



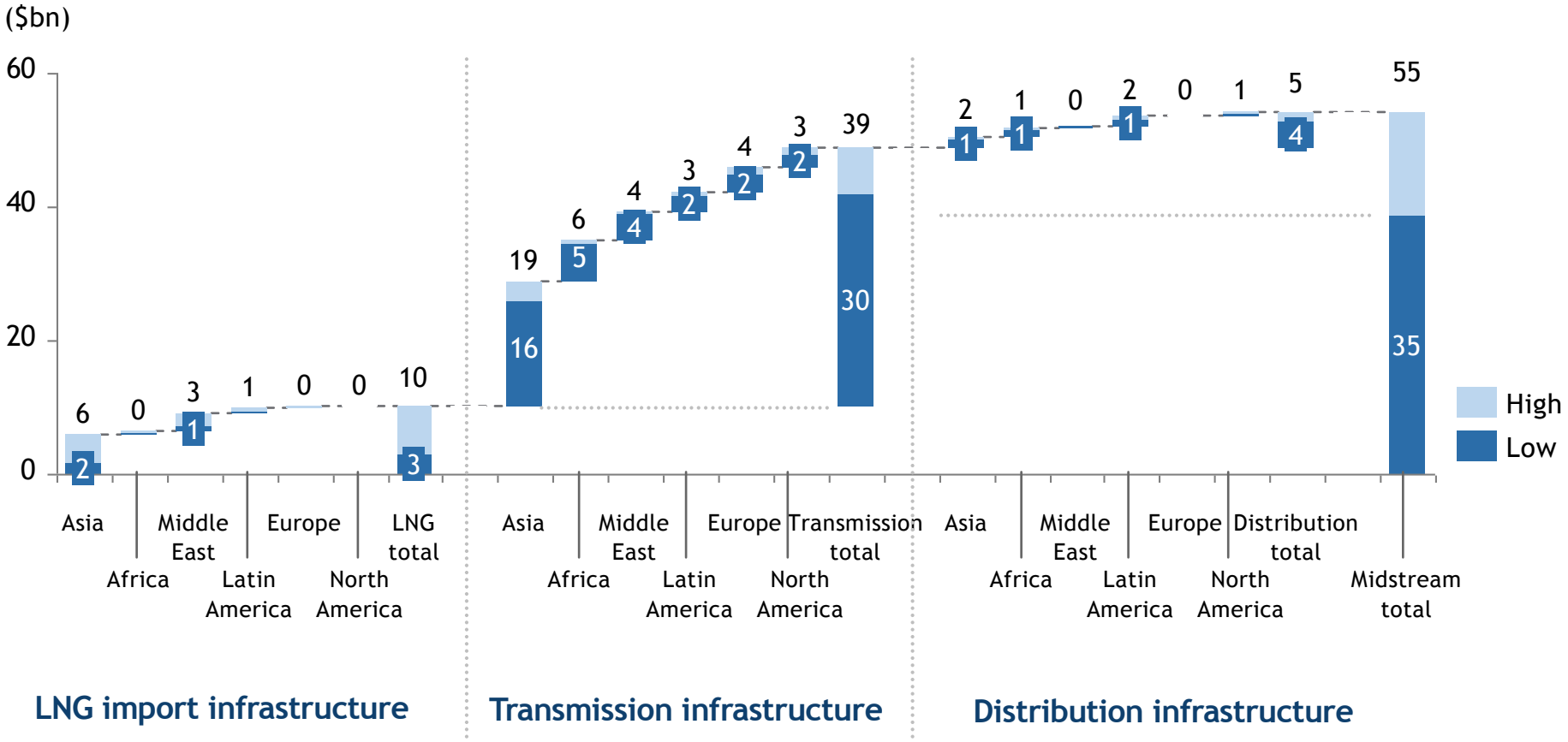
Gas consumption/GDP per province (2016)



Source: China NBS, BCG analysis

$35-55bn investment per year required to extend gas access to cities

Annual midstream gas investment required per year through 2040[1]



Requirement to achieve projected gas demand growth under IEA New Policies Scenario
Source: IEA, Douglas Westwood, BCG analysis

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Questions for discussion

1. Role of new sources of LNG supply
   - Does the global LNG market risk under-investment in supply by the mid-2020s?
   - Given recent price cyclicality, how can new LNG project developers ensure they will achieve acceptable returns?
   - What steps can industry and governments take to reduce LNG project costs?

2. Key drivers of gas market development
   - What markets/countries will drive the next wave of LNG demand growth?
   - What measures are needed to initiate the development of new gas markets?
   - How can new technologies and business models facilitate the development of new gas markets?

3. Accelerating gas infrastructure investment
   - Do small scale LNG and other new technologies provide an opportunity to leapfrog traditional gas infrastructure investment?
   - How can governments and industry facilitate investment in new gas infrastructure?
   - What financing tools can be deployed to facilitate that investment?