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

IEF-IGU Gas Ministerial

22nd November 2018
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

Global regasification capacity

Liquefaction Utilization\(^1\) (%)

Regasification Utilization\(^2\) (%)

1. Liquefaction utilization = \(\text{LNG Exports} / \text{Liquefaction capacity} \times 100\)
2. Regasification utilization = \(\text{LNG Imports} / \text{Regasification capacity} \times 100\)

Source: CEDIGAZ data (Trade, Plants, Terminals), IGU, BCG analysis
Global liquefaction capacity increasing by 1/3 from 2016-21

Projected annual liquefaction capacity (BCM)

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…

- LNG supply forecast (mtpa)
  - LNG demand - 5% pa growth
  - LNG demand - 3% pa growth
  - +87 mtpa

… Requiring $110-160bn capital

Pre-FID capital requirement ($bn)$

- Low case: 110
- High case: 160

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

**LNG market growth**

Gas infrastructure requirements

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

1. China
   - 52 bcma demand
   - 20% yoy growth

2. "Niche" markets
   - 44 bcma demand
   - 49% yoy growth

3. Established markets
   - 288 bcma demand
   - <1% yoy growth

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

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

Source: Cedigaz, University of Columbia, BCG analysis

Niche market receiving capacity may nearly double by 2021

Potential receiving capacity (BCM)
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

Source: IGU, BCG analysis
Growth among "established" LNG markets has been weak and faces headwinds

Established market LNG demand

Future drivers of LNG demand

Note: "Established" markets defined as all LNG consumers existing prior to 2009, excluding China
Source: Cedigaz, BCG analysis
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Questions for discussion
Gas pipeline and storage infrastructure is concentrated in North America & Europe

Total gas pipeline distance by region

<table>
<thead>
<tr>
<th>Region</th>
<th>2016 pipeline distance (km,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>2,004</td>
</tr>
<tr>
<td>CIS</td>
<td>271</td>
</tr>
<tr>
<td>Europe</td>
<td>187</td>
</tr>
<tr>
<td>Asia-Oceana</td>
<td>168</td>
</tr>
<tr>
<td>Latin America</td>
<td>69</td>
</tr>
<tr>
<td>Middle East</td>
<td>41</td>
</tr>
<tr>
<td>Africa</td>
<td>41</td>
</tr>
</tbody>
</table>

Underground storage capacity by region

<table>
<thead>
<tr>
<th>Region</th>
<th>2016 storage (bcm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>144</td>
</tr>
<tr>
<td>CIS</td>
<td>116</td>
</tr>
<tr>
<td>Europe</td>
<td>113</td>
</tr>
<tr>
<td>Asia-Oceana</td>
<td>16</td>
</tr>
<tr>
<td>Middle East</td>
<td>7</td>
</tr>
<tr>
<td>Latin America</td>
<td>0</td>
</tr>
<tr>
<td>Africa</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: Cedigaz, BCG analysis
Greatest urbanization will occur in regions with lowest gas penetration today

**Gas share of energy consumption¹**

- Middle East: 59%
- Non-OECD Europe: 40%
- OECD Americas: 33%
- OECD Asia Oceania: 24%
- OECD Europe: 24%
- Non-OECD Americas: 22%
- Africa: 13%
- Non-OECD Asia (ex. China): 12%
- China: 4%

**Projected urban population growth (2015-50)**

- Middle East: 118 mn
- Non-OECD Europe: -11 mn
- OECD Americas: 134 mn
- OECD Asia Oceania: 2 mn
- OECD Europe: 70 mn
- Non-OECD Americas: 132 mn
- Africa: 867 mn
- Non-OECD Asia (ex. China): 797 mn
- China: 271 mn

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)

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

LNG import infrastructure  | Transmission infrastructure  | Distribution infrastructure

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

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Questions for discussion
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?