Introduction

Current context

• Low gas prices across all markets are a result of low oil prices and the existent oversupply situation in key markets (LNG, US, Europe etc.)

• Natural gas demand could increase due to (1) it becoming more competitive in the current context of low prices, and (2) its lower emissions vs. other fossil fuels

• Nations are committed to arrest global warming; local air quality initiatives are also in play. Gas can support sustainability but global policy is necessary

Forum objectives

• To discuss the future prospects of natural gas demand

• To review the impact of gas & LNG trade with regards to market integration and regional gas markets

• To explore the impact of policy on the growth of the natural gas sector

Key Question: *What is the role for gas in an oversupplied market and in a world facing multiple challenges with regards to sustainability?*
Agenda

Gas/LNG demand growth

LNG supply as an integrating force

Sustainability needs a mind-shift

Putting it all together – key observations & questions
Natural gas: the greatest growth fossil fuel
Demand expected to be driven by non-OECD Asia

Predicted demand growth for natural gas leads other primary energy sources

Growth expected to be driven by non-OECD Asia

1. New Policies Scenario
Source: IEA, BCG LNG Market Model
Separation between the major future demand sinks and producing regions will necessitate the increased flow of LNG.

LNG flow expected to increase from 325Mtpa in 2015 to ~700Mtpa in 2035; gas demand becomes an LNG story.

Source: IEA WEO 2016
LNG demand is expected to grow at 5-6% p.a. between 2015 and 2025 under the base scenario.

Source: BP Statistical review of world energy, Cedigaz, WoodMackenzie, BCG analysis
China, India and Asean countries are the drivers of LNG future demand growth

Source: BCG LNG Market Model
More countries can join supporting a higher demand growth rate

- Jordan has deployed a FSRU LNG terminal
- LNG supplied via tendering
- Further CCGT capacity to be develop

- Development of more CCGTs
  - FSRU already in place

- Develop new LNG terminals and FSRU
  - Development of new CCGTs
  - CNG market will keep growing

- Development of FSRU CCGTs
  - Currently 4 LNG terminals proposed
    - EWC, Shell, First Gen Meralco

- Development of CCGTs
  - Potential market for transport and distribution

- Ninho makes hydro production went down and LNG imports are needed to supply CCGTs needs

- LNG plant is currently under construction
  - CCGTs will be developed fostering natural gas demand

- Development of CCGTs
  - Total consortium to develop 0.4bcma FRSU plant that is planned to reach 1bcma

- Development of CCGTs
  - Potential market for transport and distribution
  - At least 4 FSRU
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Putting it all together – key observations & questions
LNG supply is set to increase with 13 projects becoming operational in the next 3-5 years

### 13 projects with FID to come on line during the next 3-5 years

<table>
<thead>
<tr>
<th>Country</th>
<th>Project</th>
<th>Announced start up</th>
<th>Operator</th>
<th>Capacity (bcma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>AP LNG T1/T2</td>
<td>2015</td>
<td>Conoco</td>
<td>12.6</td>
</tr>
<tr>
<td>US</td>
<td>S. Pass T1-T5</td>
<td>2015-2018</td>
<td>Cheniere</td>
<td>31.5</td>
</tr>
<tr>
<td>Australia</td>
<td>Gorgon LNG</td>
<td>2016</td>
<td>Chevron</td>
<td>21.8</td>
</tr>
<tr>
<td>Malaysia</td>
<td>MLNG Train 9</td>
<td>2016</td>
<td>MLNG</td>
<td>5.0</td>
</tr>
<tr>
<td>Australia</td>
<td>Wheatstone</td>
<td>2016</td>
<td>Chevron</td>
<td>12.6</td>
</tr>
<tr>
<td>Malaysia</td>
<td>Kanowit</td>
<td>2016/18³</td>
<td>Petronas</td>
<td>3.8</td>
</tr>
<tr>
<td>Australia</td>
<td>Ichthys</td>
<td>2017</td>
<td>Total / Inpex</td>
<td>11.8</td>
</tr>
<tr>
<td>Australia</td>
<td>Prelude FLNG</td>
<td>2017</td>
<td>Shell</td>
<td>5.0</td>
</tr>
<tr>
<td>Russia</td>
<td>Yamal</td>
<td>2019</td>
<td>Novatek</td>
<td>23.1</td>
</tr>
<tr>
<td>US</td>
<td>Freeport T1-T3</td>
<td>2018</td>
<td>Freeport LNG</td>
<td>18.5</td>
</tr>
<tr>
<td>US</td>
<td>Cameron T1-T3</td>
<td>2018</td>
<td>Sempra</td>
<td>18.9</td>
</tr>
<tr>
<td>US</td>
<td>Cove Point</td>
<td>2018</td>
<td>Dominion</td>
<td>7.3</td>
</tr>
<tr>
<td>US</td>
<td>Corpus Christi LNG T1 T2</td>
<td>2018</td>
<td>Cheniere</td>
<td>12.6</td>
</tr>
</tbody>
</table>

### Recent FID activity has been heavily concentrated in the US

![Graph showing capacity committed with FID per year](#)

**Year of FID**

- **2011-2013**
  - Australia: 119 bcma
  - US: 66 bcma
  - Other: 23 bcma
- **2014-2015**
  - Australia: 64 bcma
  - US: 89 bcma
- **Total**
  - Australia: 185 bcma
  - US: 153 bcma
  - Other: 23 bcma

**Source:** CEDIGAZ, LNG consortiums, Wood Mackenzie, BCG LNG Market Model
Substantial additional capacity without FID

Source: Broker reports; BCG LNG Market Model
Strong risk of delays on new project developments, given the mismatch between development costs and LNG prices

Supply cost curve (FOB)

- **Existing**
- **FID**
- **Proposed**

Note: 2$/mmbtu have been deducted from DES prices in order to make them comparable with FOB prices

Source: BCG LNG Market Model
Substantial oversupply risk in the coming years
Driven by the ca.185 bcma of additional capacity expected to come on line in the next 3-5 years

Global LNG supply (@ 85% load factor)
- Low supply scenario
- Base supply scenario
- High supply scenario

Source: BCG Market Model
In a context of increased liquidity in the LNG market

Spot/short-term LNG volumes

bcma

1% 6% 13% 18% 27% >35% >35% % share of global LNG

Source: Cedigaz, Waterborne LNG reports, Quant, GIIGNL BCG analysis
LNG spot prices could continue registering low levels for the coming years

Argus LNG spot prices June 2014 – November 2016

$/mmbtu

Argus NEA Spot

Argus NWE Spot

Note: NEA = North East Asia. NWE = North West Europe
Source: Argus LNG
Western Europe hubs will act as a regulation valve for LNG
Western European markets have become liquid and hubs are the key price reference

European hubs are becoming liquid during the last decade

Evolution of traded volumes at the main Continental European hubs (bcm)

- 2006: 80
- 2009: 277
- 2012: 598
- 2014: 700

+0.30% p.a.

European hubs have become the key reference for gas prices in Europe

Wholesale Gas Price Formation in Northwest Europe (%)

- 2005: 72%
- 2009: 56%
- 2012: 80%
- 2014: 88%

1. Information for 2014 traded volumes at TTF not reported by Prospex: 2014 TTF traded volumes estimated based on delivered volumes at TTF
Source: Prospex, Gasunie Transport Services, IGU
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LNG supply as an integrating force

*Sustainability needs a mind-shift*

Putting it all together – key observations & questions
**COP21 was a step forward towards sustainability and climate change mitigation**

Signed agreement sets ambitious goals...  

<table>
<thead>
<tr>
<th><strong>Hybrid agreement framed</strong></th>
<th><strong>... benefitting all key parties involved</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Legally binding</strong></td>
<td><strong>Governments</strong></td>
</tr>
<tr>
<td>Transparency and accountability: Submitting an emissions reduction target (INDCs) and regularly review that goal</td>
<td>• The Paris Agreement was adopted; it has legal force</td>
</tr>
</tbody>
</table>
| Burden sharing: Legal obligation on developed countries to continue to provide climate finance to developing countries  
  • Details about the mechanism moved out of the legally binding agreement | • Other bilateral financial agreements were also made during the conference, including pledges to the Green Climate Fund |
| **Not legally binding**     | **Investors & companies**                 |
| Emissions reduction: no formal enforcement mechanism at global level | • Climate commitment by over 2,000 companies and 400 investors |
| Financing mechanism: further negotiations required  
  • Countries should agree a “new collective quantified goal” from the floor of $100bn per year | • Long-term and more stable framework for investors; clear signal sent that the transition to a low-carbon economy is underway, and that governments intend on supporting the process |
| **NGOs & civil society**   | **Mention of a 1.5°C goal has been unexpected** |
| • There were also mentions of food security, humanitarian concerns and “ratcheting up” | |

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1. Intended National Determined Contributions  
Source: BCG analysis, KM (Climate and Energy Trends)
Current pledges are far off reaching 2°Celsius Scenario (2DS)

2DS requires GHG concentrations below 500ppm (450 is widely used as target)

Analysis based on 300 baseline and 900 mitigation scenarios in the literature

Climate action tracker provides 2.7°C as median value while Climate Interactive 3.5°C as of April 2016

Note: Unlike other short-lived species of GHG for which stable concentrations are associated with stable emissions, stable concentrations of CO₂ in the long-term require net emissions to decline to zero. Hence, a key metric to consider in evaluating potential future global warming is cumulative CO₂ emissions.

Source: BCG analysis; IPCC AR5 2014; Climate action tracker; Climate interactive
Action needs to be fast, global and radical

**Fast**
Asset base will last long

We need results by 2030, but assets lifetime and deployment are long, driving inertia

**Global**
Difficult non-OECD action

Change in emerging economies is necessary, and at odds with current economic development model

**Radical**
Regulatory action needed

Energy transition must accelerate, cannot rely on natural technology cycle only – regulation has to be part of it

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**CO2 Emission (GtCO2)**

- Curve needs to break
- Natural death of 2015 coal plant
- Current trajectory
- 2°C

**Fossil fuel demand (mtoe)**

- Non-OECD is 115% of demand increase
- Non-OECD: 4,290
- OECD: 6,376
- 2013 - 2040 New Policies
- Non-OECD: 14,415
- OECD: 20,021

**World TPED (mtoe)**

- 2013 - 2040 New Policies
- Non-OECD: 15,318
- OECD: 20,748
- Non-OECD is 115% of demand increase

For the first time in history, new source needs to replace old ones, not just cover the growth

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Note: asset lifetimes are subject to substantial longevity differences depending on region, specs, and economics. Lifetimes can be prolonged or shortened depending on commodity economics

Natural gas is the ideal bridge fossil fuel to support sustainability initiatives.

Economic attractiveness and less than half the CO2 of Coal

- **Levelized cost of energy**
  - Solar Thermal
  - Wind on-shore
  - Solar PV
  - Gas
  - Coal

- **CO2 emissions (KGCO2/MWh)**

In addition, natural gas is clean burning and will improve local air quality.

- **Emissions per BTU, Coal Equals 1**
  - NOx
  - SOx
  - PM 2.5

1. New Policies Scenario
Source: IEA, IGU Urban Air Quality Report, BCG LNG Market Model
A tale of two cities: natural gas' positive impact on air quality

Dublin's successful efforts to eliminate severe winter smog

Concrete action taken
- "Smoky Coal Ban" in 1990
  - Prohibited sale, marketing & distribution of bituminous coal
  - Drove NG in home heating, commercial and transportation use
- NG now >75% of energy share in residential with ~67% of households in Dublin using NG

Tangible results
- Reduction in CO, SOx, Benzene
- Smog eliminated
- PM concentrations fell between 80-90% from 1990 to 2014

Berlin's strides in improving air quality since reunification

Concrete action taken
- NG primary energy share increased from 17% (1990) to 41% (2010); coal fell 37% to 17%
- NG share in power increased to 37% and in district heating increased to 45% (2012)
- Lignite burning within coal mix reduced by ¾
- Coal furnaces for heating in commercial and residential sector dropped (400,000 to 40,000)

Tangible results
- From 1989 to 2015
  - SOx dropped by 95%
  - NOx decreased by 76%
  - PM$_{10}$ reduced by 83%

Source: IGU Urban Air Quality Report
Despite these advantages, left to its own devices non-OECD Asia will gravitate to coal

**The average power generation cost of coal/gas fired power plants (including capex & opex) (US cents/kWh)**

<table>
<thead>
<tr>
<th>Country</th>
<th>Gas</th>
<th>Coal</th>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>13.9</td>
<td>5.9</td>
<td><strong>Cost advantage for coal, new build focused on inland areas</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Closure of old coal city plants, growth in transmission ('coal by wire')</td>
</tr>
<tr>
<td>India</td>
<td>7.3</td>
<td>5.9</td>
<td><strong>Coal to remain dominant</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Focus on coal fired generation given concern on gas supply security</td>
</tr>
<tr>
<td>Indonesia</td>
<td>7.2</td>
<td>8.9</td>
<td><strong>Both coal and gas to gain share in power mix, coal to remain dominant</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Govt. promoting coal to reduce use of oil fuels, and gas shortage concerns</td>
</tr>
<tr>
<td>Thailand</td>
<td>7.5</td>
<td>6.2</td>
<td><strong>Share of coal in power mix to increase</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Govt. promoting coal – concern on gas supply security and higher gas prices</td>
</tr>
<tr>
<td>Malaysia</td>
<td>4.4</td>
<td>6.9</td>
<td><strong>Gas price reforms and coal supply security to decide share in power</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Gas plant cost advantage dependent on gas price reforms by Govt.</td>
</tr>
<tr>
<td>Vietnam</td>
<td>6.1</td>
<td>6.8</td>
<td><strong>Gas &amp; coal import prices to decide share in power, coal likely to dominate</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Currently 13 GW of coal plants being built, and only one gas plant (750 MW)</td>
</tr>
<tr>
<td>Philippines</td>
<td>8.4</td>
<td>8.4</td>
<td><strong>Share of coal in power mix to increase</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Coal based plants likely to have cost advantage as gas prices expected to rise</td>
</tr>
</tbody>
</table>

Source: Coal and gas competition in power generation in Asia, IEA Feb-15 ; Press search ; BCG analysis
Agenda

Gas/LNG demand growth
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Sustainability needs a mind-shift
Putting it all together – key observations & questions
Key observations

Natural gas is expected to experience the greatest growth among fossil fuels
- Growth is expected to be centered in Non-OECD Asia as well as niche markets (ME & South America)
- LNG to continue to gain dominance given future demand sinks located far from production sources

LNG expected to become more of an integrator of disparate markets
- LNG as a commodity is becoming more liquid
- Cross market flows are increasing (especially out-flows from HH)
- European market now liquid enough to act as a balancing mechanism for global LNG
- Increasing supply will further depress prices and increase liquidity

Sustainability issues becoming more prominent
- Both global climate change as well as local air quality issues are gaining importance
- Although the world is starting to recognize these issues, the current pace of change is not adequate

Natural gas is the ideal bridge fuel
- Due to its reduced emissions (CO2 and others) vs. other fossil fuels, together with its competitiveness
- However, despite this and the current favorable market environment, non-OECD Asia will gravitate to coal
Key questions

• Will lower prices stimulate demand as envisioned a decade ago?

• Will non OECD Asia deliver as per expectations?

• What consequences will the expected LNG oversupply have in the different regional markets?

• What will be the appropriate method for pricing gas?

• Will increased LNG market liquidity eventually result in prices linked across all regions (US-Asia-Europe)?

• With the backdrop of global sustainability, how can governments/industry come together to catalyze the transfer of resources and technology to the non-OECD world in short order?

• What role does natural gas have to play in this sustainability journey?

• How can industry & governments move towards making natural gas a more favorable fuel of choice for non-OECD Asia?