Plenary Session 2:
Natural gas: Market and policy hurdles to the golden age of gas

Background Paper
Disclaimer

The observations presented herein are meant as background for the dialogue at the 7th Asian Ministerial Energy Roundtable. They have been prepared in collaboration with The Boston Consulting Group and should not be interpreted as the opinion of the International Energy Forum or The Boston Consulting Group on any given subject.
Introduction

Market context

- Asia is home to the world’s largest new gas consuming markets, and counts among its number the world’s most rapidly growing economies that seek to embrace the “Age of Gas”
  - Despite already high growth rates, infrastructure and market hurdles remain

- Liquified Natural Gas technologies have made global gas markets more competitive

- As Asia weighs the costs and benefits of gas bilateral producer-consumer relations built up over the past decades have never been more critical for longer term gas market security

Session objectives

- Discuss which policy and market levers will enable gas to shape healthy and affordable energy matrices in support of clean energy technologies to underpin sustainable growth and development in Asia

- How will Ministers help enhance gas market penetration, and overcome market and policy hurdles to achieve healthier energy matrices in Asia?

Key Question:
How can hurdles be overcome in the Gas sector in Asia?
Contents

What is the future role of natural gas globally?

What is the natural gas balance in Asian Pacific (APAC) countries?

Key questions and discussion
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.

World wide regional Natural gas balance 2014-2035 (Mtoe)

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.

2015 Global LNG demand projections between 2015 and 2025

Source: BP Statistical review of world energy, Cedigaz, WoodMackenzie, BCG analysis
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 developed

- 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 CCGTs
  - Potential market for transport and distribution

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

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

- 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
There are also three new market segments that has potential to increase natural gas consumption

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Marine transport</th>
<th>Road transport</th>
<th>Off-Grid and small scale LNG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulatory Compliance</td>
<td>• Emissions Control Areas (ECA)</td>
<td>• Euro VI</td>
<td>• Environmentally friendly emissions with lower carbon content</td>
</tr>
<tr>
<td>Economic</td>
<td>• Fuel pricing, compliance, and reduced maintenance costs</td>
<td>• Fuel pricing, compliance, and reduced maintenance costs</td>
<td></td>
</tr>
<tr>
<td>Practical</td>
<td>• Technological advances in LNG bunkering</td>
<td>• Natural gas engines operate at lower noise levels – facilitating access to urban zones</td>
<td>• A means of creating gas distribution networks where no pipeline supply current exists</td>
</tr>
<tr>
<td>Market potential 2030</td>
<td>• 120-180bcma</td>
<td>• 400-600bcma</td>
<td>• ~40bcma power</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 30-50bcma industry</td>
</tr>
</tbody>
</table>
A new 'bullish' industry consensus has emerged on the growth of gas between now and 2035

Key global gas consumption growth forecasts

Gas expected to be the fastest growth fossil fuel, surpassing coal by 2035

Non-OECD Asia is a critical driver of global gas growth

Projected gas consumption growth to 2040 (2016 IEA NPS)

Annual gas consumption (BCM)

- Global total
- Americas
- Africa
- Europe/CIS
- Bunkers
- Asia

Non-OECD Asia: 739 bcm or 43% of total growth

Source: IEA, BCG analysis

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But natural gas consumption growth has been slower than anticipated

Gas consumption growing slower than anticipated...

... Though gas has started to gain share against coal since 2014

Annual gas consumption growth rate (%)

<table>
<thead>
<tr>
<th></th>
<th>Global consumption</th>
<th>OECD consumption</th>
<th>Non-OECD consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010-2015</td>
<td>1.8</td>
<td>0.9</td>
<td>2.6</td>
</tr>
<tr>
<td>Actual growth</td>
<td>1.5</td>
<td>0.7</td>
<td>2.2</td>
</tr>
</tbody>
</table>

Share of global energy mix by fuel (%)

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2014</th>
<th>2016 (est.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas</td>
<td>21.9</td>
<td>21.9</td>
<td>22.3</td>
</tr>
<tr>
<td>Coal</td>
<td>29.2</td>
<td>29.5</td>
<td>27.7</td>
</tr>
</tbody>
</table>

... And for different drivers than the ones anticipated by the golden gas era

WEO 2010 Expected growth by region

Real demand growth by region

Greater growth than expected in domestic N. Am & ME consumption; Asia growth driven in large part by Japan
As actual gas consumption was growing less than forecasted, projections have been lowered.

IEA – World Gas Demand Forecasts

World Gas Demand (Bcm)

ASEAN governments have set very ambitious targets for renewable energy penetration but more policy support is needed.

<table>
<thead>
<tr>
<th>Country</th>
<th>Hydro</th>
<th>Solar PV</th>
<th>Wind</th>
<th>Geothermal</th>
<th>Biomass</th>
<th>Tidal</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>5.3 GW in 2016, 18 GW by 2025</td>
<td>80 MW in 2016, 5 GW by 2020</td>
<td>7 MW in 2016, 100 MW by 2025</td>
<td>1.6 GW in 2016, 12.6 GW by 2025</td>
<td>n/a</td>
<td>n/a</td>
<td>25% of generation by 2025^2</td>
</tr>
<tr>
<td>Malaysia</td>
<td>30 MW^5 in 2016, 490 MW^6 by 2020</td>
<td>295 MW in 2016, 1 GW by 2020</td>
<td>n/a</td>
<td>n/a</td>
<td>124.39 MW¹ in 2016, 1.4 GW by 2020</td>
<td>n/a</td>
<td>11% of generation by 2020^4</td>
</tr>
<tr>
<td>Singapore</td>
<td>n/a</td>
<td>126 MW in 2016, 350 MW by 2020</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>8% (no date)</td>
</tr>
<tr>
<td>Philippines</td>
<td>3.6 GW in 2016, 9 GW by 2030</td>
<td>0.4 GW in 2016, 0.6 GW by 2030</td>
<td>490 MW in 2016, 2.3 MW by 2030</td>
<td>2 GW in 2016, 3.5 GW by 2030</td>
<td>290 MW in 2016, 315 MW by 2030</td>
<td>70 MW by 2030</td>
<td>3.5 GW in 2016, 15 GW by 2030 (50% power mix)</td>
</tr>
</tbody>
</table>

1. Includes biogas and municipal waste. 2. Share from primary energy of renewables sources. 3. Share from final energy of renewables sources. 4. Share of renewables in generation mix. 5. Mini-hydro only.

On the other hand, forecasts have often been over pessimistic on renewable deployment.

### World New Policies Scenario forecast

<table>
<thead>
<tr>
<th>Year</th>
<th>GW</th>
<th>+35%</th>
<th>+20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2025</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2030</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Non-OECD New Policies Scenario

<table>
<thead>
<tr>
<th>Year</th>
<th>GW</th>
<th>+26%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>2025</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2030</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Source: IEA WEO 2012-2016

Renewable in Non-OCDE countries to lead renewable deployment.
Energy efficiency policies and cheap coal have also reduced natural gas demand growth

1. Due to low CO2 prices
Source: CERA, BCG analysis

...With renewable and Coal pants competitiveness¹

1. Efficiency
2. Electrification
3. Energy
4. Electricity

Energy Security in the Transition-Towards A New Paradigm

From Efficiency

To Electrification

Renewables (wind and solar)
Low Demand
Coal Plants
CCGT
Is natural gas use in the transport sector also being over-optimistic given the EV outlooks?

---

**Global light duty vehicle fleet**

Cars on the road (M)

2,000
1,500
1,000
500
0

2015 2020 2025 2030 2035 2040

ICE Fleet  EV Fleet

**Annual global EV sales by market**

Cars per year (M)

80
60
40
20
0

2015 2020 2025 2030 2035 2040

Rest of Europe  Germany  China  US

France  Japan  UK  Rest of World

Source: Bloomberg new energy finance
Contents

What is the future role of natural gas globally?

What is the natural gas balance in APAC countries?

Key questions and discussion
Natural gas demand has soared (>6% CAGR) in APAC region since the beginning of this century.

Natural gas demand by country in APAC region 2000-2015

1. Papua New Guinea, Philippines, Brunei, and Myanmar
   Source: Cedigaz
APAC countries natural gas supply and demand is diverse, which stimulates cross border trade and investment.

Source: Cedigaz
APAC countries can be identified by 4 supply and demand balance categories

APAC countries production, consumption and trade in 2015

Source: BCG analysis and Cedigaz
Japan shut down most of the nuclear fleet after Fukushima, but is now considering restarts

Japanese reactors fleet

- PWR
  - Applied for restart: 12
  - Stopped for inspection: 12
  - Genkai 3/4 (Kyushu)
  - Ikata 3 (Shikoku)
  - Ohi 3/4 (Kansai)
  - Sendai 1/2 (Kyushu)
  - Takahama 3/4 (Kansai)
  - Tomari 1/2/3 (Hokkaido)
  - No indication or Fault not active or Fault likely to be associated with an active fault
  - Ikata 2 (Shikoku)
  - Takahama 1/2 (Kansai)
  - <=32 years: 1
  - >32 years: 10
  - Hamaoka 4 et 5 excluded due to Chubu's hostility to nuclear+ problem of public acceptance

- BWR
  - Applied for restart: 7
  - Cold shutdown: 1
  - Stopped for inspection: 12
  - Oragawa 3 (Tohoku)
  - Oragawa 2 (Tohoku)
  - Shika 2 (Hokuriku)
  - Shimane 2 (Chugoku)
  - Hamaoka 4 (Chubu)
  - Hamaoka 5 (Chubu)
  - <=25 years: 1
  - >25 years: 1
  - <=12 years: 2
  - >12 years: 7

1. under the criteria of this model this should not be consider for re-start, nevertheless due to other reasons they have been included (extended life) 2. these are particular cases as they are both pretty younge reactors economically profitable

Source: BCG Nuclear Power Model.
METI has already published an outlook which is optimistic on Efficiency, Renewable, LNG, Nuclear, and Clean Coal

Electric power demand

- Through energy efficiency and conservation 196.1 billion kWh
  (17% lower than before the implementation of the energy conservation measures)
- Economic growth 1.7%/year

<table>
<thead>
<tr>
<th>Year</th>
<th>Electric power</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY2013</td>
<td>966.6 billion kWh</td>
</tr>
<tr>
<td>FY2030</td>
<td>980.8 billion kWh</td>
</tr>
</tbody>
</table>

Power source mix

- (Power transmission distribution loss, etc)
- Energy efficiency and conservation and renewable energy account for 40%

<table>
<thead>
<tr>
<th>Power Source</th>
<th>FY2030 (Total power generation) 1,065 billion kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable</td>
<td>22 to 24%</td>
</tr>
<tr>
<td>Nuclear</td>
<td>20 to 22%</td>
</tr>
<tr>
<td>LNG</td>
<td>27%</td>
</tr>
<tr>
<td>Coal</td>
<td>26%</td>
</tr>
<tr>
<td>Oil</td>
<td>3%</td>
</tr>
<tr>
<td>Geothermal</td>
<td>1.0 to 1.1%</td>
</tr>
<tr>
<td>Biomass</td>
<td>3.7 to 4.6%</td>
</tr>
<tr>
<td>Wind</td>
<td>1.7%</td>
</tr>
<tr>
<td>Solar</td>
<td>7.0%</td>
</tr>
<tr>
<td>Hydro</td>
<td>8.8 to 9.2%</td>
</tr>
<tr>
<td>Biomass</td>
<td>3.7 to 4.6%</td>
</tr>
<tr>
<td>Wind</td>
<td>1.7%</td>
</tr>
<tr>
<td>Solar</td>
<td>7.0%</td>
</tr>
<tr>
<td>Hydro</td>
<td>8.8 to 9.2%</td>
</tr>
</tbody>
</table>

Renewables will grow mostly on account of Solar PV and Hydro

Note: Values are approximate
Renewable technology may challenge coal and gas technologies in Japan if a Carbon tax is added.

Total cost of power generation in Japan by source
Carbon tax estimated @ 2000¥/ton

Note: METI could try to add a carbon tax in order to meet 27% emission reduction target
Source: Macquarie Research Japan's energy choices
No urgency for new LNG long term contracts in Japan
Current long term contract volume exceeds expected demand 2018-21

Long-term LNG supply contracts (>4 years) in Japan, 2013-2025 (mtpa)

Demand does not account for nuclear re-start

METI 2030 LNG contracting target

The country's top-8 consuming companies make up ~80% of the long-term contracted volume in 2013-2018

1. Includes traditional Japanese producers (INPEX, JAPEX) as well as corporations/trading houses (Mitsubishi, Mitsui, Toshiba, Itochu, etc.)
2. Includes Chukoku Electric, Okinawa Electric and Shikoku Electric’s contracts
3. Essentially includes the contracts of Shizuoka Gas, Saibu Gas, Hokkaido Gas, Nippon Gas, Hiroshima Gas and Sendai Gas

Source: GII, company annual reports, broker reports; BCG analysis
China will also have a surplus of contracted LNG from 2016

Supply contracts VS expected LNG needs 2011-2023

Surplus from 2016 onwards

1. Demand based on bottom-up forecast of needs for each of Gas Distribution, Storage and transmission, Commercial, Residential, Petrol. E&P, Power, District heating, Transport, Industry; minus expected local gas supply
Source: BCG analysis, Cedigaz, UBS, Deutsche Bank, Rystad
China and multiple policy measures driving rapid growth of gas across all sectors

Multiple policies supporting gas consumption are in place

Coal boiler conversation to gas
• Target conversation of 200k coal boiler units to natural gas

New residential connections
• Target to increase penetration from 35% to 85%, adding >120m new connections

Incentives for CNG/LNG for transport
• Discounts provided on prices in gas price formula
• Gas consumption of cars targeted to more than double from 2014 to 2020

New 5 year plan prioritizing gas power
• Targeting 44GW of new gas-fired capacity...
• ... Though also targeting 200GW of new coal capacity

Despite a higher price vs. coal, policy makers have supported a greater role for gas in China

Source: CEDIGAZ data (Terminals and Plants), IEA data (Natural gas balance), analyst reports, BCG analysis
China gas consumption has outpaced domestic production growing at over 10%
Gas demand is expected to double over the next decade driven by the use of clean fuels in industries.
Share of imports expected to increase to almost 50% by 2025; pipelines imports play an increasingly important role

China Gas Supply by Source 2011-25

Source: China National Bureau of Statistics, Morgan Stanley, BCG Analysis
Indian gas sector has witnessed a slowdown over the last five years as domestic production fell significantly.

**Share of natural gas in energy basket, %, 2010-15**

<table>
<thead>
<tr>
<th>Year</th>
<th>Coal</th>
<th>Oil</th>
<th>Natural Gas</th>
<th>Electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010-11</td>
<td></td>
<td></td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>2011-12</td>
<td></td>
<td></td>
<td>11%</td>
<td></td>
</tr>
<tr>
<td>2012-13</td>
<td></td>
<td></td>
<td>9%</td>
<td></td>
</tr>
<tr>
<td>2013-14</td>
<td></td>
<td></td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>2014-15</td>
<td></td>
<td></td>
<td>7%</td>
<td></td>
</tr>
</tbody>
</table>

**India natural gas reserves, BCM, 2010-15**

<table>
<thead>
<tr>
<th>Year</th>
<th>BCM</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010-11</td>
<td>1,142</td>
</tr>
<tr>
<td>2011-12</td>
<td>1,167</td>
</tr>
<tr>
<td>2012-13</td>
<td>1,172</td>
</tr>
<tr>
<td>2013-14</td>
<td>1,199</td>
</tr>
<tr>
<td>2014-15</td>
<td>1,252</td>
</tr>
<tr>
<td>2015-16</td>
<td>1,227</td>
</tr>
</tbody>
</table>

**India natural gas production, MMSCMD, 2010-15**

<table>
<thead>
<tr>
<th>Year</th>
<th>MMSCMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010-11</td>
<td></td>
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<tr>
<td>2011-12</td>
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<td>2015-16</td>
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**India natural gas consumption, MMSCMD, 2010-15**

<table>
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<tr>
<th>Year</th>
<th>MMSCMD</th>
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<td>2011-12</td>
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<td>2012-13</td>
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<td>2013-14</td>
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<tr>
<td>2014-15</td>
<td></td>
</tr>
<tr>
<td>2015-16</td>
<td></td>
</tr>
</tbody>
</table>

Source: Ministry of Petroleum and Natural Gas

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Demand impacted by low ability of affordable natural gas for key sectors; Future growth comes from City Gas Demand (CGD)

India Gas Demand by Sector, 2011-25

MMSCMD

Power Sector  Fertilisers  Petchem/Refineries/International Cons.  CGD  Industrial  Sponge Iron/Steel

2011-12  166  148  121  115  131  136  142  149  156  163  171  179  188  198
2012-13  148  121  115  131  136  142  149  156  163  171  179  188  198
2013-14  121  115  131  136  142  149  156  163  171  179  188  198
2014-15  115  131  136  142  149  156  163  171  179  188  198
2015-16  131  136  142  149  156  163  171  179  188  198
2016-17  136  142  149  156  163  171  179  188  198
2017-18  142  149  156  163  171  179  188  198
2018-19  149  156  163  171  179  188  198
2019-20  156  163  171  179  188  198
2020-21  163  171  179  188  198
2021-22  171  179  188  198
2022-23  179  188  198
2023-24  188  198
2024-25  198

CAGR

Power  0.5%
Fertilizers  3.3%
Petchem/Refineries/International Cons.  4.3%
CGD  9.5%
Industrial  6.3%
Sponge Iron/Steel  3.6%

Source: Ministry of Petroleum and Natural Gas, BCG Analysis
Regulated pricing structure resulted in significant decline in domestic production and consumption.

- Regulated price structure resulted in artificially low domestic prices...
- Specific regulated pricing structure for domestically produced natural gas...
- Resulting in significant gas production decline...
- And declining consumption

Source: India Ministry of Petroleum and Natural Gas, BCG analysis
Gas supply expected to rise significantly if TAPI is confirmed; Share of domestic gas to go below 30%

India Natural Gas Supply from Source, 2011-2025

TAPI Pipeline

- TAPI will run 1,800 km, starting from Turkmenistan (through Afghanistan, Pakistan to at Punjab India)
- Pipeline will carry 90 MMSCMD of gas with India, Pakistan, and Afghanistan originally set to have received 38, 38, and 14 MMSCMD respectively
- Construction of pipeline work in Turkmenistan has already been awarded to a Chinese Firm
- The pipeline is expected to be completed by 2019 and may change paradigm of gas sector in India

Source: Ministry of Petroleum and Natural Gas, BCG Analysis
**Indonesian natural gas market suffers from a geographical supply/demand mismatch**

**Overview and challenges**

**Geographical supply/demand mismatch**
- Many small fields in remote and distributed locations
- Present pipeline capacity insufficient to deliver demand: Need to use LNG domestically

**Significant "costly" reserves with mixed qualities require high investment**
- Future potential lies in non-conventional gas reserves - CBM and shale gas
- High level of CO₂ in main fields

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**Natuna holds the largest reserves**
- Largest reserve: 1.4Tcm
- Problematic commercial potential due to high level of CO₂

**Most recent discoveries are in East Indonesia**
- Coalbed Methane (CBM) est. potential resources 12Tcm
- Mostly deep water projects

**Java accounts for 67% of consumption**
- Indonesian economic concentration accounts for 67% of energy consumption but far from main gas fields
- 3 LNG terminals but no sufficient pipeline infrastructure

**NG accounts for 16% of energy consumption**

Indonesia energy split 2015(%)

- Petroleum: 33%
- Coal: 16%
- Natural Gas: 16%
- Renewable: 34%
- Total: 100%

Source: Regulatory reform in the Indonesian Natural Gas Market Aldi Hutagalung, Maarten Arentsen and Jon Lovett University Of Twente 201, EIA, iGU
Indonesia is a large scale natural gas producer and exporter

C.60% of production consumed domestically

Consumption: mostly industrial and power

Exports: mostly LNG to Asia

Geographical mismatch between production and consumption and lack of pipeline infrastructure forces Indonesia to consume LNG domestically

Source: BP Statistical Review of World Energy June 2013; EIA, PGN Indonesia’s Gas Transportation and Distribution Infrastructure: The Perspective of PGN 2013

AMER7-Session-2-Natural-Gas-Market-2017-IEF.pptx
Malaysian natural gas market divided in 3 distinct areas

Malaysian market divided into 3 areas

Key highlights about industry structure

216 gas fields discovered in total

Sarawak is the largest production area, and is the only LNG export gateway in Malaysia
- The world's largest LNG complex w. ~27.6 mtpa capacity: MLNG Satu (3 trains), Dua (3 trains), Tiga (3 trains)

Peninsula Malaysia represents ~86% of consumption, with gas distributed via 'PGU'
- 'Peninsular Gas Utilization' pipeline: ~2500 km

No pipeline linking the Peninsula with East Malaysia, causing supply-demand mismatch and the need to import
- Despite being an LNG exporter, Malaysia imports gas via pipeline from Indonesia, Vietnam and Thailand
- Additionally, Malaysia imports LNG, although they expect to avoid this from 2016, when the country’s first floating LNG facility is ready to supply the Peninsula from Sarawak

First LNG regasification facility completed in 2012 in Melaka for supplying the Peninsula
- 2 more confirmed, and 1 being contemplated

Joint-Development Area (JDA) set up by Malaysia and Thailand in 1979 for E&P on the overlapping continental shelf claimed by both countries (north-east of Peninsula)
- 0.3Tcm of proved plus probable natural gas reserves

Source: Malaysia Economic Monitor - Harnessing Natural Resources, June 2013; Maybank, Malaysia sector update 2012 - data on map refers to 2011, except demand which refers to 2010; EnergyQuest; press search; EIA
Malaysia is a large natural gas producer, and the 3rd largest LNG exporter in the world, since Australia surpassed it lately.

**63.1 Bcm natural gas produced of which 52% for export in 2015**

- **Production**: 63.1 Bcm, 31.2 Bcm (48%)
- **Consumption**: 31.2 Bcm (48%)
- **Export**: 35.0 Bcm (52%)

Despite being a large exporter, import is necessitated by a supply-demand mismatch.

**All export goes to Asia, with Japan making up ~60% in 2015**

- **Japan**: 21 Bcm (62%)
- **Other**: 5 Bcm (13%), 4 Bcm (9%), 3 Bcm (1%), 0 Bcm (0%), 33 Bcm (100%)

**Reserves** – 2.7Tcm, #13 in the world

**Production** – 63.1Bcm, #12 in the world

**Exports** – 33.4Bcm, #3 of LNG in the world

Source: Cedigaz
Gas represents ~40% of domestic energy consumption, power generation stands as the main gas consumer.

43% of energy came from NG in 2014 ...

% of total energy consumption, 2014

... with 46% dedicated to power generation

(Mtoe)% of domestic gas consumption, 2014

Source: IEA world energy balance 2016
Despite being a large exporter with material resources, Malaysia has recently become a gas importer.

Energy consumption very heavily focused on densely-populated Peninsula Malaysia...  
...but gas resources most strongly focused in Sarawak¹...

With local demand outstripping supply, imports have gained importance:
- With the first LNG regas terminal in Melaka, other LNG suppliers will be able to access the Malaysian market under TPAs.
- 2 more LNG regasification facilities confirmed: 1 on the Peninsula and 1 in Sabah. 1 more contemplated for the Peninsula.
- Additionally Malaysia expects to finish their first floating LNG facility by 2015.
- LNG imports, however, expected to cease by 2016, as Malaysia will supply the Peninsula with LNG from Sarawak.
- The expected decrease in LNG available for exports will cause PETRONAS to have to use LNG production from elsewhere in the world to meet their long term export contracts.

1. Government planning to develop industries in Sarawak to use local resources (petrochem and aluminum).
Source: Maybank, Malaysia sector update 2012 - data refers to 2011, except demand which refers to 2010; EnergyQuest; Reuters.

AMER7-Session-2-Natural-Gas-Market-2017-IEF.pptx
Thailand: Upstream reserves and production

Proved reserves have declined 40-50% between 2002 and 2015

Around 70% of Thailand's upstream production is gas

Note: Proved reserve includes only quantity of petroleum which is has a clear production plan approved by the Government and is expected to be commercially viable. 1bbl of condensate is equivalent to ~0.9bbl of crude oil; 1mmcf of gas is equivalent to ~174.5bbl of oil. Exclude JDA production

Source: EPPO, Department of Mineral Fuels (DMF), BCG analysis
Thailand is running out of gas and no new development is expected

Expected reserves evolution 2015-2035

Expected production profile 2015-2035

Source: Rystad
Thailand: Evolution of energy demand mix

Primary Energy Demand by Fuel Type (Mtoe) from 2006 to 2015

<table>
<thead>
<tr>
<th>Year</th>
<th>Renewables¹</th>
<th>Coal</th>
<th>Oil</th>
<th>Natural gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>7</td>
<td>2</td>
<td>14</td>
<td>30</td>
</tr>
<tr>
<td>2007</td>
<td>14</td>
<td>2</td>
<td>32</td>
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<td>2008</td>
<td>15</td>
<td>2</td>
<td>44</td>
<td>34</td>
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<tr>
<td>2009</td>
<td>14</td>
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<td>50</td>
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<tr>
<td>2010</td>
<td>15</td>
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<td>46</td>
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<td>2011</td>
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<td>3</td>
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<td>2012</td>
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<td>2014</td>
<td>18</td>
<td>3</td>
<td>53</td>
<td>47</td>
</tr>
<tr>
<td>2015</td>
<td>18</td>
<td>3</td>
<td>57</td>
<td>48</td>
</tr>
</tbody>
</table>

¹ Includes hydro, nuclear, geothermal, wind, tidal, bio-energy and solar energy

Source: BP Statistical Review, BCG analysis

2006-15 CAGR (%)
- Renewables¹: 5.6%
- Coal: 10.8%
- Oil: 2.9%
- Natural gas: 5.3%
Thailand energy outlook counts on renewables and energy efficiency to curb emissions and import dependency

Blueprint scenario primary Energy demand 2015–35

<table>
<thead>
<tr>
<th>Year</th>
<th>Nuclear</th>
<th>Hydropower</th>
<th>Renewables</th>
<th>Natural gas</th>
<th>Solid fuels</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>42%</td>
<td>2.2%</td>
<td>39%</td>
<td>40%</td>
<td>37%</td>
</tr>
<tr>
<td>2020</td>
<td>39%</td>
<td>2.2%</td>
<td>40%</td>
<td>37%</td>
<td>35%</td>
</tr>
<tr>
<td>2025</td>
<td>37%</td>
<td>2.2%</td>
<td>40%</td>
<td>37%</td>
<td>35%</td>
</tr>
<tr>
<td>2030</td>
<td>35%</td>
<td>2.2%</td>
<td>37%</td>
<td>37%</td>
<td>35%</td>
</tr>
<tr>
<td>2035</td>
<td>35%</td>
<td>2.2%</td>
<td>37%</td>
<td>37%</td>
<td>35%</td>
</tr>
</tbody>
</table>

CAGR (%)

- Energy Efficiency Plan: Decrease energy intensity by 30% vs 2010
- Alternative Energy Development Plan: Renewable energy to achieve 20%
- Power Development Plan: Improve generation mix keeping a 15% reserve and accounting for environmental cost
- Gas plan: Reduction in power generation use and improve supply
- Oil plan: Manage change to biofuels and renewables energy while increasing oil quality standards

Source: Thailand Energy Outlook 2016
Natural gas demand in Thailand will be reduced from previous plans towards ~1% growth

Source: PTT Analyst Meeting 1H2017
LNG seem to be the only solution for Thailand to meet natural gas demand

Thailand gas supply forecast 2017–30

Note: Assumptions: Base on 5 year plan production, Domestic supply (2P) excluding the expiring blocks (3P+2C), Keep production after end of two majors concession at 1,500 MMSCFD JDA and Myanmar base on keep production expanding to the end of contract
Source: Minister of Energy Thailand; Producer Consumer Cooperation towards Developing LNG Market in Asia
Low natural gas prices are one of the risks faced to develop new reserves and accomplish gas import plans.

**JKM vs Thailand pooled price recent evolution**

![Graph showing the price evolution of JKM vs Thailand pooled prices from QI 2014 to QII 2017.](graph)

- **Pooled gas price**
- **JKM**

**2 FSRU terminals proposed to complement Map Ta Phut**

- Map ta phut I
  - 8.6 bcm
  - 2022

- Map ta phut II
  - 10 bcm
  - 2022

- Songkhla
  - 3 bcm
  - 2022

Source: PTT analyst meeting several presentations, Cedigaz and Bloomberg
Contents

What is the future role of natural gas globally?

What is the natural gas balance in APAC countries?

Key questions and discussion
Challenges to enhance gas market penetration in APAC region

Key questions

1. Greater LNG market integration among the world’s three main regional gas markets – North America, Europe, and Asia will impact price formation and contracts globally
   - How can Asian Ministers cooperate to enhance natural gas liquidity on gas trading hubs?
   - What are the prospects for long-term contracts, destination clauses, and oil indexation in Asia?
   - How will Ministers facilitate cross border and downstream gas infrastructure investment?

2. Greater natural gas market flexibility comes with new risks and opportunities
   - How do Asian Ministers evaluate gas market security in terms of storage, connectivity, and spare capacity?
   - What role can the Joint Organization Data Initiative Play to improve natural gas market data transparency?
   - Will greater gas market flexibility result in more volatile gas prices?

3. Upstream gas sector investment, deeper downstream gas penetration and market security in Asia will continue to depend on well established, and new producer consumer country relations
   - How can the IEF platform be used to advance gas market integration in Asia?
   - Should Ministers set new benchmarks to help industry to retain efficiency gains and lower cost of transportation?
   - How is digitalization affecting gas sector costs and industry performance?

4. Despite comparatively high prices for importers, Asia’s appetite for natural gas is robust to overcome pollution and capitalize on its versatility across economic sectors
   - How can Ministers strengthen the value proposition of gas in Asian markets?
   - What lessons have been learned from carbon pricing and subsidy reforms?
   - Are synergies between renewables and natural gas markets sufficiently explored?