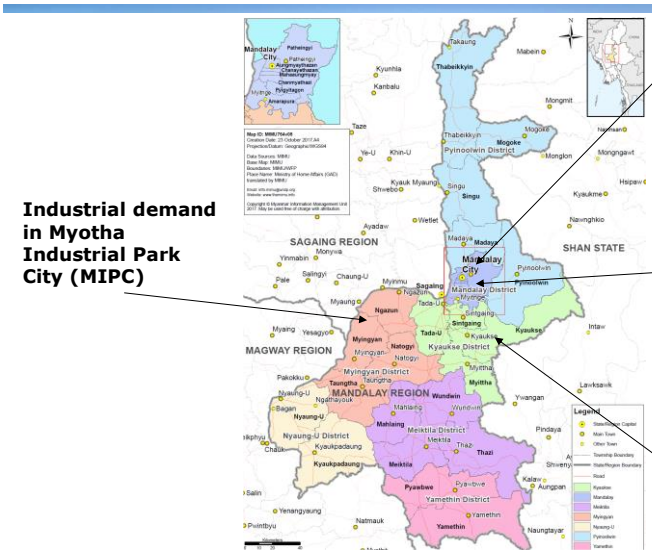
Appendix 1

Trip schedule

2

- 30 July 2018 (Mandalay)
  - Government of Mandalay region (Energy Department and Industry Department)
  - Industries in Kyaukse (three cement factories)
- 31 July 2018 (Mandalay)
  - Mandalay Myotha Industrial Park City
- 1 August 2018 (Yangon)
  - Government of Yangon region
  - Thilawah Gas Power Plant
  - Compressed natural gas (CNG)-fuelling station for taxis
- 2 August 2018 (Yangon)
  - Liquefied petroleum gas (LPG)-distribution station
  - Ywama natural gas-distribution station
  - Ywama gas-fired power plant
  - Compressed Natural Gas (CNG) cylinder-testing centre
  - CNG Industry (a private city gas user)
- 3 August 2018 (Nay Pyi Taw)
  - Trip report to the Oil and Gas Production Department

Potential gas demand in Mandalay



Mandalay Industrial Zone

- There is no current plan to use natural gas in MIZ.
  - The high cost of constructing pipeline, concerns about supply reliability, and high energy prices are the primary reasons for this.
  - Most of the factories in MIZ are 'light industry' whose energy consumption is relatively small.
- Demand potential still exists.
  - MIZ is Myanmar's second largest economic centre.
  - It is close to the existing pipeline network.
  - Sustainability issues will drive the use of lower carbon energy in the long run.
  - More value-added industries will prefer to use gas.
- Access, cost, and reliability of the supply are key issues.
  - The government or the public sector may need to support pipeline development to create demand.
  - The price must be relatively competitive.
  - A stable supply must be ensured.

Kyaukse Industrial Area

- Several industrial facilities have used natural gas in Kyakuse.
  - One cement factory and one glass factory have used natural gas in the past, but both no longer use natural gas due to supply unavailability and factory renovation.
- There are limited possibilities to use gas at this stage.
  - Most large energy users are cement factories that usually prefer to use cheaper coal.
  - There is severe competition among cement factories and high sensitivity to the input energy price.
- Future potential for natural gas use exists.
  - There is a potential supply from the existing Kyaukpyu–China pipeline network.
  - Intensive coal consumption will have environmental impacts in the long run.
  - The need to reduce carbon emissions is growing.
  - Another industry that prefers gas to coal may emerge.

Myotha Industrial Park City

- MIPC is a newly developed industrial park.
  - It is part of a comprehensive regional development plan being implemented by the government.
  - Conveniently located on the Ayeyarwady River.
  - Seven factories are currently operating.
- It has large demand potential.
  - Easy access to the Kyaukpyu–China pipeline (approximately 5 kilometres away)
  - The Belt and Road Initiative may develop a highway or railroad between the Kyaukpyu deep sea port and the Chinese border.
    - A liquefied natural gas-receiving facility in Kyaukpyu will boost gas supply capability along the pipeline route.
- Will the park be able to invite industry that uses natural gas intensively?
  - Thus far, the park only contains less energy-intensive industries such as food processing, furniture, and animal feed factories.
  - Industries such as glass, ceramics, and paper will be major users of natural gas.

Residential and commercial demand in Mandalay city

7

- Energy demand from the residential and commercial sectors will grow.
  - This will be driven by population growth, enhanced incomes, economic expansion, and improved living standards.
- There is limited incentive to switch from electricity to gas at this stage, due to:
  - The high cost of a pipeline connection,
  - A relatively cheap electricity tariff, and
  - Limited demand for heating purposes.
- Residential and commercial demand is usually the last to develop in emerging countries.
- Commercial demand may emerge.
  - This would be driven by hotels, restaurants, and shopping malls in the city centre.
  - Targeted development of a pipeline network to the station area may be considered.
  - The government and/or the public sector will need to develop a pipeline network to realise the extensive use of natural gas in the residential and commercial sectors.

Potential gas demand in Yangon

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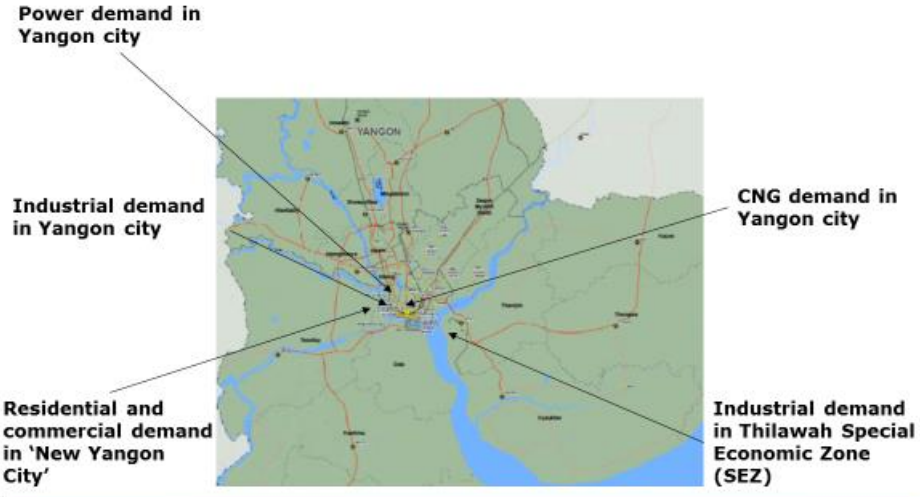

Gas demand for power in Yangon

- The power sector will remain the dominant demand segment for the foreseeable future.
- Gas seems to be the only realistic option for power generation in Myanmar.
  - There is public opposition to a new coal or hydropower plant.
  - Other factors include high cost and limited available land for renewables.
- Older power plants need to be upgraded and replaced.
  - Older facilities (30–40 years old) have low efficiency.
  - Significant gains are expected from replacing these plants with advanced generation facilities.
- Power development is urgently needed.
  - A gas-to-power project is expected.
  - The utilisation of an independent power producers scheme is possible.
  - Electricity tariff reform should be on the future policy agenda.

Industrial gas demand in Yangon

- Demand for industrial energy is already high.
  - Large industries such as steel mills, tire factories, and beverage manufacturers exist near the Ywama natural gas-distribution station; it will be easier to extend the pipeline network to those factories.
- The key issue is the availability of the gas supply, rather than the price level.
  - Some factories will have to slow their operations to avoid breaching the upper limit of natural gas consumption.
  - Private industry can accommodate a higher gas price ($8-$9 per million British thermal units).
- Is it possible to provide re-gasified LNG to private industrial players?

Gas demand in Thilawah Special Economic Zone

- Thilawah SEZ has a very large and firm demand potential.
- Power-generation demand
  - A new 50-megawatt power plant is planned, with an expected gas consumption of 21 million cubic feet per day (mmcfd).
  - As the SEZ grows in size, further expansion is possible.
- Industrial demand
  - Some existing factories seem to be using liquefied petroleum gas.
    - + City gas can be competitive.
  - Suggested natural gas demand for industrial purposes at this stage is 6 mmcfd–7 mmcfd.
  - Demand can grow significantly depending on the development of the SEZ.

Compressed natural gas demand in Yangon

- Government initiative to promote the use of CNG
  - The adverse effects of a sudden increase in the price of crude oil in the 2000s had to be managed.
  - CNG played a significant role in reducing dependence on imported oil.
- CNG-based bus services (the Yangon Bus Service) is a vital means of transportation for Yangon's citizens.
  - There are currently 4,000 buses in operation.
  - Due to demand growth, another 500–1,000 buses are planned to be ordered.
- Demand is likely to remain flat.
  - Demand fundamentals are very strong.
  - Yet, due to the low availability of gas, it may be difficult to expand supply capacity.
  - Concerns exists as to the sustainability of subsidies, availability of cheap domestic natural gas, among other issues.

Residential and commercial demand

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- The residential and commercial sectors are the last city gas demand segment.
- It may be difficult to develop a city gas pipeline network in downtown Yangon at this stage.
  - As an increasing number of households are using LPG for cooking purposes, promoting the use of LPG for residential purposes is a more realistic option.
- Targeted 'gasification' might be possible in newly developed areas.
  - There is a plan to develop a 'New Yangon City' in the southwest part of Yangon city.
  - A well-developed plan and coordinated policy arrangements are needed.
  - Action must be taken immediately.
  - The availability and price of the gas supply will remain an issue.

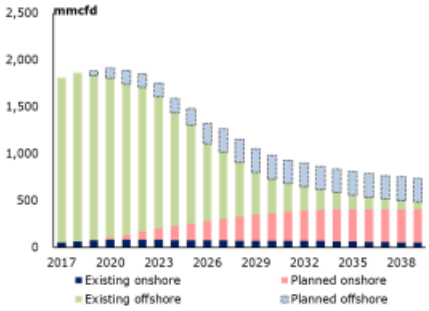
Source: NYDC

Domestic production and export

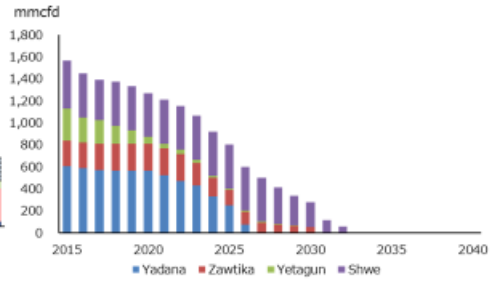
14

- Received data suggest that onshore production will grow significantly.
  - Should all of the expected growth be counted?
- What is the expected peak production volume for the A-6 and M-3 blocks?
- Exports will stop in the 2030s.
  - Will production from the new gas fields be exported to Thailand and/or China?

Domestic production outlook



Natural gas exports by field



Sources: Ministry of Electricity and Energy, IEEJ.

Next field trip

- Date
  - 17–20 September 2018
- Purpose
  - Research for a pipeline connection between Yangon and Magway
- Proposed schedule
  - 16 September (Sunday): Arrival from Japan to Yangon
  - 17 September (Monday): Trip from Yangon to Shwedaung
  - 18 September (Tuesday): Meetings with local government representatives and natural gas users in the Shwedaung area
  - 19 September (Wednesday): Pipeline status from Shwedaung to Magway, trip to Nay Pyi Taw
  - 20 September (Thursday): Meeting at the Oil and Gas Production Department, departure from Nay Pyi Taw to Japan
- Research items
  - Current status of the pipeline
  - Rough cost estimate for the pipeline renovation
  - Demand potential along the pipeline route

Thank you for your attention.

The IEEJ was raked **second** in the field of energy research in the 2017 **Global Think Tank Ranking** conducted by the University of Pennsylvania.

(ranked third in 2016 and first in 2015)

2017 Global Go To Think Tank Index Report (p.105)
http://repository.upenn.edu/think_tanks/

Please visit our website at
http://eneken.ieej.or.jp/

Appendix 2

1

ERIA Study for a Natural Gas Master Plan in Myanmar September Field Trip

20 September 2018

Yoshikazu Kobayashi

The Institute of Energy Economics, Japan (IEEJ)

2

Trip schedule

- 17 September 2018
  - Road trip from Yangon to Pyay
- 18 September 2018
  - Local township officer in Pyay
  - Shwedaung gas-turbine power station
  - Myanma Petroleum Product Enterprise
  - Myanma Oil and Gas Enterprise pipeline gas compression office in Titut
- 19 September 2018
  - Kyauk Swe Kyoe pressure control station
  - Yone Sade bar station
  - Aung Lan bar station
- 20 September 2018 (Nay Pyi Taw)
  - Trip report to the Oil and Gas Production Department

Overview of Pyay

- Overview of Pyay city
  - Mid-sized city along the Ayeyarwady River
  - Population: 251,643; downtown population: approximately 140,000
  - The primary industry is agriculture, and the main crop is rice.
  - Warm climate throughout the year (29.8–38.9 degrees Celsius)
- Its primary commercial energy is electricity.
  - Oil products for transportation and industry
  - Natural gas for generating power and textile manufacturing
- Natural gas supply to Pyay
  - Most natural gas is supplied from the offshore Yadana gas field via a 14-inch pipeline.
  - Limited production from the Pyay oil and gas field
- Status of the pipeline beyond Pyay
  - Pipeline connected, but not currently operating beyond Aung Lan bar station due to gas leakage caused by pipeline corrosion.

City gas demand in Pyay

- Current natural gas users
  - There is one gas-turbine plant and one textile company.
- Potential for industrial natural gas demand
  - The primary industry in the township is agriculture, and manufacturing has a limited presence.
  - There is no solid plan for economic or industrial development.
  - Given the city's good pipeline access, an increased natural gas supply at a competitive price may develop industrial demand.
- Residential and commercial demand
  - Limited demand for heat due to the warm climate.
  - The primary demand component is cooking.
  - The local government prioritises expanding LPG as a residential energy for its convenience and cleanliness.
    - The use of charcoal is banned in Shwedaung.
- There is limited potential demand for natural gas in Pyay city and its suburbs at this stage.

Demand for power generation in Pyay

5

- Potential demand for natural gas to generate power also appears limited at this stage.
- Shwedaung gas-turbine power plant
  - Built in 1982
  - Three 18.45-megawatt turbines (55.35 megawatts in total)
  - Heat efficiency rate of 20 percent
  - Gas consumption is 9 million cubic feet per day (mmcfd) per turbine unit (a maximum of 27 mmcfd)
- Utilisation is largely affected by hydropower generation.
  - Utilised as a peak-shaving generation source
  - Gas consumption has not grown in the last 2 years, although the region's power demand has grown. Imports from other regions supplement the increased demand.
- No expansion or renovation plan
  - Modifying the older unit will improve heat efficiency and save gas use.

Pipeline status

6

- Pipeline conditions
  - Bare pipeline without any coating
  - Signposts showing the pipeline location have been lost.
  - Although the pipeline mostly runs underground, in some locations it is placed aboveground without sufficient protection.
  - Comprehensive renovation is urgently required.

- Location of the existing pipeline
  - The pipeline is located away from major roads.
  - It is difficult to conduct regular safety inspections and identify irregularities in the pipeline operation.
  - The cost of maintenance tends to be high if access to the pipeline is difficult.

- Pressure monitoring
  - Monitoring is conducted at each bar station.
  - There is scope for the installation of a remote pressure monitoring system (such as Supervisory Control and Data Acquisition) in the future.

Toward pipeline renovation

7

- Anti-corrosion treatment is urgently needed for the entire pipeline network to avoid more problems with pipeline leakages.
  - Treatment while using the pipeline is possible.
- Route selection for the new pipeline (if built)
  - Building a new pipeline (instead of replacing the existing pipeline) appears to be a more realistic option.
  - The new pipeline can using the same route as the existing pipeline or a completely new pipeline can be built in a new route.
- Demand development along the pipeline
  - There are no natural gas users along the pipeline beyond Shwedaung.
  - Natural gas users once existed along the pipeline (including cement and brick factories, and steel and sugar mills), but they no longer use gas for various reasons.
  - Securing a natural gas supply as well as renovating the pipeline is necessary.

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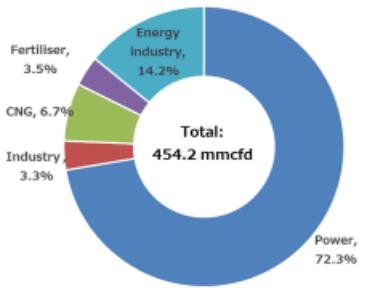
Demand outlook (interim)

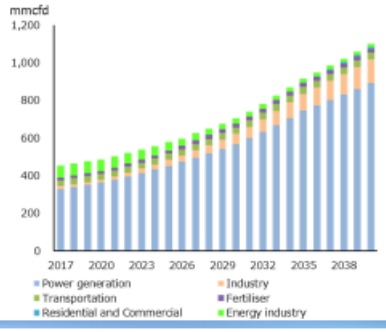
8

- Most gas demand will be used in the power sector.
  - Given the current growth speed, the rate of demand growth may rise even higher.
- Industry will be the second largest demand segment.
- Residential demand may be created in Yangon and Mandalay.
  - This will require a well-prepared infrastructure plan and policy arrangement.
- Note: The level of natural gas demand is determined also by supply factors.

Natural gas demand (as of FY2017)



Natural gas demand outlook



IEEJ © 2018

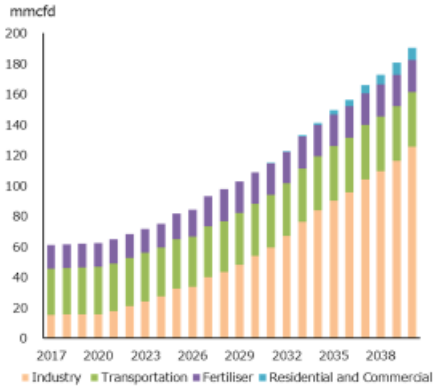
mcfd = thousand cubic feet per day.
Sources: Ministry of Electricity and Energy (MOEE), IEEJ.

City gas demand outlook (interim)

9

- City gas demand (demand for non-power generation) is estimated to grow 2.3 times by 2040.
- Industrial demand will grow mainly in Yangon and Mandalay.
  - Many factories in Thilawah Special Economic Zone use liquefied petroleum gas; and city gas can be price-competitive.
  - Industrial demand in Mandalay is subject to the pipeline connection and availability of natural gas.
- The transportation sector is expected to grow but at a more moderate rate.
- It is assume that residential demand will be created after 2030.
  - Demand creation is largely subject to infrastructure development and residents' ability to afford the supply.

City gas demand outlook



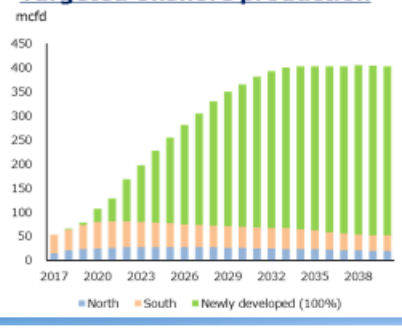
Source: IEEJ.

Natural gas balance (interim)

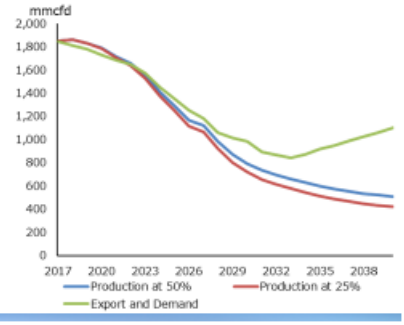
10

- It is forecasted that Myanmar will need to begin importing liquefied natural gas in the mid-2020s.
  - Domestic onshore production is targeted to increase by 350 mmcfd by 2040.
  - Estimates assume 50 percent and 25 percent achievement of targeted production.
  - Pipeline exports to Thailand and China are expected to stop in the 2030s.
- As natural gas demand is constrained by supply, additional supply (domestic production or imported liquefied natural gas) will help secure demand.

Targeted onshore production



Natural gas balance outlook



mcfd = thousand cubic feet per day.
Sources: MOEE, IEEJ.

Proposal for final report seminar

- Date and time
  - **11 December 2018 09:30~12:00**
  - Followed by networking lunch
- Venue
  - Ballroom, **Thingaha Hotel**, Nay Pyi Taw
- Proposed agenda
  - 09:00–09:30 Registration
  - 09:30–09:50 Opening remarks
  - 09:50–10:00 Photo session
  - 10:00–10:20 Current natural gas policy in Myanmar (by the Oil and Gas Production Department, and MOEE)
  - 10:20–10:30 Introduction of the Economic Research Institute of ASEAN and East Asia (ERIA) project 'Natural Gas Master Plan in Myanmar' (by ERIA)
  - 10:30–11:50 Brief of the final ERIA report supporting the study project 'Natural Gas Master Plan in Myanmar' (by Yoshikazu Kobayashi [IEEJ])
  - 11:50–12:00 Summary (by ERIA)
  - 12:00 Closing and networking lunch

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