Chapter 6

Natural Gas Infrastructure

1. Existing Natural Gas Infrastructure

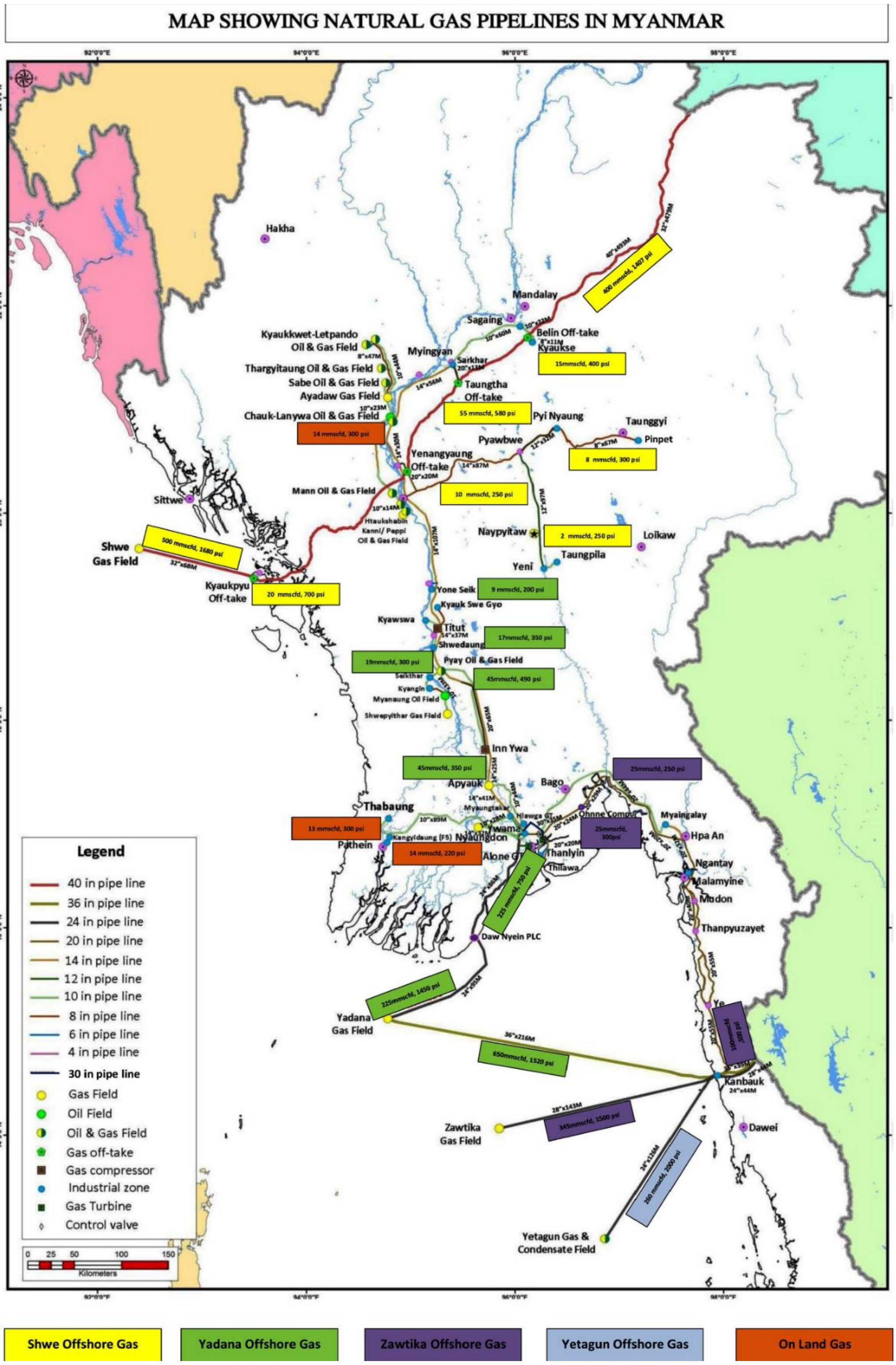
As one of the oldest oil and gas producers in Southeast Asia, Myanmar has a nationwide natural gas pipeline network covering all major demand centres in the country (Figure 6.1). The total length of the network is 4,100 kilometres (km). The state-owned Myanma Oil and Gas Enterprise (MOGE) owns and exclusively operates and maintains the pipeline network.

Myanmar has both a domestic pipeline network and export pipelines. The largest domestic natural gas pipeline is the Yangon–Magway pipeline network. This pipeline runs south–north through the centre of Myanmar and supplies offshore gas from the south to the interior of the country. As of September 2018, the pipeline is not fully operational; it is in use between Yangon and Shwedaung, but the pipeline between Shwedaung and Magway is out of operation due to a technical problem (gas leakage caused by pipeline corrosion).

Leakage problems are not unique to the Shwedaung–Magway pipeline. An assessment conducted by the Asian Development Bank (ADB) in 2016 found more than 100 leakages in the country's natural gas pipeline network, as a result of which 15% of the natural gas transported in the network is being lost (ADB, 20160. Restoring the Shwedaung–Magway pipeline segment is the most pressing issue in the country's natural gas logistics, and the Korean Export–Import Bank is conducting a study with the aim of replacing the existing pipeline.

Myanmar also has two export pipelines: one to Thailand and another to China. The Thailand pipeline began exporting natural gas in 2000, and had an export volume of 1,106 million cubic feet per day (mmcfd) in 2017. Natural gas is Myanmar's largest export product, and the Thailand pipeline is a critically important piece of infrastructure for the country. Feed gas for export to Thailand is produced from three offshore gas fields in the south, namely, Yadana, Yetagun, and Zawtika.

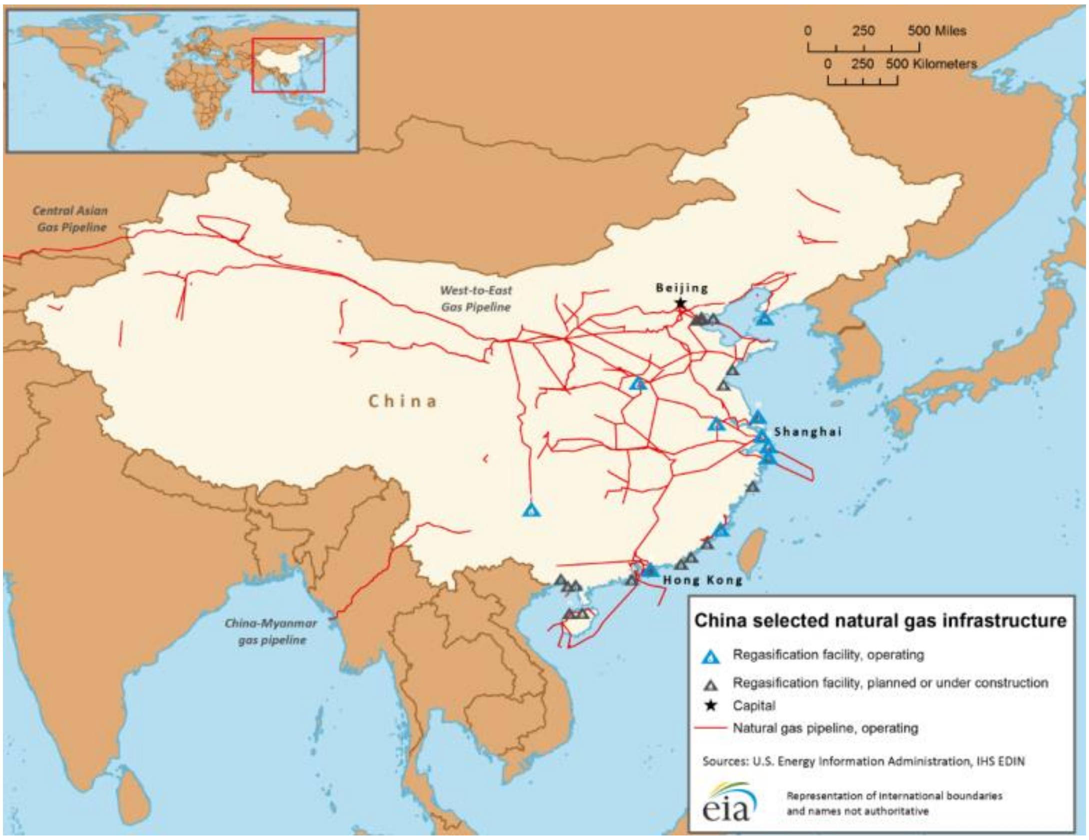
Figure 6.1: Existing Pipeline Network in Myanmar



" = inch, m = metre, mmscfd = million standard cubic feet per day, PLC = public limited company, psi = pounds per square inch.

Source: Data provided by the Myanma Oil and Gas Enterprise.

Figure 6.2: China's Natural Gas Import Infrastructure



EDIN = Energy Development in Island Nations; EIA = Energy Information Administration; IHS = Information Handling Services; U.S. = United States.
Source: Energy Information Administration website (2014).

The export pipeline to China is relatively new, having commenced operations in 2014. Its exported volume was 372 mmcfd as of fiscal year 2017. The pipeline runs west–east across northern Myanmar to the border with China. The exported gas is then transported to Yunnan Province and eventually to Chongqing City in China. To cope with rapidly increasing domestic natural gas demand, China has tried to secure natural gas from every available source as well as diversifying its natural gas supply sources in the interest of energy security. China therefore regards the import pipeline from Myanmar is as a key piece of natural gas import infrastructure.

The export pipeline to China was constructed by the Chinese state-owned company, the China National Petroleum Corporation (CNPC), and is jointly owned by the CNPC and MOGE. The CNPC constructed a crude oil pipeline along the same route from Kyaukpyu to the Chinese border. The pipeline is 32 inches in diameter and its transportation capacity is approximately 12 billion cubic metres. However, utilisation of the pipeline is relatively low (around 25%). The source of the gas exported to China is the Shwe gas field. There are four 'offtake points' of natural gas along the pipeline (Kyaukpyu, Yenangyaung, Taungtha, and Belin), and the allocated gas is consumed as fuel for gas-fired power generation plants, industrial fuel, and feedstock for fertiliser, among other uses.

2. Required Pipeline Development

2.1 North–South Pipeline Connection

While Myanmar has an extensive pipeline network, there are a number of operational issues and problems with its utilisation. One of the country's highest priorities is to restore the pipeline connection between Shwedaung and Magway. Since this segment has been cut off due to corrosion, pipeline networks are currently being operated separately in the northern states (including Rakhain, Magway, and Mandalay) and in the southern states (including Yangon, Ayeyarwady, and Thanintharyi). Renovating the Shwedaung–Magway pipeline connection and restoring the network connection between the northern and southern pipeline systems are critical issues with regard to both supply security and operational concerns.

One of the reasons why it is urgent to restore this connection is to ensure supply security. As the country's natural gas demand grows, its economic activities and social functions increasingly depend on a stable natural gas supply. If an offshore natural gas field in the south were forced to shut down, the natural gas supply to the domestic market would be severely impacted. Power plants would be unable to secure a natural gas supply to sustain generation, and public bus transportation in Yangon could also be affected as it depends mostly on the supply of compressed natural gas. Economic activities in newly developed industrial bases such as the Thilawah Special Economic Zone will also be damaged. Without the connection between the north and south networks, the natural gas supply cannot be adjusted flexibly to minimise impacts on the country's economy and society.

Another mid- to long-term imperative is to build supply capability to fill the supply–demand gap in the north and south. As of 2018, states in both the north and south are self-sufficient in terms of their natural gas supply, and do not require a supply of natural gas from the other half of the country. There is also no significant demand along the interrupted pipeline section. Thus, other than the need to ensure supply security to prepare for unexpected supply disruptions, there is no imminent economic or operational need to connect the northern and southern natural gas markets.

However, this connection will become more important as Myanmar's natural gas market evolves. First, the operational need to transport natural gas from the south to the north may increase in the future. The original purpose of the Shwedaung–Magway pipeline was to ship natural gas from southern offshore fields such as Yadana to meet demand along the pipeline to Magway. If there is an increase in the natural gas supply in the south, production from new offshore natural gas fields, or liquefied natural gas (LNG) imports, and a delay in the planned expansion of onshore natural gas production in the Magway region, the restored pipeline could provide an increased gas supply to the northern states.

On the other hand, a reverse flow from north to south could also be necessary. Demand growth will be larger in the southern states and, if southern offshore production growth stalls and LNG imports are delayed, the country will need to allocate onshore gas produced from the newly developed northern fields to demand in the south. Furthermore, if natural gas exported to China can be diverted to the domestic market with China's consent, the north–south pipeline will be the only route that can deliver the diverted gas to meet the demand in the southern market.

Connecting the pipelines may also help develop demand in the long run. Although there is no significant demand potential along the pipeline as of 2018, if the pipeline connection is restored and abundant natural gas is transported, new demand can be developed. Several industries, including cement factories and sugar and steel mills, are already connected to the existing pipeline and used to consume natural gas to operate in the past. If the pipeline is restored and the supply increases, these former users may revert to using natural gas for their operations.

2.2 Demand and Status of the Shwedaung–Magway Pipeline

Demand potential near the pipeline

In assessing the feasibility of renovating the Shwedaung–Magway pipeline, the study team found that natural gas demand potential along the pipeline is limited at this stage. In Shwedaung, only one gas-turbine power plant (the only power plant in the area) and one textile factory are using natural gas. The plant was built in 1982, and its generation capacity is 55.35 megawatts (from three 18.45-megawatt turbines). The plant is operated by the state-owned Electric Power Generation Enterprise. Each gas turbine consumes 9 mmcfd of natural gas at full load, meaning that the plant consumes 27 mmcfd if all three units are fully operating. However, the plant is used as a mid- to peak-load power generation source, and its utilisation is not high. Its generational operation is largely affected by the hydropower plants that serve as baseload generation sources in Myanmar. The plant's gas consumption was only 6.6 mmcfd in 2017. Since the plant is 36 years old and has a low heat efficiency (20%), an overhaul renovation funded by the Korean Export–Import Bank is being considered. Yet, as of 2018 no capacity addition plan is being implemented, and it currently has no natural gas demand growth potential.[1]

Figure 6.3: Shwedaung Gas-Turbine Power Plant

Source: Photograph from the study team site visit.

City gas demand potential in Pyay and Shwedaung is also slim. The major industry in Shwedaung is agriculture, and manufacturing does not have a large presence. There is also no solid industrial policy or economic development program in the city. The only industrial gas user in Shwedaung is a single textile company. Along the pipeline route beyond Shwedaung several factories (cement, sugar, steel, and brick) are connected to the pipeline network; these used to consume natural gas, but they have all switched to alternate forms of energy. Some factories have shut down due to the limited profitability of their business, but others are not operating due to an insufficient supply of natural gas. Therefore, securing a natural gas supply, as well as renovating the pipeline, is crucial to develop demand along

[1] Study team interview at the Shwedaung power plant on 18 September 2018.

the pipeline route.

Pipeline status

The Shwedaung–Magway pipeline is operational up to the Aung Lan bar station, approximately 80 km north of Shwedaung (Figure 6.4). Beyond Aung Lan the pipeline is out of service due to corrosion and leakage problems.

Figure 6.4: Yangon–Magway (North–South) Pipeline

Source: United States Central Intelligence Agency.

The Shwedaung–Magway pipeline is not well-placed nor properly maintained. Most of the pipeline was laid in a bare condition without a protective coating and with no cathodic treatment. This is the main reason why corrosion forced the pipeline to cease operating. The relatively acidic soil between Aung Lan and Magway is another cause of pipeline corrosion.[2]

Furthermore, although most of the pipeline is placed 3.0 feet–3.5 feet underground, in some places it runs aboveground without any protection. Signposts showing the location of the underground pipeline have been lost although they were placed immediately after the pipeline was constructed. This suggests that the underground pipeline may have been damaged by construction work or other infrastructure development such as highway and water works.

Figure 6.5: Aung Lan Bar Station

Source: Photograph from the study team site visit.

Another complicating feature of the Shwedaung–Magway pipeline is that it was placed some distance away from the main road, making it difficult to conduct regular monitoring and maintenance. While MOGE conducts regular safety inspections to safeguard pipeline operation, checking the status of the pipeline takes time as staff members have to walk through the bushes to reach the pipeline. The difficulty of conducting regular safety inspections makes it hard to note any irregularities in the pipeline.

[2] Study team interview at the MOGE pipeline operation office on 18 September 2018.

Figure 6.6: Unprotected Pipeline Appearing Aboveground at Aung Lan Bar Station

Source: Photograph from the study team site visit.

2.3 Estimated Investments for the North–South Connection

The cost of reconnecting the interrupted pipeline network between Shwedaung and Magway will be approximately $77 million.

Table 6.1: Estimated Cost of the Magway–Aung Lan Pipeline Connection

	Distance from gas source (m)	psi	Pipeline size (inches)	Underground construction ($/m)	Above ground construction cost ($/m)	Pipeline cost ($/m)	Total cost ($ million)
Aung Lan - Magway	130,000	400	16	680	340	142	77.4

m = metre, psi = pounds per square inch.
Source: Study team estimate.

The cost was calculated based on the assumption that a new pipeline will be built between Magway and Aung Lan, the northernmost end of the pipeline network currently in operation. Building a new pipeline is recommended because (i) the existing pipeline was laid in a bare condition and has not been properly maintained; (ii) significant corrosion is expected in the existing pipeline as a result, and renovating the existing pipeline may be more costly than building a new pipeline; and (iii) the new pipeline should be built along a new route to make it easier to carry out regular inspection and maintenance. The existing pipeline is 14 inches in diameter; however, given the growing natural gas demand and expanding size of the country’s natural gas market, this should be upgraded to 16 inches to accommodate a greater flow of natural gas.

Construction of the new pipeline will start from the Aung Lan bar station, the northernmost end of the operational pipeline network, to Magway (a distance of about 13 km). The unit cost of the pipeline construction is assumed to be $680 per metre for the underground section and $340 per metre for the aboveground section. The cost of coated pipe is $142 per metre. These costs have been estimated based on representative costs in Japan, and adjusted to reflect construction, labour, and engineer costs in Myanmar.

The cost estimate assumes that the new pipe will be coated for cathodic protection. In addition to this coating, additional protection methods such as the installation of galvanic anodes or the application of impressed current can be adopted.[3] However, the estimate does not include the cost of such additional arrangements.

3. Required Liquefied Natural Gas Receiving Terminals

3.1 Natural Gas Demand and Supply Balance

As domestic natural gas demand grows while domestic production declines, Myanmar will need to secure additional supply sources. There are several options to consider, including increasing domestic production, importing LNG, and reducing exports. The first option has already been explored and is being implemented by the government; the second and third options still need to be considered and implemented, either separately or in combination.

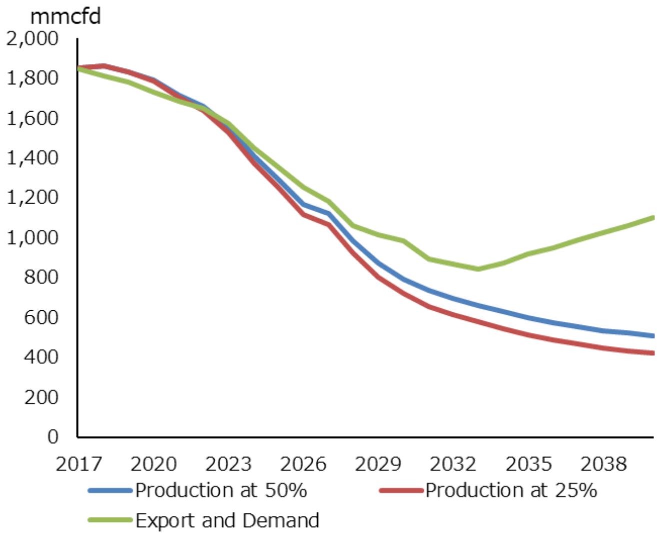
Myanmar’s natural gas balance will depend various factors. If demand grows faster than expected, particularly in the power sector, the natural gas shortage will be more severe than expected in the near future. If, on the other hand, domestic natural gas production grows thanks to the discovery of new fields or enhanced recovery from existing fields, the supply–demand balance will ease.

This study estimates that Myanmar will need to begin importing natural gas from 2022 or 2023. Figure 6.7 shows the balance of domestic production, domestic demand, and export requirements for natural gas. Because the level of onshore production remains uncertain, the figure shows two domestic production scenarios, that is, 25% and 50% of

[3] For further details, see the American Society of Mechanical Engineers (2016), *B31.3-2016 Process Piping*. New York, p.96.

MOGE's targeted production volume. The figure suggests that Myanmar will have to begin importing natural gas from 2022 if onshore production reaches only 25% of the targeted volume, and from 2023 if production reaches 50% of the targeted volume.

Figure 6.7: Natural Gas Balance of Myanmar



mmcfd = million cubic feet per day.
Source: Institute of Energy Economics, Japan estimate.

There is a caveat to this balance outlook. While the figure suggests that the gross natural gas demand (domestic demand plus export requirements) will exceed domestic production, the actual gross demand will be equal to domestic production because there is no inventory adjustment. If production is insufficient to meet the gross demand, either the domestic demand or export volume will need to be reduced to achieve the necessary balance. The demand shown in the figure is an implied demand calculated from the specific assumptions of this study.

3.2 Liquefied Natural Gas Import Requirements

As there is no international natural gas import pipeline project for Myanmar, LNG is the only import option. Myanmar is planning three LNG import terminals using gas-fired power generation in the south of the country (Table 6.2). The project near Yangon is small because the draft in that area is shallow and the size of the receiving facility is limited.

The LNG demand volume is forecasted to reach 1.4 million tonnes per annum (mtpa)–2.1 mtpa by 2030 and 4.2 mtpa–5.2 mtpa by 2040. As shown in Figure 5.3, Yangon will be the largest demand centre for Myanmar; thus, the development of the Yangon and Kanbauk terminal projects should be prioritised. The Mee Long Gyaing terminal project may be developed later because it requires the development of additional pipeline from the receiving terminal to the existing pipeline network. Since all three projects are small and insufficient to meet the forecasted import demand, it will be necessary to either expand these terminals or build an additional LNG import terminal. As shown in Figure 6.8, demand in the northern regions of the country such as Mandalay and Magway is expected to grow. Thus, additional LNG receiving terminals should be planned in the long term.

Table 6.2: Liquefied Natural Gas Import Projects in Myanmar

Project	Import capacity (mtpa)	Installed generation capacity	Region
Alone LNG to Power project	0.4	356	Yangon
Mee Long Gyaing LNG to Power project	1.6	1,390	Ayeyarwady
Kaunbauk	1.0	1,230	Tanyintharyi

LNG = liquefied natural gas, mtpa = million tonnes per annum, MW = megawatt.
Source: Date provided by the Ministry of Electricity and Energy.

Figure 6.8: Liquefied Natural Gas Import Requirements for Myanmar

mtpa = million tonnes per annum.
Source: Institute of Energy Economics, Japan.

It is estimated that these LNG receiving terminals (excluding power generation) will require \$1.35 billion in investment through 2040. All three terminals are assumed to be floating storage and regasification units (FSRUs) because these are easier to install in a short period of time than conventional onshore terminals. The estimated investment necessary to build three standard-size FSRUs (2 mtpa each) in the southern part of the country is \$1.35 billion (\$450 million each). This estimate assumes that all three FSRUs will be new-build vessels. If secondhand tankers are utilised, the capital expenditure will be saved. To develop an additional section of pipeline 10 inches in diameter from Mee Long Gyaing to Pathein (about 20 km) will cost approximately \$8.8 million.

The study also recommends the installation of one FSRU in Kyaukpyu to meet the growing demand in the north. As Kyaukpyu already has a pipeline network, it will be easy to connect the new FSRU to the existing network. An LNG receiving terminal in Kyaukpyu will significantly improve supply capacity to the northern regions. If the Shwedaung–Magway pipeline connection is restored, the surplus can be sent to Yangon. Since the Kyaukpyu–China pipeline has a large surplus capacity, Myanmar can jointly procure LNG with China, and China can import the regasified gas via the pipeline. Myanmar may even be able to procure LNG at a competitive price by taking advantage of China's bargaining power through the joint procurement.

Figure 6.9: Location of Planned Liquefied Natural Gas Receiving Facilities in Myanmar

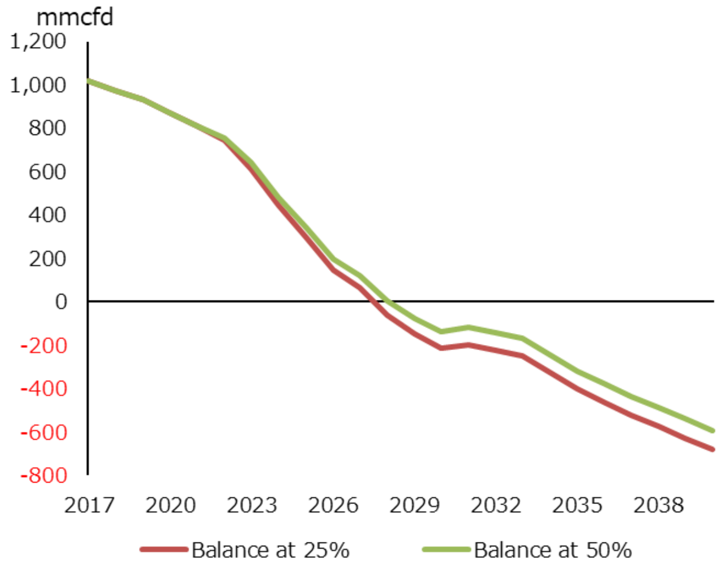
Source: United States Central Intelligence Agency.

3.3 Reducing Exports

Importing LNG is the most realistic and effective option to meet the growing power and natural gas demand in Myanmar. However, importing LNG is not easy, and requires many difficult decisions and arrangements on the receiving side. For example, the government must determine who will lead the project, who will be partners, who will take what risks during the project development and implementation phases, from which country the LNG will be procured, to whom the regasified gas will be provided, and at what price. It can take a long time for the government, state-owned entities such as MOGE or the Electric Power Generation Enterprise, and the foreign companies proposing an LNG receiving project to agree on the project structure and proceed with actual planning, development, and operation.

If Myanmar is unable to import LNG before the mid-2020s, it may need to reduce its exports to Thailand and/or China after obtaining their consent. Reducing exports to Thailand will be more effective because this export volume is larger and this border is closer to Yangon. If Myanmar can divert exports to Thailand to domestic needs, it can defer importing LNG for another 5 years to 2028 (Figure 6.10).

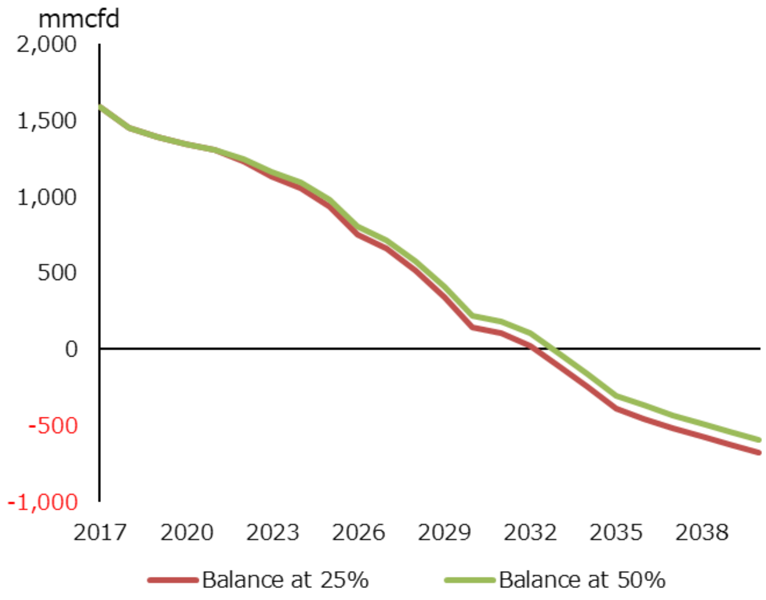
Figure 6.10: Natural Gas Balance if Exports to Thailand are Diverted to Meet Domestic Demand



mmcfd = million cubic feet per day.
Notes: The ‘balance at 50%’ case shows the balance of natural gas when 50% of the targeted onshore production is achieved and exports to Thailand are diverted to the domestic market. The ‘balance at 25%’ case shows the balance of natural gas when 25% of the targeted onshore production is achieved and exports to Thailand are diverted to the domestic market.
Source: Institute of Energy Economics, Japan.

If all exports including exports to China can be diverted to the domestic market, the LNG import deadline can be deferred further. Figure 6.11 shows that the natural gas balance in both cases will become negative from 2033, suggesting that Myanmar can be self-sufficient for another 10 years compared to the base cases.

Figure 6.11: Natural Gas Balance if All Exports are Diverted to Meet Domestic Demand



mmcfd = million cubic feet per day.
Notes: The 'balance at 50%' case shows the balance of natural gas when 50% of the targeted onshore production is achieved and all exports can be diverted to the domestic market. The 'balance at 25%' case shows the balance of natural gas when 25% of the targeted onshore production is achieved and all exports can be diverted to the domestic market
Source: Institute of Energy Economics, Japan.

As always, this assumption comes with several caveats. First, the supply–demand balance can change subject to various factors, including macroeconomic conditions, domestic production, infrastructure development, and domestic demand status. Thus, the 'deadline' years specified above should be treated as benchmarks at which point Myanmar will have to begin importing LNG.

Second, Myanmar must obtain consent from Thailand and China before diverting these natural gas exports to the domestic market. China and Thailand are both net natural gas importers and regard natural gas imports from Myanmar as a vital gas supply source. Thus, they are very likely to insist that imports from Myanmar continue. Exports to these countries are made under long-term contracts, and Myanmar is subject to supply obligations as provided in these contracts. Myanmar may even have to pay a penalty or compensation to cancel the contracts and divert the supply. Such potential economic costs must be taken into account if the option to divert exports is chosen.

Third, the infrastructure needs to be modified. Currently, the infrastructure (particularly pipelines from production sites) is designed for export, not domestic supply. Thus, the pipeline capacity to the domestic market would have to be expanded to accommodate the increased supply to the domestic market. In this regard, it may be worth considering constructing a new subsea pipeline from Kanbauk, where export gas is accumulated, to Yangon. If exports to China are diverted, the Magway–Shwedaung pipeline connection will need to be reactivated because some of the diverted gas will need to be supplied to the Yangon region. Thus, comprehensive pipeline renovation will need to be implemented to realise the diversion plans.

Finally, reducing pipeline gas exports means reducing foreign currency revenues. Natural gas exports have long been a major source of foreign currency for the country, and other sources of foreign currency revenues will need to be secured. If the diverted natural gas is supplied to the domestic market at a regulated price, this will create opportunity losses as the exported gas is sold at the international market price. Thus, the government must compare such economic costs with the benefits of diversion, and decide what option to take.

References

ADB (2016), *Myanmar Energy Sector Assessment, Strategy, and Roadmap*, December. Manila: ADB.

Energy Information Administration website (2014), 'Natural gas serves a small, but growing, portion of China's total energy demand', Available at: https://www.eia.gov/todayinenergy/detail.php?id=17591 (accessed 25 October 2018).