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Fuelling the future: Capturing opportunities in the emerging LNG market

With an abundance of supplies in a low price environment, liquefied natural gas (LNG) is emerging as the fastest growing fossil fuel even as the world transits to a low-carbon future. IE Singapore examines the global trends and factors driving new demand, and how Singapore companies can position themselves for future growth in this period of uncertainty.

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Summary

// The liquefied natural gas (LNG) sector presents immense prospects and opportunities for companies over the medium to long term. Natural gas is gaining prominence both as a primary fuel source for power generation and as a transportation fuel.

// Natural gas is the fastest growing fuel. From 2015 to 2030, demand for natural gas is expected to grow up to two and a half times faster than demand for crude oil.

// The key factors driving LNG growth are an increase in population, global economic growth, a transition to a low-carbon economy, liquefaction capacities adding to new supplies, limitations of traditional sources, alternative uses of LNG as a transportation fuel and the rise of small scale LNG.

// To meet growing demand, expenditure on LNG facilities and carriers are expected to rise to over US$240 billion from 2016 to 2020, a 34% increase over the previous five years.

// Singapore is embarking on initiatives to grow the local LNG ecosystem. The open-access Singapore LNG terminal will support growing physical trade while the SGX LNG Index Group (Sling) will allow for neutral price discovery.

// Singapore companies can transform their existing capabilities to transit into the emerging LNG sector. They can form strategic alliances to access project opportunities and build track records. IE Singapore can help facilitate these initiatives.

Natural gas as the **fastest growing fossil fuel**

Natural gas, which consists mainly of the hydrocarbon methane, is the cleanest burning fuel. It emits 50% less carbon dioxide than coal and 20-30% less than fuel oil. It has become a popular source of power generation due to its abundance, reliability and affordability.

In its gaseous state at normal atmospheric temperatures, natural gas is traditionally transported from its source to power plants via pipelines. The discovery of vast reserves in regions such as Africa that are far away from demand centres such as East Asia makes pipeline transportation unfeasible.

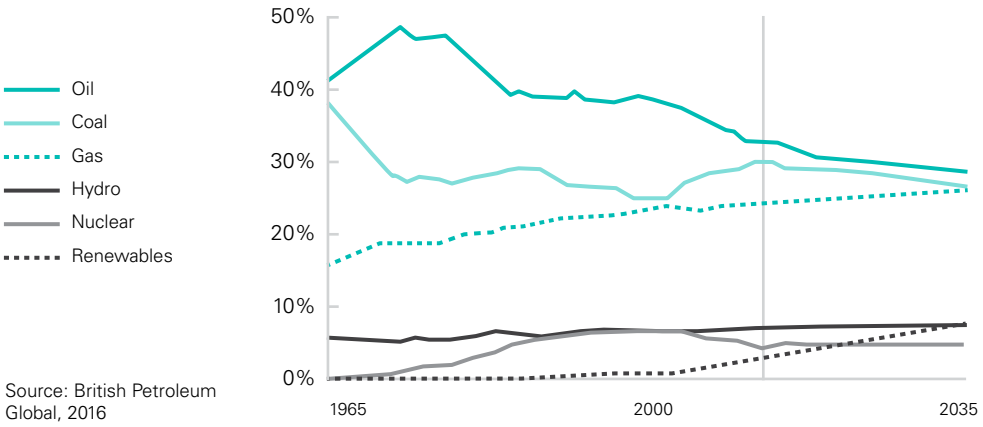
As such, natural gas is converted into LNG through liquefaction – a process that cools it to liquid form at -162°C and shrinks it to 1/600th of its original volume. This dramatic reduction in size allows it to be efficiently transported safely across oceans aboard specially designed vessels. Upon arrival, the LNG is warmed back to gaseous state and delivered through pipelines.

Global demand for natural gas is on the rise. Today, about a quarter of the world's energy needs are met by natural gas, of which about 10% is liquefied[1]. The global natural gas consumption is expected to rise from 310 bcf/d (billion cubic feet per day) in 2010 to 507 bcf/d in 2040[2].

1 "World LNG Report", International Gas Union IGU, 2016
2 "International Energy Outlook", Energy Information Administration (EIA), 2013

Natural gas as the fastest growing fossil fuel

Figure 1: Share of primary energy



Source: British Petroleum Global, 2016

World trade in LNG has almost quadrupled in the last two decades and is expected to further double in the next two[3]. With domestic gas fields in decline in most places, LNG is expected to provide greater supply assurance and is slated to outstrip pipeline gas as the main form of traded gas in twenty years.

This paper examines the factors driving the increasing demand for LNG, global trends accelerating this change and potential new uses of LNG. We also present what Singapore has done to date to grow the local LNG sector, identify regions with the largest opportunities and suggest strategies companies can pursue for future growth in the sector.

3 "LNG at the crossroads – Identifying key drivers and questions for an industry in flux", Deloitte Centre for Energy Solutions, 2016

Global trends

Natural gas is set to gain prominence as a primary fuel in the global energy mix, with LNG an increasingly important means to transport the gas to where it is needed. This section examines the key factors that will drive LNG growth over the long term.

Figure 2: Global LNG facts

Country rankings (LNG)

	Imports	Exports	Liquefaction capacity	Regasification capacity
1	Japan	Qatar	Qatar	Japan
2	South Korea	Australia	Australia	USA
3	China	Malaysia	Indonesia	South Korea
4	India	Nigeria	Malaysia	Spain
5	Taiwan	Indonesia	Algeria	China
6	UK	Trinidad	Nigeria	UK

Global capacity

Liquefaction capacity
Global:
301.5 Mtpa (Million tonnes per annum)
Under construction:
141.5 Mtpa
Utilisation rate: 84%

Regasification capacity
Global:
757 Mtpa
Under construction:
54.9 Mtpa
Utilisation rate: 33%

Source: International Gas Union, 2016

The key factors driving LNG growth are:

// Population change and economic growth
// Global transition to a low-carbon economy
// Limitations of traditional sources of energy
// Liquefaction capacities adding to new supplies
// Alternative uses of LNG
// Development of small scale LNG

Macro trend – Population trends and economic growth drive energy demand

Mega trends such as worldwide population growth, an increase in life expectancy, rapid urbanisation and economic growth are drivers of energy demand. As living standards improve and industrial activities increase, more energy is required to fuel these changes. While short term global economic slowdown and rapid gains in energy efficiencies will moderate the growth in energy demand, the International Energy Agency (IEA) predicts that global energy demand will be 37% higher in 2040 than it is today.

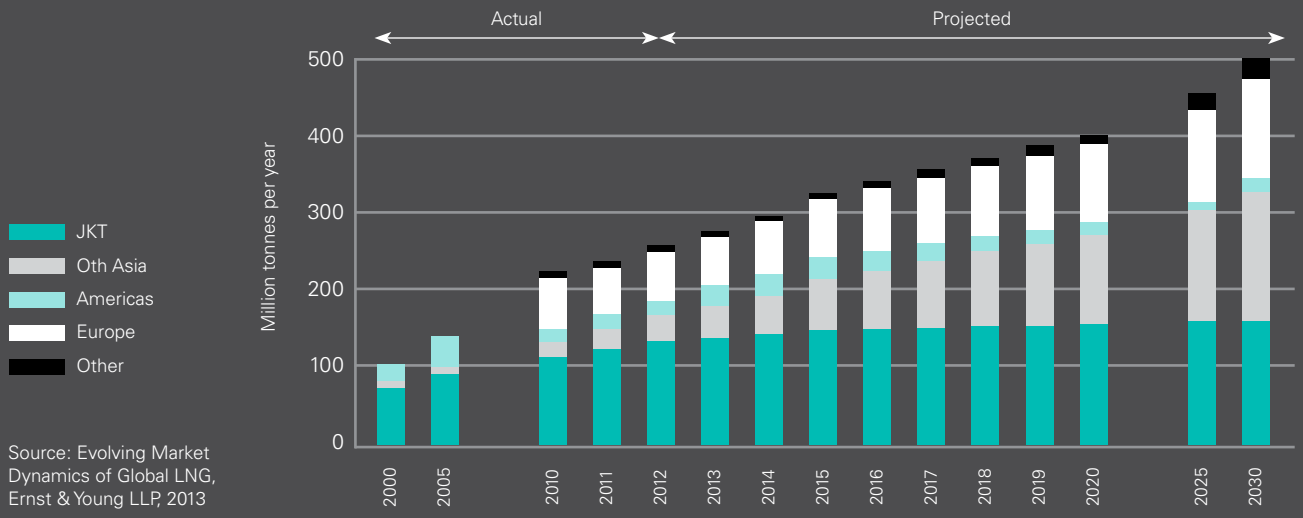
Although renewables are on the rise, much of this demand will continue to be met by fossil fuels as the key power generating resource that is affordable, reliable and available on scale. ExxonMobil predicts that in 2040, oil and natural gas will still supply nearly 60% of global supplies[4].

Asia as the new demand driver

With growth in Europe slowing down, demand for LNG is expected to shift from Europe to Asia. Japan and Korea currently account for about 50% of global LNG imports. However, with Japan's nuclear capacity restarting, the IEA expects future demand for gas to depend primarily on the economic growth in China, India and other developing Asian countries.

Within Asia, ASEAN-5 GDP growth is expected to average 5.3% until 2020[5]. The availability of cheap and stable power – a role LNG can fulfil - is key to realising this figure. Consequently, Southeast Asia's LNG markets are expected to account for a third of overall Asian LNG demand growth by 2025. The region is set to become the fastest growing LNG market in the world, growing from zero in 2011 to 45 Mtpa by 2025[6].

Figure 3: Global LNG demand through 2030 and Asia as main demand growth driver



Source: Evolving Market Dynamics of Global LNG, Ernst & Young LLP, 2013

4 "The Outlook for Energy: A View to 2040", ExxonMobil, 2016
5 ASEAN-5 = Vietnam, Thailand, Indonesia, Philippines, Malaysia. For period 2016-2020.IMF World Economic Outlook Database, October 2015 edition https://www.imf.org/external/pubs/ft/weo/2015/02/weodata/index.aspx
6 "Wood Mackenzie Says SE Asia LNG Demand Growth to Far Outstrip India's to 2025 (http://www.woodmac.com/media-centre/content/11719042)", Wood Mackenzie, 2013

Macro trend – Global transition to a low-carbon economy

In 2015, nations from around the world came together in Paris and committed to respective Intended Nationally Determined Contribution (INDCs) at the Paris Climate Convention, also known as the Conference of the Parties (COP21). As world leaders seek to reduce their carbon footprint, demand for natural gas is expected to grow vis-à-vis other higher carbon emissive fuels – about 40% of the growth in global energy demand from 2014-2040 is projected to be met by natural gas[7].

Supply-side factor – Limitations of traditional sources of energy

The legacy gas market	The hydro market	The coal market

// Some emerging markets with legacy gas reserves have used gas-fired generation for base load e.g. Indonesia, Malaysia, Philippines, Bangladesh.
 	
// However, with demand growth and depleting domestic gas reserves, these countries are turning to LNG imports especially for power.
	// Other emerging markets have depended on hydro-power for base load e.g. typically Latin American countries of Brazil, Colombia, Panama.
	
	// However, with erratic weather patterns, these countries are having to turn to LNG importation for gas-fired power generation.
		// Other emerging markets have relied on coal-fired power for base load e.g. India, China.
		
		// Environmental concerns are driving them towards aggressive clean energy programs.
		
		// Renewables are unable to fill the gap of coal-fired power adequately, creating a need for gas-fired power as an intermediate or peaking power solution.

7 "The Outlook for Energy: A View to 2040", ExxonMobil, 2016

Supply-side factor – Liquefaction capacities adding to new supplies

A rapid expansion of liquefaction capacities over the medium term – the result of many final investment decisions (FID) taken during the period of high prices – will further increase LNG's market share. According to the International Gas Union (IGU), global liquefaction capacity reached 301.5 Mtpa in 2015. Another 142 Mtpa of liquefaction capacity was under construction as of January 2016.

New supplies are set to come mainly from the United States and Australia, with additional sources of supply in the long term. For example, Iran – home to the world's second largest gas reserves – is now open to international investment. Shale reserves from Canada's Pacific Coast, coupled with recent discoveries in East Africa's Mozambique and Tanzania, can increase global LNG exports substantially.

An oversupplied market with lower prices could provide benefits to LNG importing countries, potentially displacing competing fuels and renewable energy sources.

Demand-side factor – Alternative uses of LNG

While gas is traditionally used for utility-scaled power generation and industrial applications, LNG is also emerging as a potential transportation fuel.

For example, the Japanese Ministry of Economy, Trade and Industry (METI) has earmarked 10% of its 300,000 heavy-duty long-distance trucks to be fuelled by LNG "soon" and for a "substantial" part of the fleet to use gas "eventually"[8]. Shell is working on a network of LNG fuel stations for such trucks in the United States.

Lloyd's Register Marine and the University College London's Energy Institute see a parallel trend for LNG as marine fuel. The number of LNG vessels has gone up from 194 in 2005 to over 373 in 2014, with average ship capacity increasing 25% from 130,000m^3 to 161,000m^3 [9].

Shell estimates that the global transportation sector accounts for 750 Mtpa of LNG equivalent. If 10% to 12% of this demand was converted to LNG, it could lead to an 80-100 Mtpa of increment in LNG demand[10].

8 "Monthly Energy Review", Energy Information Administration, Jan 2016
9 "LNG at the crossroads – Identifying key drivers and questions for an industry in flux", Deloitte Centre for Energy Solutions, 2016
10 "LNG Producer-Consumer Conference Summary Statement", Ministry of Economy, Trade and Industry of Japan (METI) and Asia Pacific Energy Research Centre (APERC), 16 September 2015

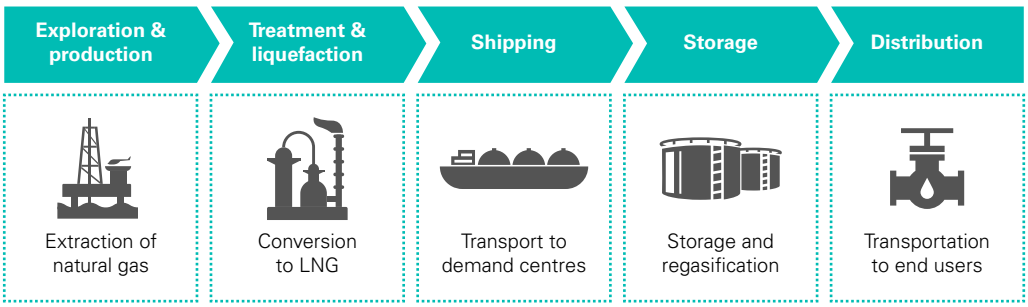
Demand-side factor – Development of small scale LNG

One of the key changes expected to happen in Asia is the development of small scale LNG and break bulk facilities. Smaller cargo vessels (and trucks) that can supply LNG to islands or remote regions can increase the mobility of LNG. Such modes of distribution are not new and would be ideal for LNG cargo transfers within archipelagic states (for seaborne transfers) and large land masses with scattered, small demand centres.

While such small scale users probably represent only a fraction of existing volumes, expanding access geographically could provide a steady stream of new demand for LNG. There could also be knock-on effects of introducing new types of customers to LNG.

The LNG **value chain**

Figure 6: LNG value chain



1 – Exploration and production (E&P)

Such activities relate to the extraction of natural gas from natural reservoirs. These reservoirs could be from conventional and unconventional sources, located both on land and offshore.

2 – Treatment and liquefaction

Natural gas is treated to remove liquids, solids, vapours and impurities. It is then converted to a cryogenic liquid i.e. liquid cooled to sub-zero temperatures (in this case -162°C), through a multi-stage refrigeration process. This process is called liquefaction. Liquefaction reduces the volume of the gas, making it easier for transportation.

3 – Shipping

Once liquefied, LNG is loaded into cryogenic sea vessels (LNG carriers) to transport the gas to centres of demand. These ships have insulated cargo tanks to maintain the LNG in a liquid state throughout the voyage.

4 – Storage and regasification

LNG is received at either an onshore or floating receiving terminal near-shore and then stored in cryogenic storage tanks. Regasification is the process of converting LNG back to its gaseous state through a method known as vapourisation.

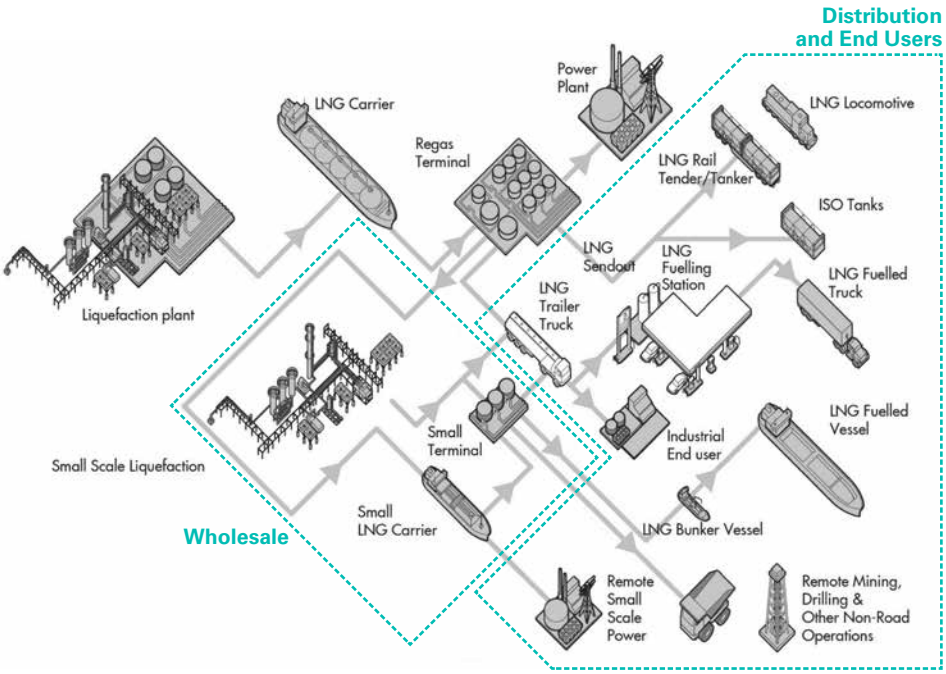
An offshore solution that is rapid gaining popularity as a mainstream solution for LNG regasification is the Floating Storage and Regasification Unit (FSRU). FSRUs have been in operation for just over ten years. The sector is dominated by three companies - Excelerate Energy, Golar LNG and Hoegh LNG - but other companies such as BW are keen to expand into this area as LNG demand continues to grow. As of January 2016, the number of FSRUs in the world has grown to 23 vessels, with an additional seven being built. Imports through FSRU terminals have also increased. Provisional estimates put the number at 22.8 million tonnes in 2015 – a jump of 44%. This increase is mainly due to new FSRU projects in Pakistan, Egypt and Jordan[11].

FSRUs have helped open up new markets and lower the barriers to entry to LNG. Such floating (or nearshore) solutions (vis-à-vis onshore terminals) lower capital expenditure (CAPEX) requirements. Construction or conversion can be done in a controlled shipyard environment with existing skilled labour, thereby reducing the uncertainties of construction and increasing the predictability of project costs and schedule.

5 – Distribution

LNG can either be delivered to end users via gas pipelines after being regasified or via other means like transportation containment systems on board trucks or barges. LNG distribution via trucking and barging are viable modes of transportation to serve off-grid or remote industrial, mining, small scale power generation requirements.

Figure 7: Small scale LNG value chain in addition to the conventional LNG value chain



Source: "2012-2015 Triennium Work Report", International Gas Union, June 2015

11 "Global LNG - FSRU Overview 2016", Wood Mackenzie, 2016

Opportunities in LNG

The world, particularly Asia, has the potential for a large growth in demand but unlocking it requires in-market infrastructure development and environmental regulations. A period of low prices could facilitate this.

Although the recent decline in oil prices reduces the users' immediate impetus to convert to other forms of fuel such as natural gas, it generally does not diminish the advantages of doing so over the longer term. This is particularly so in view of the macro-economic drive towards greater energy security, cheaper and cleaner energy sources. The low price environment could thus enable the building of new import infrastructure in countries or regions with no or limited access to supplies.

With LNG in oversupply, established LNG import markets (buyers) are expected to take advantage of the market imbalance to focus on growing import, storage, and vessel berthing capacities, as well as small scale reloading and bunkering through either green field projects or brown field expansion. New buyers in less mature LNG markets could favour the use of floating or near-shore receiving terminals to meet local demand requirements. By 2021, LNG imports among developing Asian economies (including China) are set to increase by more than 100 billion cubic metres (bcm)[12].

In line with growing natural gas demand, global expenditure on LNG export facilities, import facilities and LNG carriers will have to rise in tandem. This figure is expected to be in excess of US$240 billion from 2016-2020, representing a 34% increase over the previous five years[13]. Singapore companies should seek opportunities in the region to build up a flexible web of transport and delivery options in the region for LNG. With the potential for an increase in long term demand and supply, these developments could catalyse the formation of a much broader and globalised industry.

12 "Medium-Term Gas Market Report", International Energy Agency (IEA), 2016
13 IE Singapore & "LNG Market Outlook", Douglas Westwood, 2016

Market spotlight – Where are the opportunities?

Southeast Asia

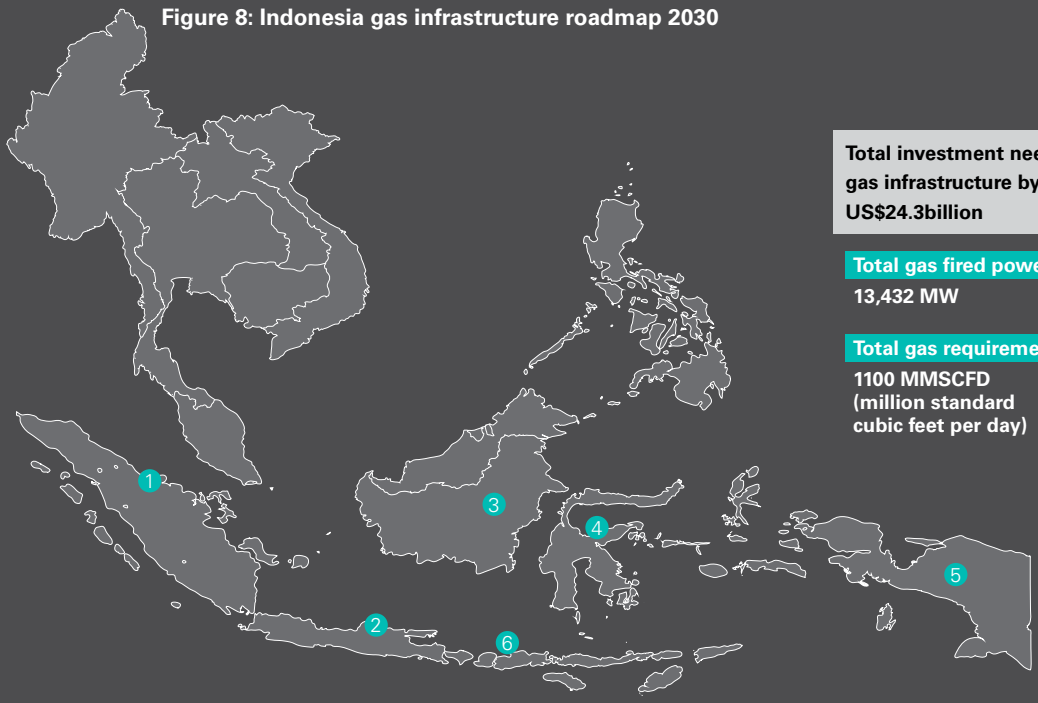
Indonesia

The Indonesian government has a plan to add 35,000 MW to the nation's power generation capacity, of which 13,432 MW will be gas-fired power generation. These new independent power projects (IPP) will be developed by PT PLN predominantly to serve the central and eastern Indonesian regions.

To realise this vision, the Ministry of Energy and Mineral Resources (ESDM) has outlined a gas infrastructure roadmap, whereby US$24.3 billion worth of investments will be required to put in place the necessary pipelines, liquefaction, regasification and distribution infrastructure to support plans for more efficient and less pollutive gas-fired power generation[14].

14 Oil & Gas council panel: Presentation by Dr Ir. IGN Wiratmaja Puja, Director General, Ministry of Energy & Mineral Resources (ESDM), Indonesia, 2016

Figure 8: Indonesia gas infrastructure roadmap 2030



Gas generation capacity and feedstock requirements

	Region	Generation capacity (MW)	Feedstock Required (MMSCFD)
1	Sumantra	2867	267
2	Java	6764	423
3	Kalimantan	1091	86
4	Sulawesi	1830	147
5	Papua	440	48
6	Nusa Tengara	490	38

Besides the government-driven gas to power program, Pertamina is also pursuing a national programme for fuel diversification (LNG Jawa) for transport (25 mmscf/ day)[15] and industrial demand in order to reduce carbon emission and pollution in Java.

Under this fuel diversification initiative, the priority is to provide clean and competitive fuel for public transportation, railway and subsequently ships, including passenger and fishing boats. In the initial phases, an LNG hub with truck filling stations will have to be put in place in Northern Java to transfer LNG to trucks and rail cars. These will then distribute them to LNG or CNG (compressed natural gas) stations for vehicles. Opportunities therefore exists for retrofitting of diesel dual fuel (DDF) kits on mining trucks, road tankers, rail cars and CNG converter kits for small vehicles.

For projects driven by the private sector, there are also requirements for mini LNG infrastructure and gas-fired power generation to feed remote off-grid locations where the laying of dedicated gas pipelines is not economical. Such small scale demand locations could be mining sites or industrial demand centres (for steel, aluminium, foods, paper, chemical, glass) where LNG barges and small scale carriers compatible to receiving infrastructure will have to be built to service small volume requirements.

15 Pertamina presentation, 4th Gas forum, Nusa Dua, 30 May 2016

Myanmar

Myanmar is a major producer of natural gas in Southeast Asia. Most of its supplies are exported on long term contracts to neighbouring China and Thailand.

Myanmar is currently undergoing intensive industrialisation and is looking to step up its development of infrastructural projects to spur growth. To succeed, improving electricity access to industrial zones in peripheral areas is required.

Myanmar's power transmission system is old, resulting in a 30% inefficiency loss and occasional blackouts which hinder the optimal output of Myanmar's 18 industrial zones[16]. Infrastructure support, including transmission and distribution networks, is currently also minimal for the seven planned industrial zones that will be scattered from the capital. As refurbishing and building new transmission and distribution lines are costly, the government is encouraging existing and new industrial zones to build individual captive power plants with generation capacities between 50 MW to 100 MW to directly supply electricity[17].

Such scattered captive power plants may best be served by small scale LNG distribution. Coupled with the higher energy demand as a result of development objectives and underdeveloped gas resources, Myanmar may look to import LNG in the medium term, creating demand and market conditions for downstream LNG infrastructure. Myanmar currently has no LNG terminals.

Notable developments:

- In June 2015, Thai state-owned PTT Public Company Limited (PTT) signed deals with Ratchaburi Electricity Generating to invest in a LNG terminal project and power generating facilities in Myanmar. Under the terms of the contracts, PTT and Ratchaburi will work on developing a 3 Mtpa FSRU and conduct a project feasibility study. The project will supply natural gas to power generation facilities.

- In July 2015, Japan pledged about US$6.1 billion in financial aid to help move the Dawei Special Economic Zone (SEZ) project forward as an equity partner. This is a US$50 billion, 20 km industrial and trade development along west Myanmar aimed at transforming the Mekong region into a broader trading hub between the Middle East, Africa as well as South and Southeast Asia. The first phase of development includes a LNG import terminal, along with separate plans for a gas-fired power plant, a sea port as well as road connections to Thailand.

16 "The review and evaluation of industrial policy especially SMEs development of CLMV countries", ASEAN-Canada Research partnership, 2014

17 "Rangoon promises 24-Hour to residents during summer", The Irrawaddy, 20 January, 2014

South Asia

India

In India, domestic production, which has traditionally been concentrated in the western and southern regions, is projected to reach 230 mmscmd (million metric standard cubic metre per day) by 2030 against a projected demand of 746 mmscmd. Even with the Turkmenistan- Afghanistan-Pakistan-India (TAPI) pipeline up by 2017, piped gas and domestic production will not be sufficient to support India's growing demand for gas[18].

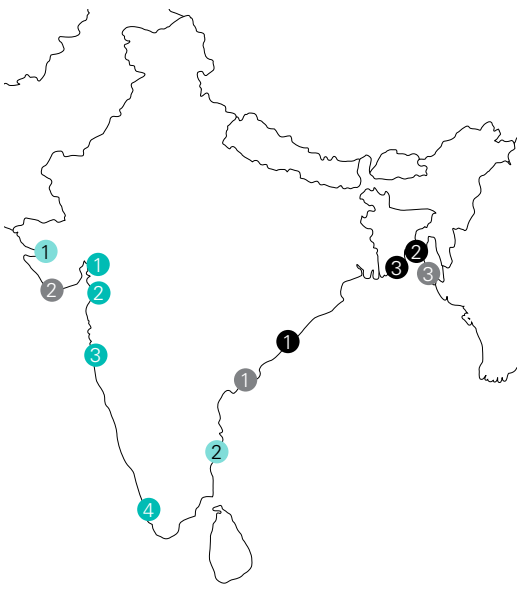
As demand outpaces supply, this translates into an opportunity of up to 131.2 Mtpa of LNG to be imported by 2029-2030. However, this means that India will need to sign more long term contracts and establish sufficient regasification capacity.

Taking into account India's long term contracts, which are mostly expected to come into force between 2016-2018, there is still a deficit of approximately 100 Mtpa needed to support demand. This means there is a need for India to take advantage of the current low price environment to secure more long term contracts.

In addition, LNG supply to India has been constrained by its regasification capacity. As of 2015, India's existing regasification capacity was at 21.1 Mtpa, with another 34.4 Mtpa to be up by 2016-2017. By 2030, India aims to reach a total capacity of 58.0 Mtpa through expansions of existing terminals and commissioning of new terminals in Kochi and Mundra[19].

However, considering existing and planned regasification projects, there is still a shortfall of approximately an additional 70 Mtpa of regasification capacity.

Figure 9: Overview of receiving terminals in South Asia



Existing Import Terminals

1. India Dahej (10 Mtpa)
2. India Hazira (5 Mtpa)
3. India Ratnagirl (2.5 Mtpa)
4. India Kochi (5 Mtpa)

FSRU (Under construction)

1. India Mundra (5 Mtpa), 2017
2. India Ennore (5 Mtpa), 2019

Import Terminals (Proposed)

1. India Gangavaram LNG (5 Mtpa), 2018
2. Bangladesh Chittagong (2.5-5 Mtpa)
3. Bangladesh Patuakhali

FSRUs (Proposed)

1. India Kakinada Deepwater Port (3.5 Mtpa), 2017
2. India Jafrabad LNG Port (5 Mtpa), 2017
3. Bangladesh Moheshkhali (3.5 Mtpa), 2017

18 "Vision 2030 - Natural Gas Infrastructure in India", Petroleum and Natural Gas Regulatory Board (PNGRB), 2013
19 "LNG-Global challenges & opportunities and imperatives for India", Boston Consultancy Group, 2014

Central America and the Caribbean

Central America and the Caribbean countries are best placed to capitalise on the imminent rise in US gas exports, and stand to benefit from lower prices and greater flexibility in natural gas trade. Countries in this region can greatly reduce costs of power generation, while cutting carbon emissions by displacing oil products with less expensive natural gas.

Puerto Rico and the Dominican Republic are currently the only LNG importers in Central America. These LNG imports are sourced mainly from Trinidad and Tobago. Imported oil products remain a substantial part of the region's electricity matrix as they are used to supplement renewable energy sources during periods of drought. Switching to gas-fired generation may cut electricity prices by as much as 20-30%. Within the Caribbean, 11 out of 14 countries rely on diesel and fuel oil-fired plants for over 75% of installed capacity. Electricity prices across the region may be slashed by half via a fuel switching program to natural gas[20].

Figure 10: Existing and future terminals in USA & Caribbean

Existing Import Terminals

1. Altamira (3.5 Mtpa)
2. Freeport LNG (13.5 Mtpa)
3. Golden Pass LNG (15.6 Mtpa)
4. Lake Charles LNG (13.3 Mtpa)
5. Cameron LNG (11 Mtpa)
6. Gulf LNG Clean Energy Project (11.5 Mtpa)
7. Andres (1 Mtpa)
8. Penuelas (1.8 Mtpa)

Existing Export Plants

1. Sabine Pass LNG T1/T2 (9 Mtpa)
2. Atlantic LNG T1/ T2/T3/T4 (14.8 Mtpa)

FLNG (Under construction)

1. Caribbean FLNG (0.5 Mtpa)

FSRUs (Proposed)

1. Aguime GasPort (3.8 Mtpa), 2016
2. AES Ocean LNG, 2019
3. Colombia FSRU (3.75 Mtpa), 2018

Import Terminals (Proposed)

1. Annova LNG & Texas LNG (8.99 Mtpa), 2021
2. Golden Pass LNG (15 Mtpa), 2020
3. Lake Charles LNG & Magnolia LNG (23 Mtpa), 2020+
4. Calcasieu Pass Project (10 Mtpa), 2018
5. Louisiana LNG (2 Mtpa), 2020
6. Gulf LNG Liquefaction (20 Mtpa), 2019

FLNG (Proposed)

1. CE-FLNG (8 Mtpa), 2018

20 "Pre-feasibility Study of Potential market for natural gas as a fuel for power generation in the Caribbean", Inter-American Development Bank, 2013

As US LNG export terminals come on-stream, Central America and Caribbean can look to develop island hubs with large regasification plants that connect supply to neighbouring countries via smaller LNG vessels. For example, Andres LNG in the Dominican Republic, the only regasification terminal in Caribbean that can support reload operations (by Q3 2016), could receive cargo from the US, break bulk and then deliver smaller volumes to demand centres in Jamaica and Cuba.

Given the lack of financial resources and poor credit ratings of many member countries, private sector investments will be key to realising the region's potential as an import market for US gas. Most Central American and Caribbean countries by themselves are not major offtakers. To enhance its attractiveness as a gas import market, the region may need to work on integrating plans for gas imports and presenting itself to exporters as a unified market – a challenge in itself given varied energy policies and market structures.

Panama

Asia is considered one of the most likely destinations for LNG exports from the US. The expansion of the Panama Canal makes it faster to move LNG from the US Gulf Coast to Asia Pacific, with a return trip taking 43 days compared to 62 days via Suez Canal. Although reduced gas prices make such trade from US to Asia Pacific less attractive in the short term, Panama still has the potential to become a regional hub for LNG.

The Panama government has outlined strategic goals related to energy generation and LNG. They include positioning Panama as an LNG hub for transhipment and bunkering, and diversifying the country's energy generation matrix through installing additional sources of electricity generation.

With regard to the goal of diversifying the energy generation matrix, the Panama state company Empresa de Transmision Electrica S.A. (ETESA) assigned a contract involving the supply of 350 MW of electricity in September 2015. The project includes the construction of a 170,000 cubic metre storage and regasification facility on the Colon terminal which is expected to be ready in 2018[21].

As part of the initiatives to position Panama as a LNG hub, the Panama Canal Authority (ACP) is currently evaluating several LNG projects, including transhipment and bunkering.

21 "AES to build natural gas-fired generation power plant in Panama", Powergrid International, 2015

Africa

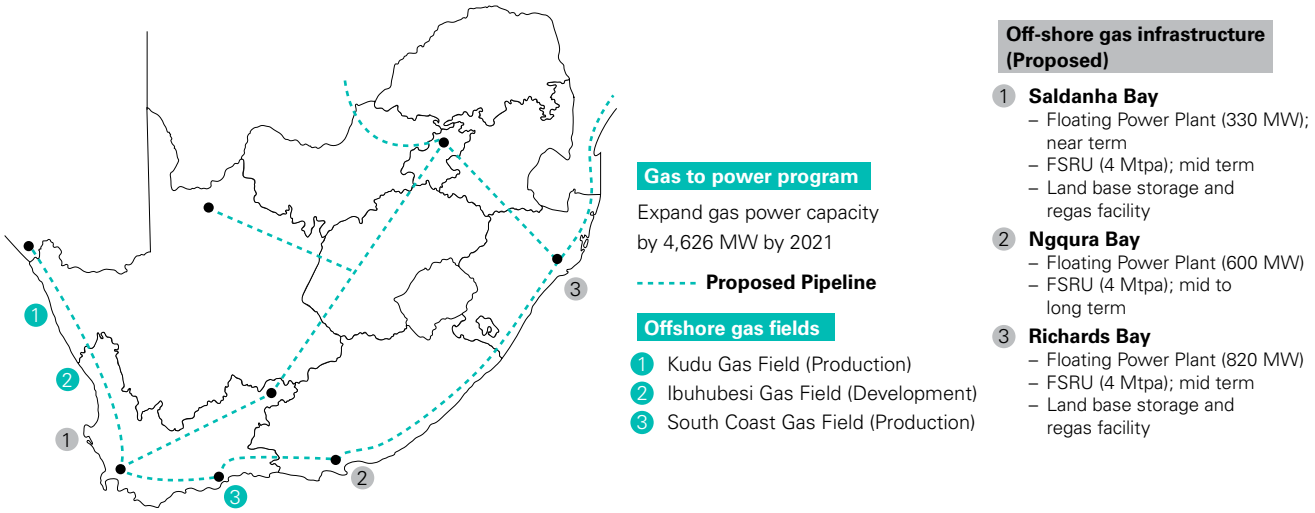
South Africa

Load shedding (rolling blackouts) has been occurring on a regular basis in South Africa. State owned utility ESKOM has been relying on diesel-fired turbines to support the grid. Diesel accounts for 15% of ESKOM's primary fuel costs but only contributes to 1.6% of the power generated. In 2013/2014, ESKOM spent US$1 billion on 1,148 litres of diesel for electricity generation (equivalent of $25 - $30 per thousand standard cubic feet)[22]. There is a long term plan to diversify away from diesel for power generation, in favour of more economical gas feed stock.

To support South Africa's base load energy mix as part of a medium to long term risk mitigation programme, the Department of Energy (DOE) has issued a request for information (RFI) in May 2015 for the procurement of 3,126 MW of generation capacity from any gas type or source generated using any appropriate technology framed under a "Gas to Power Programme".

During the Gas Options Conference 2015, South Africa port authority, Transnet, shared that three sites have been selected for the LNG import terminals – Coega, Richards Bay and Saldanha Bay (Figure 11). In the short term, the government envisions the use of jetty-moored FSRUs that provide 4 Mtpa each for the import and regasification of LNG and piped to onshore power plants or grid. In the long term, the government plans to build land-based import terminals when the domestic gas market is established.

Figure 11: South Africa's long term planning for gas infrastructure[23]



In February 2016, it was announced that the capacity of the Programme was increased to 4,626 MW. According to the IPP office, the target is to have early power generation facilities and medium to long term LNG infrastructure in place by 2020 and 2021.

There are opportunities for Singapore companies to provide gas/LNG-related infrastructure, engineering solutions or service for municipal-level requirements in the Western Cape region. There are also opportunities to meet the demand of industrial hubs (i.e. smelters and rare earth sectors.)

22 Ibhubesi Gas Project, Investor Roadshow, April 2015
23 "Transnet preparation for gas infrastructure in South Africa", South Africa Gas Options Conference, September 2015

Growing the **Singapore LNG ecosystem**

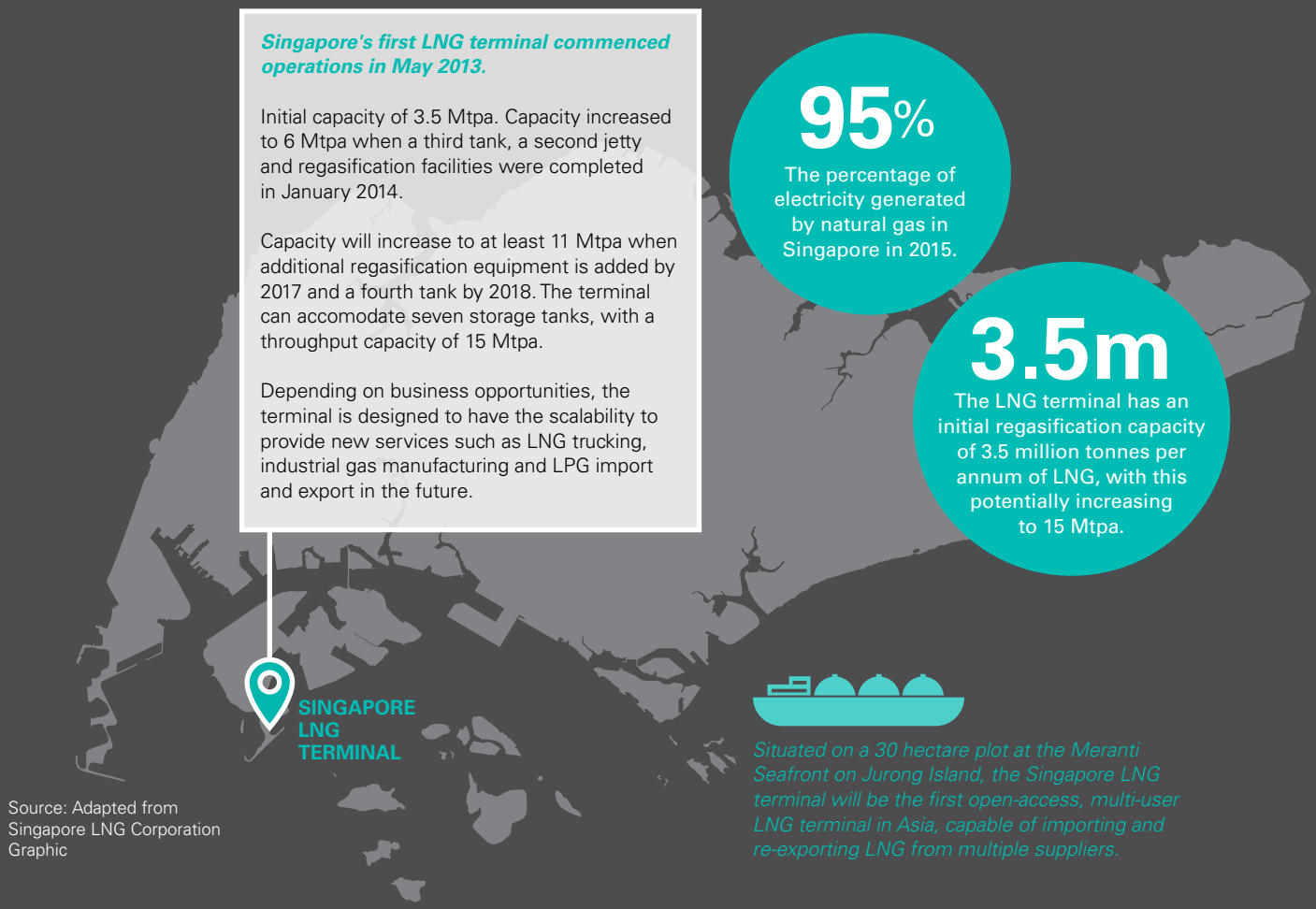
Singapore is a world-renowned centre for oil trading and price discovery, with over 400 companies trading in petroleum and petroleum products. It is also the world's top oil bunkering hub and among one of the top five oil refining centres in the world.

With its proximity to traditional and emerging buyer demand in Asia, status as a neutral marketplace and reputation as a leading trading and financial hub, Singapore is well-placed to ride the growth of natural gas and become Asia's LNG hub.

The Singapore government has invested heavily in infrastructure to support the country's energy needs. As an open access terminal, the Singapore LNG terminal (SLNG) can be used to support physical LNG trading in the region.

Growing the Singapore LNG ecosystem

Figure 12: Singapore LNG terminal



Source: Adapted from Singapore LNG Corporation Graphic

The Singapore Exchange (SGX) and Energy Market Company (EMC) have launched the SGX LNG Index Group (Sling), a LNG spot price index that can serve as a neutral Asian price. This Index is suitable for most Asian seaborne LNG trade, regardless of whether it is offloaded or stored in Singapore or passes through the Straits of Malacca and Singapore. In January 2016, SGX launched swaps and futures derivatives as risk management tools based on the Sling index.

Anticipating future trends and demand, the Maritime Port Authority (MPA) is also planning for LNG bunkering in the Port of Singapore. A pilot programme is targeted for early 2017 to help prepare and develop Singapore as a key LNG bunkering hub in Asia. To catalyse the growth of LNG usage, MPA will also be funding up to S$12 million for the building of six LNG-fuelled vessels.

All these are building blocks that will position Singapore to work with regional partners to integrate Singapore's capabilities to support regional markets' growth and development in the area of LNG moving forward.

Strategies for companies to capture LNG sector opportunities

At the enterprise level, Singapore companies can also plug into the developing needs for LNG in the region and beyond.

Over the past 40 years, Singapore has evolved from a regional ship repair centre to a world leading offshore and marine hub and developed a comprehensive ecosystem in the onshore oil and gas process industries. Singapore companies can leverage on past experience and track records to position themselves for mid-to-long term opportunities emerging from the LNG sector.

Transforming capabilities

Singapore companies can leverage their capabilities in existing fields to meet the demands of the growing LNG sector.

Shipyards, construction companies and engineering firms involved in offshore oilfield services, modules fabrication, systems integration, plant and marine civil engineering are examples of such firms. Their know-how in their current industries can be translated to meet project-based requirements related to both conventional and small scale LNG infrastructure, transportation and distribution.

Singapore's offshore support services (OSS) companies can also build on their experience in ship finance, management and operations to address opportunities in midstream and downstream LNG asset ownership and operatorship. For example, small scale LNG carriers (SS LNGC) for inter-island, costal and river trade (1,000 – 30,000 cubic metres cbm), FSRBs (Floating Storage and Regasification Barges) and gas-fired power barges are likely to be purpose-built against long term tolling or take-or-pay type contracts. This allows OSS companies to pursue revenue and asset diversifcation strategies, to hedge against the cyclical nature of the upstream oil and gas segment.

Over the longer term, Singapore companies looking to gain a foothold in the LNG sector, may proactively seek out technical partners or pursue mergers and acquisitions as a way to access new capabilities. Suggested core capabilities that Singapore companies can seek to acquire can be found in the Annex.

Strategies for companies to capture LNG sector opportunities

Strength in alliances

Prospective importing countries and energy companies, especially those in Asia, will need external partnerships to build the domestic gas value chain and meet corresponding LNG infrastructure, shipping and distribution requirements essential for furthering the growth of domestic and regional gas markets.

An entry approach for Singapore companies to address small scale LNG marine and onshore infrastructure requirements would be to form strategic alliances with companies offering complementary capabilities. Such an alliance is typically anchored by a larger lead company, with partner companies providing LNG equipment or services to the project and taking minority equity stakes.

By forming strategic alliances, Singapore companies will be able to better exploit market opportunities and play a crucial role in transforming the way energy is delivered. Such alliances also allow Singapore companies to value add to smaller, private developers for turnkey LNG projects from an early or developmental stage, thereby enhancing their success of securing preliminary track records.

Connecting the dots

With overseas centres in over 35 locations around the world, IE Singapore can help Singapore companies interested in entering the LNG sector to:

// Foster strategic alliances with industry partners with complementary or niche capabilities
// Catalyse partnerships or sub-contracting relationships with large engineering companies, contractors and project developers
// Be introduced to local partners adept at navigating the local landscape and gaining access to projects
// Acquire and integrate intellectual property related to the gas/LNG value chain
// Identify opportunities for strategic, distressed asset acquisitions to gain "bolt-on" expertise in the gas/ LNG value chain
// Tap professional networks of advisory and engineering consultancies
// Gain access to financial partners and equity investors to raise/seed developmental or early stage equity for LNG projects

Annex

Some core capabilities Singapore companies can seek to acquire include:

- **LNG process modules engineering and fabrication**
  - Mobile and modular vapourisers or regasification systems
- **LNG cryogenic equipment component manufacturing and distribution**
  - Standalone, plug and play, mini / micro scale liquefier for small scale LNG production and boil-off gas re-liquefaction for LNG delivery to remote locations
  - Cryogenic valves
  - Transfer systems
- **LNG containment (double walled, insulated, cryogenic tanks) fabrication**
  - Storage Tanks: Factory or site built, vertical or horizontal, 500 – 5,000 cbm
  - Transportation tanks: Goes onto trucks railway and barges
- **LNG fuel systems retrofit:**
  - Diesel dual fuel (DDF) converter
  - Component-related manufacturing

The above capabilities will strengthen the ability and value proposition of Singapore firms in providing turnkey engineering for:

- **Seaborne LNG transportation solutions for costal and inland waterways**
  - SS LNGC design and engineering for river and coastal (up to 4,000 cbm), inter-island (4,000 – 15,000 cbm) and international transportation
  - As of 2014, global fleet size for SSLNGC currently stands at 24, with vessels ranging from 1,100 – 23,096 cbm (an additional 14 vessels ranging from 2200 – 30,000 cbm are on order)
- **Mini / Small scale LNG infrastructure**
  - Mini FSRB/ FSB (Floating Storage Barges) (Storage 750 – 12,000 cbm) design and engineering
  - Mini LNG terminal (2,000 – 3,0000 cbm) for 30 – 400 MW requirements
  - Satellite stations consisting of storage tanks (1,000 cbm), vapourisers, flow and pressure control skids & programmable logic controller (PLC) based controls for 50 – 30 MW demand centres
  - (Fixed) LNG/ CNG refueling Stations (for land transport)
  - Mobile LNG refuelling: Skid mounted, self contained, re-locatable, allows for spot billing
- **LNG Bunkering stations**
  - LNG storage tanks, with control systems for local and remote operations, spill prevention features

International Enterprise Singapore

International Enterprise (IE) Singapore is the government agency promoting international trade and partnering Singapore companies in going global. Its vision is a thriving business hub in Singapore with Globally Competitive Companies (GCCs) and leading international traders.

Trade has always been the backbone of Singapore's economy. In addition to promoting export of goods and services, IE Singapore also attracts global commodities traders to establish their global or Asian home base in Singapore. Today, Singapore is a thriving trading hub with a complete ecosystem for the energy, agri-commodities and metals & minerals trading clusters.

GCCs are a critical growth engine for the next phase of Singapore's development. GCCs compete on the global stage against the very best in their industries. They contribute to Singapore's economic resilience, develop Singaporeans into global business leaders and strengthen the Singapore brand. Through its Global Company Partnership and Market Readiness Assistance, IE Singapore works with Singapore-based companies in their various stages of growth towards being globally competitive.

IE Singapore's global network of overseas centres in over 35 locations provides the necessary connections in many developed and emerging markets.

Visit **www.iesingapore.gov.sg** for more information.

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