LNG in Asia-Pacific
- Favoring trade and rational market development

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Foreword

This report follows the tasks of the APEC LNG Trade Facilitation Initiative presented in September 2014 at the 11th Energy Ministerial Meeting in Beijing, in terms of disseminating information and promoting multilateral dialogue. The report analyzes regional LNG markets, identifies some of their major challenges and proposes several recommendations for the consideration of policy-makers about the development of more efficient LNG markets. I must add that this is the first report ever prepared by the Asia Pacific Energy Research Centre exclusively dedicated to the topic of LNG.

Hosting the largest LNG consumers, the Asia-Pacific Basin and Asia in particular are expected to become the driving force of LNG demand worldwide in the next decades. Nevertheless, economies in this region have historically paid the highest LNG prices in the world, for which the expansion of APEC-wide trade hinges on introducing more flexible business practices and market-driven mechanisms more conducive to trade and cooperation among diverse stakeholders.

The insights presented in this report greatly benefited from the feedback gained by the attendance of APERC and IEEJ staff to the workshops, forums and industry seminars listed in the Annex. I would also like to congratulate both institutions, as 2016 marks the 50th anniversary of the Institute of Energy Economics, Japan and the 20th anniversary of the Asia Pacific Energy Research Centre.

As an independent work of APERC, this study does not necessarily reflect the views of or the policies of the APEC Energy Working Group or of individual member economies, although it shares the APEC LNG Trade Facilitation Initiative's goal of expanding intraregional LNG trade under more competitive and transparent market principles, with the aim of bringing about benefits for suppliers and consumers alike that ultimately strengthen the region's energy security.

I am confident that this document will advance the understanding of LNG markets to enrich the discussion between policy-makers and industry players, who will ultimately capitalize on the economic strengths and trade opportunities offered by the APEC region to expand intraregional LNG trade flows under more competitive conditions.

Takato OJIMI
President
Asia Pacific Energy Research Centre

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The views in this study do not necessarily reflect those of the expert reviewers named above. Any errors and imprecisions are solely the responsibility of the authors.

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List of abbreviations

ABAC	APEC Advisory Business Council
APEC	Asia-Pacific Economic Cooperation
APERC	Asia Pacific Energy Research Centre
APGAS	APEC Gas Forum
EGCFE	Expert Group on Clean Fossil Energy (APEC Energy Working Group)
EWG	Energy Working Group, APEC
FID	Final investment decision
FLNG	Floating LNG
FSRU	Floating Storage Regasification Unit
HOA	Heads of Agreement
IEEJ	The Institute of Energy Economics, Japan
IOC	International Oil and Gas Company
JCC	Japanese Custom Clearance Price
JKM	Japan Korea Marker
JSA	Joint Study Agreement
LNG	Liquefied Natural Gas
METI	Ministry of Economy, Trade and Industry (Japan)
NOC	National Oil and Gas Company
NYMEX	The New York Mercantile Exchange's
OGSI	APEC Oil and Gas Security Initiative
SPA	Sales and Purchase Agreement
USD	United States Dollar

Energy units and conversions

Bcf	Billion cubic feet
Bcm	Billion cubic meters (10^9 cubic meters)
BTU	British Thermal Unit
Mcf	Thousand cubic feet
MMBTU	Million BTU
MT	Million tons
Mta	Million tons per annum
Mtoe	Million tons of oil equivalent
Tcm	Trillion cubic meters (10^{12} cubic meters)
Toe	Tons of oil equivalent

From	*To cubic meters of natural gas*	*To billion cubic feet of natural gas*	*To million tonnes of oil equivalent*
	Multiply by		
1 billion cubic metre of natural gas	**1**	**35.315**	**0.9**
1 billion cubic feet of natural gas	**0.028**	**1**	**0.025**
1 million tonnes of oil equivalent	**1.111**	**39.239**	**1**

Please note that due to the amplitude of crude oil types and the varying energy contents of the natural gas stream, these factors must be seen as approximate equivalents.

Executive summary

Establishing a well-functioning LNG market is paramount to enhancing regional trade and in promoting investment in the LNG supply chain. However, it takes concerted efforts and firm actions, both on the regional and domestic fronts, to resolve the hurdles facing the LNG supply chain and to change the current market landscape. One key issue is oil-linked pricing for natural gas (and LNG), which creates market imbalances as oil price volatility may lead to the deferment of some LNG projects.

Like no other economic region, APEC has a privileged position in the global LNG industry bolstered by a remarkable potential for growth. The volumes traded in member economies accounted for 68% of the imports and 40% of the exports of LNG traded worldwide in 2015. Around 57% of the LNG imported and nearly all of the LNG exported by member economies were traded exclusively within APEC.

Furthermore, the relevance of APEC to the global LNG industry is poised to expand in the near future, as a significant amount of the regasification and liquefaction capacity expected to come online in the short term will be located in the region. Member economies are home to 14 of the 20 receiving terminals under construction before 2019, which will comprise 69% of the new regasification capacity worldwide. As for liquefaction, APEC will be even more relevant, as 27 out of 28 liquefaction plants built through 2019 will be located in member economies, representing nearly all the additional global capacity. Australia and the United States alone will host 20 of those liquefaction plants.

But an expanded LNG trade faces several major challenges. Although the Asia-Pacific is one of the most important regions for LNG and the driving force of its worldwide expansion, Asian markets have historically paid the highest LNG prices, which were worsened by a period of high oil-prices in the early 2010s and by Japan's peaking gas demand after the nuclear accident at Fukushima. LNG assets were historically developed under a business model characterized by long payback periods, whereby buyers and sellers signed long-term contracts with destination restriction, shipping responsibility, and sales volume obligation (take-or-pay) clauses.

At the root of these problems however are three major challenges: an ambiguous role for natural gas in a low-carbon energy transition, rising energy security concerns and a lack of alignment in the expectations of different stakeholders involved across the LNG value chain. The recognition of these three major elements is likely to be the cornerstone of a truly constructive dialogue, at the economy-wide, regional and global levels, necessary to help LNG buyers and sellers introduce more flexible business practices and foster more conducive settings for trade, market-based mechanisms and cooperation.

The recommendations outlined in this report aim to overcome existing challenges in the LNG industry. In addition to targeting the LNG industry's formal transactions, these recommendations also advocate for a clearer role of natural gas and LNG in energy policy, for the deregulation of the natural gas and electricity industries, and for policies on economic competitiveness, open trade and good governance. The cooperation between diverse stakeholders, including those who often have opposing interests, such as buyers and sellers, and governments and local industries is critical for the success of all these initiatives.

The following are the 15 recommendations for APEC member economies to remove trade and investment barriers:

1. Define the role of natural gas in energy and climate policies
2. Steer structural shift in the natural gas and energy industries toward market liberalization
3. Remove barriers to LNG trade and investments as well as energy subsidies
4. Enforce fiscal and investment frameworks that facilitate gas upstream projects
5. Acknowledge the critical role of LNG infrastructure for energy security
6. Improve procurement and technological processes
7. Explore alternative LNG business models
8. Advance new LNG contract features
9. Promote financing alternatives for LNG projects
10. Support the development of gas price hubs
11. Facilitate the investment and regulatory environments for LNG projects
12. Develop competent institutions for regulatory enforcement
13. Engage stakeholders in LNG projects
14. Foster regional cooperative activities
15. Use collective power to encourage more balanced interactions and discussions

The current conditions of the LNG industry in the Asia-Pacific are particularly promising for a paradigm change in contract specifications. New sellers like those in the United States are offering more favorable transactions without destination clauses and more flexible terms that undermine the traditional contract conditions in the industry, while the present oversupply has increased the bargaining power of buyers. This has allowed for more ambitious demands on sellers, including the possibility of participating directly in upstream LNG projects or promoting backwards integration as a means of securing supply. In essence, these issues should encourage dialogue to promote a more balanced alignment of interests between different stakeholders, which could positively affect trade flows in coming years.

LNG trade in the APEC region has a strong potential to grow in step with the coordination and collaboration of buyers and sellers to create mutually beneficial business opportunities, economic prosperity and enhanced energy security.

1 Introduction

Efforts to significantly decouple energy use from growing carbon dioxide emissions are constrained by major technological and economic challenges that prevent meeting energy demand entirely with renewable energy or zero-emissions technologies. Therefore, in the near-term, and notwithstanding the strong actions underway to expand the share of renewable energy and other low-carbon systems, energy demand on a global scale and in most economies will still rely on fossil fuels.

It is in these circumstances that increased use of natural gas is seen by APEC economies as an effective vehicle to meet rising energy needs while minimizing carbon emissions. Moreover, if natural gas displaces oil and coal consumption, it would provide a cleaner and more diversified energy supply that still allows for the economic development of low-carbon economies, especially as more efficient energy systems and technologies mature.

Following this premise, natural gas is expected to become increasingly relevant in the world's energy mix and particularly in the APEC region. Even though the share of natural gas in primary energy demand in APEC has remained relatively constant around 20% between 1990 and 2013, it is expected to grow rapidly to as much as 27% by 2040 (APERC, 2016). However, some major issues stand in the way of an expanded use of natural gas in the region.

The first challenge concerns the geographic asymmetries in the worldwide supply and demand of natural gas. As of 2014, the production and reserves of natural gas were concentrated in five economies, with Iran, Russia and Qatar accounting for almost half of the total proved reserves, clearly giving them a strong advantage over the larger number of importing economies.

Another challenge is the fragmentation of gas markets worldwide. In the case of oil, its widespread demand and transportation flexibility have led to an effectively unified market in which incremental production is easily priced and traded at a global scale. In contrast, natural gas is a less liquid commodity whose trade hinges on securing customers who can create demand to underpin the rest of the value chain. Fundamentally, natural gas is demand-driven, and due to its intrinsic properties, its transport and final delivery to consumers depend on dedicated infrastructure, usually of large scale.

Because of these physical constraints and the typically long distances between major supply and demand centers, there is not an integrated natural gas market, but several disconnected regional markets, each with distinctive economic and institutional settings, which in turn have led to divergent price levels and price formation mechanisms around the world.

Although the bulk of gas has been traditionally transported by pipelines, the advent of liquefied natural gas (LNG) has connected stranded gas supplies in distant locations or places unreachable by pipelines with new markets. LNG has truly amplified the geographic reach of the gas industry and has allowed the above-ground stockpiling of natural gas supplies for energy security purposes.

An expanded LNG trade is not exempt from major obstacles. Shipping and receiving LNG

requires technologically advanced assets characterized by high capital costs with lengthy construction timeframes. These technological and economic profiles along with the uncertainty and price volatility prevalent in international energy markets increase the risks of LNG projects, and have therefore led to a widely used business model characterized by long payback periods, whereby buyers and sellers legally engage with each other over long-term timeframes under fairly restrictive conditions. These characteristics, in combination with large volumes of traded LNG provide buyers in the Pacific Basin with growing bargaining power and call for progressively more flexible and transparent markets.

Natural gas in APEC

The energy mix of the APEC region has been, currently is, and for some decades more will continue to depend on fossil fuels. From 1990 to 2013, coal was the fastest-growing energy source in the regional primary energy mix and it remains the dominant energy source and fossil fuel. The abundance and low cost of coal favor its massive use in APEC, especially in the generation of electricity. However, this dominance is clearly unsustainable from the environmental and climate change perspectives, prompting critical actions that include an expanded use of natural gas in order to reduce the carbon intensity of the energy mix.

From 1990 to 2013, the demand for natural gas in APEC grew at an annual rate of 2.2% and its share in the primary energy mix increased from 20% to 21%. The volume of natural gas consumed in APEC member economies in 2013 amounted to nearly 1 820 Bcm, or approximately 54% of worldwide natural gas consumption (APERC, 2016; BP, 2016).

Global energy outlooks (IEA, 2015c) emphasize the key role of natural gas as the fossil fuel with the lowest emissions and expect it to become the fastest-growing fossil fuel, serving as a bridge to transition away from the high use of coal in Asian economies. Emphasis is on China because of the country's strong growth in energy demand, high share of coal use in the energy mix and the scale of its energy systems, which altogether impose substantial sway on worldwide patterns of energy demand and supply.

The energy outlooks centered on the APEC region (APERC, 2016) project that by 2040 under a business-as-usual scenario, natural gas is the fastest growing fossil fuel, increasing at a rate of 2.2% per year. This growth rate closely approximates the historical growth rate and would lead to natural gas becoming the second fastest-growing energy source after renewable energy (excluding hydro). Projections also suggest that the share of natural gas in the region's primary energy could reach 27% by 2040, and in the electricity sector it could expand from 24% in 2013 to 27% in 2040. This expansion is driven by the installation of incremental gas-based electricity capacity as well as the replacement of current coal-based generation, which is especially intensive in China and other member economies in South-East Asia.

The projected increase in natural gas consumption will require sufficient and growing supplies. Although some of the largest gas-producing economies are APEC members and the region's contribution was more than half of the global gas production in 2013, the pace of regional production will continue to fall short of demand. Between 2013 and 2040, the combined production of natural gas in APEC is projected to grow by only 1.7% per year (APERC, 2016).

Currently, all member economies except for Hong Kong China and Singapore produce natural gas, but the size and distribution of their respective reserves lead to different shares of economy-wide consumption levels. Domestic gas production accounts for as low as 1% of the domestic consumption in Korea and as high as 95% in the United States, while

in other economies domestic production exceeds their economy-wide demand and allows these economies to export the excess volumes of natural gas.

At a regional level, APEC was a net exporter of natural gas in 2013, but in view of the future trends of demand and production, this balance is expected to reverse. Net gas trade will pass from a surplus of 16 Bcm in 2013 to a deficit of 261 Bcm in 2040 (APERC, 2016). This outlook signals a considerable expansion in the volumes of natural gas that will be traded into APEC under business-as-usual assumptions, let alone under scenarios with more favorable policies for the use of gas.

APEC in the LNG arena

Based on the production-consumption balances of natural gas, the APEC member economies fall into three main groups according to their net trade balances. As of 2015, the largest group is formed by net gas-importing economies and consists of Chile, China, Hong Kong China, Japan, Korea, Mexico, Singapore, Chinese Taipei, Thailand and the United States. Another group includes the net gas-exporting economies of Australia, Brunei Darussalam, Canada, Indonesia, Malaysia, Papua New Guinea, Peru and Russia. Lastly, New Zealand, The Philippines and Viet Nam form a small group of member economies lacking of physical infrastructure to import or export natural gas to other economies.

In 2015, approximately 30% of total gas consumed in the world was sourced from imports, with roughly 20% in the form of pipeline gas and 10% as LNG. In APEC, several member economies have increasingly developed infrastructure systems, particularly natural gas liquefaction and regasification facilities, to participate in the international trade of natural gas. Out of the 21 APEC member economies, 17 of them [1] had LNG terminals as of 2015. Although APEC member economies represented less than 30% of global pipeline gas imports, they accounted for more than two-thirds of LNG imports (BP, 2016).

Like no other economic region, APEC has a privileged position in the global LNG industry bolstered by a remarkable potential for growth. Member economies imported 230 Bcm and exported 136 Bcm of LNG by the end of 2015, which respectively accounted for 68% and 40% of the LNG imports and exports traded worldwide (BP, 2016). Furthermore, around 57% of the LNG imported and 96% of the LNG exported by member economies were traded exclusively within the APEC region (BP, 2016).

APEC includes the largest LNG importing economies in the world. In 2015 Japan, Korea, and China were the three largest LNG importers, and along with Chinese Taipei which was the fifth largest, they accounted for more than 61% of the total LNG imports in the world. In the same year, APEC had 66 of the 108 receiving terminals and 13 of the 25 liquefaction plants in operation. Overall, these facilities were respectively equivalent to 70% and 37% of the global capacity for regasification and liquefaction (IGU, 2015b).

APEC has a privileged position in the global LNG industry, bolstered by a remarkable potential for growth. The volumes traded in member economies accounted for 68% of the imports and 40% of the exports of LNG traded worldwide in 2015. Around 57% of the LNG imported and nearly all of the LNG exported by member economies were traded exclusively within APEC.

[1] Please see the Annex for details.

Furthermore, the relevance of APEC in the global LNG industry is poised to expand in the near future, as a large amount of the regasification and liquefaction capacity coming online in the short term will take place in the region. Member economies have 14 out of the 20 receiving terminals under construction until 2019, which will be equivalent to 69% of the new regasification capacity worldwide. As for liquefaction, APEC will be even more relevant, as 27 out of 28 liquefaction plants built up to 2019 will be located in member economies, representing nearly all the additional global capacity plants (IGU, 2015b). Australia and the United States alone will host 20 of those liquefaction plants. These figures illustrate the relevance of the APEC region in the LNG industry, at present and in coming years.

Textbox 1
Fundamentals and relevance of LNG

Natural gas mainly consists of methane (CH_4) along with a smaller proportion of heavier hydrocarbons (such as ethane, propane and butane) and other components (carbon dioxide and nitrogen). This mix is gaseous at standard temperature and pressure, for which its physical transport necessarily involves its pressurization in pipelines or its liquid conversion to LNG.

LNG is natural gas cooled at -161.5°C to convert it from a gaseous to a liquid state. This allows its economic transportation and storage since the same amount of energy can be reduced by more than 600 times in volume in the form of LNG. Historically, pipelines allowed the bulk transmission of natural gas, but as demand for this fuel grows in places where pipelines are unfeasible on the grounds of technical, economic or political factors, LNG remains the only viable transport option.

Developing LNG infrastructure is a very complex task. The technological intensity and scale of LNG projects not only involve high capital costs, but also long construction timeframes and long lead times before the start of operations. Adding to this complexity, the uncertainty surrounding the future trends of global markets and prices complicates the decision to undertake these projects. Therefore, the usual lead time required for construction of terminals of five years might double when considering the prior evaluation, feasibility and appraisal activities at the initial planning stage (Songhurst, 2014). Likewise, the construction of one ship can take around three years (Weems & Hwang, 2013).

The LNG value chain is in the midstream segment of the natural gas industry. As explained below, this value chain involves the treatment and liquefaction of gas, its shipping and regasification.

- **Liquefaction**

Natural gas is produced as a result of the exploratory and extractive activities in the industry's upstream segment. This natural gas is treated to strip water and pollutants and then goes to feed a liquefaction unit or *train*.

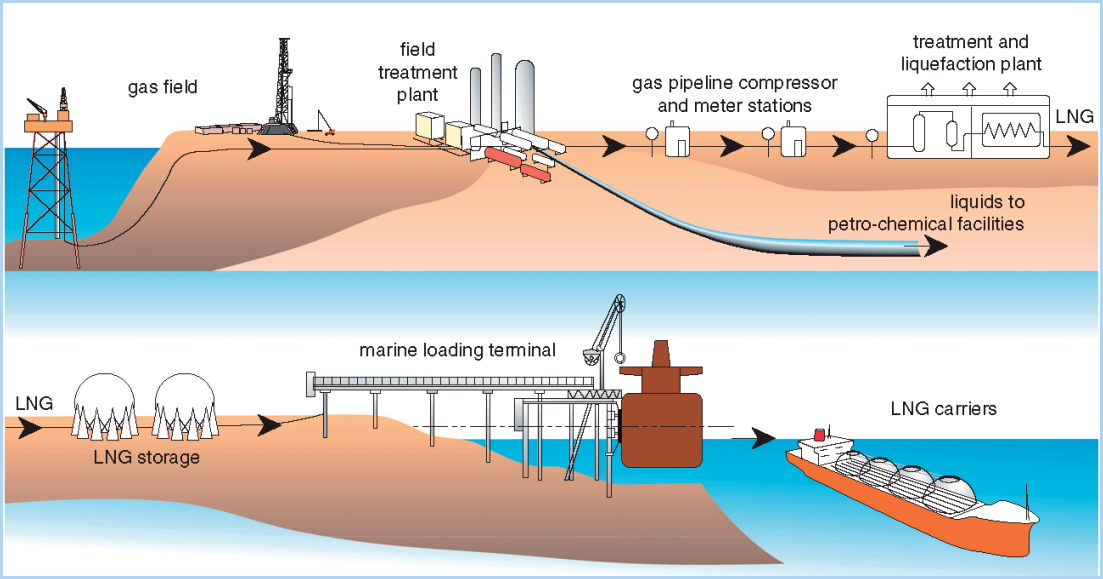
The liquefaction process at the train involves the extreme refrigeration of natural gas to condense it for storage and shipping. Due to the type of technology required, liquefaction is typically the most capital-intensive process in the LNG value chain. Figure 1 shows a simplification of this stage.

- **Shipping**

Shipping is the actual transport stage of LNG and the link between liquefaction and regasification (and their respective terminals). LNG is loaded in specially insulated ships that transport and deliver it to regasification terminals. The role of shipping can be seen graphically in Figure 1.

The low volumetric energy density of natural gas weakens the economic efficiency of its transport and storage over other fuels, namely crude oil. While in 2014 the construction cost of a VLCC (very large crude carrier) of 320 000 tons amounted to USD 97 million, that of a typical LNG tanker of 160 000 cubic meters (equivalent to 93 528 toe) was of USD 200 million (CSR, 2015). Consequently, on a heating value basis, an LNG tanker is seven times more expensive than an oil tanker.

Figure 1
LNG value chain, liquefaction and shipping

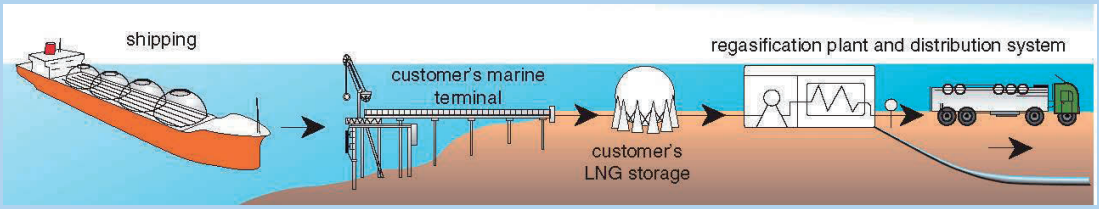


Source: Modified from Jahn (2008, p. 289).

- **Regasification**

Contrary to liquefaction, the regasification stage comprises the unloading of LNG from the ship to return it to its gaseous state in a dedicated plant. Natural gas is then stored or transported to consumers in the market as depicted in Figure 2.

Figure 2
LNG value chain, shipping and regasification



Source: Modified from Jahn (2008, p. 289).

Traditionally, the LNG value chain has been mostly based on inland facilities, but as technology advances, offshore liquefaction and regasification have become technically and economically possible, promising a reduction in environmental and social impacts as well as reduced operational costs. At the end of 2015 there were 20 offshore regasification terminals in the world, four of them in APEC, to receive LNG offshore and deliver it to onshore markets through subsea pipelines. Although there are no offshore liquefaction terminals currently in operation, the first ones equipped with treatment and liquefaction units more convenient for offshore natural gas wells are set to open in 2016 and 2017 in member economies of Malaysia (Petronas PFLNG1) and Australia (Shell Prelude FLNG).

Policy approach

Originally established in 1989 to promote economic growth and prosperity driven by free trade and multilateral economic integration in a sustainable business environment, APEC is a non-binding forum that operates through the dialogue, consensus-based decision-making and voluntary commitments of its 21 member economies[2].

APEC covers a range of key policy areas which are periodically reviewed in Leaders' and Sectoral Ministerial Meetings. These high-level meetings set the policy priorities and agenda, leaving their operationalization to subject-matter Working Groups. Since APEC includes some of the world's most intensive and fastest-growing energy users, energy is a critical policy item.

Energy matters fall within the ambit of the Energy Working Group (EWG), which facilitates energy trade and investment by implementing the directives stemming from Energy Ministerial meetings and by regularly discussing and assessing the operationalization of initiatives and projects for the energy sector. The EWG is further divided into four expert groups, with its Expert Group on Clean Fossil Energy (EGCFE) in charge of the activities in the value chain of fossil fuels. Additionally, the EWG leverages the aid of the Asia Pacific Energy Centre (APERC) for the study of natural gas and LNG issues.

The production, supply and trade of natural gas with emphasis on LNG are at the forefront of discussion in APEC. So far, several notable policies have focused on these topics, mainly because of the implications for the region's energy security and economic growth. The following section summarizes these regional policy milestones, underscoring those pertaining to LNG.

[2] Please see the Annex for APEC members.

Milestones

Although the EWG was created in 1990, Energy Ministers met for the first time in 1996, and it was not until 1998 that they explicitly addressed natural gas issues. In consideration of the market trends projected at the time, Energy Ministers launched the 'Natural Gas Initiative' to seek enhanced cooperation and investment that would support expansion of production, infrastructure and trade of natural gas across the region. The initiative sought the development of trading networks alongside the construction of cross-border pipelines and LNG terminals (APEC, 1998).

In 2004, Energy Ministers renewed their support for the competitive trade of pipeline gas and LNG in the context of a collective framework on energy diversification, energy security and sustainable development. For LNG in particular, Energy Ministers encouraged member economies to adopt the best practices recommended earlier that year in the document 'Facilitating the Development of LNG Trade in the APEC Region' (APEC, 2004). The document summarized recommendations from an expert workshop and outlined 17 best practices in key five areas: trade; financing and investment; emergency scenarios; technology transfer and knowledge sharing; and public education (EWG, 2004).

This policy initiative spurred several workshops in San Francisco and Tokyo in 2004 and in Chinese Taipei in 2005, which resulted in expert feedback suggesting continued dialogue and cooperation with a diversity of stakeholders involved in LNG projects; discussion of technical, financial, and regulatory issues; collection of dedicated data and exchange of experience and lessons (EWG, 2005).

All these efforts and policies were designed during a period of limited LNG expansion in APEC. From 1998 to 2004 only one LNG facility – whether as a regasification terminal or as a liquefaction train – was added in APEC

every year. However, numerous other projects began the planning and approval process.

From 2005 to 2010 the region saw a faster pace of growth in the construction of LNG facilities, with an average of five facilities coming online per year. Aside from capacity expansions in those economies already engaged in LNG trade, LNG imports began for the first time in Canada, Chile, China and Mexico. Similarly, the first LNG exports started in Russia (Sakhalin 2) and Peru (Peru LNG Melchorita). Accelerated penetration of LNG was accompanied by policies targeting an increased use of natural gas under more efficient regional market arrangements. To that end, in 2005 Energy Ministers expressed their intent to support the creation of the APEC Gas Forum (APGAS) and instructed the EWG to execute the 'LNG Public Education and Communication Information Sharing Initiative' (APEC, 2005).

At their subsequent meeting in 2007, Energy Ministers instructed the EWG to review best practices for the upstream, infrastructure and trade activities of natural gas inclusive of LNG, and they also invited member economies to embrace the recommendations derived from APGAS (APEC, 2007), which had held two forums in 2005 and 2006. The most important recommendation from APGAS referred to the funding of a regional parent organization in charge of fostering and improving the use of natural gas:

> Ministers should direct APEC to provide funding to APGAS Limited (or some other organization endorsed by the Ministers) to actively promote and facilitate the use of natural gas in regional markets and to provide expert advice to Ministers and the APEC Energy Working Group on measures to:
>
> - enhance energy security,
> - slow the growth of greenhouse gas emissions,
> - accelerate cross-border gas trade, and
> - educate the public on gas as an energy choice (EWG, 2008).

The next meeting occurred in 2010, framed by a growing concern about energy security. Again at this meeting, Energy Ministers confirmed the relevance of enhancing natural gas production and trade as an effective vehicle for energy transition. Insofar as this fuel has a lower footprint than other fossil fuels it complements the use of variable renewable energy, and in the form of more globally distributed unconventional resources it has the potential to strengthen energy security. Energy Ministers did not address LNG explicitly in these declarations but rather focused on natural gas issues in the industry's upstream segment, specifically on unconventional hydrocarbon resources that could enhance the region's self-sufficiency in gas (APEC, 2010). The positive effects of increased energy security and economic growth in the United States because of the rising production of this type of resources, particularly of shale gas, are likely to have largely influenced this policy proposal.

By 2011, the outcomes from the 'LNG Public Education and Communication Information Sharing Initiative' formulated years before were finally released in a document that examined several case studies in APEC economies with the aim of providing a set of recommendations concerning the public trust in LNG projects. The document highlighted the permanent integration of outreach exercises with major stakeholders, through appropriate messaging and communication strategies deployed over the lifecycle of an LNG project. Key to this recommendation is sensitivity for a diversity of local and corporate cultures and the dissemination of unbiased information (APEC, 2011).

The period from 2011 up to the end of 2015 has been equally active in the development of LNG infrastructure. Accordingly, in 2012, Energy Ministers pledged once more to increase the production and trade of natural gas because of its role as a transitional fuel to

sustain low-carbon economies. In particular, Energy Ministers expressed an intention to improve the share of natural gas in the regional energy mix through an assessment of several factors: the production of conventional and unconventional gas resources; the trade potential and environmental benefits of natural gas; and the continuous investment in gas-related facilities to strengthen energy security and economic growth, with emphasis on LNG facilities (APEC, 2012a). Later that year, in a higher level of policy discussion, APEC Leaders committed to decouple regional economic growth from rising carbon emissions, echoing the Ministers' statements on natural gas and LNG (APEC, 2012b).

While the regional policy approach to natural gas trade had remained fairly consistent, it was not until 2014 that Energy Ministers noted the changing energy landscape, leading to a recognition of the importance of LNG:

> We take special note that the Asia-Pacific natural gas market will develop and mature in the coming years, with the Asia-Pacific LNG market playing an increasingly important role in the global and regional fuel mix, and that a prosperous, diversified, flexible and integrated LNG trading mechanism will emerge in the Asia-Pacific region. As such, member economies are encouraged to create favorable conditions for trade and investment to support the LNG market in the APEC region, including by relaxing destination clauses (APEC, 2014a).

Moreover, they acknowledged that natural gas infrastructure, including LNG terminals, was fundamental to the region's long-term energy security:

> We believe improved connectivity in the APEC region will help achieve its goal of energy security. We thus encourage member economies to strengthen infrastructural development, such as oil and natural gas pipelines and transmission networks, LNG terminals, smart grids and distributed energy systems. Efforts should also be intensified to coordinate the management of trans-border oil and gas networks, power grids and other major energy infrastructure to ensure secure and stable operation of relevant facilities (APEC, 2014a).

These declarations resulted in Energy Ministers inviting member economies to improve their practical response to oil and gas emergencies through the development of more resilient supply chains and expanded stockpiles. In practice, this instruction formally inaugurated the APEC Oil and Gas Security Initiative (OGSI) by enhancing the scope of the APEC Oil and Gas Security Exercises (OGSE) conceived and implemented during the previous two years. More importantly, however, the overview and priorities from Energy Ministers translated into specific actions for the region's LNG market under the following terms:

> We instruct the EWG to launch the APEC LNG Trade Facilitation Initiative, to encourage dialogue, exchanges and cooperation, develop public-private partnerships and support market-based LNG pricing mechanism to ensure the interests of LNG suppliers and consumers and boost the healthy development of APEC natural gas markets (APEC, 2014a).

More recently, in 2015, Energy Ministers reaffirmed their commitments, recognizing the growing role of natural gas in the region and the importance of ensuring a favorable environment for its open trade and continued investment in the form of pipeline gas and LNG. Energy Ministers also encouraged member economies to sustain their efforts towards a flexible and diversified gas market, and explicitly listed LNG as one of the energy options, along with advanced coal technologies, nuclear power, biofuels and renewable energy to support the regional transition to a low-carbon economy (APEC, 2015).

Textbox 2
APEC-wide studies on natural gas and LNG

For many years APEC has pursued the regional study of natural gas issues, covering several topics that reflect the policy priorities and the international context at the time, but also the market trends expected in the short and long term. The scope of some of these studies has included LNG.

EWG reports

The EWG has commissioned from private consulting firms a number of these specialized studies, which were later disseminated as publicly available reports. As seen in the list below, these publications have spanned the entire natural gas value chain, from the production and transport of natural gas to its trade. As for LNG, one of these reports explored the management of public trust in LNG projects developed in several member economies. The titles of these publications and their year of publication (in parentheses) are:

- Great expectations: Cross-border natural gas trade in APEC economies (2004)
- Potential for growth of natural gas as a clean energy source in APEC developing economies (2006)
- Case Studies of LNG Public Education and Information Campaigns in APEC Economies and Development of Best Practice Guidelines (2011)
- Unconventional natural gas census (2013)

APERC research

In addition to EWG's work, APERC has advanced the APEC-wide examination of natural gas issues, both through its permanent energy research activities and through specific research projects. APERC's permanent research efforts center on the *APEC Energy Demand and Supply Outlook*, its flagship research document published every two or three years, which provides an overview of current energy trends affecting the region and their long-term outlook. While the document typically covers the most relevant aspects of natural gas markets, the latest editions have underscored the growing relevance of natural gas, and LNG in particular.

- The publication of the 4th Outlook in 2009 highlighted the booming production of unconventional gas in the United States and its consequences for the global LNG market, anticipating that the US would reduce its LNG imports and thereby allow a greater amount of LNG to flow to other member economies. The effect of this development was expected to ultimately increase the use of gas in the regional energy matrix and enhance energy security.

- The 5th Outlook published in 2013 suggested an even more positive outlook for natural gas production, including an alternative but still fairly conservative 'High Gas' scenario of incremental production contingent on lifting trade barriers. Back then, APERC correctly predicted that surplus gas production in the United States and possibly Canada would eventually be exported as LNG.

- Lastly, the publication of the most recent 6th Outlook in early 2016 underscored the benefits of reduced carbon emissions from the widespread use of gas over other fossil fuels. One of its alternative scenarios assumed that the total replacement of coal-based electricity capacity additions from 2020 to 2040 would reduce regional carbon emissions by 14%, but would also cause natural gas imports to expand 3.6 times by 2040. This outcome clearly signals the increasing necessity of more efficient trade mechanisms and the development of sufficient LNG infrastructure.

Apart from the Energy Demand and Supply Outlook, APERC has produced the reports listed below to look at critical issues in the natural gas market. While the majority of these reports have responded to EWG's priorities, a few of them have been prepared by APERC's own initiative in recognition of potentially game-changing issues in international energy markets. It is worth noting that this document is the first one entirely focused on LNG issues.

- Natural Gas Pipeline Development Southeast Asia (2000)
- Natural Gas Pipeline Development Northeast Asia (2000)
- APEC Energy Pricing Practices Natural Gas End-use Prices (2001)
- Industrial Sector Natural Gas Use (2002)
- Gas Storage in the APEC Region (2002)
- Natural Gas Market Reform in the APEC Region (2003)
- Pathways to Shale Gas Development (2015)

Altogether, the studies from EWG and APERC make up a considerable knowledge repository pertaining to the development of natural gas and LNG markets, for the benefit of APEC member economies.

LNG Trade Facilitation Initiative

Chinese Taipei submitted the APEC LNG Trade Facilitation Initiative in September 2014, at the 11th APEC Energy Ministerial Meeting in Beijing, China. This document acknowledges the rising importance of natural gas in the region while highlighting the weakening supply gap outlook due to the complexity of ensuring sufficient investment in and the timely development of upstream and LNG infrastructure projects.

Accordingly, and capitalizing on the membership of the largest LNG importers and some of the fastest-growing LNG exporters in the world, the initiative calls for expanded intraregional LNG trade under more competitive and transparent market principles, with the aim of bringing about shared benefits for suppliers and consumers to ultimately strengthen the region's energy security.

The LNG Trade Facilitation Initiative established the following three major action areas and proposed corresponding activities to fulfill its goals:

1. Promotion of information sharing
   - □ Workshop on APEC LNG trade facilitation to discuss LNG trading situation, barriers and cooperation potentials in the region.
   - □ Establishment of an integrated LNG information platform to promote the information transparency of LNG-related regulations, standards and quality specifications.
2. Promotion of cross-cutting dialogue and cooperation
   - □ Collaboration between APEC's Committee on Trade and Investment and the EWG's Expert Group on Clean Fossil Energy on best practices of APEC LNG trade facilitation.
   - □ Collaboration with Japan's Oil and Gas Security Initiative.
3. Promotion of Public-Private Partnerships
   - □ Establishment of broader engagement and dialogue between the public and private sectors (APEC, 2014b).

LNG Trade Facilitation Conference

As part of the activities outlined in the LNG Trade Facilitation Initiative, Chinese Taipei held a follow-up conference from July 15-16, 2015. Conference participants included APEC

economy officials and experts, international organizations, consulting firms and industry players engaged in promoting dialogue on removing trade barriers and strengthening potential cooperative mechanisms.

The conference touched on the challenges of expanding LNG markets, encompassing regulatory harmonization, pricing mechanisms, trading hubs, open access to markets, energy subsidies, technical issues and other economy-specific constraints. Another topic of discussion referred to the drastic changes in the international LNG industry since the previous LNG-focused conference was held in Chinese Taipei in 2005. Back then, the United States was a net LNG importer, but currently it is an exporter with strong prospects for increasing its export volumes The rise of the United States as a major LNG exporter will diversify LNG supplies, very likely under new contract and pricing arrangements, improving flexibility and competition in the international LNG market.

Another turning point in the LNG industry was the aftermath of the nuclear accident in Fukushima in 2011 that led to the unprecedented spike in Japan's LNG demand at high price levels, spurring the development of several projects expected to come online in the near term. On this matter, the participants of the July 2015 conference praised the ongoing efforts in multilateral and bilateral forums to improve the understating of LNG issues and balance the conflicting priorities of producers and consumers. This has been the explicit goal of Japan's LNG Producer-Consumer Conference, as described in Textbox 3.

On the possibility of building a gas pipeline between the largest LNG consumers (Japan, Korea and Chinese Taipei), officials pointed out that political factors are the major hurdles, and that even under the best case scenario for such a project, the volumes traded would be very small given the overall reliance on LNG and the lack of domestic production in these economies.

The role of Canada as an emerging LNG supplier was also considered, while a great number of projects had been planned, few of them are likely to go forward in the next few years. The success of these projects will be determined by their cost-competitiveness, particularly against brownfield projects in the United States that capitalize on the conversion of former import terminals to liquefaction plants. Canadian courts and regulatory authorities have also acknowledged increased accountability for meaningful consultation in LNG projects, especially with First Nations communities who demand greater involvement and shared benefits from the development of this infrastructure.

Despite the diversity of issues and insights discussed, the conference concluded that while LNG projects are driven by business considerations, energy policy is still essential to the further the development of LNG markets, chiefly in the form of efficient regulations and the promotion of open and transparent markets. The exchange of market information and know-how across economies will also bolster the sound development of LNG markets in APEC. The conference agreed that APERC should continue to provide LNG research and accurate energy data to help facilitate energy security in the region.

The APEC LNG Trade Facilitation Initiative calls for expanded intraregional LNG trade under more competitive and transparent market principles, with the aim of bringing about shared benefits for suppliers and consumers that ultimately strengthen the region's energy security

Textbox 3
LNG Producer-Consumer Conference

The fourth annual LNG Producer-Consumer Conference was held in Tokyo, Japan, on September 16, 2015, with speakers that included business leaders and experts from the international energy and LNG industry, as well as top ranked officials from economies producing and consuming LNG. More than 600 people attended this event.

The Conference fosters a high-level dialogue between the major economies involved in the global LNG trade, with the ultimate goal of enhancing mutual understanding and developing a more stable, competitive and flexible market. This Conference has been held every year in Tokyo since 2012 through the continued sponsorship of Japan's Ministry of Economy, Trade and Industry (METI) and the organization of APERC.

Japan is key to future of the LNG industry worldwide, accounting for nearly 35% of total LNG imports in 2015 (BP, 2016). In recent years the volume of LNG imports to Japan surged to offset the shutdown of its nuclear-based electricity generation capacity in the aftermath of the 2011 accident at the Fukushima Daiichi power plant. As an initiative hosted by the Japanese government in order to encourage a global dialogue on natural gas and LNG markets, the scope of the Conference reaches beyond the APEC region. The Conference has enjoyed growing international recognition, as it provides an opportunity for meaningful conversation on LNG trade and investment both at the event and at the bilateral meetings conducted by participants alongside the conferences. The 2014 Conference had more than 1 000 participants from 50 economies.

Highlights

At the fourth annual Conference in 2015, participants shared the latest trends in the global LNG market and discussed current and future developments related to the LNG supply and demand balance, project investment and the unconventional gas production boom that transitioned the United States into an LNG exporter.

Figure 3

Official photo – LNG Producer-Consumer Conference 2015

Key points included the quantitative and qualitative changes underway in the groups of producers and consumers of LNG to support the diversification and expansion of natural gas supplies across the world; the role of LNG to potentially replace a large amount of coal used in the electricity sector, especially in South-East Asia; the long-term horizons embedded in the development of commodity market hubs; the advantages of having an LNG portfolio diverse in pricing options and contract maturity; the removal of destination clauses in order to accelerate LNG trade and infrastructure; and the design and enforcement of efficient and swift regulations in consideration of the long lead times in constructing, installing and operating LNG facilities.

Source: LNG Producer-Consumer Conference (2015).

Scope of the document

In line with APEC's policy milestones described above and the priorities defined in its LNG Trade Facilitation Initiative, this report analyzes the region's LNG markets, explores some of the major issues affecting them and provides a number of recommendations for the consideration of policy-makers about the development of more efficient LNG markets that promote trade and business opportunities among member economies.

While the contents of this report are not exhaustive, they aim to provide an accurate picture of the critical opportunities and challenges for LNG markets in the APEC region. The insights offered in this report greatly benefited from the feedback gained by APERC and IEEJ staff from their attendance at multilateral workshops, forums and industry seminars, within and beyond APEC as outlined in the Annex.

As an independent work of APERC, this study does not necessarily reflect the views or the policies of the APEC Energy Working Group or individual member economies. However, the information in this report intends to advance the understanding of LNG markets in the region, pursuing the tasks of the LNG Trade Facilitation Initiative in terms of disseminating information and promoting multilateral dialogue.

Having determined the background and scope in this introductory chapter, the main contents of this report are developed in three remaining chapters. Chapter 2 provides the overview and outlook for natural gas in the APEC region, with emphasis on LNG markets. Chapter 3 introduces gas pricing formation and discusses the potential to introduce pricing mechanisms other than oil-indexation in the APEC region. Lastly, Chapter 4 outlines some policy implications and recommendations to overcome the challenges to investment and trade liberalization in order to foster a more competitive market with benefits for both the energy security and economic competitiveness of member economies.

2 Natural gas and LNG markets in APEC

Natural gas markets

Natural gas demand in the APEC region grew 2.2% per year from 1990 to 2013, from 994 million tons of oil equivalent (Mtoe, equivalent to 1 104 Bcm) to 1 638 Mtoe (1 820 Bcm). During this period, the share of natural gas in the primary energy mix increased from 20% to 21%, while the volume consumed in APEC accounted for 54% of the world's natural gas consumption in 2013.

During the same period, the highest growth in natural gas consumption in APEC took place in Asian economies. On a sub-regional basis[3], China had the fastest annual growth rate, of 11%, followed by the economies in South-East Asia and northeast Asia, at 6.7% and 5.6%, respectively. While the demand growth rate was somewhat modest at 1.4% in the United States, the rest of the economies in the Americas had higher growth rates at 3% annually. By 2013, the United States accounted for 37% of natural gas consumption in the region, followed by Russia at 24%, other Americas at 10%, northeast Asia at 10%, China at 9%, South-East Asia at 8%, and Oceania at 2% (APERC, 2016).

As for production, some APEC members are major natural gas producers, including Canada, China, Russia, and the United States. Their combined share of regional gas production amounted to 54% of the total output in the world in 2013 (BP, 2016). With the shale gas revolution in the United States came substantial production growth, from 465 Bcm in 1990 to 630 Bcm in 2013. On the other hand, production in Russia had a meager increase of 0.4% per year during the same period, stemming from a deteriorated economy and serious infrastructure deficiencies after the collapse of the Soviet Union. With annual growth rates of 9.4% in China and 4.4% in Oceania, natural gas production in these economies grew steadily (APERC, 2016).

Outlook

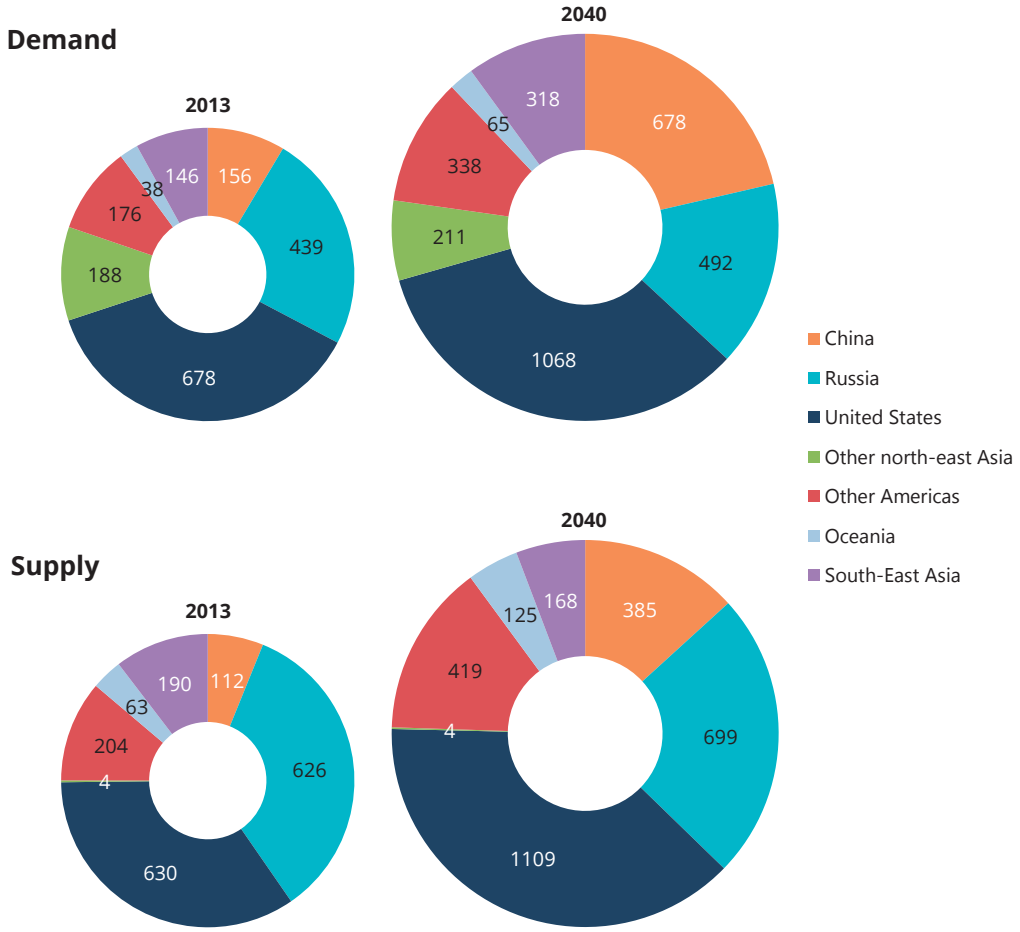
APEC is projected to be a major natural gas growth region for the foreseeable future. The historic natural gas consumption growth rate of 2.2% annually is projected to continue in the future and remain at 2.1% from 2013 to 2040, with consumption reaching as much as 3 171 Bcm by the end of the forecast period. By sub-region, the most rapid growth is expected in China, with a growth rate of 5.5% per year, followed by South-East Asia at 2.9%. While all sub-regions will see growth in their primary demand for gas, in Russia and the economies of northeast Asia this rate will be marginal, at 0.4% per year. The United States will hold the largest share of natural gas consumption in APEC, accounting for 34% of total regional consumption in 2040. This share will be followed by China at 21%, Russia at 16%, other Americas at 11%, South-East Asia at 10%, other northeast Asia at 7% and Oceania at 2% (APERC, 2016).

In terms of production, the growth rate of 1.7% in the APEC region through 2040 is similarly expected to keep up with the historic rate of 1.9%. Nevertheless, this pace of growth will not be sufficient to meet growing

[3] Please see the Annex for details on the sub-regional grouping used in this report.

demand, especially in Asia, where expected demand growth is most modest. Production is projected to grow at only 0.3% annually in northeast Asia and it is expected to decline annually at 0.4% in South-East Asia (APERC, 2016).

Figure 4
Natural gas demand and supply outlook in APEC, 2013 and 2040 (Bcm)



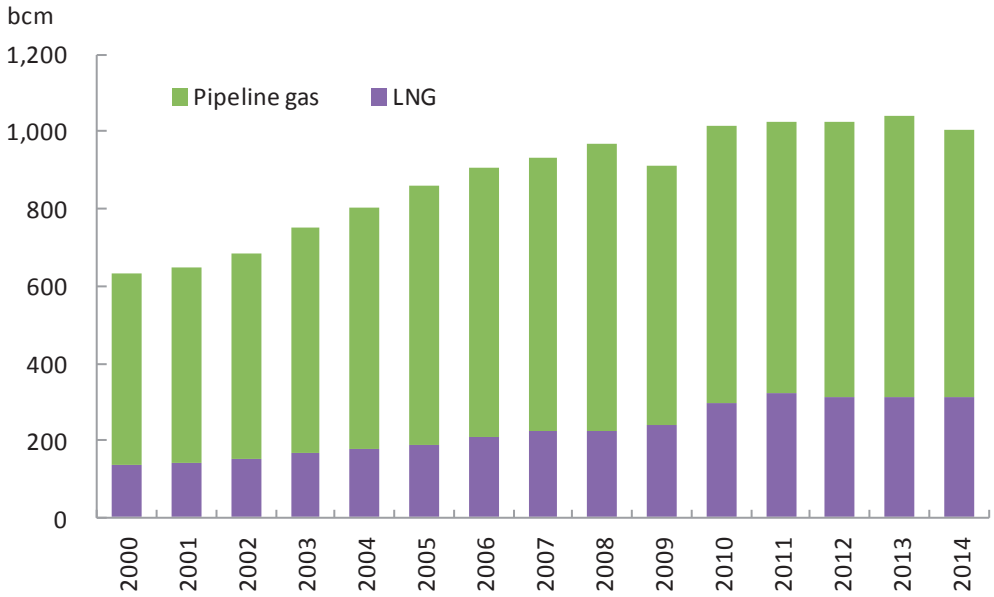
Note: Figures converted to Bcm from Mtoe
Source: APERC (2016).

LNG markets

In 2014, nearly 1 005 Bcm (905 Mtoe) of natural gas were traded in the world. This volume represented 30% of the total production in that year.

On an annual basis, natural gas trade has increased by 5% since 2000, much faster than demand. In comparison, in the same year 57 million barrels per day of crude oil (equivalent to 64% of the total production) and 1 375 million tons of coal (equivalent to 916 Mtoe and 17% of the total production) were traded internationally. Thus, the share of traded gas is slightly larger than that of coal but still much smaller than that of oil. Out of the total volume of traded gas worldwide, LNG represents only 31%, while the bulk is carried out by pipeline. Essentially, the higher transportation costs of the trade of natural gas compared with crude oil explain its lower volume traded internationally.

Figure 5
Total gas trade worldwide, 2000-2014

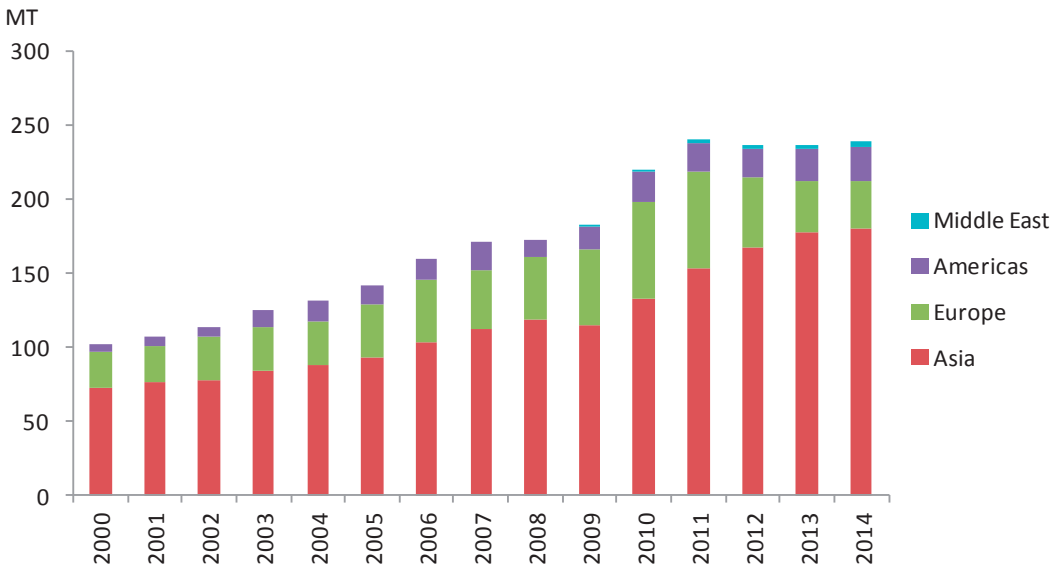


Source: Cedigaz (2015).

Overview

LNG imports grew by 5.6% per year from 118 million tons (MT) in 2000 to 239 MT in 2014. Asia is the largest importing region, followed by Europe and the Americas. Asia's import dominance is bolstered by Japan, Korea, China, Chinese Taipei and India, which have steady economy-wide consumption of natural gas often in combination with very modest domestic production levels. In 2014, 29 economies imported LNG, with 11 of these economies found in APEC (Canada, Chile, China, Chinese Taipei, Japan, Korea, Malaysia, Mexico, Singapore, Thailand and the United States).

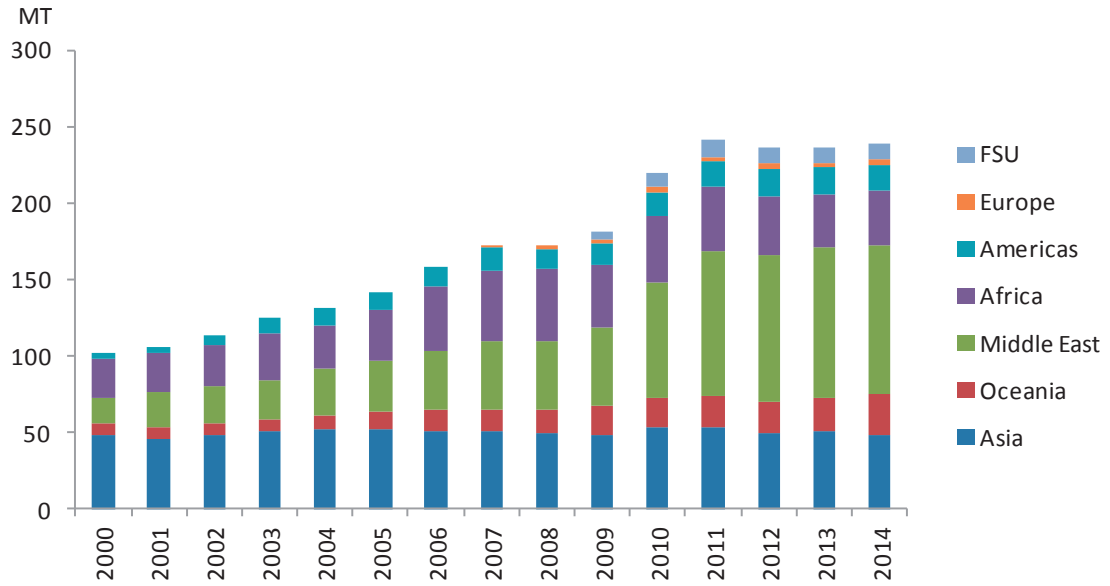
Figure 6
Worldwide LNG imports by region, 2000-2014



Source: GIIGNL (2015).

In comparison, the largest LNG-exporting region is the Middle East, comprised of Qatar, UAE, Oman, and Yemen, which together exported 96 MT in 2014. This region was followed by Asia, Africa, and Oceania. In total, 19 economies exported LNG in 2014, with 8 of them being members of APEC: Australia, Brunei Darussalam, Indonesia, Malaysia, Papua New Guinea, Peru, Russia and the United States.

Figure 7
Worldwide LNG exports by region, 2000-2014



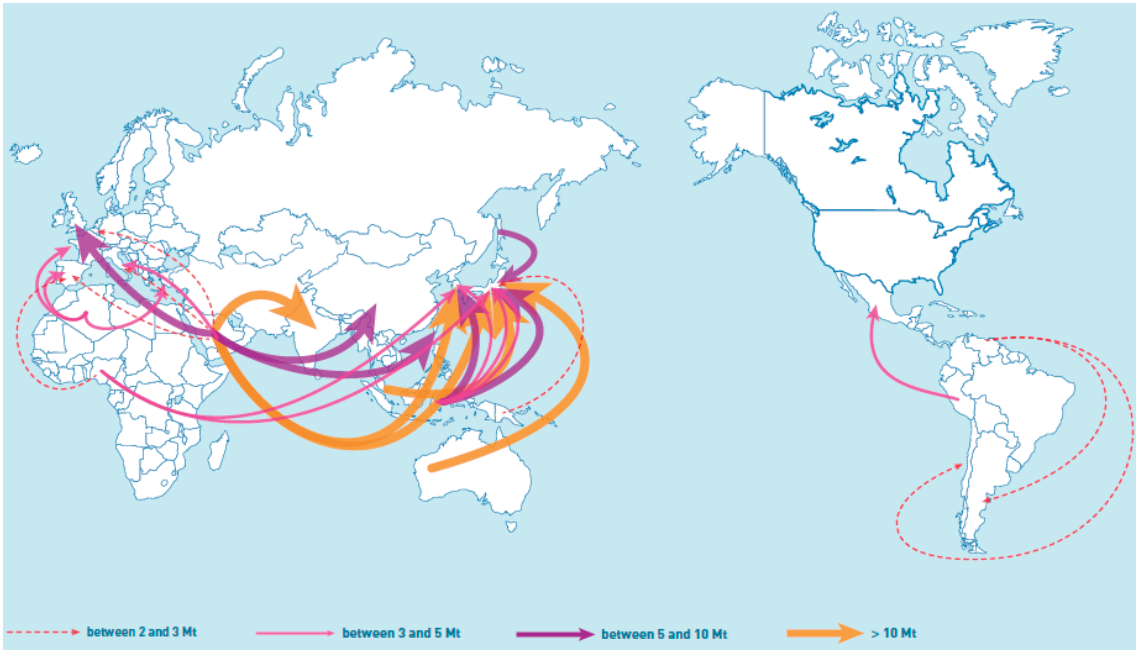
Source: GIIGNL (2015).

By 2014, the major LNG flows remained from the Middle East to Asia (74 MT), South-East Asia to northeast Asia (48 MT), Oceania to Asia (27 MT), the Middle East to Europe (18 MT), and Africa to Europe (15 MT). Because of reduced LNG demand in Europe, 6 MT was reloaded at European LNG terminals and re-exported to Asia and Latin America. Nevertheless, current LNG trade flows are rapidly evolving as new players enter the industry or reverse past trends and as technology evolves.

In the near future the United States is poised to become a major supply source of LNG, which will affect global trade flows of LNG across the world. Moreover, with the finished expansion of the Panama Canal in June 2016, nearly all of the current LNG marine fleet will now be able to transit through it, in comparison to the much smaller share of LNG vessels able to use the Canal before the expansion. This expansion increases the flexibility of LNG trade by creating ease of access between Atlantic and Pacific terminals and reducing shipping costs from the Gulf of Mexico to Asia.

Current LNG trade flows are rapidly evolving as new players enter the industry or reverse past trends. In the near future, the United States is poised to become a major LNG supply source, which will affect the global trade flows of LNG across the world

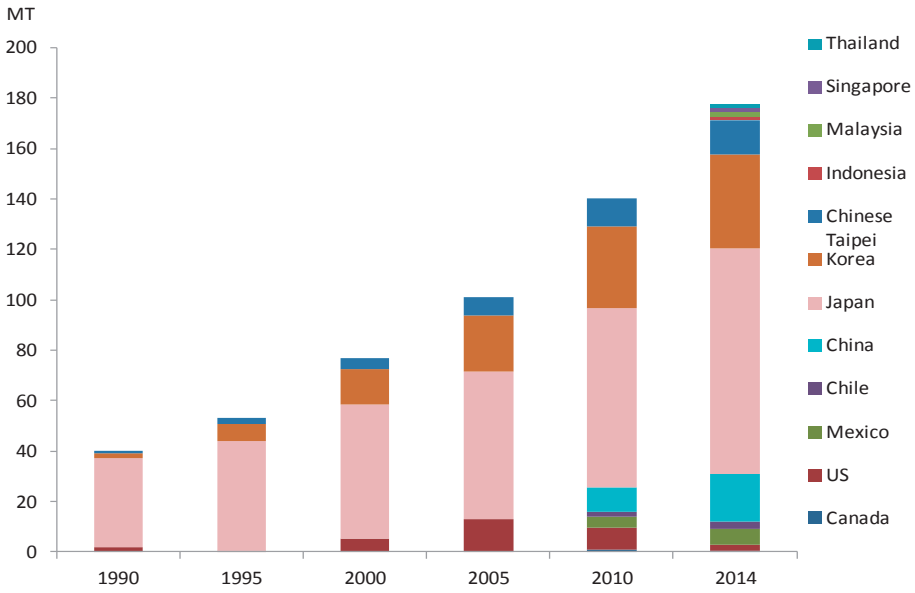
Figure 8
Major worldwide LNG trade flows, 2014



Note: Arrow width denotes the volume of LNG traded
Source: GIIGNL (2015).

LNG demand in the APEC region has increased rapidly. In 1990, only four economies (Japan, Korea, Chinese Taipei, and the United States) imported 40 MT in total. In 2014, the number of LNG importers increased to 12 and imports to 178 MT. Japan remains the largest importer throughout the projection period, followed by Korea, China and Chinese Taipei. While the United States imports decreased in 2014, South America and South-East Asia are emerging as new importing regions.

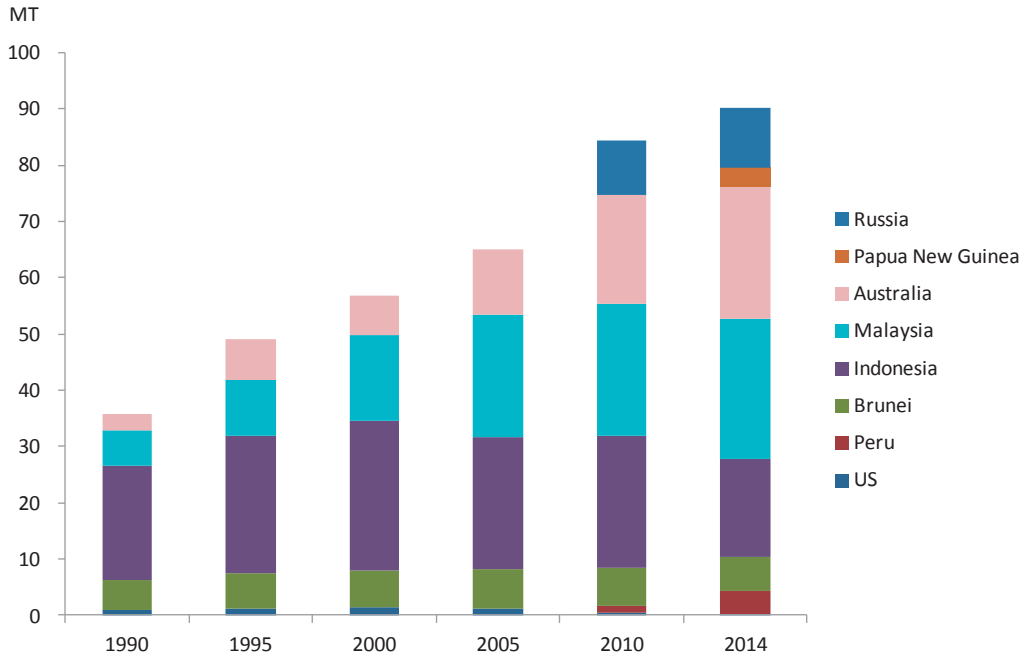
Figure 9
LNG demand in APEC, 1990-2014



Source: GIIGNL (2015).

The LNG supply in the APEC region has also increased, but has not kept pace with the growth in demand. In 1990, five economies (Australia, Brunei, Indonesia, Malaysia, and the United States) shipped 36 MT, with nearly all that volume shipped to Japan. In 2014, the number of exporters increased to eight and exports grew to 90 MT, mainly to APEC economies but also to Europe, the Middle East, and India. The regional supply gap has been met mainly by the Middle East and Africa.

Figure 10
LNG supply in APEC, 1990-2014



Source: GIIGNL (2015).

In accordance with these aforementioned market dynamics, the challenges for APEC-wide security of supply increased. Total LNG imports in 2014 were around 241 Mta, an increase of roughly 2% from around 237 Mta in 2013, with more than 70% of the world's LNG imports occurring within the APEC region in both years. (IGU, 2015b).

Based on the IEA's data for 2015, APEC net gas imports have been increasing, while the net exports of gas are decreasing. Net imports to northeast Asia including China reached 250 Bcm in 2013, where the majority of natural gas was imported as LNG, equivalent to 223 Bcm or 89%.

Textbox 4
Energy security and LNG

Preoccupation with energy security is a global phenomenon subject to many interpretations that can vary by economy. One of the most common measures of energy security is the diversification of the primary energy supply mix. As such, natural gas (including LNG) is increasingly popular in many economies in the Asia Pacific region, with possibilities to expand its share in the regional energy supply.

In comparison with other fossil fuels, such as crude oil and coal, the combustion of natural gas generates lower carbon dioxide emissions, which helps economies in meeting their environmental targets. Recent technological developments in shale gas extraction hold the promise of a better distributed and larger gas supply worldwide. Because of this, public policies are crucial to the expansion of natural gas usage and the development of LNG. The liberalization of domestic gas and electricity industries has helped to expand LNG trade. Additionally, governmental efforts to reduce greenhouse gas emissions under international climate agreements call for a greater use of natural gas.

Prior to the commercial use of LNG, deliveries of natural gas were limited to markets that could be served by pipeline. However, gas pipelines also have limitations, including:

- Underwater pipelines are costly and exposed to high technical risk.
- Pipelines have limited flexibility in terms of destination.
- Pipeline capacity is affected by pressure differentials, as well as the seasonality of pipeline contracts.
- Certain pipelines that might be technically and economically feasible entail much higher geopolitical risks.

With the development of LNG technology and cost reductions across the value chain, LNG is rapidly becoming an internationally traded commodity. With most of the developed gas supply and undeveloped gas reserves being geographically distant from the main consumption markets, LNG is expected to play a greater role in bringing gas to markets in the Asia-Pacific region.

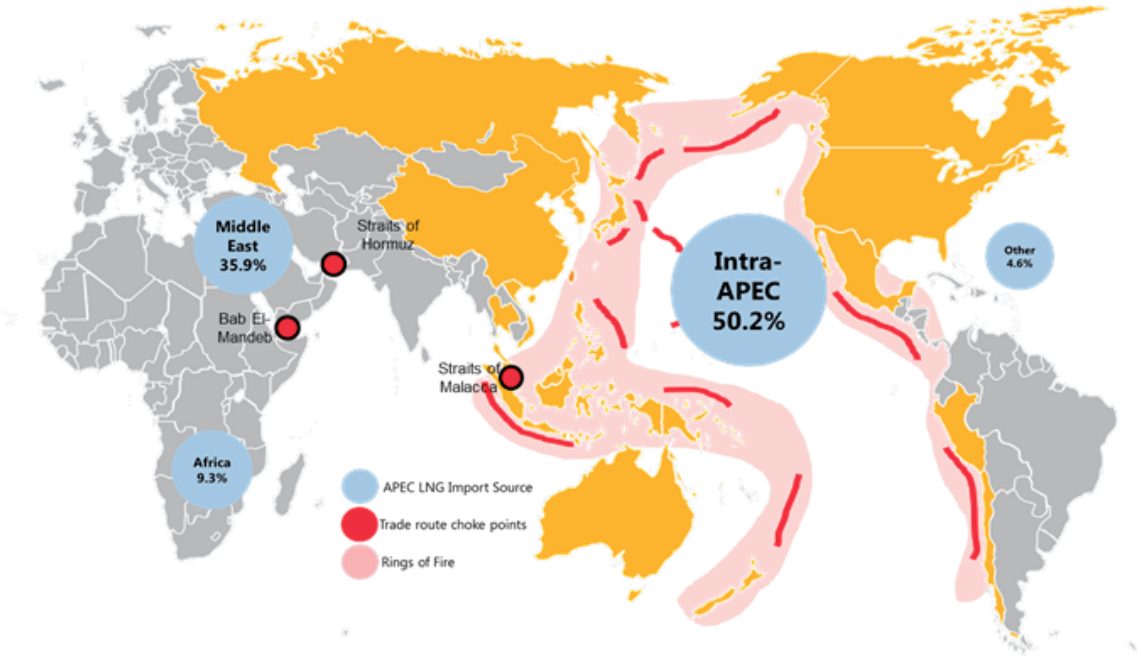
Several supply challenges underlie the expected growth in LNG demand in the APEC region. Building a critical mass of LNG infrastructure is crucial to facilitation of regional trade and expansion of the market. More Final Investment Decisions (FID) for LNG infrastructure projects must be made by industry players in 2016-20 in order to develop additional facilities by 2021 and beyond in order to address a projected supply shortfall.

Nearly 50% of LNG imported into APEC came from the Middle East and North Africa regions. As much as the diversification of import sources helps to improve supply security, these particular regions bring other type of risks, related to the supply disruption at certain choke points.

Shown in Figure 11, these choke points include the Straits of Hormuz, Bab El-Mandab, Malacca as well as the Suez Canal. These points can pose as serious threats to a reliable LNG supply insofar as they are located in politically turbulent areas.

As of the first quarter of 2015, 128.1 Mta of liquefaction capacity was under construction worldwide with nearly all new capacity being built in the APEC region. Australia led with 57.6 Mta, followed by the United States (44.1 Mta), Russia (16.5 Mta), Malaysia (7 Mta) and Indonesia (2.5 Mta) (IGU, 2015). Most LNG analysts indicated that in the next five years they expect to see a surplus of liquefaction capacity, which will help to boost LNG supply security if the right market structure exists. However, in the long term, the increasing demand for natural gas may outpace liquefaction capacity additions, as LNG consumption is expected to increase. This scenario would certainly raise significant energy security concerns.

Figure 11
LNG imports in APEC by regional source, 2014



Source: APERC analysis based on BP (2016).

Outlook - Demand

With robust natural gas demand growth and expected lower supply growth, international trade of natural gas, especially in the form of LNG, is likely to increase rapidly before 2030. According to the analysis of IEEJ, LNG demand in the APEC region will expand from 178 MT in 2014 to between 242 to 341 MT in 2030. See Table 1.

However, there is a considerable difference in the projected growth of the economies in the region. Japan, the largest LNG importer in the world, is projected to decrease its LNG consumption primarily as a result of nuclear power plants returning to service, an increasing share of renewables in the energy mix and energy efficiency measures focused on reducing energy use. Korea is expected to follow a similar path, with the expansion of nuclear and coal-fired power generation.

Table 1
LNG imports outlook in APEC, 2010-2035

Region	Economy	Year and Scenario				
		2014		2020	2030	
		Actual	Low	High	Low	High
		Million tons				
Northeast Asia	China	19	45	50	63	102
	Japan	89	74	75	74	82
	Korea	38	39	42	43	51
	Chinese Taipei	13	13	14	17	21
	Sub total	159	171	181	197	256
South-East Asia	Indonesia	2	2	9	6	12
	Malaysia	2	4	7	4	8
	Philippines	-	-	2	3	5
	Singapore	2	6	11	7	14
	Thailand	1	6	11	14	24
	Viet Nam	-	-	3	2	5
	Sub total	6	16	42	36	68
Oceania	New Zealand	-	-	-	-	1
North America	Canada	0.4	-	0.4	-	2
	Mexico	7	3	7	2	5
	United States	3	2	4	4	6
	Sub total	9	4	9	4	11
South America	Chile	3	2	4	4	6
APEC total		**178**	**194**	**237**	**242**	**341**

Source: IEEJ analysis

China has the highest uncertainty in terms of LNG demand growth in the APEC region. Depending on the extent of energy efficiency, gas-fired generation in the power mix, and pipeline gas imports, China's LNG imports are expected to range from 63-102 MT in 2030. Compared with northeast Asia, other regions will remain relatively minor importers. Nevertheless, South-East Asia imports are projected to quickly increase to reach 36-68 MT in 2030. In contrast, demand growth potential in Oceania, North America – a formerly major importing region – and South America is fairly limited before 2030.

Outlook - Supply

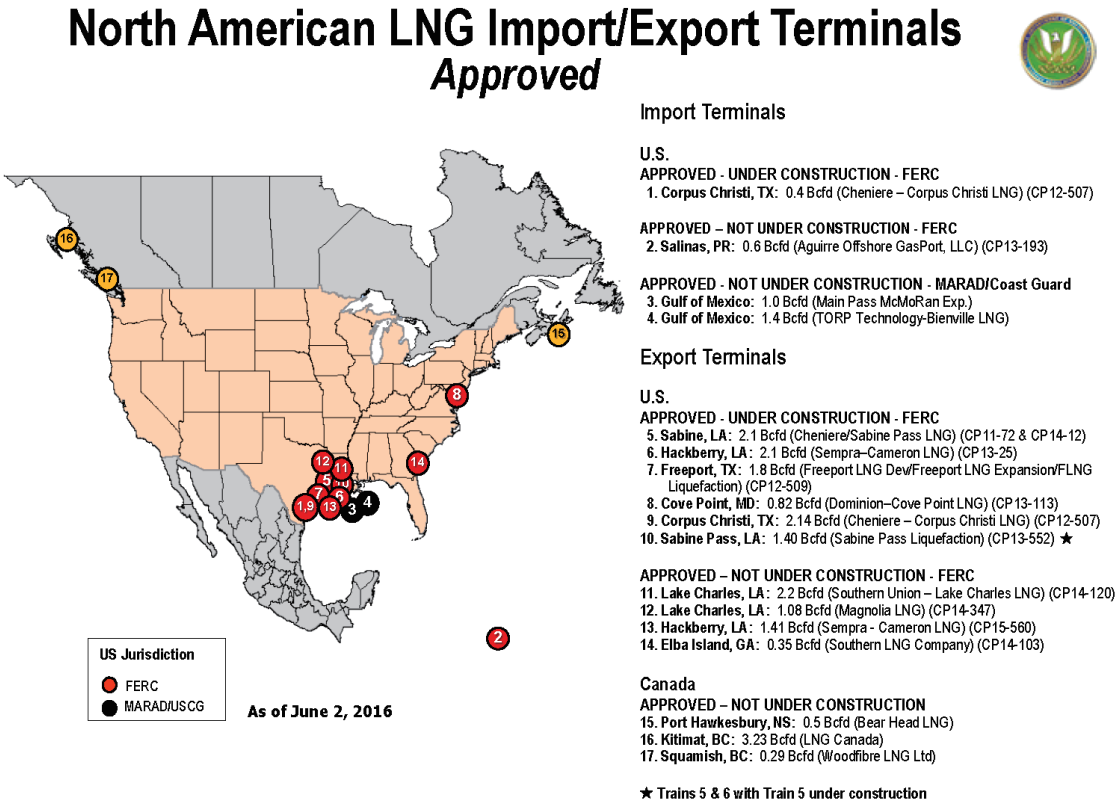
A significant supply of LNG is expected to be available in the APEC region in the future. Because LNG projects have high capital intensity, project finance usually requires long-term legally binding contracts, HOA (Heads of Agreement) or SPA (Sales and Purchase Agreement). Thus, new projects with a HOA or SPA signed with importers will be commercialized in due course. As shown in Table 2, the aggregated capacity of such projects in the APEC region in 2015 is 183 MT.

Australia is expected to complete development of several new LNG projects with an additional 25 MT of liquefaction capacity added in 2014-15 and 37 MT to be added in 2016-17. With an aggregated capacity of 87 MT, Australia should surpass Qatar to become the largest LNG exporter by 2020.

As depicted in Figure 12, the United States is following closely, with the first LNG exports from the Gulf of Mexico in February 2016. It is slated to become the third largest LNG exporter in the world by 2020 with aggregated capacity of 62 MT. Other APEC economies including Indonesia, Malaysia, Papua New Guinea and Russia have plans to expand export capacity, but the growth is expected to be fairly modest through 2030.

Although not all new LNG capacity additions will be built in the APEC region, the additional diversity in the geographical location of these capacities is likely to decrease single-supplier dependency from current exporters, especially during the period from 2015 to 2025.

Figure 12
LNG terminals with regulatory approval in Canada and the United States



Source: FERC (2016).

Table 2
Current LNG export projects with HOA or SPA signed

Region	Economy	Project name	Capacity (Mta)	Expected start year
Americas (North America)	United States	Sabine Pass (Train 1-2)	9	2016
		Sabine Pass (Train 3-4)	9	2017
		Sabine Pass (Train 5)	4.5	2018
		Freeport (Train 1-2)	8.8	2018
		Freeport (Train 3)	4.4	2019
		Cameron (Train 1-2)	8	2018
		Cameron (Train 3)	4	2019
		Cove Point	5.3	2018
		Main Pass Energy Hub	8	2022
		Magnolia	8	2020
		Corpus Christi	9	2018
		EOS	12.2	2022
	Canada	BC LNG	1.8	2020
		Pacific Northwest	12	2019
		Goldboro	10	2023
		Sub total	114	
South-East Asia	Indonesia	Tangguh (Train 3)	3.8	2019
		Sengkang	2	2019
	Malaysia	Petronas LNG	3.6	2016
		Petronas FLNG	1.2	2016
		Sub total	10.6	
Oceania	Australia	Gorgon	15.6	2016
		Prelude	3.6	2017
		Wheatstone	8.9	2017
		Ichthys	8.9	2017
		Subtotal	37	
Former Soviet Union	Russia	Yamal LNG	16.5	2017
		Rosneft	5	2020
		Sub total	21.5	
APEC Total			**183.1**	

Source: IEEJ analysis

There are an even larger number of new planned projects in the APEC region without an existing HOA or SPA. Shown in Table 3, the aggregated capacity of these projects could amount to as much as 414 MT, a figure well in excess of current global LNG demand. The majority of these additions are planned in North America, but other regions have equally significant potential for expansion. Whether these projects can be commercialized depends to a great extent on the competitiveness of the market characteristics underlying each project (demand, supply and price).

Table 3
LNG export projects currently under planning

Region	Economy	Project name	Capacity (Mta)	Expected start year
Americas	United States	Jordan Cove	6	2020
		Annova	2	2023
		CE FLNG	8.1	2023
		Golden Pass	15.6	2023
		Lake Charles	15	2022
		Lavaca Bay	4.4	NA
		Oregon	9	2023
		Alaska LNG	15	2025
		Sabine Pass (Train 6)	4.5	2024
		Gulf Coast LNG	21.3	2022
		Gulf LNG Liquefaction	11.4	NA
		Southern LNG	3.8	2025
		Barca	12.2	NA
		Delfin	13.7	NA
		Eos	12.2	NA
		Gasfin Development	1.5	NA
		Pangea	8.3	NA
		Venture Global	5	NA
		Waller Point	1.3	NA
		Texas LNG	2.1	NA
		Louisiana LNG Energy	2.1	NA
	Canada	Kitimat LNG	10	2023
		Triton	2.3	NA
		LNG Canada	24	2023
		Prince Rupert	14	NA
		Melford	1.4	NA
		WCC	5	2024
		Woodfibre	2.3	2020
		Aurora	12	2025
		Kitsault	20	NA
		Stewart Energy	30	2030
		Sub total	295.3	
South-East Asia	Indonesia	Abadi (Masela)	7.5	2025
		East Natuna	5	2030
		Sengkang (expansion)	3	NA
		Sub total	15.5	
Oceania	Australia	Fisherman's landing	1.9	NA
		Scarborough	7	2025
		Browse	12	2023
	Papua New Guinea	Papua LNG	3.8	2020
		Sub total	55.7	
Former Soviet Union	Russia	Pechora LNG	2.6	2025
		Baltic LNG	10	2025
		Shtokman	30	2030
		Sakhalin 2 (Train 3)	5	2023
		Sub total	47.6	
APEC Total			**414.1**	

Source: IEEJ analysis

Textbox 5
Integration in the natural gas and LNG value chain

A variety of firms operate in each of the natural gas industry's three major segments.

Upstream

In this industry segment, players are responsible for the exploration, extraction and treatment of natural gas. In connection with the LNG value chain, the upstream segment might be integrated with the liquefaction of gas and with the transportation of natural gas under Ex-Ship contracts (*forward vertical integration*). Traditionally, international oil companies (IOCs – such as BP, Chevron, ExxonMobil, Shell and Total) and national oil and gas companies (NOCs – such as Petronas, Pertamina, Qatar Petroleum) have been major upstream LNG players, and it is often the case with LNG projects in Asia that Japanese trading houses like Mitsubishi, Mitsui, Itochu, Marubeni, and LNG Japan are part of an upstream project while also marketing the product. In addition, most LNG export projects in the United States are commercialized by 'tolling' players that do not actually own the natural gas or LNG, but rather provide liquefaction services for a fee.

Midstream

Midstream players in the LNG business are in charge of transporting LNG by tankers. Upstream players (LNG sellers) also become midstream players in Ex-Ship contract where sellers are responsible for transportation. Likewise, downstream players (LNG buyers) might also become midstream players under Freight-On-Board (FOB) contracts where buyers are responsible for transporting the LNG. Actual tanker operation is usually delegated to shipping companies like Mitsui OSK, Hyundai, and Golar. Major LNG exporters like Qatar and Malaysia also own LNG shipping companies to transport their LNG.

Since most LNG cargoes have been traded under long-term contracts, LNG tankers are usually selected for certain shipping routes. Recently, however, with more spot LNG trades, shipping companies such as Golar LNG, Hoegh LNG, Excelerate Energy, and Teekay have also operated LNG tankers specialized in spot transactions.

Downstream

Players in this segment are responsible for receiving and regasifying the LNG, which has its calorific value adjusted (in the case of city gas), and is odorized and then distributed to consumers. In Asia, power and gas utilities like Tokyo Electric and Tokyo Gas, as well as state owned oil and gas companies like KOGAS (Korea), CPC (Chinese Taipei), CNOOC (China), and Petronet (India) are downstream players. Recently, traditional downstream players have been investing in upstream companies or projects (*backwards vertical integration*) as well as buying equity shares that can entitle the owner to receive a portion of the project's natural gas output (*equity lifting*), which can then be sold elsewhere under more flexible terms.

In Europe, gas utilities like ENGIE (France) and Gas Natural Fenosa (Spain) have traditionally been in charge of downstream operation. However, these utilities were unbundled in the process of the EU gas market liberalization, enabling independent gas infrastructure companies like ELENGY (France) and ENAGAS (Spain) own and operate LNG receiving terminals in Europe. Upstream players sometimes either own or hold capacity in LNG terminals in the region. In North America, LNG terminals usually belong to gas companies. In Central and South America, shipping companies often own FSRU (Floating Storage and Regasification Unit) type receiving terminals, with foreign players like ENGIE, ENAGAS, Gas Natural Fenosa, KOGAS and Mitsui also owning terminals.

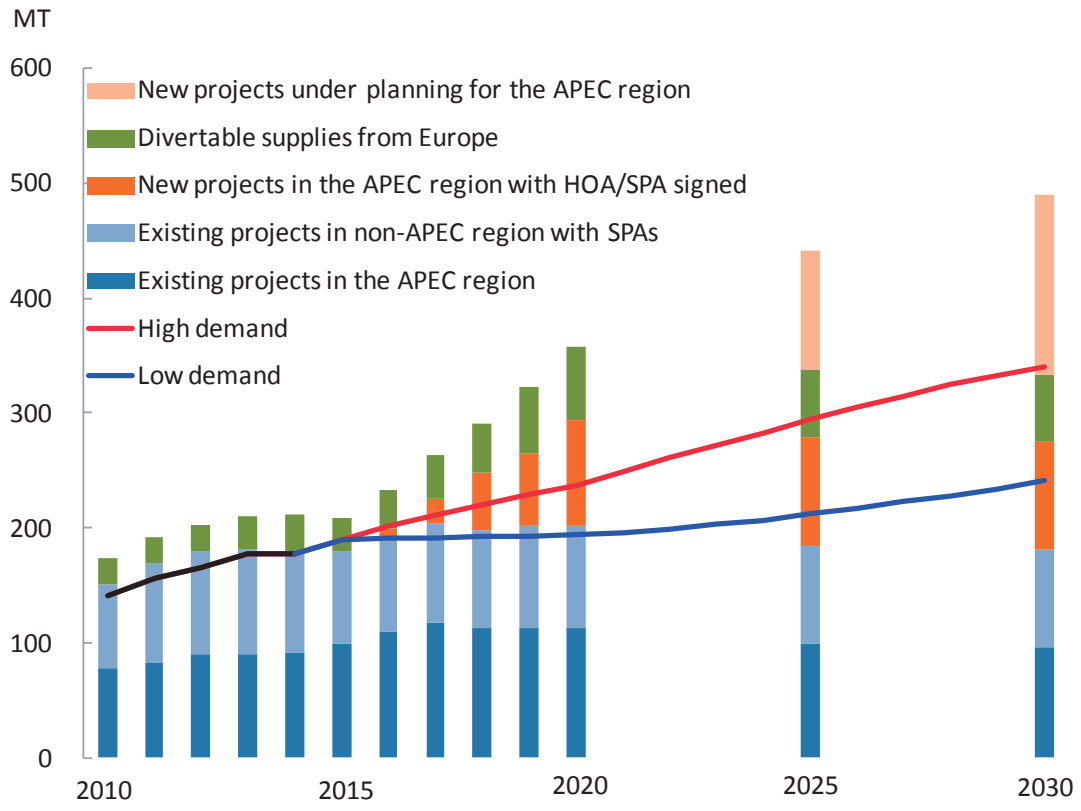
Demand-supply balance

The LNG demand and supply outlooks are shown in Figure 13.

Supply is broken into five categories:

- "Existing projects in the APEC region" refers to the existing liquefaction capacity in Australia, Brunei, Indonesia, Malaysia, Papua New Guinea, Peru, Russia, and the United States.
- "Existing projects in the non-APEC region with SPAs" covers existing capacity in Abu Dhabi, Oman, Qatar, Trinidad and Tobago, and Yemen that have long-terms SPAs with importers in APEC member economies.
- "New Projects in the APEC region with HOA/SPA signed" refers to the emerging capacity in APEC economies listed in Table 2, with some modifications in terms of the start of operations relative to company timelines.
- "Divertible supplies from Europe" includes the total SPA amount for European importers that are considered as divertible to APEC economies.
- "New projects under plan for the APEC region" are new capacity without HOA or SPA in both APEC and non-APEC economies.

Figure 13
LNG trade balance, 2010-2030



Source: IEEJ analysis

While APEC demand will increase between 242 and 341 MT in 2030, the capacity of "new projects in the APEC region with HOA/SPA signed" mainly in Australia and the United States is expected to increase much quicker than demand. As a result, in 2020, APEC economies will be oversupplied by existing and new terminal capacity, eliminating the need for divertible supplies from Europe.

In 2030, low demand can be met by existing and new capacity with HOA/SPA. Satisfying high demand in 2030 would require 66 MT, either from Europe or new projects under plan, in addition to existing and new capacity with HOA/SPA. In any case, timely investment is crucial to meet the high demand scenario in 2030.

3 Gas price formation mechanisms

Price formation of internationally traded natural gas differs from region to region. While gas on gas competition (GOG) is dominant in North America and northwestern Europe, oil indexation or oil price escalation (OPE) is more common in southern and eastern Europe and in the Asia Pacific. Alternatively, bilateral monopoly (BIM), where the price is determined by bilateral agreements between a large seller and a large buyer, is common in the Former Soviet Union (FSU) and the Middle East.

Table 4
Worldwide natural gas imports by price formation mechanism (Bcm)

Economy/region	Price formation mechanism			
	OPE	GOG	BIM	Total
North America	0	114.4	0	114.4
Europe	144.5	216.3	9	369.9
Asia	69.4	8.3	0	77.7
Asia-Pacific	185	28	7.2	220.2
Latin America	17.5	18.3	1.2	37
Former Soviet Union	34.2	0	27.8	61.9
Africa	4.9	0	4	9.3
Middle East	9.2	2.3	18.7	30.8
APEC Total	**464.7**	**388.2**	**37.8**	**921.1**

Note: OPE = oil price escalation, GOG = gas on gas, BIM = bilateral monopoly.
Source: IGU (2015)

LNG for Asia has been typically priced in relation to Japan's average crude import price. This price is the Japanese Custom Clearance price or JCC.[4] Oil indexation is an issue not only for price formation, but also for flexibility because oil indexation prices cannot always flexibly follow market fundamentals.

Oil indexation originated from Europe, where the majority of imported gas was priced by formula so that natural gas could reflect the competition with alternative fuels (mainly fuel oil and gas oil derived from crude oil) in the market of importing economies. Although gas-on-gas pricing has been rapidly increasing in Europe, oil indexation is still the dominant price formation in international gas trade in eastern and southern Europe.

Due to the predominance of this mechanism, in recent years many importers and analysts have started to question the rationality of keeping oil-indexation as a price formation process in gas supply contracts for Europe and Asia.

[4] Also informally referred to as 'Japanese Crude Cocktail'.

Textbox 6
LNG Contracts

As much as technological breakthroughs keep improving the cost-effectiveness of the LNG value chain to greatly expand the geographic reach of the gas industry, LNG facilities still require substantial capital spending. Specifically, the materials used to preserve LNG at extremely low temperatures increase the costs of vessels, raising the cost of transportation and storage and the associated investment risks. In practice, this represents an entry barrier for many players, leaving the value chain to a select number of financially strong companies who wish to secure long-term pricing stability in their commercial arrangements as a means to mitigate the risk in these endeavors.

Traditional natural gas supply contracts for Western Europe and Asia feature terms to reduce upstream investment risk and secure operation in a quasi-vertically integrated manner.

- First, products typically are sold under long-term contracts that often span more than 20 years. This is still largely the case with new projects, either LNG or pipeline gas. Nevertheless, there have been significant changes in terms of contractual roles. Traditionally, sellers are (inter)national oil companies, and buyers are power and/or gas utilities. However, since the 2000s, it is often the case that international oil companies lift the LNG and market it to the highest valued destination at any given time.

  A series of Qatar's mega train projects (Qatargas 2, 3, 4, RasGas 3) are examples of this new model where IOCs such as ExxonMobil, Shell, Total and ConocoPhillips are responsible for marketing the products. Another new contractual arrangement is found in LNG projects in the United States. Unlike traditional projects where sellers own and operate liquefaction plants, most operators of liquefaction plants do not own the commodity, but instead only sell liquefaction and loading services to sellers or buyers.

- Second, term contracts of international gas supply usually include a "take-or-pay" clause where a buyer is required to pay for the cargoes even if it cannot receive them for whatever reason (although an allowance of 5-10% upward or downward is typically embedded in the contract).

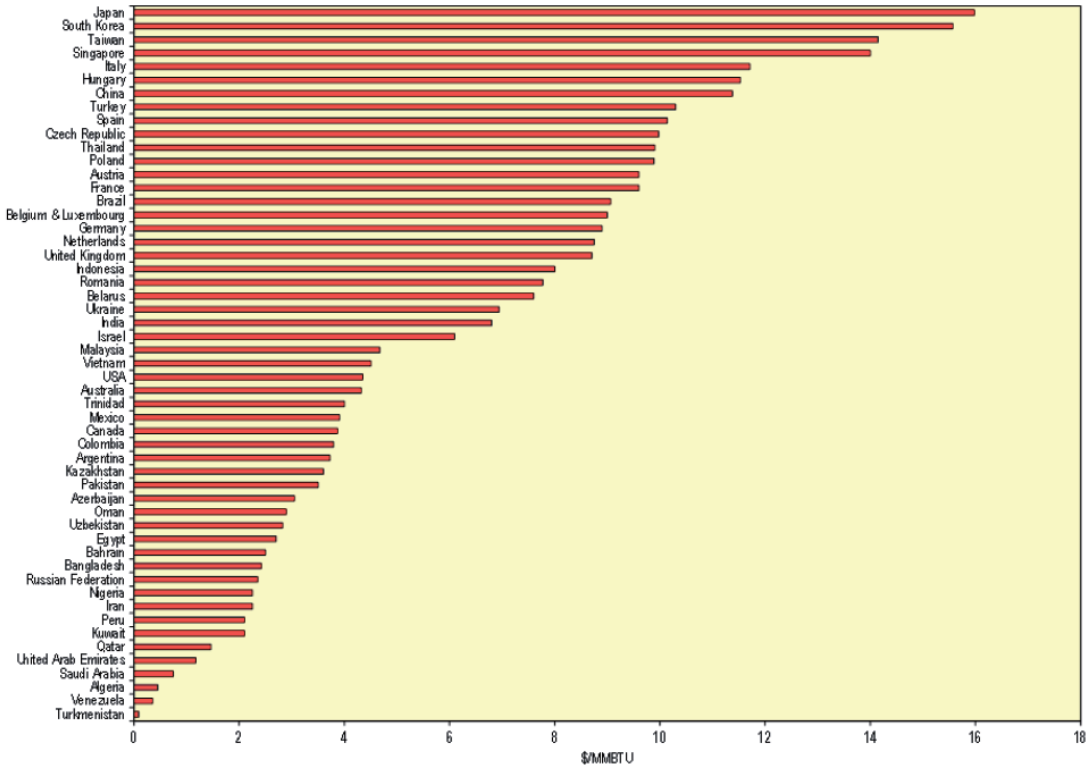
- Lastly, in most international gas contracts for Asia, products are only shipped to specific geographical point(s) or economies determined under a 'destination clause'. This clause was originally intended to enhance security of supply for buyers and demand for sellers. With a destination clause, even in the case of an FOB contract, a buyer is not allowed to resell a cargo to another buyer without the seller's consent.

Price level

Wholesale prices

It is difficult to conduct a comprehensive price comparison in the APEC region because of a lack of data, although OECD economies generally publish more data than others. Nevertheless, a recent survey (IGU, 2015) indicates there is a significant price gap in the APEC region. While APEC economies in the Americas and Russia enjoy the lowest wholesale prices, traditional APEC LNG importers like Japan, Korea, Chinese Taipei and Singapore paid more than USD 14 per million British Thermal Units (MMBtu) in 2014, the highest in the world. Other APEC economies like Indonesia, Malaysia and Vietnam fell somewhere in between.

Figure 14
Wholesale natural gas prices, 2014



Source: IGU (2015)

These significant price discrepancies stem mainly from gas supply costs, the demand/supply balance and market liquidity in a given region. It is likely that producing economies tend to have lower domestic prices often because of the absence of liquefaction and/or long-distance transportation costs.

Import prices

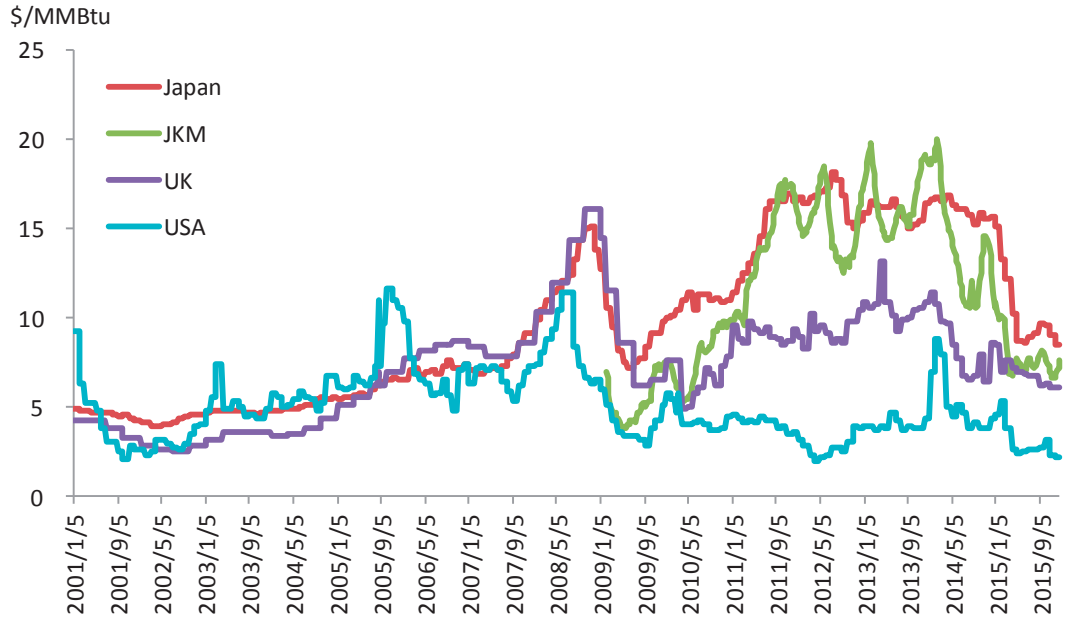
Figure 15 depicts natural gas import prices in Japan, the United Kingdom, and the United States, as well as spot LNG assessment prices for northeast Asia, which are termed JKM (Japan Korea Marker). While the United Kingdom and the United States prices include both pipeline gas and LNG, the price in Japan is determined only on an LNG basis, since the economy does not support imports of pipeline gas.

Import prices were in a similar range until early 2008, although prices in the United States occasionally spiked because of cold snaps and hurricanes. This trend changed completely during the 2010-2014 period, when prices in Japan were far above those in the United Kingdom and the United States.

This unprecedented price gap has been termed the 'Asian Premium'. Concern over this gap prompted Asian LNG importing economies to argue that its existence is largely irrational. However, with the decline of crude oil prices since the summer of 2014, Japan's import prices largely indexed to oil prices have fallen dramatically, as did the Asian Premium. At the end of 2015, import prices were USD 2.2 per MMBtu in the United States, USD 6.0 per MMBtu in the United Kingdom, USD 8.5 per MMBtu in Japan, and between USD 7.1 and 7.6 per MMBtu for JKM.

Considering that most LNG in Japan is imported under long-term contracts, the gap between the average import price for Japan (USD 8.5 per MMBtu) and JKM, which is a spot-market price, (USD 7.1 to 7.6 per MMBtu) signals weakening demand in Asia.

Figure 15
Natural gas import prices and spot LNG assessment prices for Northeast Asia, 2001-2015



Source: Japan Customs (2016), Platts (2009-2015), Energy Intelligence (2001-2015), EIA (2016)

Price formation of natural gas

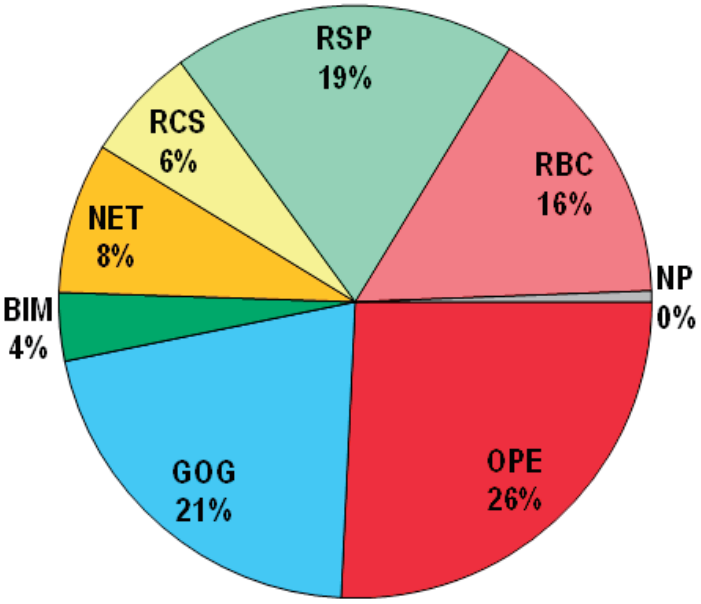
This section describes the different price formation mechanisms of natural gas in the major sub-regions of APEC (Americas and Asia) as well as in Europe. (Textbox 6 has more information on the different price formation mechanisms around the world.)

Americas

In North America, domestic gas prices in the United States were regulated until 1978. A series of liberalization measures in the 1980s and 1990s transformed the structure of the gas industry. In particular, open access to pipeline capacity reduced the need for long-term contracts in the industry. As the market started functioning more efficiently, transaction costs declined. As a result, gas prices are currently determined by market forces, or more accurately, the demand-supply balance in different market locations. The most liquid marketplace in the United States is Henry Hub, Louisiana. The imported gas price in North America is usually linked to hub pricing. The New York Mercantile Exchange's (NYMEX) natural gas futures contracts, launched in 1990, also use Henry Hub as the contract delivery point.

In South America, domestic pricing is much less homogeneous. IGU (2015a) estimates that although OPE and GOG share almost half of the regional demand, while the other half was made up of various other regulated pricing schemes (Regulated Cost of Service [RCS]; Regulated Social and Political [RSP]; and Regulated Below Cost [RBC]) and by netback of final product (NET), and bilateral negotiated (BIM) pricing mechanisms. However, as far as LNG is concerned, Henry Hub indexation seems to be fairly common in this region.

Figure 16
Natural gas pricing mechanisms in South America, 2015



Note: OPE = Oil Price Escalation, GOG = Gas on Gas, BIM = Bilateral Monopoly, NET = Netback from Final Product, RCS = Regulation: Cost of Service, RSP = Regulation: Social and Political, RBC = Regulation: Below Cost, NP = No Price.
Source: IGU (2015)

Asia

In Asia, gas trade is mainly carried out in the form of LNG, given the poor endowment of this fossil resource in many economies. The majority of LNG prices for Asian importers are linked to crude oil prices, since LNG was assumed to compete with crude oil and heavy fuel oil at the time of Japan's first imports in 1969. Initially, LNG prices were determined in relation to crude oil prices of the relevant LNG exporter. However, as the gap between OPEC's export prices and market prices widened after the second oil crisis, nearly all Japanese contracts started to use the JCC in 1987 (Energy Charter Secretariat 2007), with other Asian importers following suit afterwards.

Europe

Until a few years ago, oil-linked pricing was dominant in this region. More precisely, the majority of imported gas is priced by formula so that natural gas can compete with alternative fuels (initially fuel oil and gas oil) in markets of importing economies. However, as a result of the EU gas market liberalization, spot trading volume at hubs in Europe has been increasing rapidly (International Energy Agency 2014). Some 58% of the gas imported into Europe in 2014 was priced by GOG, with 39% priced by oil indexation (International Gas Union 2015). Natural gas futures contracts have been available at ICE in the United Kingdom since 1990, at EEX in Germany since 2007, and at Powernext in France since 2008.

Textbox 7
Price formation mechanisms

Some of the most common price formation mechanisms across the world are explained below:

- **Oil Price Escalation (OPE)**

Price is linked, usually through a base price and an escalation clause, to competing fuels, typically crude oil, gas oil and/or fuel oil. In some cases coal prices can be used along with electricity prices.

- **Gas-on-Gas Competition (GOG)**

The price is determined by the interplay of supply and demand – gas-on-gas competition – and is traded over a variety of different periods. Trading takes place at physical or virtual hubs, and it is likely to occur in developed futures markets. Not all gas is bought and sold on a short-term fixed price basis and there will be longer term contracts, but these will use gas price indices to determine the price in a period given, rather than competing fuels. This pricing category also includes spot LNG, any pricing which is linked to hub or spot prices and bilateral agreements in markets where there are competitive conditions (i.e. multiple buyers and sellers).

- **Bilateral Monopoly (BIM)**

The price is determined by bilateral discussions and agreements between a large seller and a large buyer for a fixed time period of typically one year. There is typically a written contract in place and often the arrangement is at the level of the government or state-owned company. To distinguish this category from GOG where there are multiple buyers and sellers, in BIM there is a single dominant buyer or seller on at least one side of the transaction.

- **Netback from Final Product (NET)**

The price received by the gas producer is contingent on the price the buyer receives for the final product. For example, this might occur when the gas is used as a feedstock in chemical plants and is the major variable cost in the production process.

- **Regulation: Cost of Service (RCS)**

The price is determined or approved by a regulatory authority, or possibly a Ministry, but the level is set to cover the 'cost of service', including the recovery of investment and a reasonable rate of return.

- **Regulation: Social and Political (RSP)**

The price is set on an irregular basis, probably at a Ministry level and on a political and social basis, in response to the need to cover rising costs, or possibly as a revenue raising exercise – a hybrid between RCS and RBC.

- **Regulation: Below Cost (RBC)**

The price is knowingly set below the average cost of producing and transporting the gas, often as a form of state subsidy to the population.

- **No Price (NP)**

The gas produced is either provided for free to the population and industry, possibly as a feedstock for chemical and fertilizer plants, or in refining and enhanced oil recovery processes. The gas produced might be associated with oil and/or liquids and treated as a byproduct.

Source: IGU (2015a, p.7)

Potential for gas-on-gas pricing in APEC's LNG trade

Much of the discussion in APEC's industry and official forums centers on the possibility of expanding gas-on-gas pricing as a way to foster a more rational market. The following subsections address some of the main considerations for further analysis.

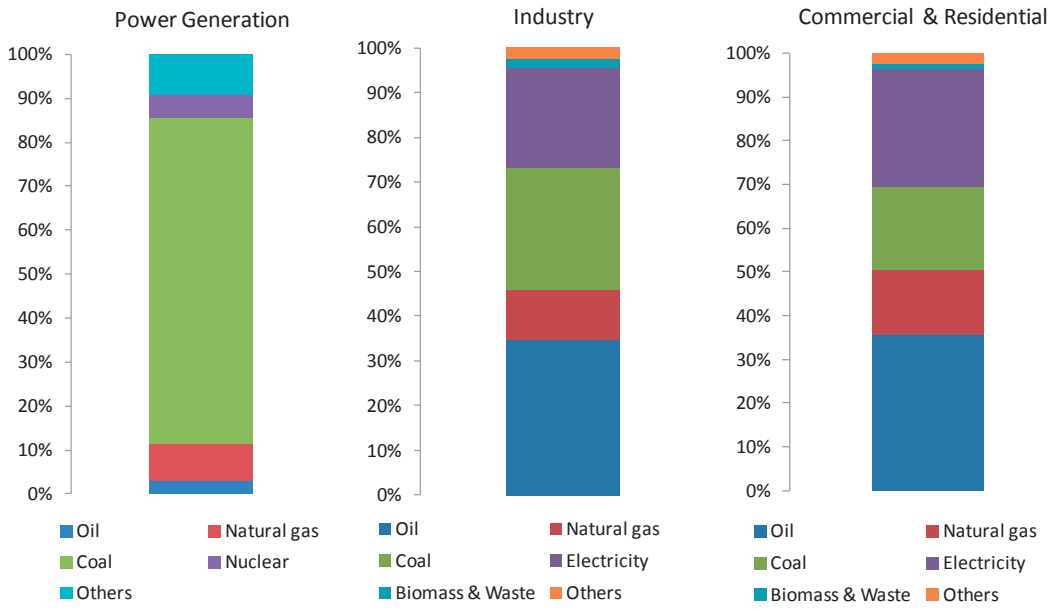
Rationality of oil indexation

For decades, oil indexation has been the norm for pricing imported natural gas in Europe and Asia. The origin of oil indexation dates to the 1960s when NAM (a joint venture between ExxonMobil and Shell) and the Dutch government introduced it with the intention of giving natural gas a price advantage to incentivize its use over other oil-based fuels (Energy Charter Secretariat 2007). Oil indexation was subsequently applied by other exporters, such as Norway, Russia, and Algeria.

In Asia, the first international natural gas trade occurred when Japan imported LNG from the United States in 1969, with a price that was fixed in accordance with feed gas, liquefaction, and transportation costs. However, oil indexation was introduced into Asia as the oil market grew more uncertain in the 1970s. In both Europe and Asia, the rationale for an oil indexation pricing scheme was rationalized on the substitution between natural gas and oil-based fuels in importing economies.

After more than 40 years, however, natural gas has now significantly penetrated the market in traditional importing economies. In particular for emerging importing economies, competition between oil and gas hardly exists anymore. Figure 17 and Figure 18 depict the energy mix in current LNG importing economies (China, Japan, Korea and Chinese Taipei) and in those expected to begin importing it in the future (Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam).

Figure 17
Energy mix by demand sector of current LNG importers*, 2015



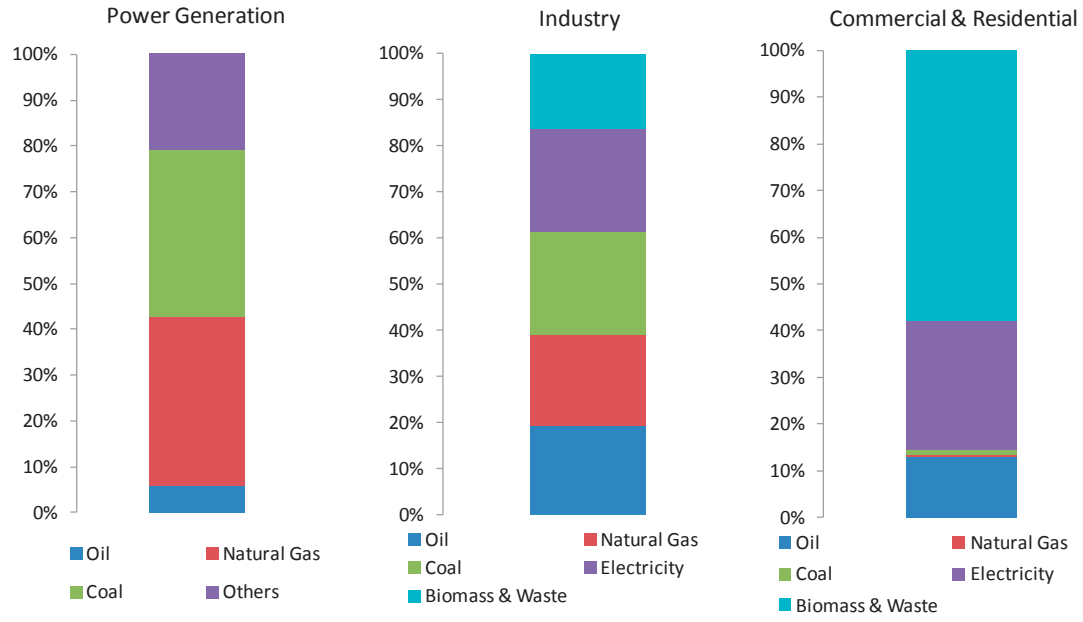
* China, Japan, Korea, and Chinese Taipei
Source: IEA (2015a, 2015b)

In the first group of current LNG importers, coal dominates as the main fuel for power generation, particularly because of China. Oil accounts for 35% in the industrial and the combined commercial and residential sectors; albeit coal and electricity are significant in those sectors. Therefore, natural gas is neither competitive against oil, nor is oil the only fuel of competition in those economies.

In the second group, the use of oil is minimal in the power generation sector. The shares of oil in industry and the joint commercial and residential sectors are even lower than those in the first group of LNG importers. Certainly, in the majority of economies in South-East Asia, the use of non-commercial energy like biomass and waste is considerable, especially in the commercial and residential sectors. This suggests that the supply of commercial energy is insufficient in many geographical areas in these economies, and pricing mechanisms would not necessarily create competition between the use of other fuels and natural gas.

In essence, if the rationale for oil indexation remains linked to oil and gas pricing competition, these fuels are now less likely to be in sole competition with each other in most gas-importing economies in Asia.

Figure 18
Energy mix by demand sector of future LNG importers*, 2015



* Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam
Source: IEA (2015a, 2015b)

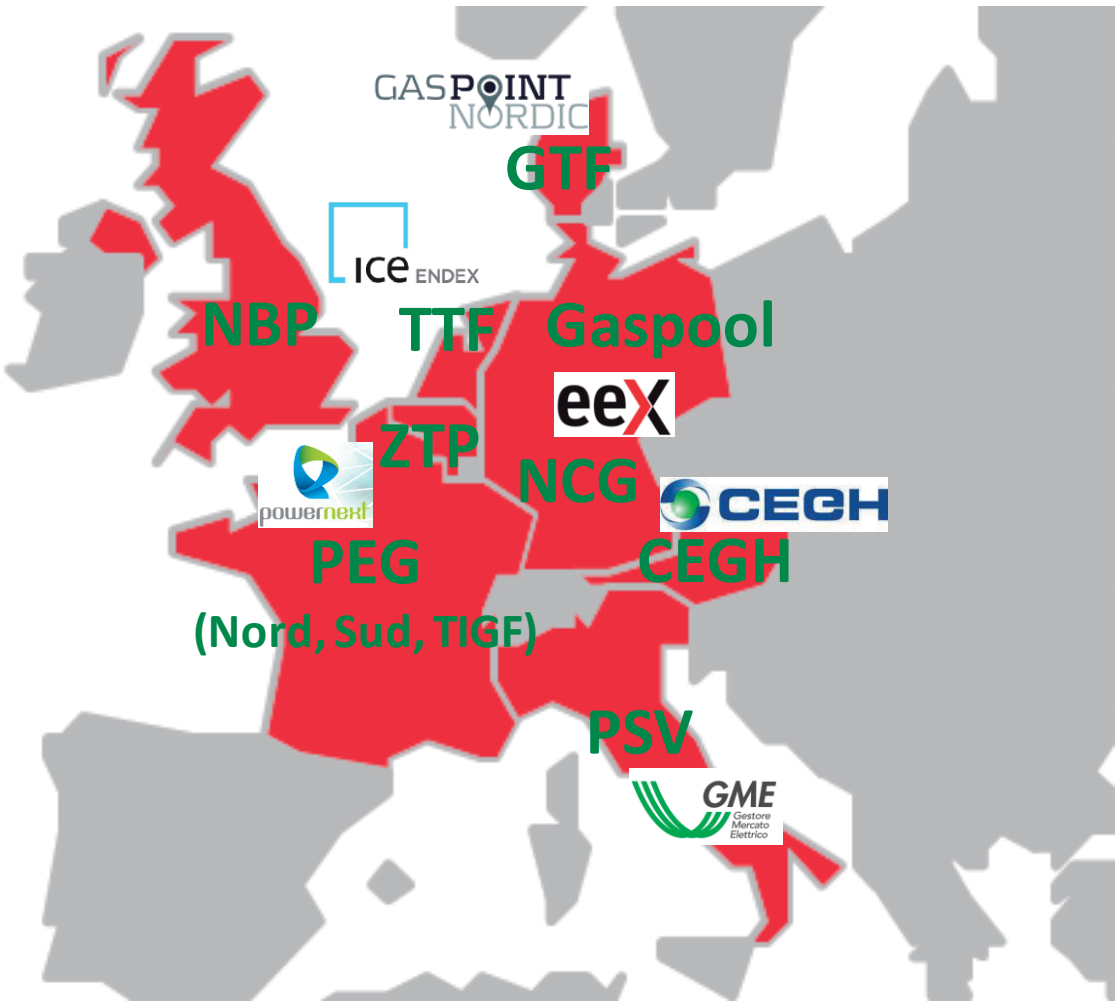
Oil de-indexation in Europe

The pricing of imported gas in Europe has traditionally been oil-indexed. However, there has been a nascent transformation to market-based pricing, or more accurately wholesale spot or hub prices, which have been progressively influential in pricing imported pipeline gas and LNG since 2010. A number of gas hubs are currently available in Europe as depicted in Figure 19, and two major factors are salient in this transformation of gas markets.

Firstly, gas market liberalization, especially unbundling of incumbent gas utilities, necessitated wholesale pricing in Europe. Before liberalization, natural gas in European economies mostly flowed inside the supply chain within vertically-integrated gas utilities

that were granted a monopoly in a particular economy or region. Those companies either produced or imported natural gas and then transported and distributed it to the final consumers. In this structure, there were only well-head or imported prices and retail prices. Wholesale prices did not exist because there was no need for wholesale trade. However, unbundling necessitated a wholesale market to buy or sell natural gas between market players, both incumbents and new entrants, and wholesale pricing began to emerge.

Figure 19
Gas hubs and exchanges in Europe



Source: IEEJ Analysis

Secondly, the divergence between indexed and hub prices accelerated oil de-indexation. This was caused through the combination of demand decrease, oversupply, and higher oil prices than gas prices between 2009 and 2013. Economic downturn also slashed natural gas demand growth, along with low carbon prices that incentivized power generators to switch to coal, and increased renewables development aided by official government support. These issues slowed gas demand, mainly for power generation.

With the US shale gas revolution reducing its gas import levels, a significant amount of inexpensive spot LNG became rapidly available for Europe, at least until the Fukushima accident in 2011. Oil prices quickly recovered in 2009 and floated above USD 100 per barrel for most of the 2011-2014 period. As a result, oil indexed prices were

significantly higher than hub prices in many European economies. Consumers then rushed to hub pricing in order to buy cheaper gas, leaving traditional gas importers like E.ON and GdF Suez (now ENGIE) at a disadvantage because their import cost was oil indexed but their sales price was hub based. Since then, many importers have come to negotiate with exporters and have largely succeeded in securing hub linked gas import prices.

In 2014, around 58% of the total imported natural gas was priced in accordance with hub pricing in Europe (IGU, 2015). Active hubs are in place in Western Europe, often as gas exchanges attached to those markets.

Potential for oil de-indexation in Asia

Will oil de-indexation be possible in Asia? The answer is largely positive, but it will likely manifest differently than it did in Europe for reasons explained below.

In the first place, with the exception of China, Malaysia and Indonesia, most Asian economies have no significant level of domestic natural gas production that could expand their markets and sources of supply to increase market liquidity. This contrasts with the situation in North America, the United Kingdom and the Netherlands, where domestic production paved the way accelerating the development of natural gas markets. Next, the pipeline network in Asia is still insufficient in geographical reach and flow capacity. Even in Japan, which is a very large consumer, there is no economy-wide pipeline network nor pipeline gas imports. In China and Korea, despite significant efforts to expand their networks, these markets are currently not interconnected with each other or with other gas-importing economies. Even though interconnections are better in South-East Asia they still do not exist to the extent seen in Europe.

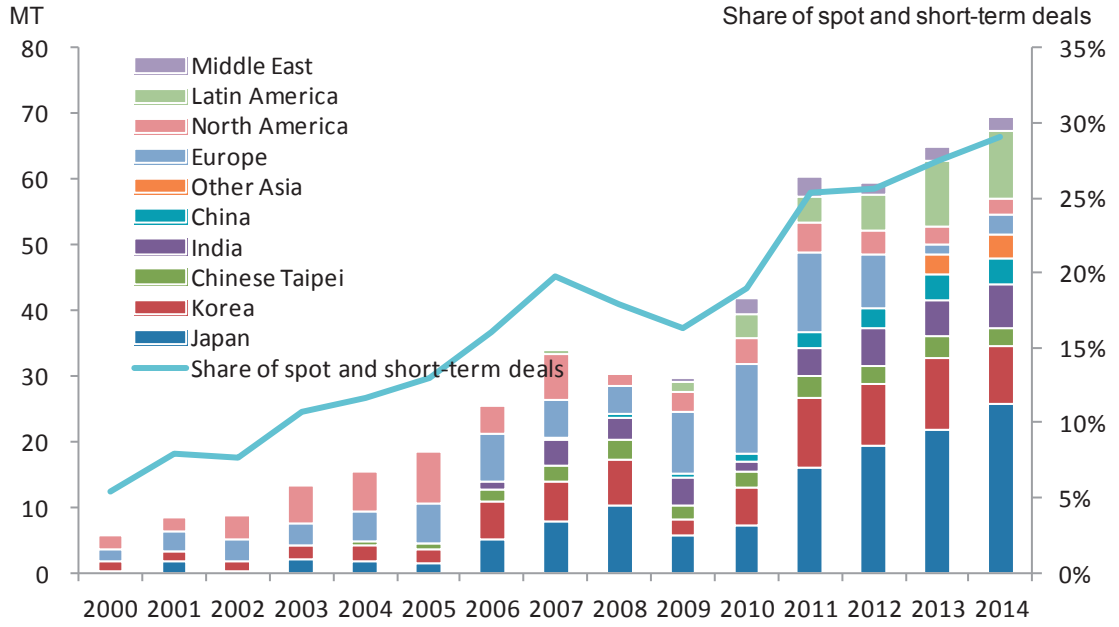
Secondly, gas market liberalization is still in its infancy in Asia. Japan and Singapore are the only economies where the gas market is open to competition, and the former market is dominated by a few big players. China has only just introduced third party access to some of its transportation pipelines in 2014, and whether significant wholesale trading will take place remains to be seen. Other economies such as Thailand are assessing similar schemes, but have not yet implemented them.

Considering the above reasons, it is unlikely that Asian importing economies will develop a gas hub anytime soon, let alone to a level of sophistication comparable with Henry Hub in the United States, or NBP in the United Kingdom where wholesale spot natural gas prices will replace oil-indexed import pricing.

Will oil de-indexation be possible in Asia? The answer is largely positive, but it will likely manifest differently than it did in Europe for a number of reasons

Instead, what seems more likely for Asia is that spot LNG prices (i.e. international prices instead of domestic wholesale prices) will replace oil indexation. Figure 20 shows the flows of LNG trade and the share of spot or short-term contracts (i.e. less than four years). In 2014, this share reaches 29% in the world and 27% in the APEC region.

Figure 20
LNG spot and short-term deals, 2000-2014



Source: GIIGNL (2015)

Spot and short-term deals are on the rise mostly because a few major projects, such as the Qatargas and RasGas expansions, were undertaken without securing the traditional long-term contracts with gas and power utilities in importing economies. Instead, these projects assumed equity lifting by sellers (typically international oil companies) who are also responsible for LNG marketing.

The trigger for this business model was the robust production of shale gas in the United States. Many projects commercialized during 2008-2011 were initially assumed to supply LNG to the United States and Europe, but as the United States' demand did not increase in step with production, excess natural gas supply resulted in spot cargoes flooding into Europe in 2010 and 2011.

In consequence, oil-indexed pipeline gas lost its ability to compete in the region. Buoyant demand in Asia and South America also attracted spot cargoes. This trend accelerated when Japanese power utilities needed more than 10 MT of additional LNG after the Fukushima accident in 2011. Should LNG trade become more short-term oriented, it is possible that spot LNG prices will influence long-term contracts similarly to the oil market.

With the expansion of spot LNG trade, energy information media like Platts and Argus started to offer spot LNG assessment prices. Platts', the most recognized information provider, started publishing the JKM (Japan Korea Marker) assessment price in 2009. However, the spot LNG market is not yet large enough and these assessment prices have not necessarily gained substantial confidence from LNG buyers and sellers.

Possible scenario for benchmark LNG price formation in Asia

Despite the fact that many LNG players acknowledge the advantages of more market oriented LNG pricing in the Asia Pacific, it is not clear how the market will get there. Should that happen, a possible scenario might be the one described below.

Breakthroughs

The LNG market is currently oversupplied due to a series of liquefaction plants reaching commercialization and weaker gas demand than expected. This trend is projected to continue, if not accelerate, towards 2020, especially with the capacity additions in Australia and the United States.

While as much as 100 Mta of capacity will be added between 2016 and 2020, mainly in the the APEC region, demand will not grow fast enough to absorb this additional supply. The extent of oversupply is unprecedented in LNG markets, and can be seen as a breakthrough to enhance market liquidity and to formulate a benchmark LNG price (de-linked from oil) in the region. Rapid oil price recovery will accelerate the process because oil-indexed prices will be considerably higher than spot prices, and buyers will have an incentive to engage in spot pricing – a similar vein as what happened in Europe a few years ago. Robust price disclosure by LNG players has the ability to reinforce spot price discovery in the region.

Accelerators

The following three measures can accelerate the process toward benchmark LNG pricing in the APEC region.

The first is the abolition of destination clauses that prevent LNG buyers from reselling shipments without sellers' consent. These clauses are included in many LNG contracts. It is clear that abolishing these clauses will allow LNG cargoes to flow more freely to where they are most needed.

The second is the adoption of spot LNG prices into term contracts. This will not happen quickly because of the sheer number of term contracts. Nevertheless, should this become the norm in the industry, the majority of cargoes, irrespective of contract duration, would be priced in relation to the spot market, ensuring benchmark price formation.

The third is flexibility in project financing on upstream projects. It is still typically the case that upstream financing requires rigid long-term contracts to reduce investment risk. However, if the volume of long-term contracts can be decreased, some supply would be available for the spot market and would therefore increase market liquidity. With a more liquid market, investment risk, especially volume risk, would be reduced and the necessity of long-term contracts would be diminished.

Self-sustained growth

If breakthroughs become reality and accelerators can be realized, there is the potential for increased liquidity in the LNG market among APEC members by the 2020s, when cargoes could be priced in relation to spot markets and irrespective of contract duration. Entry barriers would be lowered, and more new entrants could trade LNG easily with benchmark pricing.

At such a stage, LNG prices would be more volatile because spot prices would be used for both spot and term contracts. Therefore, forward and futures contracts in over-the-counter markets or at exchanges would be common to hedge price risks. Regional LNG prices in Asia, Americas, and Europe could become more related and convergent, with any difference largely the result of transportation costs.

4 Policy challenges and recommendations

This chapter addresses some policy implications of the previous chapters and suggests some recommendations for policy-makers that could contribute to the expansion of LNG pricing reflecting more rational criteria and market dynamics.

In contrast to pipeline gas, the advent and growth of the LNG industry allowed for the truly international trade of natural gas, which paradoxically, remains largely inflexible because of long lead times, high capital requirements, irrational price mechanisms and above all, commercial practices that made sense in the industry's beginnings, but which are increasingly questionable given the current status of energy markets worldwide.

The Asia Pacific region is one of the most active in LNG trade and yet Asian markets have historically paid the highest LNG prices in the world. Still worse, the prevalence of oil-indexation in Asian LNG markets during the period of high crude oil prices from 2010 to mid-2014, along with Japan's peak LNG demand in response to the nuclear emergency in Fukushima in 2011, further worsened the price levels of Asian buyers and eroded their bargaining power in receiving more favorable terms from LNG sellers. This issue has spurred several initiatives to seek more competitive LNG pricing in Asia, on par with North American and European markets, under flexible contracts decoupled from oil-indexation mechanisms.

Markets, particularly in the energy sector, are never constant and may change drastically at any moment if pushed by external events. An environment of prolonged low oil prices in the second half of 2014 developed along with the startup of a large number of LNG export projects. The fast-growing gas output from shale formations enabled the United States to become much less dependent on LNG imports, altering the traditional patterns of international LNG trade.

Of more relevance, this gas boom allowed the United States to start exporting LNG, pushing the emerging suppliers in that economy to agree to more flexible commercial terms than traditional LNG sellers. This milestone was a factor in the oversupply of LNG on a global scale that introduced landmark changes in the industry and has strengthened the bargaining power of LNG buyers, temporarily weakening their insistence on having their LNG contracts decoupled from oil-indexed pricing mechanisms.

But are LNG-importing economies in APEC, and particularly in Asia, most concerned about the prices they pay? Or, are they equally, if not more concerned about the price formation mechanisms underlying those prices and the economic rationality of the market fundamentals reflected by price levels and price mechanisms alike?

While the LNG oversupply with low oil prices certainly benefits LNG buyers, these conditions also discourage industry players and investors from undertaking new development projects. In considering the time delay between the FID and the actual start of operations of LNG facilities, it is likely that the advantages of LNG buyers will diminish in a few years under business-as-usual conditions, when the LNG surplus in the global market starts leveling off and potentially falling short of demand.

Furthermore, the promise of unconventional gas development to provide an abundant gas supply has so far been mostly limited to the United States. Beyond that economy, unconventional gas development is proving to be rather complex, with only a few economies currently producing this type of gas resource at a fairly modest scale. It remains fairly uncertain whether these resources might ever be developed more extensively across the world at a similar magnitude as that in the United States (APERC, 2015).

Although the Asia-Pacific is one of the most important regions for LNG, Asian markets have historically paid the highest LNG prices, which was exacerbated by a period of high oil-prices in the early 2010s and by Japan's peaking gas demand from the impact of the nuclear accident at Fukushima

Challenges

Structural change in the LNG market faces at least three broad challenges. These major challenges are shown in Figure 21.

As noted in the introductory chapter, as the APEC region looks forward to decoupling its economic growth from a carbon-intensive energy supply, one of its main strategies consists of an increased use of natural gas to decrease the predominance of coal and oil in its primary energy balance. However, the specific role of natural gas in the future energy mix is rather unclear. Natural gas always lies somewhere in between other energy sources: it is not as polluting as coal, but it is not as cost-competitive; and although large-scale use of gas might be more affordable in comparison with renewable energy or other low-carbon energy technologies, it is not as environmentally sustainable, leaving natural gas largely ineligible for deliberately favorable policies or incentives.

These issues exemplify why the expansion of natural gas is unable to compete against other fuels with stronger environmental or cost advantages. Consequently, the predominant policy approaches to natural gas overlooks the environmental value of this fuel against other energy sources more deleterious and hinders the implementation of policy actions that effectively capitalize on its expanded use to support a faster transition towards low-carbon energy systems.

This point is strongly connected with a second major challenge: energy security. A scenario of stronger and more extensive natural gas demand hinges on a sufficient supply, which is currently constrained by rapid depletion and increasing geographical concentration with nearly half of the worldwide proved reserves of natural gas being held by three economies alone — two of which are not APEC members.

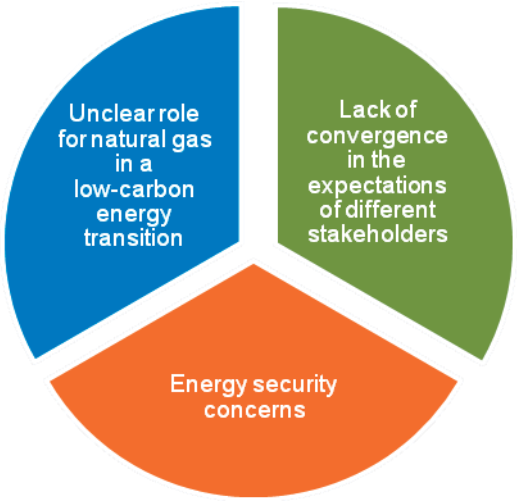
This situation is particularly more challenging in Asia, where the magnitude of domestic gas resources is very small in comparison with its regional demand. As gas pipeline interconnectivity is severely underdeveloped, most economies are highly dependent on LNG to fuel their needs, which is subject by a great extent to terms imposed by sellers.

Addressing LNG purely as a technical or economic issue neglects its strategic energy security dimension as well as the different trade-offs that sellers and buyers are willing to make. For LNG-exporting economies that are able to supply their domestic gas markets and chose to engage in LNG trade in order to maximize resource rents, energy security is of low concern relative to return on investment. However, for LNG-importing economies, energy security has a positive, quantifiable value. The challenge exists in that both importers and exporters value this concept differently, allowing exporters to command a premium through stronger bargaining power

at contract initiation. Although a more liquid LNG market has the ability to reduce the value of this premium, only importers are incentivized to improve their own energy security.

These considerations reveal a third major challenge: the alignment of expectations between different stakeholders. Owing to the transformation of the LNG industry in recent years, LNG buyers and sellers are no longer the only major stakeholders involved. Governments and private actors, shipping companies, tolling companies, marketers, natural gas producers, power and gas utilities, large consumers of natural gas and local communities affected by the development of LNG infrastructure increasingly call for a more transparent market with a balanced distribution of the benefits and risks across the entire value chain.

Figure 21
Major challenges to LNG trade



Source: APEC EGEDA (2014).

The lack of convergence in these expectations and the long lead times of LNG infrastructure projects suggest that the LNG industry is overly cyclical. These issues set up complex causal relationships whereby a goal of more flexible gas pricing mechanisms depends on a larger spot market, but the latter also depends on the former to occur.

This is similar to the widespread aspirations of developing gas trade hubs in Asia, which depend on an increased number of LNG spot and short-term transactions, but in turn require the existence of hubs to incentivize more of these transactions. Owing to these causal dilemmas, the LNG industry remains unable to swiftly adapt to its external environment and to rapid price fluctuations.

In essence, these issues highlight the interdependence in the expectations of the major stakeholders in LNG projects, whose interests and perceptions differ and change over time. Therefore, at a broader level of analysis, a misalignment of expectations affects the creation of settings favorable to more competitive LNG markets, enhanced trade and shared benefits. This issue also influences LNG players to favor long-established commercial arrangements and paradigms that help to mitigate risks despite their progressively disappearing compatibility with the industry's evolving technologies and structures.

The recognition of and the correspondence between these three major elements is likely to be the cornerstone for a truly constructive

dialogue at the economy-wide, regional and global level. Addressing these elements will be the key to creating substantial progress in helping LNG buyers and sellers to introduce more flexible business practices and transparent, market-driven mechanisms that foster settings more conducive for trade and cooperation among diverse stakeholders. The next subsections provide some recommendations in this direction.

Key recommendations

The extensive use of coal in South-East Asia and the need for more stringent actions to achieve an energy supply less intensive in carbon emissions offer remarkable potential to expand the primary demand of natural gas in APEC in the form of LNG.

The recommendations outlined below are not entirely exclusive to the LNG industry. In addition to targeting the major challenges in the LNG industry's formal transactions, these recommendations also advocate for a clearer role for natural gas and LNG in energy policy, for the deregulation of the natural gas and electricity industries, and for policies on economic competitiveness, open trade and good governance. The cooperation between diverse stakeholders, including those who often have conflicting interests, such as buyers and sellers, and governments and local industries is strategically important for the success of all these initiatives.

The LNG trade in the APEC region has a strong potential to grow depending on the coordination and collaboration of buyers and sellers to create mutual benefits in terms of business opportunities, economic prosperity, and enhanced energy security.

1. Define the role of natural gas in energy and climate policies

The political agenda in most economies — especially in developed economies— keenly promotes a 'green' component that has little role or interest in fossil fuels. Thus, while natural gas represents a viable energy option that emits less carbon than other fossil fuels and could pave the way to other more environmentally sustainable energy sources, the use of this fuel is largely neglected by green energy policies.

Expanded use of natural gas is especially critical in the aftermath of the COP21 Agreement in Paris and to help meet targets to curb global carbon emissions through more ambitious clean energy initiatives in each adhering economy. To that end, natural gas should not be the elephant in the room in green energy policy-making. Narratives about its use and trade as LNG in APEC economies should be accompanied by actions that strive for a cleaner energy mix and improved physical energy security.

At least in the short and medium terms, where energy technologies and markets are technically and economically mature enough to sustain a larger scale of low-carbon energy sources, economies should have a less ambivalent position about natural gas and LNG. This is likely to stir action that increases gas trade flows, in particular between LNG exporters and importers, with possibilities to expand demand beyond electricity generation to end-use sectors.

2. Steer structural shift in the natural gas and energy industries toward market liberalization

A more robust LNG trade requires strong political will to proactively introduce significant and sometimes disruptive changes that permeate the structure of the energy industry. These actions should strive for market liberalization in order to unbundle activities across the value chain, introduce more competition and fragment the concentration of market power over a larger number of players. Owing that natural gas markets are predominantly demand-driven,

these efforts should also target the electricity sector, as it is traditionally the largest user of natural gas and as the use of this fuel can co-exist with the development of renewable energy. As an APEC member and the largest importer of LNG in the world, Japan has recognized the significance of these concepts and has introduced a comprehensive LNG strategy after reforming its electricity and natural gas markets. Textbox 8 provides more information on Japan's LNG strategy.

Textbox 8
Japan's official LNG strategy

On 2 May 2016, the Japanese Government through METI released its 'Strategy for LNG Market Development'. The strategy is a brief document that highlights Japan's background and current relevance in the global LNG market and outlines its two major goals: developing a more flexible global LNG market and turning Japan's domestic market into an LNG trading hub.

Following the reforms in the economy-wide electricity and natural gas sectors, Japan's strategy is based on the promotion of private entrepreneurship under a sound market design, on a global-minded approach instead of a single economy perspective and on the need to move from words to action. It revolves around three fundamental topics:

- **Improvement of tradability**

This element namely refers to the removal of artificial trade barriers such as destination clauses in LNG contracts in order to increase the number of players in the LNG value chain.

- **Formation of appropriate price discovery mechanisms**

This element calls for support of mechanisms whereby financial service providers and industry players based their decisions on a price that reflects more accurately supply and demand fundamentals, rather than other commodities or artificial conditions not applicable to a particular region or economy (as with oil price indexation). In addition, these mechanisms would allow the development of financial futures markets for LNG trading.

- **Sufficient infrastructure with open access**

Third-party access to LNG infrastructure would contribute to the development of a more flexible market that ultimately expands the demand for natural gas and strengthens energy security.

To reach these goals, Japan's LNG strategy set the following six actions:

1. Improve tradability
2. Establish gas price indices that reflect LNG supply and demand in Japan on a competitive basis
3. Develop sufficient and accessible infrastructure
4. Promote international collaboration
5. Engage private players in dialogue
6. Monitor and follow-up

Source: METI (2016)

In any case, industry reforms will not happen naturally; they need to be deliberately pushed by industry players, governments and regulators. Therefore, introducing these changes is also a lengthy process that will take time to develop depending on the convergence of financial liquidity, increased infrastructure and operations under more competitive environments. Consensus among these actors remains critical to

sustaining market reforms and increasing their chances of success in the future.

3. Remove barriers to LNG trade and investments as well as energy subsidies

To increase gas trade, particularly within the APEC region, member economies should consider reducing or removing tariff and non-tariff barriers. Among the major barriers to trade and investment are export restrictions on energy resources, domestic market obligations and energy subsidies.

In general, members should facilitate the provision of economic incentives and market signals that encourage incumbent players to participate more actively across the value chain to capitalize on potential business opportunities across the region. Restrictions on energy exports or export limits may hamper future investment and indirectly distort the LNG market. Lifting export limits or barriers will not only help to boost investment, but it will also have a direct impact on improving supply security and increasing market efficiency.

In accordance with APEC's mission to champion free and open trade and investment, upholding free-market premises must be a top priority on the energy agenda of APEC governments. These ideas should prevail on energy supply considerations over autarky. Probably one of the largest barriers to expanded natural gas use and LNG trade is the energy subsidies that distort the real prices and costs of available fuels in the economy. This issue follows in line with repeated declarations from APEC Energy Ministers calling for the removal of these subsidies.

To that end, it is advisable that in addition to the bilateral and multilateral mechanisms to promote investments in LNG activities, APEC members should stop subsidizing energy sources as much as possible without abandoning vulnerable social groups. Energy subsidies will deter investment, in both upstream and downstream, as prices do not reflect demand and supply dynamics, passing to investors the risks for the returns and viability of their projects.

The removal of these energy subsidies should target not only those fuels competing with natural gas but natural gas itself. Price subsidies and mechanisms that do not purely reflect market principles, which are set artificially by the government — including those to meet domestic market obligations — and that are linked to other fuels or energy commodities should be on the table.

In the long-term, these considerations should also stimulate discussion on the implementation of carbon prices that reflect the full costs and externalities in the use of each fuel across their respective lifecycles. In fact, the current environment of low natural gas prices might also be seen by LNG companies as an opportunity to trigger increased consumption and trade of natural gas, with the ultimate aim of letting prices adjust to promote the development of required infrastructure and supply.

4. Enforce fiscal and investment frameworks that facilitate gas upstream projects

Natural gas markets in the Asia-Pacific are not as developed and integrated as in other regions, and the geographical asymmetries between producers and consumers are more exagerated. Due to these considerations, producers and consumers, and private and public actors alike should explore ways to stimulate upstream projects that strengthen the gas supply and its potential to be traded as LNG.

Where it is geologically, economically, environmentally and socially feasible, stepping up domestic gas production, spanning conventional and unconventional

resources, could help to strengthen the dynamics of natural gas markets by diversifying the sources of supply. Many stranded gas assets could become viable if marketed as LNG to distant consumers, which would have a positive impact for an expanded LNG trade.

Furthermore, increased gas production could potentially enlarge the number of LNG exporting economies, adding more sources of supply and giving competitive impetus to markets. This is an important issue in consideration of the concentration of LNG sellers relative to the number of importers.

Given the lead times in the LNG value chain, a more active exploratory environment is needed in order to find and develop more gas resources. In the case of unconventional gas, economies should take additional measures to mitigate the expanded risks of its development in comparison with conventional projects, in order to ensure that these resources are extracted in a cost-effective, environmentally sustainable and socially responsible way (APERC, 2015).

To that end, economies should design and implement fiscal regimes that balance the allocation of risks and rents for the different actors involved, in order to let them realize value while still supporting an environment conducive to investments in upstream projects. Paradoxically, low oil price levels since the second half of 2014 could represent an opportunity for several economies to ease fiscal and investment conditions that provide strong economic incentives only to undertake upstream gas projects in consideration of their potential profitability under higher oil prices in the future. In connection with this a more conducive fiscal and investment framework in APEC economies might encourage oil and gas companies — especially the largest ones — to invest in upstream projects that include an LNG component.

5. Acknowledge the critical role of LNG infrastructure for energy security

The pace of LNG trade hinges on the development of infrastructure. Nevertheless, LNG infrastructure is usually large scale and involves significant capital investments. The long time gaps between the approval and start of operations in these projects, and the foreseeably low oil and natural gas prices discourage these types of projects in relation to other investment options.

In parallel with the development of LNG terminals and storage, other types of associated infrastructure like transmission pipelines should progress to allow the physical interconnection that supports the integration of gas markets, especially among South-East Asian members. Along with technical and economic considerations, LNG infrastructure should also be driven by a clear approach for energy security in line with the previous recommendations.

The development of LNG infrastructure at a regional level must ensure the expansion of sufficient capacity to meet future gas needs and unexpected contingencies. Promoting open access for LNG terminals and idle infrastructure capacity with a fair return to owners for the use of those facilities should also bolster a faster pace of construction.

6. Improve procurement and technological processes

Since its inception, LNG has been oriented to a large scale of operation, which favorably suited integrated energy companies in the upstream sector as well as large utilities in the downstream sector. However, the commercial viability of new technologies such a small-scale LNG terminals and smaller LNG carriers continues to progress, opening new business opportunities to accommodate the use of LNG in more diverse settings.

Additionally, the deployment of floating regasification terminals has also gained traction in the past few years, with the first floating liquefaction plants due to start operations soon, bringing energy security benefits and improving cost-effectiveness across the LNG value chain. For these reasons, APEC member economies should find ways to advance policies and initiatives that introduce new commercial technologies that reduce the costs of procurement and technology across the LNG supply chain while ensuring the safety and reliability of operations. As noted below, novel ownership and financing arrangements might contribute to adopting these technologies more rapidly.

Strategic partnerships and alliances are critical and necessary to further facilitate trade and investment and reduce procurement costs. They could also create opportunities for mutual cooperation in joint research and development in the LNG value chain, joint ventures in the supply chain and equity participation in upstream investment by importing economies, and third-party access to vital LNG infrastructure. Likewise, partnerships and alliances provide a platform for better contract negotiations that include price adjustments favorable to both parties.

7. Explore alternative LNG business models

LNG buyers and sellers are increasing their involvement across the value chain in novel ways, integrating their operations forward and backward in an effort to seize business opportunities and introduce more flexible practices.

In general, LNG supply has followed three major models: integrated, merchant and tolling. The dominant business model by LNG suppliers in APEC is either the integrated model, whereby companies control from upstream activities to the point where LNG reaches importing terminals, or the merchant model, whereby there is a partial break down of the LNG value chain into different segments. Although these models have worked relatively well for suppliers and buyers during the past decades, they still involve considerable capital investments that have been transformed by an influx of more economies with different players and strategies. In consequence, the traditionally bi-lateral structure of buyers and sellers in LNG markets has evolved into more complex arrangements.

Therefore, there is scope for new business models that can contribute to the establishment of more robust LNG markets with more vigorous trade, based on the cooperation of different market players. In the tolling model for instance, the liquefaction plant owner is not necessarily a gas producer and only charges buyers and sellers a fee for the use of facilities. With a tolling model gas sellers are relieved from the massive capital investments associated in building a liquefaction plant, while buyers can optimize their contracted volumes more flexibly as they do not entail any destination restriction. While the tolling model may create higher risk insofar as the plant's revenue is somewhat more dependent on the short term and spot market, some of its capacity can be channeled for long term contracts.

Until 2015, there was no export orientated tolling model used by any APEC LNG seller, although it was gaining popularity in the United States. Under this business model, the liquefaction plant owner is not necessarily a gas producer, which is one advantage provided by the large and liquid gas market in the United States, where the shale gas boom has resulted in an available oversupply at very low prices.

For the APEC region, and specifically for South-East Asia where the bulk of LNG sales are supplied under long-term rigid contracts, the tolling model can help to establish LNG prices increasingly based on gas-to-gas competition in order to foster spot markets. More flexible business models like this can also increase the number of supply options

available to buyers, inducing cooperation between selling companies to gain economies of scale and optimize their portfolios.

8. Advance new LNG contract features

One of the major challenges restraining LNG trade relates to the rigid contract terms in these transactions, bound by restrictive clauses on destination, shipping responsibility, sales volume obligations (take-or-pay) and long-time periods.

Traditional LNG contracts have undergone little changes since the beginnings of the LNG industry, when they were designed in such a way as to protect sellers from unforeseen risks from buyers that would jeopardize their substantial capital investments. These types of contracts made sense in an emerging LNG industry that had few sellers and buyers, but eventually the adherence to fixed volumes sales without acknowledgement of future demand trends stirred more uncertainty and problems for buyers, while high costs and volatile oil prices became an entry barrier for many sellers. The LNG industry worldwide has significantly evolved, and LNG contracts should introduce elements that reveal actual market dynamics with more fidelity.

In fact, the removal of destination clauses, increased volume flexibility and shorter contracting terms will be progressively needed by LNG sellers and buyers alike in order to cope with continued low oil prices. A relaxation in these contract terms is likely to promote a more liquid and active LNG trade. By depending on the alignment of regional prices, buyers and sellers could optimize their sales and shipping deliveries to achieve cost efficiencies and shorten delivery times. More flexible contracting terms would also suppress the progressive needs for re-exports (*re-loads*), shaping a more efficient supply chain.

The current conditions of the LNG industry in the Asia-Pacific are particularly promising for a paradigm change in contract specifications. New sellers like those in the United States are offering more favorable transactions without destination clauses and more flexible terms that undermine the traditional contract conditions in the industry, and the oversupplied market, expected to last for some years more, increases the credibility and bargaining power of buyers to make more ambitious demands from sellers. This includes the possibility to enter into LNG projects or promote their companies to integrate backwards as a means to gain control of supply. In essence, these issues should encourage dialogue to promote a better alignment of interests between different stakeholders which could positively affect trade flows in coming years.

As much as Asian buyers aim to break free from the rigidity, long-term horizons and linkage to oil prices in LNG contracts, these types of contracts will survive, as they ensure a long-term secured LNG supply and to increase the financially viability of projects. While new contract features with more flexibility are increasingly welcome, conventional contracts with long-term horizons and linkage to oil prices are necessary to ensure some projects will reach FID in order to start operations in a timely manner over the next decade.

9. Promote financing alternatives for LNG projects

To strike for a balance between LNG sellers and buyers that leads to the development of projects and accelerated trade within the APEC region, member economies should seek ways to promote innovative financing alternatives built from the dialogue among industry players and in consideration of the maturity stage of their respective LNG economy-wide markets.

Support from buyers is needed in making this happen, such as taking equity stakes in the liquefaction plant in order to lower risk and move from the traditional integrated model to a tolling model. Furthermore, with a tolling model in place, the buyers can play a bigger role in the LNG supply chain by getting involved in transporting the LNG.

Members should also invite multilateral financial institutions to participate in the dialogue of APEC's EWG, with the aim of discussing and suggesting appropriate financing schemes for LNG projects contingent on the industry's maturity level in each economy, the type of project (*greenfield* or *brownfield*) and the overall project risk. In addition, economies entering the LNG market might have weaker economic and political capacities to fulfill their financial commitments, which increases the risk of LNG projects for developers. Therefore, multilateral financial institutions, industry players and governments (especially where government-owned companies are involved) are encouraged to explore financing alternatives that enhance the viability of LNG projects and mitigate their risks in locations where economy-wide credit ratings are poor.

Closely related and capitalizing on APEC's economic strengths, another recommendation is to invite the APEC Business Advisory Council (ABAC) to explore and identify opportunities in the regional LNG industry. This effort should encourage ABAC to include LNG among its priorities, in order to have dedicated discussions and a specific working group.

10. Support the development of regional gas price hubs

Price formation of natural gas — including LNG — has been a sensitive subject worthy of intensive discussion. In particular, the rationale of oil-indexed price formation has been severely questioned by an increasing number of Asian buyers, including utility companies, government officials and end-users who have traditionally paid much higher prices than other regions in the world, namely North America and Europe. However, since the second half of 2014 price levels have declined substantially. At the end of 2015, the LNG market in Asia was oversupplied and the decline of oil-linked spot prices benefited buyers with cheaper LNG.

Member economies, mainly those in Asia, must acknowledge that the more liquid gas markets and price hubs in the United States and the United Kingdom were chiefly the result of gas markets that first developed with domestic gas production; then expanded with the increased trade from the shifting status of those economies from net importers to exporters; and finally were steered through deliberate structural reforms. As these processes take time to occur, the actions taken now will be critical to develop the type of market profiles that participants want to see in the future.

In practice, some major LNG importers in Asia including Japan, the world's largest LNG importer, have started to develop regional trading hubs, aiming to create gas-to-gas competition as detailed in Textbox 8. Although these initiatives have been led by governments of member economies, their ultimate goal must be to encourage industry players to interact in the market, while maintaining a limited role as a regulator.

In order to have LNG prices that better reflect actual market dynamics in Asia, it is advisable that member economies foster deliberately the establishment of trading hubs where possible, to allow APEC member economies in Asia to progressively reduce the influence of oil prices in the LNG traded in the region, while introducing more competitive fundamentals. Additionally, member economies should provide transparent, updated and open-access information that contributes to improve rational decision-making in LNG markets.

Textbox 9
The beginnings of a gas price hub in Asia

Prior to the decline in oil prices in 2014, oil indexation was the main reason for higher LNG prices in Asia in comparison to Europe and North America. In other words, there is little gas-to-gas competition in Asia, due to the lack of sufficient domestic production, the high reliance on imported gas — mainly as LNG — and in many economies, the existence of underdeveloped gas markets dominated by few players.

The establishment of an LNG trading hub is seen as a major step towards creating gas-to-gas competition, encouraging Asian gas markets to shift away from oil-indexation with the ultimate goal of having LNG prices that accurately reflect market dynamics in terms of supply and demand. There are two main components to the development of an LNG trading hub: first, a place where LNG cargoes can be physically traded on a frequent basis to increase market liquidity and price transparency; second, intensive physical trading must be accompanied by financial instruments. In the United States for example, the Henry Hub futures market allows traders and gas companies to hedge and diversify the risks from their supply and demand transactions.

The largest LNG importers in Asia and the world have taken the first steps to developing their own trading hubs for the Asian region, striving to create markets and prices driven by gas-to-gas competition in the hope of becoming Asia's gas price hub leveraging their respective strengths.

- **Japan (Tokyo)**

In September 2014 Japan established its own price benchmark by launching a platform called Japan Over-the-Counter Exchange (JOE), a joint venture between the Tokyo Commodity Exchange and Ginga Petroleum, a Singapore-based energy broker. By establishing JOE, Japan hopes to break the oil-indexed pricing formation to become a benchmark in Asia. Japan's JOE was the frontrunner in the group of economies looking forward to becoming Asia's gas trade hub.

- **Singapore**

The Singapore SGX LNG Index Group (SLInG) was launched in June 2015. This is a weekly price index for LNG cargoes from Singapore to different destinations, which reflects regional spot prices, competing with Japan to become the regional LNG trading center in Asia.

- **China (Shanghai)**

In July 2015, China launched the Shanghai Petroleum and Natural Gas Exchange (SHPGX), which offers spot trading for pipeline gas and LNG with the goal of establishing a market-oriented pricing mechanism based on supply and demand.

A mix of pricing mechanisms will be probably be more beneficial to the market as a whole, as oil-based pricing might still fit some buyers' needs as well as those of some portfolio players who will look for diversity in their assets when combined with spot and short-term contracts based on gas references. As oil-indexation grows weaker in Europe and faces pressures in Asia, those LNG buyers in APEC member economies might leverage this change to enhance market liquidity by improving price transparency and public information, which is essential to moving price formation away from oil indexation and also a key to ensuring gas-to-gas competition.

The progress in each of these three current price hub candidates advances the matter in Asia, and while they seem to compete with each other, it is likely that the existence of multiple price hubs will eventually be beneficial for Asia.

11. Facilitate the investment and regulatory environments for LNG projects

In order to boost LNG trade, both the government and the industry need to play a more active role and increase coordination with each other. Governments must facilitate investment by industry players in LNG projects. To that end, participants in the LNG market must have predictable macroeconomic, investment, legal and regulatory frameworks. Likewise, industry participants should provide feedback to authorities to improve regulations and policies.

Expanded natural gas demand and LNG trade will also hinge on the development of sound regulations that minimize the potentially negative impacts that may arise from the development of LNG projects. Because of this, APEC economies must design comprehensive regulatory systems that mitigate the risks to society, the natural environment and public health, while ensuring industrial safety in compliance with best international practices. The challenge for governments will be to address all these issues while streamlining the approval process for LNG projects in order to reduce lead times and facilitate the creation of physical infrastructure and overall conditions for an increased LNG trade.

12. Develop competent institutions for regulatory enforcement

In connection with the previous recommendation, a sound environment for LNG projects that improves the timeliness of the regulatory process not only depends on appropriate regulations but on the capabilities to effectively enforce them, free from political interference, with regulators who act transparently on behalf of public interest and are held accountable for their actions.

Thus, APEC member economies should invest necessary resources in creating adequate governance mechanisms for regulatory enforcement, through competent institutions formed with enough personnel and skills. Key throughout this process is adherence to transparency and accountability.

13. Engage stakeholders in LNG projects

Aside from the involvement of business stakeholders, local communities and social groups must be consulted and included in the regulatory and decision-making process of LNG projects. Preferably, engagement with these groups should occur at an early project stage, with the aim of reducing risks comprehensively, preventing any potential delays and in general, increasing the chances of achieving successful implementation.

From the government's side, this recommendation implies a proactive outreach strategy to social groups to manage public expectations better. On this point, APEC member economies must develop public campaigns and communication strategies that provide unbiased information to citizens to elicit their collaboration as well as a constructive dialogue to reach timely agreements with shared benefits.

14. Foster regional cooperative activities

APEC itself was established to build a dynamic and harmonious community from the joint collaboration of its members. To that end, member economies should strengthen APEC's LNG Trade Facilitation Initiative by launching a cooperative proposal that creates a permanent commitment to tangible actions and measurable voluntary indicators to assess the region's progress in creating more liquid LNG markets with expanded trade intraregional flows.

Member economies are encouraged to share and exchange information through workshops, seminars or periodic events. Similar events to Japan's LNG Producer-Consumer Conference, but within the scope of APEC, would help the region move in this direction. Through these initiatives, APEC economies could share issues such as fiscal measures, regulatory instruments, technological breakthroughs and safety practices along with lessons learned for policy-making.

It is also recommended that member economies explore the creation of a permanent LNG task force — ideally within EGCE — to gather experts from diverse stakeholder groups such as academia, industry and government to discuss the opportunities to create a more flexible LNG market and address technology, economic, financial, environmental and social issues.

15. Use collective power to encourage more balanced interactions and discussions

APEC is an excellent forum to discuss mechanisms that facilitate an accelerated LNG trade that leverages the dialogue and collaboration of producers and buyers across member economies.

Unlike the economies that form the Asian continent, APEC has a broader geographic scope and was created from the need to achieve shared benefits from the collective strength of its members. Therefore, the APEC region must capitalize on the complementary gas market profiles of its member economies, which includes the largest LNG consumers. Some of the largest LNG producers in the world are also member economies, including Australia and the United States, which are poised to substantially increase their export volumes and become more relevant in the next few years.

These strengths should encourage more fruitful dialogue, enhanced initiatives and specific projects that exchange information and increase the trade and investment flows between LNG-exporting and LNG-importing economies. In addition to the economic and energy priorities at the government level in each member economy, LNG-selling and LNG-consuming economies in APEC should coordinate their efforts to voice their concerns and engage in discussions to find the best methods to create business opportunities that bring about shared economic, environmental and energy security benefits.

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Annex

APEC member economies

Because APEC's mission is to support economic growth and prosperity, the term 'economies' is preferred over other terms like 'countries', to reflect he major engagement of members as economic entities rather than as individual governments with political connotations.

This precept to denote economic and trade premises is extensive to other derived words: for example, the use of 'economy-wide' is preferred over 'national'. The following are APEC's 21 member economies and their official abbreviations:

Australia
Brunei Darussalam
Canada
Chile
Chinese Taipei
Hong Kong, China
Indonesia
Japan
Malaysia
Mexico
New Zealand
Peru
Papua New Guinea
People's Republic of China
Republic of Korea
The Republic of the Philippines
The Russian Federation
Singapore
Thailand
United States of America
Viet Nam

LNG terminals in APEC by member economy

By the end of 2015, the APEC region held 66 of the 108 receiving terminals and 13 of the 25 liquefaction plants in operation. The table below shows the number and type of terminal by member economy.

- The group of member economies with LNG liquefaction terminals (for exporting LNG) is formed by eight economies: Australia, Brunei Darussalam, Indonesia, Malaysia, Papua New Guinea, Peru, Russia and more recently, the United States. Indonesia led this group for many years, although the recent expansion of liquefaction projects in Australia and in the United States in the next following years will make these economies lead the region.

- The group of member economies with LNG regasification terminals (for importing LNG) is larger, and it is formed by 12 economies: Canada, Chile, China, Indonesia, Japan, Korea, Malaysia, Mexico, Chinese Taipei, Thailand and the United States. By far, Japan is the economy with the largest number of terminals of this type.

Economy	Type of terminal		Total
	Liquefaction*	Regasification	
Australia	4	-	**4**
Brunei Darussalam	1	-	**1**
Canada	-	1	**1**
Chile	-	2	**2**
China	-	12	**12**
Indonesia	3	3	**6**
Japan	-	25	**25**
Korea	-	5	**5**
Malaysia	1	1	**2**
Mexico	-	3	**3**
Papua New Guinea	1	-	**1**
Peru	1	-	**1**
Russia	1	-	**1**
Singapore	-	1	**1**
Chinese Taipei	-	2	**2**
Thailand	-	1	**1**
United States	1	10	**11**
Total in APEC	**13**	**66**	**79**

*These numbers only refer to the actual terminal facilities. Liquefaction terminals usually have several liquefaction trains with different names and ownership arrangements within their facilities.
Source: IGU (2015b)

In step with the progress of LNG trade, natural gas demand and the pace of extraction and depletion of gas resources, Indonesia, Malaysia and the United States have both LNG liquefaction and regasification terminals. In the same year, Hong Kong China, New Zealand, the Philippines and Viet Nam did not have LNG terminals of any type.

Sub-regional grouping

The list below shows the sub-regional classification used by APERC (2016) in its Energy Demand and Supply Outlook 6th Edition. This classification includes groups of economies as well as single economies with large magnitudes of energy demand and supply.

Region	Economy
Oceania	Australia, New Zealand, Papua New Guinea
Other Americas	Canada, Chile, Mexico, Peru
Other northeast Asia	Hong Kong China, Japan, Korea, Chinese Taipei
South-East Asia	Brunei Darussalam, Indonesia, Malaysia, The Philippines, Thailand, Viet Nam
China	-
Russia	-
United States	-

Events attended by research staff

Below is the chronological list on the events related to natural gas and LNG markets in which research staff participated (form APERC and IEEJ). Due to the nature of most of these events, only general information is available for dissemination.

- **Canada LNG Export 2015**
  Calgary, Canada
  19-21 May 2015

- **APEC LNG Trade Facilitation Conference**
  Chinese Taipei
  15-16 July 2015

- **LNG Producer-Consumer Conference 2015**
  Tokyo, Japan
  16 September 2015

- **Workshop on Changing Global Gas Markets**
  Singapore
  28-30 October 2015

- **Asia Gas Market Forum**
  Beijing, China
  27 November 2015