Oil and Gas

Asian gas: Partnerships for a growing industry

Presented at the Asia Gas Partnership Summit organised by GAIL (India) Limited and FICCI
3–4 December 2013, New Delhi

Oil and Gas

Asian gas: Partnerships for a growing industry

Presented at the Asia Gas Partnership Summit organised by GAIL (India) Limited and FICCI
3–4 December 2013, New Delhi

Introduction

Global energy demand is expected to grow substantially from 490 QBTU in 2010 to 622 QBTU in 2030. This will be driven by economic development and population growth in emerging markets, primarily India and China. As an abundant, cleaner and cost-efficient energy source, natural gas is expected play a larger role in the energy market going forward.

Over the last few years, the global gas market has witnessed significant changes. Gas supply has increased with the opening up of new sources and technologies. LNG projects in Australia, North America, Russia and Africa are progressing, and are expected to contribute significant volumes over the next 5 to 7 years.

LNG consumption has shifted further towards Asia, with demand in traditional markets like USA and Europe slowing down, and demand in Asia continuing to grow. Besides current importers like Japan, Korea, Taiwan, China and India, new countries in South East Asia and the Middle East are emerging as important LNG demand centres.

Affordability is growing, but continued high prices for Asia remain a concern. Supply is likely to remain balanced for a few years, beyond which planned projects will need to be competitive to ensure offtake.

In this changing paradigm, industry players need to come together and discuss opportunities and ways to unlock the natural gas potential. The 8th Asia Gas Partnership Summit (AGPS), organised by GAIL (India) Ltd and the Federation of Indian Chambers of Commerce and Industry (FICCI), with the support of International Gas Union, is an important forum that provides this opportunity. It has become Asia's premier natural gas event, and its success reflects Asia's importance in the global energy and gas market.

To discuss the role of partnerships in this dynamic environment, McKinsey & Company has worked to develop a perspective on the global gas market (with an emphasis on Asia) and the opportunities for new partnerships to facilitate the future growth of the industry. McKinsey Energy Insights has contributed significantly through access to their proprietary global gas demand and supply databases and models.

We are thankful to McKinsey & Company for conducting this extensive knowledge effort and bringing an insightful perspective to this Summit. We hope that you will find this document informative and useful for taking effective decision in shaping the future of Asian gas industry.

B.C. Tripathi
Chairman & Managing Director
GAIL (India) Limited

Dr. A. Didar Singh
Secretary General
FICCI

Contents

Acknowledgements

On behalf of McKinsey & Company, we would like to thank Mr BC Tripathi and Dr A Didar Singh (from FICCI) for providing us with the opportunity to undertake this effort.

From GAIL, we would also like to thank Mr Rajeev Mathur, Executive Director—Marketing; Mr Rajesh Vedvyas, Executive Director—International Gas Sourcing; Mr VN Datt, General Manager—Gas Trading; Mr A Kaviraj, Deputy General Manager—International Gas Sourcing; Mr Santanu Basu, Senior Manager—Marketing; Mr Thivahar Bethune, Senior Officer—International Gas Sourcing; Mr Jignesh Vasavada, Manager—Corporate Communications; Mr Anurag Arora, Manager– Gas Marketing and Mr Devender Nahar, Executive Assistant– C&MD Secretariat for their time and support in sharing information, as well as their thoughts on the report.

From FICCI, we would like to acknowledge Mr Vivek Pandit, Senior Director and Head—Energy, Defence and Aerospace, for his help with coordination.

This research drew extensively on McKinsey's proprietary global gas models, databases, Energy Insights' Market Analytics tools and on the cumulative experience of its various international experts. Energy Insights is a McKinsey Solution which combines proprietary tools and information, advanced analytical models, and specialist expertise to identify key value levers for energy players, working closely with the broader McKinsey consultant network.

This report would not have been possible without the dedicated efforts of the McKinsey team consisting of Artika Thakur, Shreerang Godbole and supported by Joseph Cherukara with overall leadership from Abhishek Aggrawal, a Senior Associate based in our New Delhi office.

We would also like to thank McKinsey's global network for providing overall direction to this research effort—Peter Lambert, a Senior Expert based in our London office; Gjermund Øydvin, a Knowledge Specialist based in our Oslo office; Pru Sheppard, a Knowledge Specialist based in our Washington office; Ellen Mo, a Senior Research Analyst based in our Shanghai office; Jaap Strengers, a Solutions Manager in our Amsterdam office and Rahul Gupta, a Specialist based in our Singapore office.

Finally, we acknowledge the efforts and support of our communications team consisting of Tanya Gulati, Fatema Nulwala and Manasi Apte, our graphic designer Therese Khoury, and our visual aids specialists Nipun Gosain, Vineet Thakur and J Sathya Kumar.

Vipul Tuli
Director
McKinsey & Company

Amit Khera
Associate Principal
McKinsey & Company

Executive summary

The global gas market has experienced major structural changes in the last few years. Supply has significantly increased with new sources and technologies, while global consumption has fallen for the first time in 30 years, despite rising demand from Asia. Asian markets remain price sensitive, and affordability and offtake are concerns for new planned projects. Though players have started to use new pricing mechanisms and are acquiring stakes across the value chain in response to these changes, bold new partnerships will be required to ensure that key industry concerns are resolved and the market grows to its full potential.

The world of gas has changed

The world of gas has changed in the last few years, with many previously anticipated changes in supply, demand and technology becoming a reality. A large amount of gas is now becoming available to Asia from newer sources via different pricing mechanisms. Global LNG consumption fell for the first time in 3 decades, even though demand has continued to grow in India and China, and new demand centres have started to emerge in Asia and the Middle East.

More supply is coming onstream at different price points

Asia has begun to experience many discontinuities in supply with the addition of new supplier geographies, the growth of unconventional gas production, steady growth of spot and short-term market, and new infrastructure and technology facilitating supply.

The most significant change over the last few years has been the increase in LNG sourcing from North America. Asian buyers have contracted over 32 mtpa from the US in the last 3 years, accounting for 17 per cent of all deals worldwide by volume. The uncertainty about exports to non-FTA countries in Asia has significantly reduced over the last 2 years, with 6 new terminals being approved for non-FTA exports. The speed of new approvals has been somewhat faster than industry expectations.

Supply is also increasing from newer geographies. Russian gas is gradually becoming available to Asia with as many as 13 deals signed in the last 3 years that are expected to deliver over 13 mtpa by 2020. Africa's liquefaction capacity will nearly triple to 127 mtpa by 2020. Meanwhile, over 108 mtpa onshore Australian LNG is expected to come onstream by 2020, but at high breakeven costs.

Unconventional gas has also made positive strides across the world. Shale gas production in the US continues to grow at a rate of 37 per cent per annum, and it now accounts for over a third of US gas production. Meanwhile, countries like India and China, who are large importers of LNG, have also started to develop unconventional gas reserves, including shale, CBM, and other tight gas.

As Asian countries explore all means to secure supply and reduce gas costs, cross-border pipelines are being developed across the region. This supply will compete with LNG. Even pipelines that are still on the drawing board will increase bargaining power for importers of LNG. New regasification terminals being developed across Asia and the Middle East will facilitate imports. The total regasification capacity is expected to go up from the current 360 mtpa to an estimated 540 mtpa by 2020.

The increasing adoption of new technologies is also driving the development of the gas market. Floating storage and regasification (FSRU) capacity is expected to be over 74 mtpa in Asia by 2020, and will enable faster access to LNG. Floating liquefaction technology is also being deployed widely. Across the world, 21 projects are under way which are expected to add over 87 mtpa of liquefaction capacity. Mini LNG is unlocking inland demand in several countries. In China, for example, production from liquefaction terminals is expected to double by 2020. LNG transported by truck to mini regasification facilities, as far as 1,000 to 2,000 km inland, is being used to fuel vehicles, domestic consumers and industry.

The depth of Asia's spot and short-term market in LNG has also been steadily growing and is now a quarter of all imports. This provides buyers with greater flexibility and opportunities to create value through trading, relative to a few years ago.

India and China continue drive demand growth while new demand centres are emerging in Asia and the Middle East

Asia continues to strengthen its position in the global LNG market. Its demand increased by 10 per cent between 2011 and 2012, while demand from the rest of the world fell by 19 per cent.

Volume growth in Asia continues to be promising. In addition to stable demand from traditional markets like Japan, Korea and Taiwan, and higher than expected growth from China and India, a number of new smaller markets are also emerging as demand centres. These include importers such as Singapore, Thailand, the Philippines, Bangladesh and Pakistan in Asia, and several countries in the Middle East, such as Dubai, Kuwait, Israel and Bahrain, and exporter/importers such as Indonesia and Malaysia.

Players are using new pricing mechanisms and are increasing integration across the value chain

The LNG market is currently tight and is expected to remain the same in the short term. However, a consolidated demand and supply picture shows several planned and speculative projects beyond 2018. Approximately 200 mtpa of additional LNG capacity is required to meet projected demand in 2030, but plans exist for twice this capacity.

An increasing number of Henry Hub-linked supply contracts (13 deals worth 38 mtpa over last 3 years) is contributing to the softening of price expectations in Asia. Further, buyers are expecting to renegotiate favourable terms for the substantial 51 mtpa of contracts that will come up for renewal between 2015 and 2020. Of these, 33 mtpa will be renewed between 2018 and 2020, coinciding with the expected supply overhang. Meanwhile, Japan is actively looking to reduce its LNG import costs. Asian players are also investing in assets across the value chain to provide secure and hedged access to gas.

A detailed assessment of all proposed LNG terminals and their breakeven costs suggests that new terminals will need to ensure cost competitiveness, especially if prices soften.

Affordability and offtake remain concerns

Though volume growth in Asia is expected to be strong, challenges to the development of the gas market continue. Affordability is a concern given the price sensitive demand. Offtake is also a concern given high breakeven costs of projects.

China, India and other geographies face affordability challenges

China's domestic gas supply will cater to only 60 per cent of demand by 2020. Its gas demand has a potential to grow by an additional 140 mmscmd if affordability improves for industry. A further demand upside is also possible from the power sector if gas prices reduce further.

In India too, domestic gas production is well below demand. Even though supply is expected to increase at a CAGR of 4 per cent between 2012 and 2030, demand will continue to outstrip it. Infrastructure is not expected to be a bottleneck, as India has added substantial pipeline capacity, and additional planned pipelines and terminals will reach all its demand hubs. Several regulatory changes have also been made to incentivise the development of the gas market and investment in the gas value chain. These include the deregulation of alternative fuel prices, new policies for unconventional E&P, linking of gas wellhead prices to a composite market index, and pass through regulations for fuel in user industries. However, affordability remains a challenge and additional measures, including tax rationalisation, cost and tariff optimisation, and competitive pricing will be required to unlock demand.

The amount that households spend on energy has been increasing rapidly across Asia. As the examples of India and China show, most of the increase is being driven by deregulation of prices and the remaining by increased consumption. As a result, resistance caused by demand elasticity cannot be ruled out across Asia in the coming years.

Offtake could be a concern as supply increases

Demand and supply are likely to be in balance for the next 5 years. Beyond that, a number of new projects are planned, and a surplus is likely if these materialise. Several projects that are under construction require prices above USD 12 per mmbtu to break even. In a surplus situation, these projects will be hard pressed to match price sensitive demand with affordable supply.

Partnerships are critical to address key industry concerns

Asian markets have limited pipeline connectivity, low market liquidity and high dependence on LNG for gas imports. For the gas market to grow significantly, these industry concerns as well as the core issues of affordability and offtake need to be addressed. Joint initiatives could include:

- Unlocking demand and ensuring affordability
- Improving supply security
- Ensuring viability of projects
- Enabling unconventional gas production.

Different forms of partnerships between buyers, sellers and governments are required to undertake these initiatives. A multilateral "Asian Gas Partnership Forum" could be considered by industry participants as an institutional mechanism to make these partnerships a reality.

Unlocking demand and ensuring affordability

Three partnership themes can help unlock demand and improve affordability:

- **Encouraging gas usage:** Joint industry efforts could unlock demand and improve affordability. These efforts could focus on working with governments to enable policy changes (e.g., tax rationalisation), with customers to remove bottlenecks (e.g., technology and infrastructure), on building public opinion (e.g., highlighting environmental benefits) and driving new technology development and adoption. For instance, LNG used as piped gas in homes is cheaper than LPG and can provide a base load for urban gas distribution networks.

- **Partnerships to aggregate demand:** Dispersed demand in remote locations, such as islands or inland clusters, can be unlocked through a hub and spoke model. Regas storage at a port location can serve as the hub, with small vessels, barges and LNG trucks operating on the "spokes". To make this a reality, end users (e.g., industrial customers) will need to work together with regas developers and LNG traders.

- **Cross country infrastructure and an Asian gas grid:** Several transnational pipelines are under development across Asia. These require multilateral cooperation and partnerships. An Asia gas grid is also a possibility that could reduce costs, strengthen the market, and lead to mutual interdependence between suppliers and buyers.

As the industry structure and conduct evolves, new pricing mechanisms are bound to follow. A range of new mechanisms are already emerging that seek to align prices to market conditions and reapportion risk. Players can work together to develop new commercial terms (e.g., using multiple indices and s-curves) to increase affordability and drive demand growth, while ensuring the viability of LNG projects. An Asian gas index that reflects the supply and demand fundamentals of the region can provide more flexibility and facilitate investment decisions for industry players. This would require a concerted effort from the industry, with significant involvement from financial institutions, to develop a trading hub, that is connected to the major demand centres, with non-discriminatory access to infrastructure.

Improving supply security

Several flexible operating mechanisms are possible to improve supply security and reduce costs. These include:

- **Flexible destination clauses** to reduce penalties, demurrage, and risks of stock outs

- **Information sharing on inventories** to lower information asymmetry. thereby enabling better planning and scheduling, and reducing speculation

- **LNG loan agreements** to enable emergency response and reduce inventory carrying cost

- **Swaps** to reduce transportation costs and lead times.

Ensuring viability of projects

Joint initiatives between the government and industry can drive targeted interventions to bring down costs and rescue high cost projects. The potential impact of such interventions is sizeable. For example, a recent McKinsey study showed that of the USD 2.5 per mmbtu difference in breakeven landed cost between unconventional gas based LNG projects in Australia and those in Canada, tax and regulation contributed USD 0.8 per mmbtu, and project optimisation and labour productivity together contributed 0.5 per mmbtu.

Infrastructure and resource sharing can also reduce project costs. Suppliers can jointly develop fields, and co-invest in production and transportation infrastructure to reduce costs and achieve scale. This is particularly true in new greenfield projects, which are high risk and could be in countries that do not have easy access to local service providers.

Enabling unconventional gas production

Though the potential is high, there are significant challenges to the development of unconventional gas reserves. Partnerships are needed to build capacity to enable unconventional gas production. As entirely new supply chains for unconventionals are created in Asia, this will also become an attractive opportunity for service and equipment providers. Examples of such partnerships include:

- Building fracking supply chains

- Developing analytic capability for sub-surface modelling

- Improving equipment availability and reliability

- Building local teams trained on "factory" drilling models

- Creating joint R&D projects to develop cost effective water disposal solutions and fracture models (e.g., compressed gas).

Asia Gas Partnership Forum: A possible institutional mechanism

Establishing an Asia Gas Partnership Forum can facilitate partnerships to drive the growth of the gas market. This would need stakeholders to come together and agree on common objectives and activities, provide resources to a full time secretariat, and pursue initiatives of mutual interest.

A forum of this nature could serve as the glue holding the Asian LNG industry together. It could become the focal point to drive several of the initiatives mentioned earlier, such as unlocking demand, improving affordability and supply security and facilitating new contract mechanisms. The key objectives of the forum could include:

- Encouraging the use of gas
- Information sharing on demand, supply and inventories
- Technology development and experience sharing
- Capability building
- Safety and technical standards
- Creating an Asian gas grid and an Asian Gas Index.

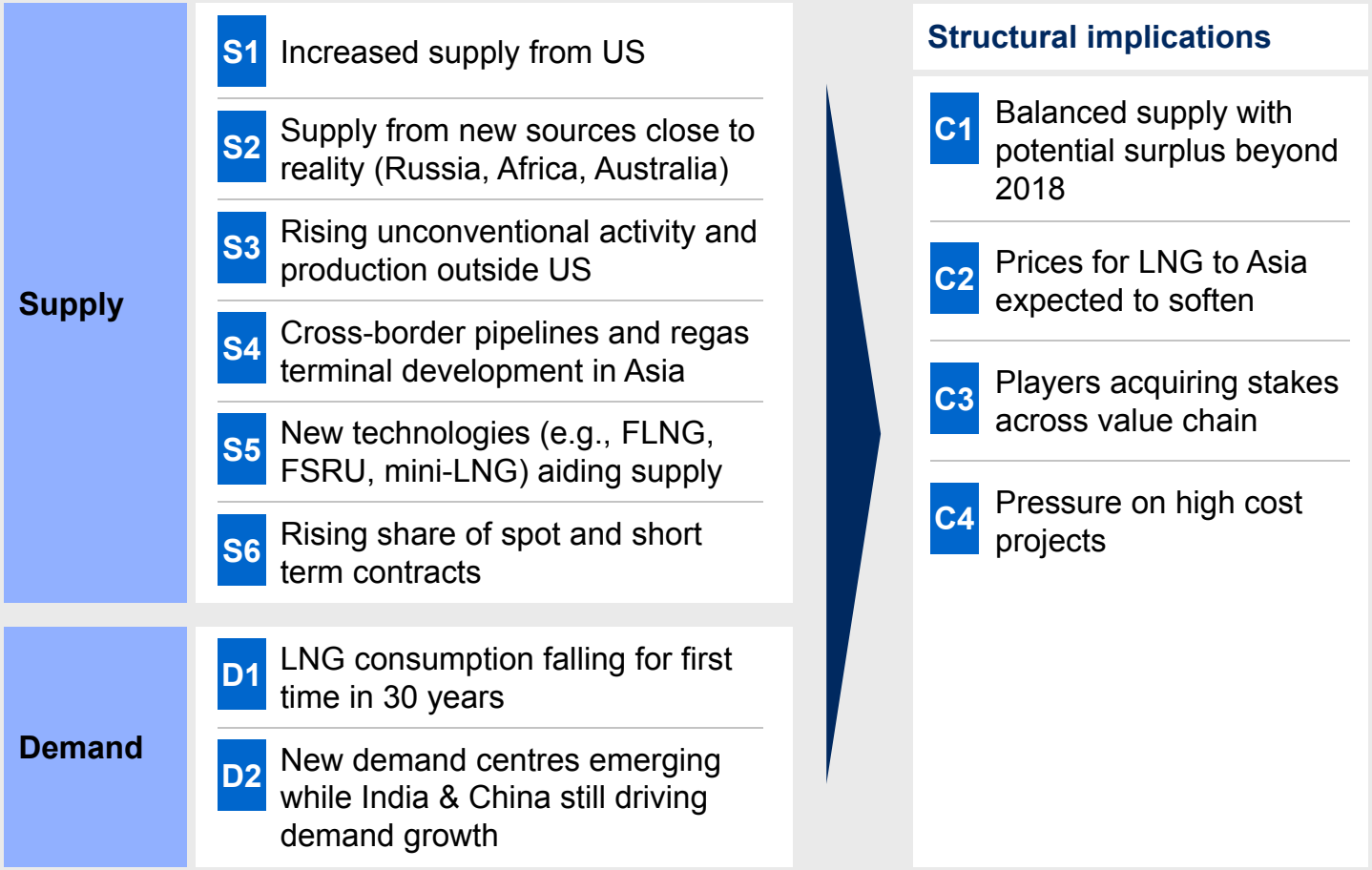
□ □ □

Our demand–supply forecasts indicate an industry in transition, with balanced supply in the medium term, and a potential surplus beyond 5 years. Partnerships across stakeholders can help unlock demand, while addressing key industry concerns on affordability and offtake. An Asia Gas Partnership Forum can facilitate a variety of partnerships and provide an institutional underpinning to this vibrant industry.

Chapter 1

The world of gas has changed

The world of gas has changed



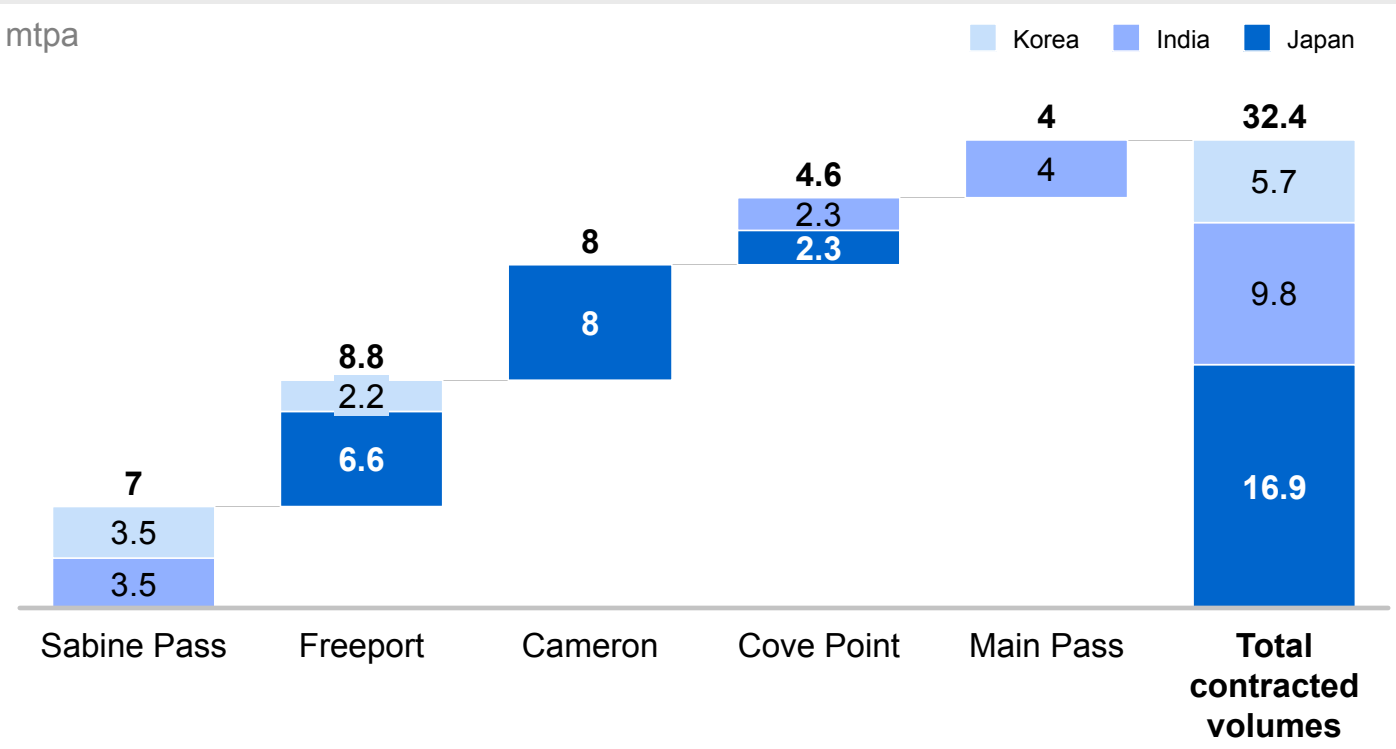
SOURCE: McKinsey analysis

The world of gas has changed in the last few years, with many previously anticipated changes in supply, demand and technology becoming a reality. A large amount of gas is now becoming available to Asia from newer sources via different pricing mechanisms. Global LNG consumption fell for the first time in 3 decades, even though demand has continued to grow in India and China, and new demand centers have started to emerge in Asia and the Middle East. As a result, the industry is going through a discontinuity.

Asia has begun to experience multiple discontinuities in supply. The most significant change has been the increase in LNG sourcing from North America to Asia. Asian buyers have contracted over 32 mtpa from the US in the last 3 years.

S1 Substantial volumes of North American gas have already been contracted to Asia

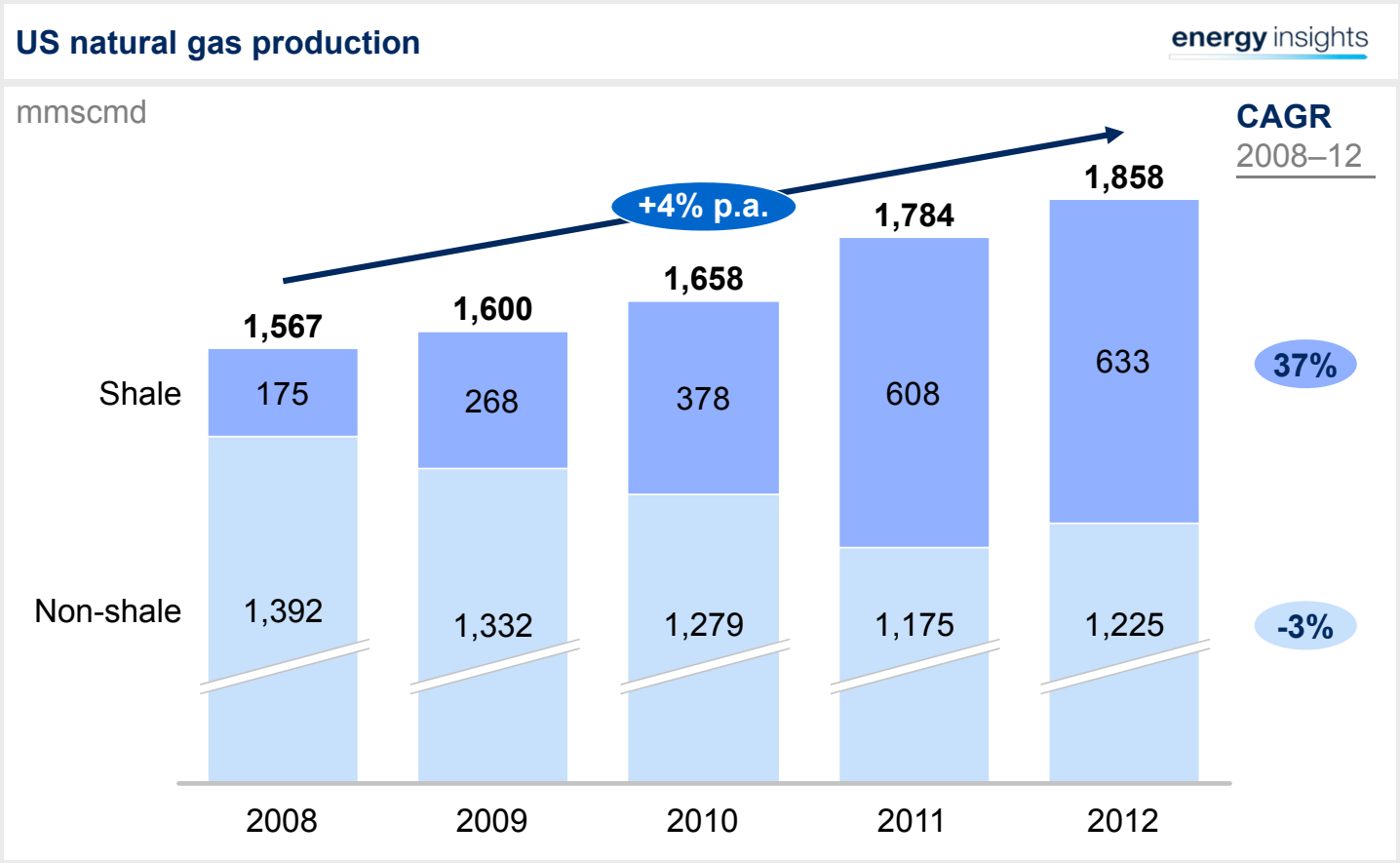
Contracted and HOA volumes from US LNG export terminals to Asia[1], 2011–2013



1 Canadian projects have not signed any contracts

SOURCE: Company websites; press releases; company presentations

S1 US shale gas production has grown rapidly



SOURCE: Energy Insights

US gas production continues to increase. This is driven by shale, whose production grew at a rapid CAGR of 37 per cent between 2008 and 2012. Shale now accounts for over a third of US gas production.

The uncertainty about exports to non-FTA countries from North America has significantly reduced, with 6 new terminals approved for non-FTA exports over the last 2 years. The speed of new approvals has been somewhat faster than industry expectations.

S1 Approvals for export terminals have accelerated

A Approved for all counties
F Approved for FTA[1] countries

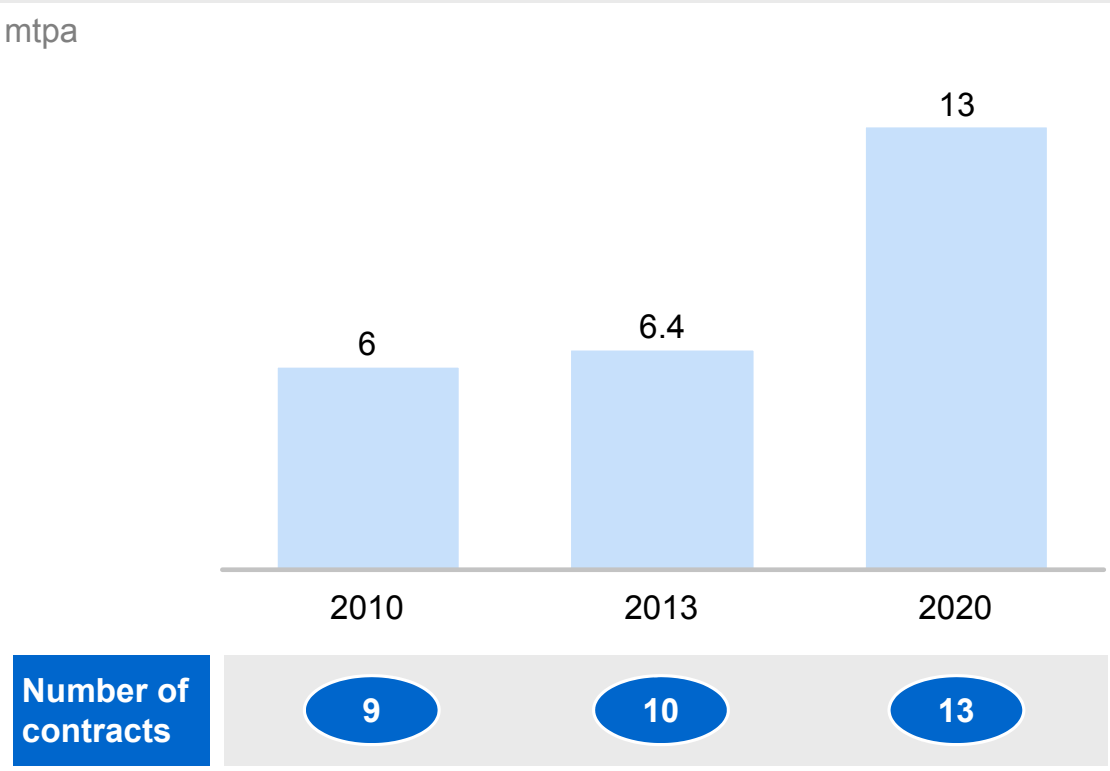
	North America proposed LNG export facilities	Initial capacity mtpa	Licence status 2011	2013
Brown-field	Sabine Pass	16.7	A	A
	Freeport-I	10.6	F	A
	Lake Charles	15.2	F	A
	Cove Point	6.1	F	A
	Freeport-II	10.6	Applied	A
	Cameron	12.9	Applied	F
	Elba Island	3.8		F
	Gulf LNG	11.4		F
	Golden Pass	19.8		F
Green-field	Kitimat LNG	9.8	A	A
	Douglas Channel	0.9	Applied	A
	LNG Canada	24.3	Proposed	A
	Brownsville	21.3		F
	Jordan Cove	9.1	F	F
	Oregon LNG	9.9		F
	Corpus Christi	16.0		F
	Lavaca Bay	10.6		F
	Cambridge (floating)	8.4		F
	South Texas LNG (floating)	8.4		F
	Main Pass Energy Hub (floating)	24.3		F
	Pacific Northwest LNG	12.0		Applied
	West Coast LNG	21.6		Applied

1 Free trade agreement

SOURCE: U.S. Department of Energy; National Energy Board Canada; International Group of LNG importers; McKinsey analysis

S2 Russian gas is becoming available to Asia

Cumulative contracted volumes from Russia to Asia



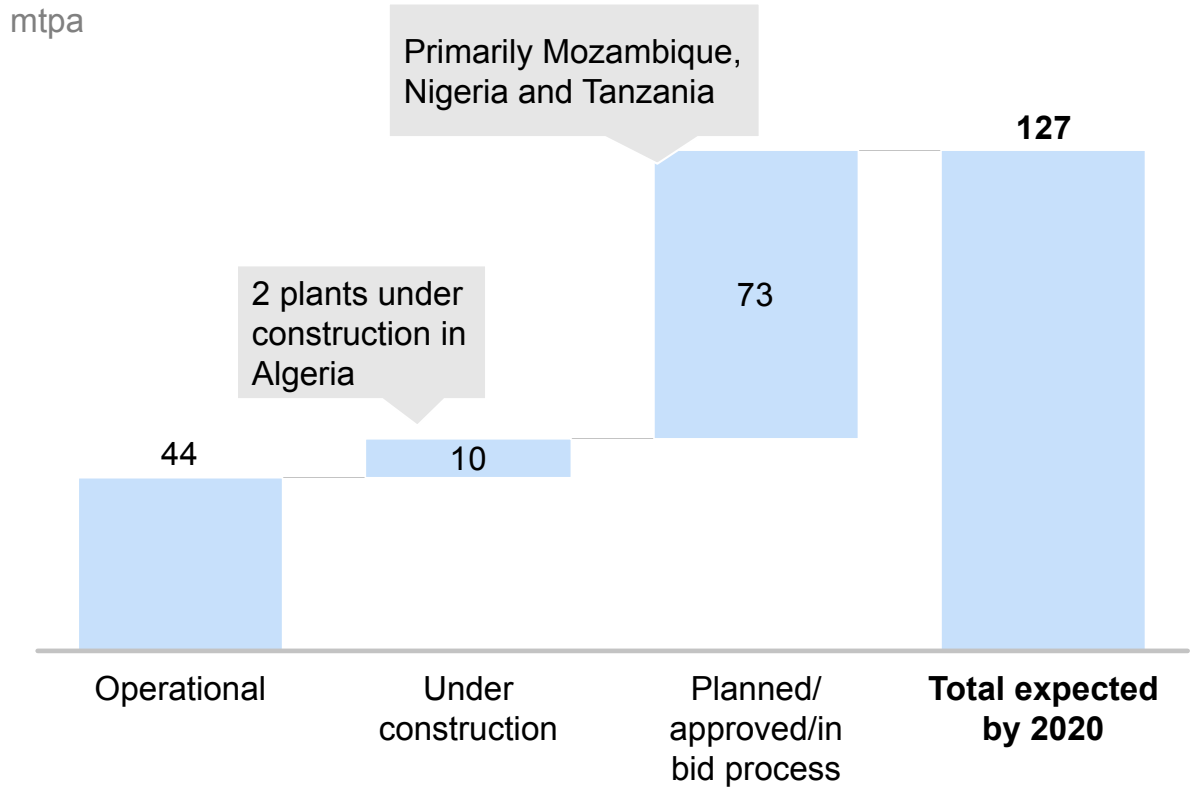
SOURCE: Drewry; GIIGNL; Cedigaz; literature search; McKinsey analysis

Gas from Russia is also gradually becoming available to Asia. As many as 13 deals have been signed, and these are expected to deliver over 13 mtpa by 2020.

Liquefaction capacity in Africa will nearly triple by 2020. Over 73 mtpa in capacity additions are planned, primarily in Mozambique, Tanzania and Nigeria, and 9 mtpa is under construction in Algeria.

S2 New export capacity in Africa has been planned

Africa liquefaction capacity status

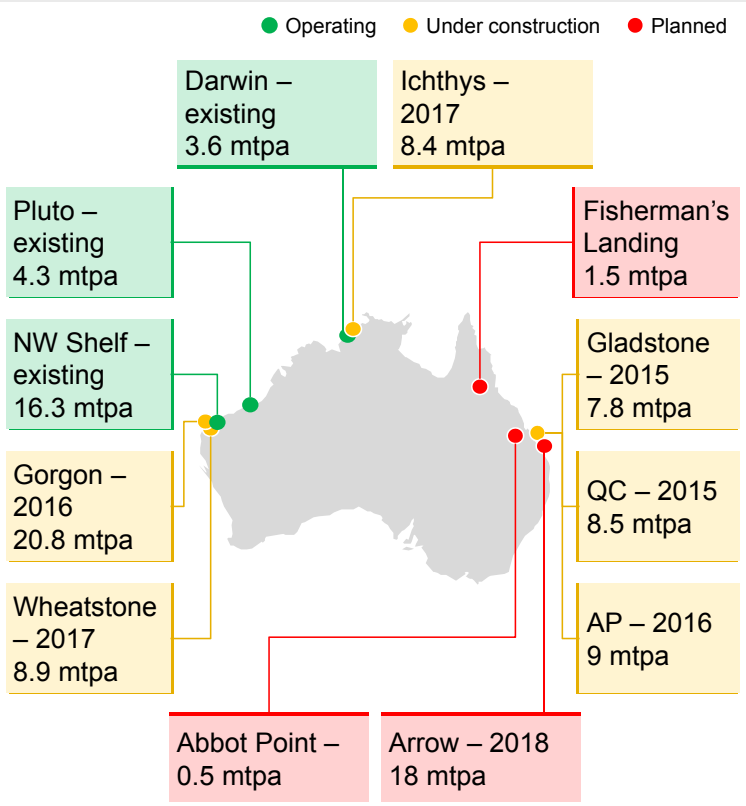


SOURCE: Energy Insights; BG website; McKinsey analysis

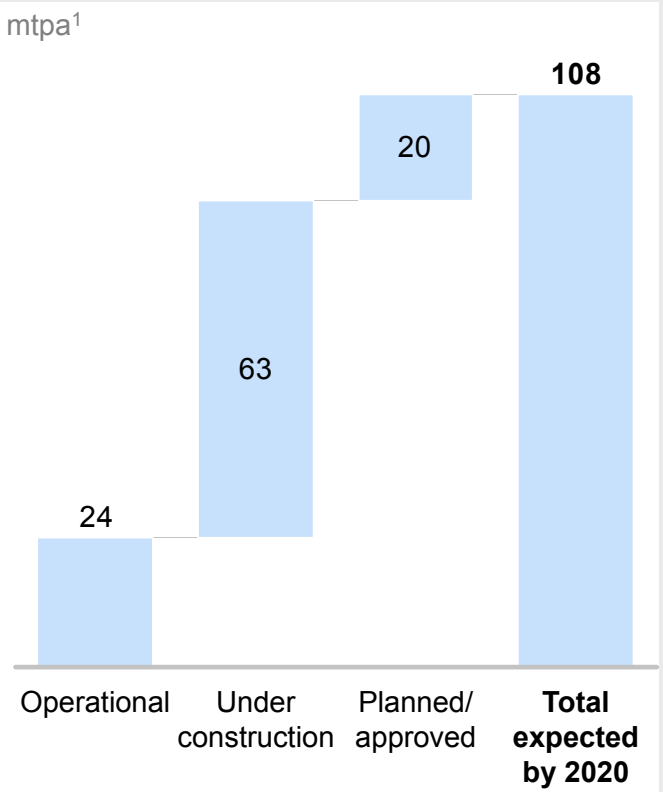
S2 Australian supply projects are progressing

Over 108 mtpa of onshore Australian LNG is expected to come onstream by 2020, but at high breakeven costs. Many projects are also experiencing time and cost overruns.

Map of onshore Australian LNG projects[1]



Project status

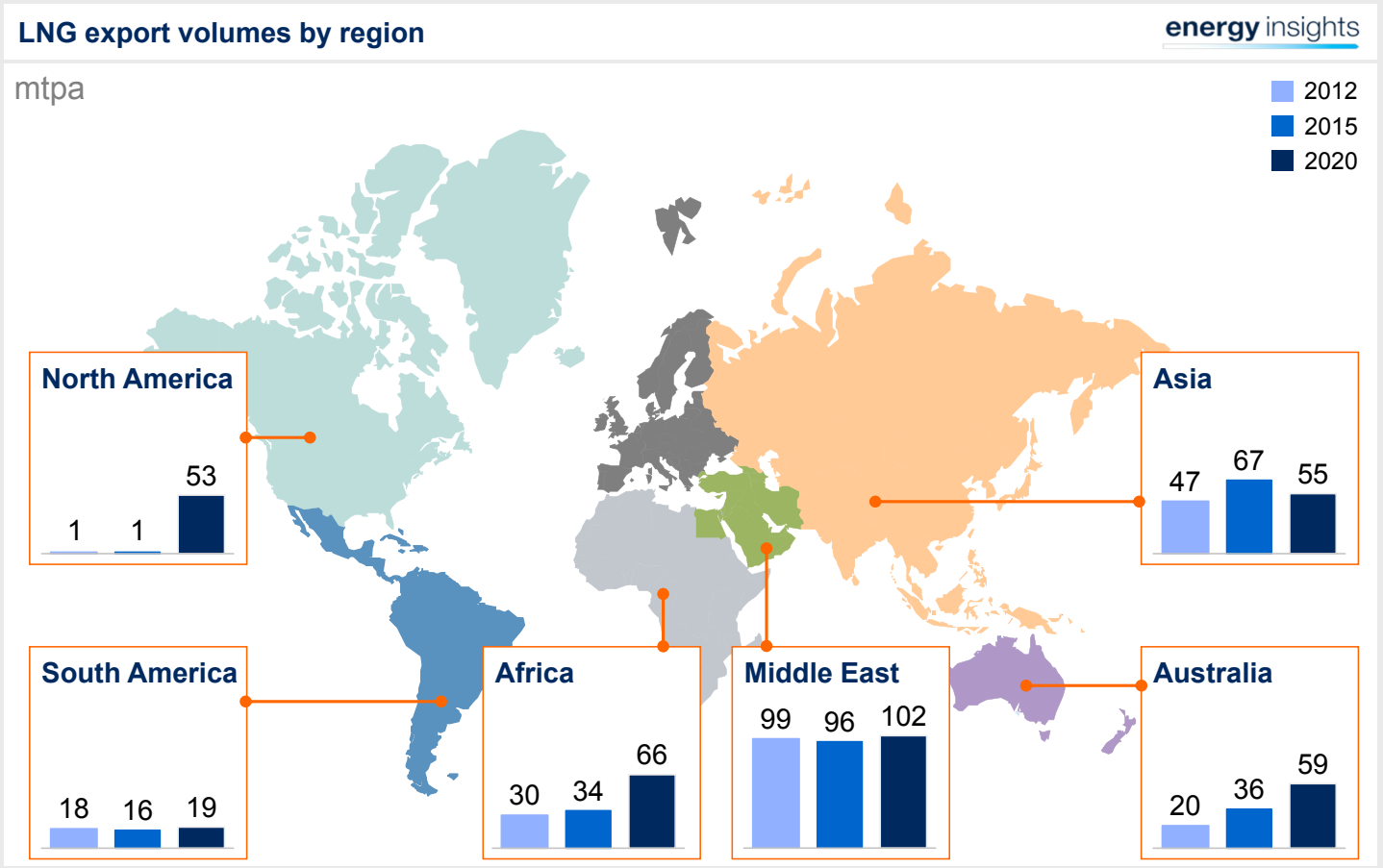


1 Excludes 5 FLNG projects of total 18.1 mtpa (Prelude, Greater Sunrise, Bonaparte, Scarborough and Tassie)

SOURCE: Enerdata; literature search; McKinsey analysis

Exports from North America, Africa, Australia and the Middle East are expected to rise significantly.

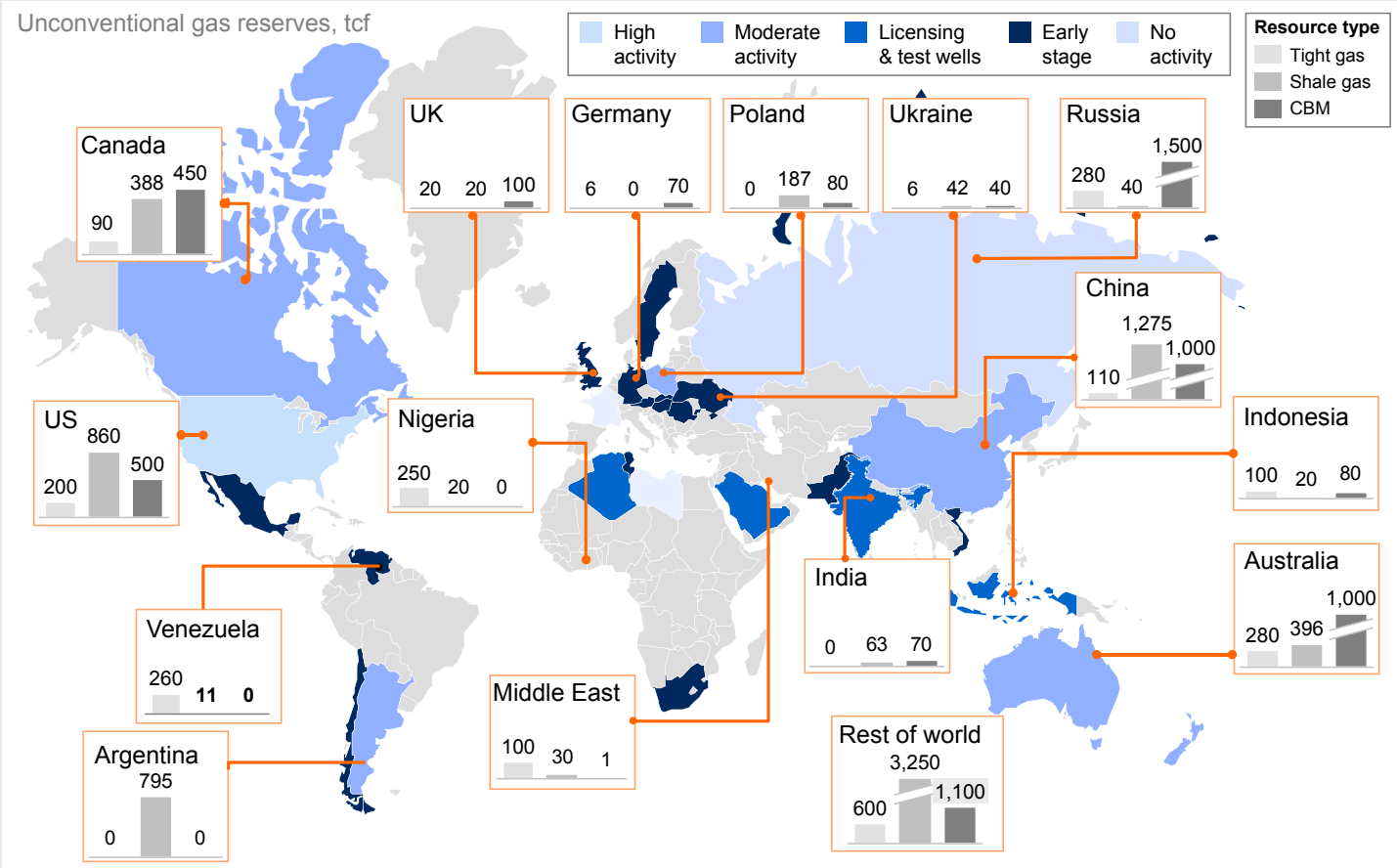
S3 Overall, global LNG volumes are expected to rise significantly



SOURCE: Energy Insights

S3

The development of unconventional reserves outside North America has picked up pace



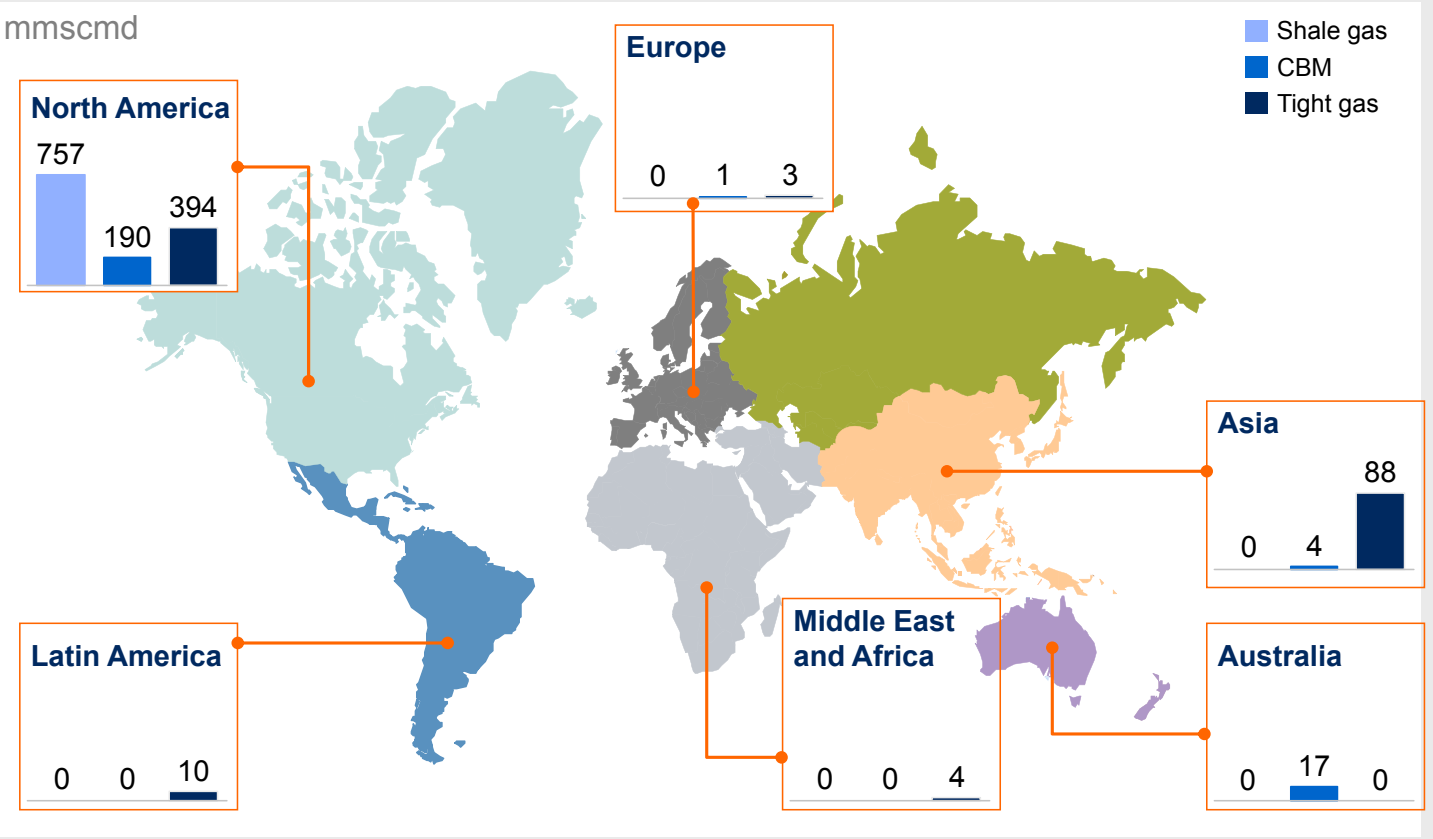
SOURCE: EIA report on World Shale Gas Resources 2011; World Energy Outlook 2013 © OECD/IEA 2013, Advanced Resources International; USGS; IHS Herald; H-H Rodger; Fox-Davis Capital; Wood MacKenzie; McKinsey analysis

Shale gas production continues to grow at a rate of 37 per cent in the US. Meanwhile, countries like India and China, who are large importers of LNG, have also started to develop unconventional gas reserves, including shale, CBM, and other tight gas.

Efforts to develop unconventional reserves have started showing early results outside North America. Production has been growing, especially for CBM and tight gas.

S3 Unconventional production is beginning across the world, especially for CBM and tight gas

Unconventional gas production, 2012



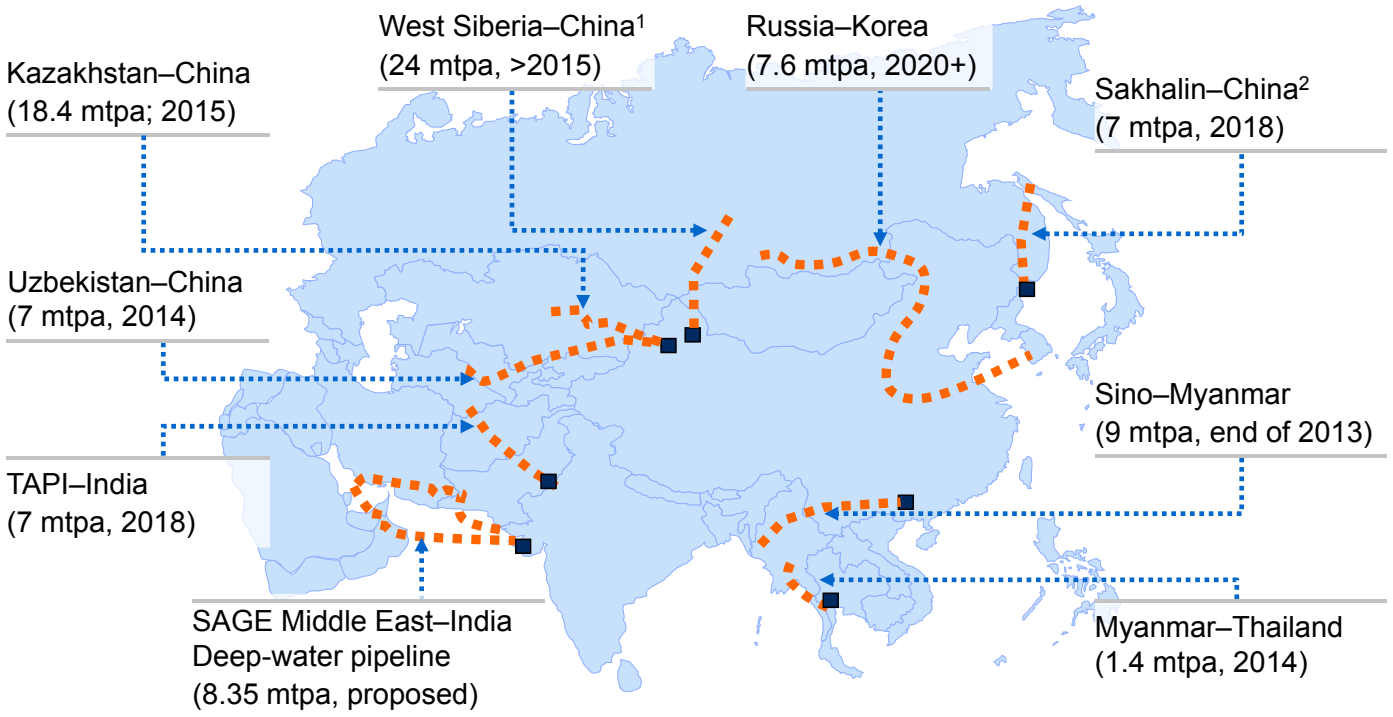
SOURCE: Rystad Energy; McKinsey analysis

S4

Transnational gas pipelines into China and India are progressing

Cross border gas pipe planned or under construction (capacity, start date)

Transnational pipelines in Asia



Asian gas grid, connecting Iran, Myanmar, Bangladesh, India, China and Pakistan, is under discussion

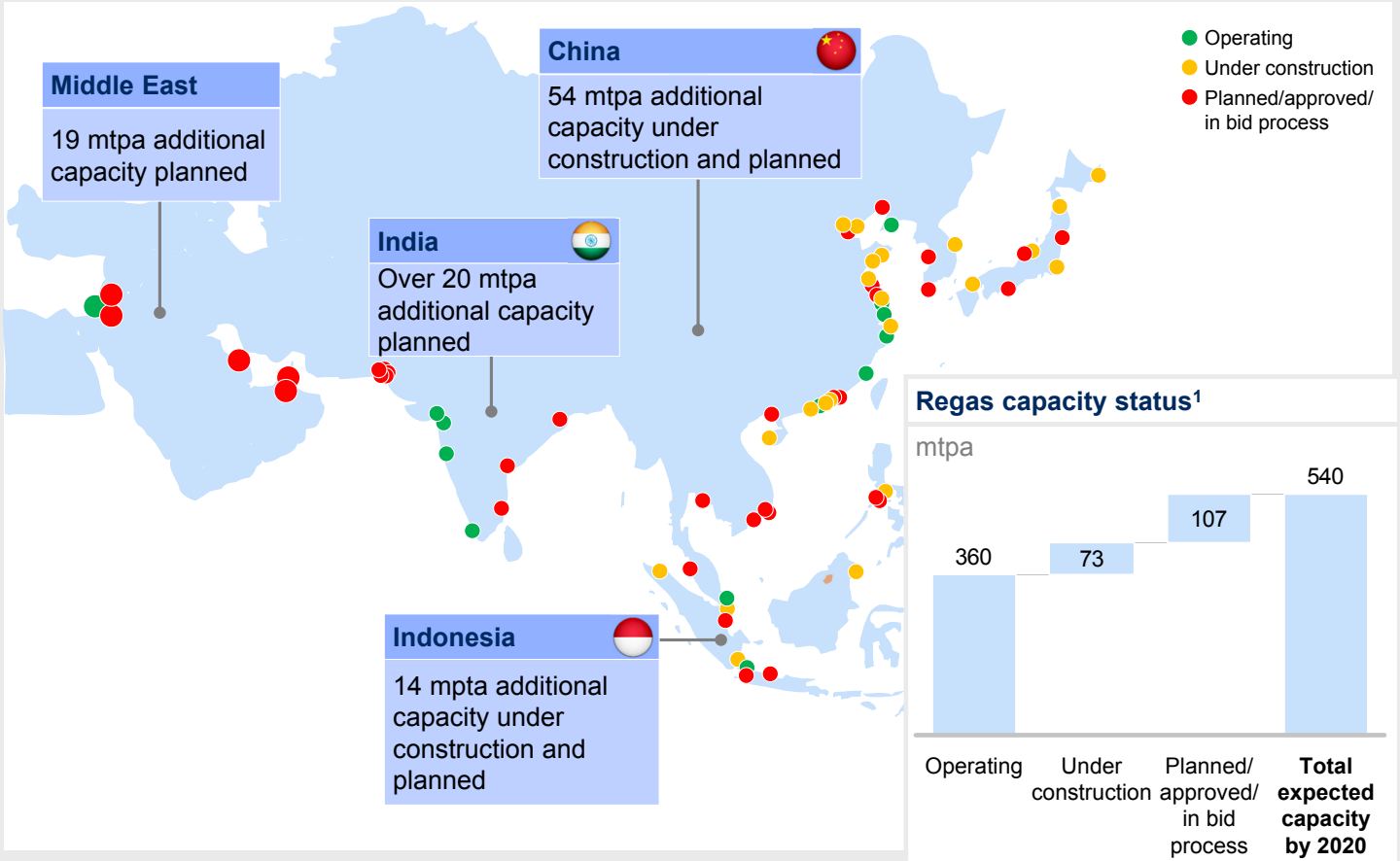
1 Project currently on hold
2 Sakhalin–China pipe is confirmed and under construction

SOURCE: International Energy Agency; OGJ; literature search; FACTS

As Asian countries explore all means to secure supply and reduce gas costs, cross border pipelines are being developed across the region. This supply will compete with LNG. Even pipelines that are still on the drawing board will increase bargaining power for importers of LNG.

New regasification terminals being developed across Asia and the Middle East will facilitate imports. The total regasification capacity is expected to go up from the current 360 mtpa to an estimated 540 mtpa by 2020.

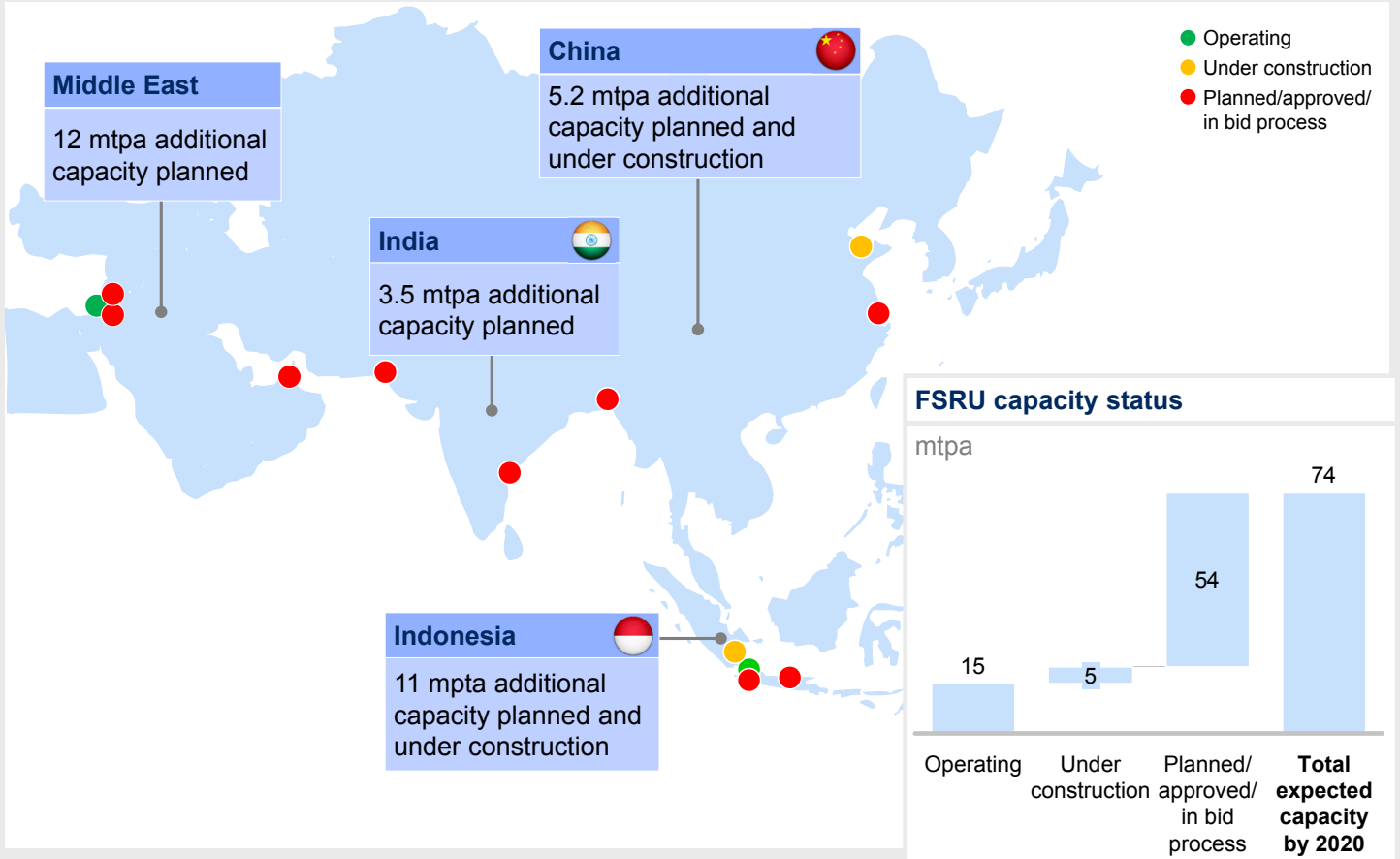
S4 Regasification terminals are being developed across the Asian coastline



1 Includes FSRUs

SOURCE: Enerdata; Planning Commission of India; literature search; McKinsey analysis

S5 FSRUs are making rapid inroads in Asia



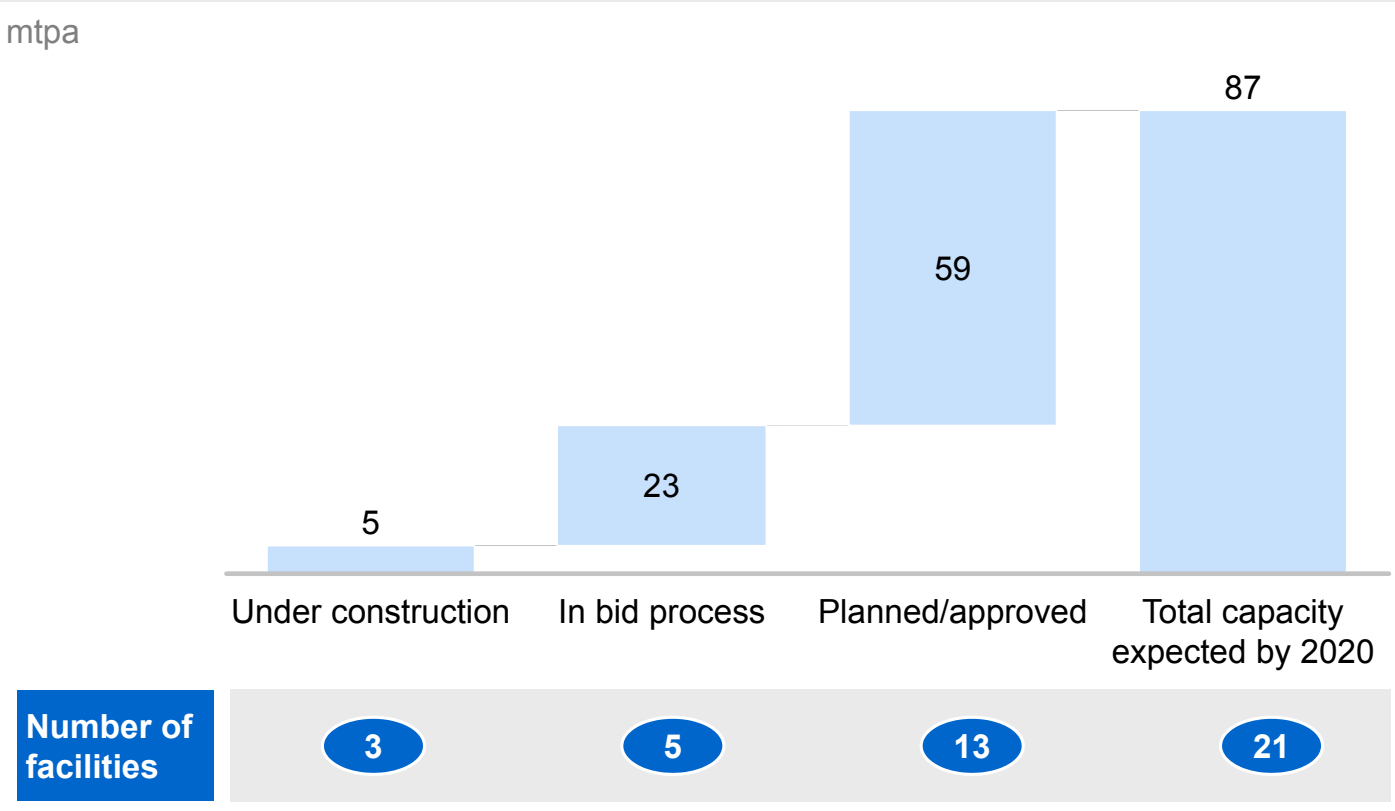
SOURCE: Enerdata; Planning Commission of India; literature search; McKinsey analysis

The increasing adoption of new technologies is also driving the development of the gas market. Floating storage and regasification (FSRU) capacity is expected to grow to over 74 mtpa in Asia by 2020, and will enable faster access to LNG.

Floating liquefaction technology is also being deployed widely. 21 projects are underway across the world and are expected to add over 87 mtpa of liquefaction capacity.

S5 Floating liquefaction projects are also opening up new areas of supply

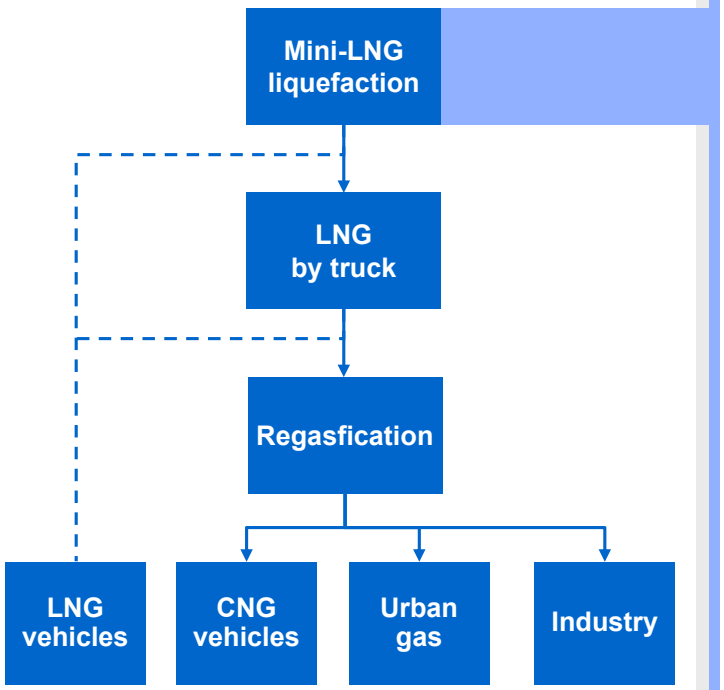
Floating liquefaction capacity



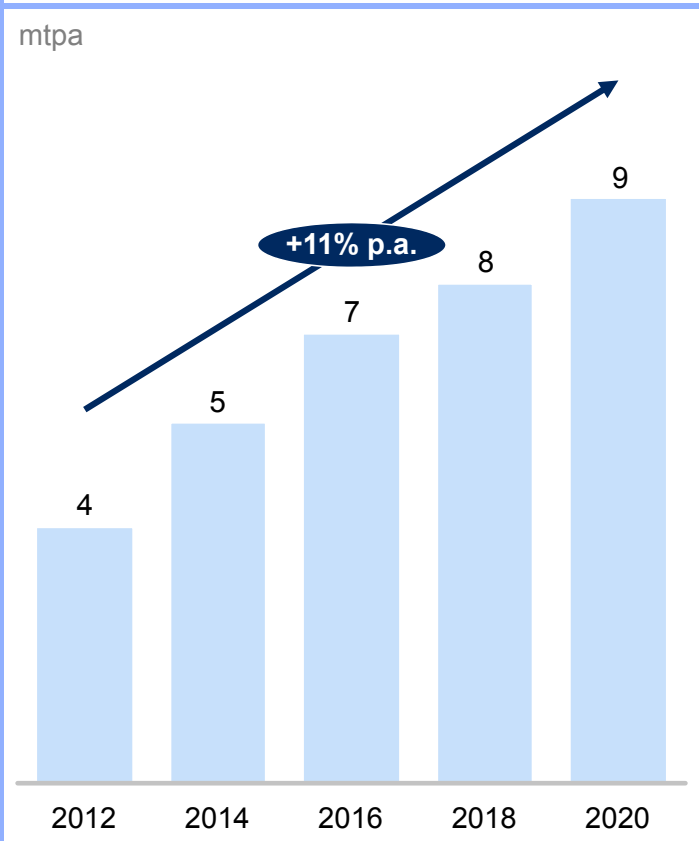
SOURCE: Enerdata; McKinsey analysis

S5 Mini-LNG is unlocking inland demand – China example

Mini-LNG value chain



Production from mini LNG liquefaction terminals



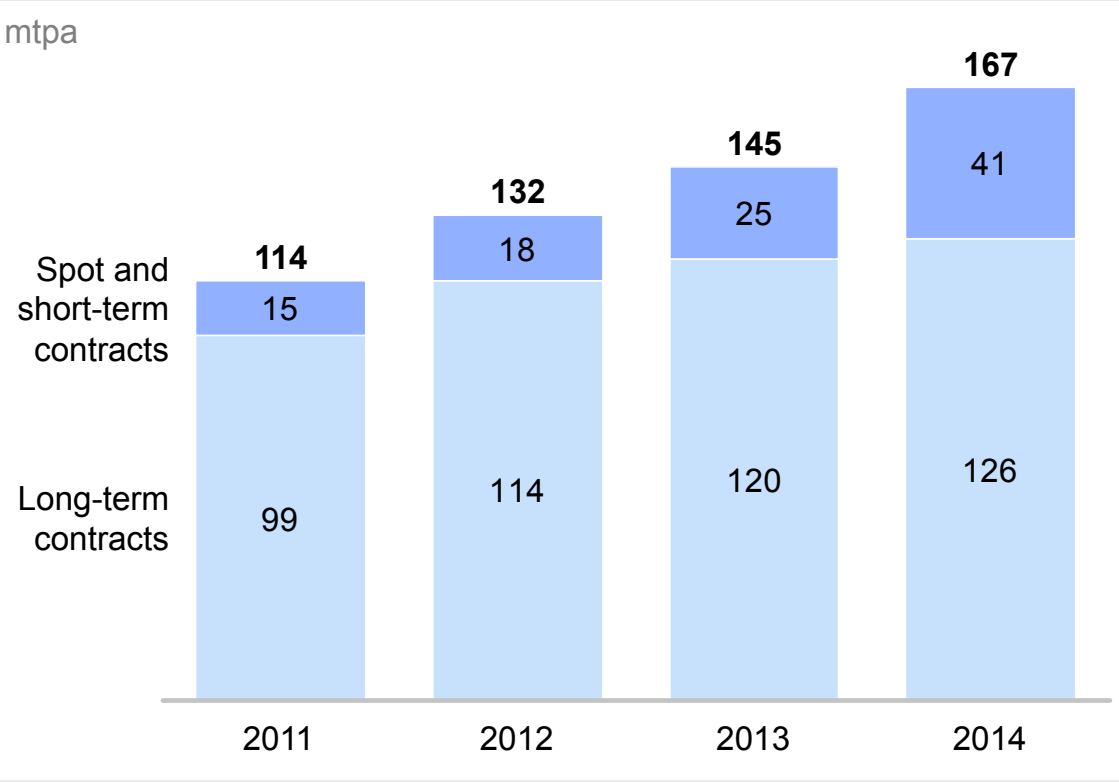
SOURCE: BHI; McKinsey analysis

Mini-LNG is unlocking inland demand in several countries. In China, for example, production from liquefaction terminals is expected to double by 2020. LNG transported by truck to small regasification facilities, as far as 1000 to 2000 km inland, is being used to fuel vehicles, domestic consumers and industry.

The depth of Asia's spot and short term market in LNG has been growing steadily, and is now a quarter of all imports. This provides buyers with greater flexibility and opportunities to create value through trading, relative to a few years ago.

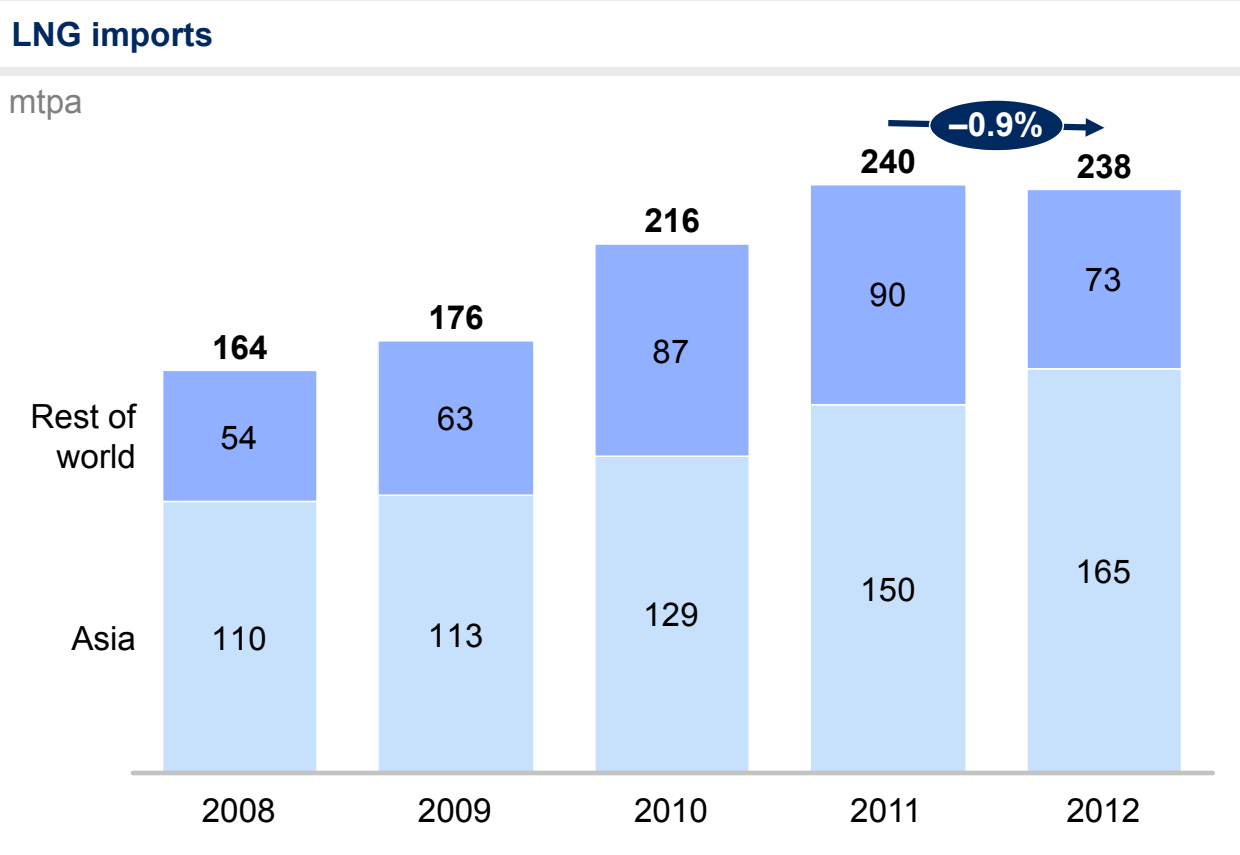
S6 The share of spot and short-term volumes is increasing

Asia LNG imports



SOURCE: GIIGN; IGU; McKinsey analysis

D1 Asian LNG demand is growing while demand in the rest of the world is shrinking



SOURCE: BP Statistical Review 2009–2013

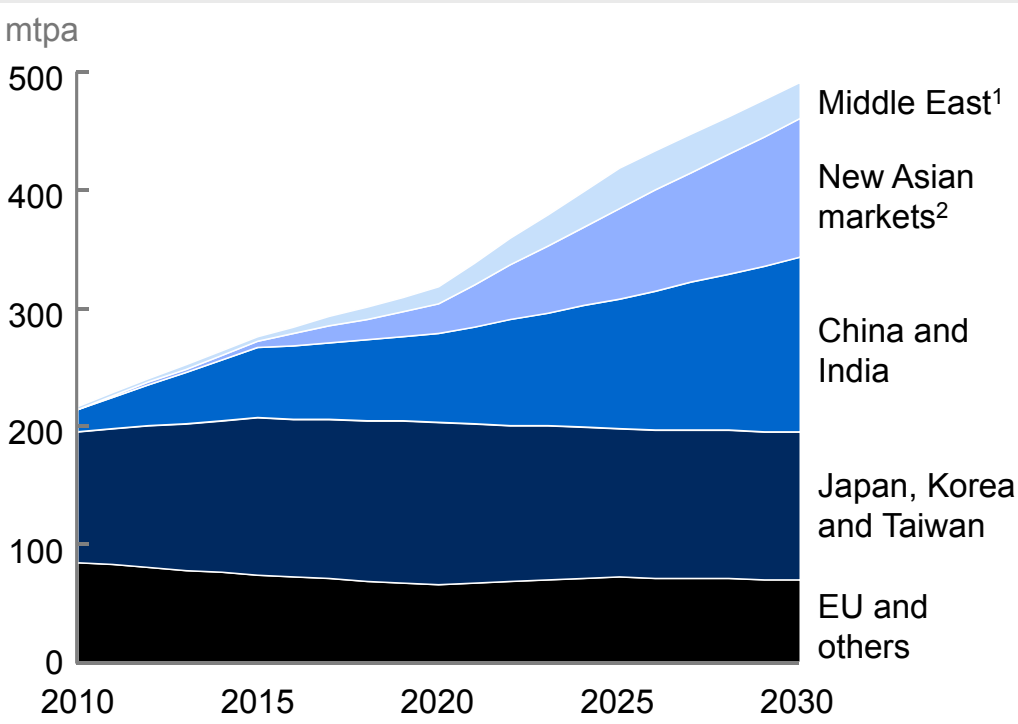
Asia continues to establish its position in the global LNG market. Its demand increased by 10 per cent between 2011 and 2012, while demand from the rest of the world fell by 19 per cent.

Volume growth in Asia continues to be promising. In addition to stable demand from traditional markets like Japan, Korea and Taiwan, and higher than expected growth from China and India, a number of new smaller markets are also emerging as demand centres. These include importers like Singapore, Thailand, Philippines, Bangladesh and Pakistan in Asia, and Dubai, Kuwait, Israel and Bahrain in the Middle East; and exporters/importers like Indonesia and Malaysia.

D2 India, China and new geographies are expected to drive future demand growth

Bottom-up modeled LNG demand – reference case

energy insights

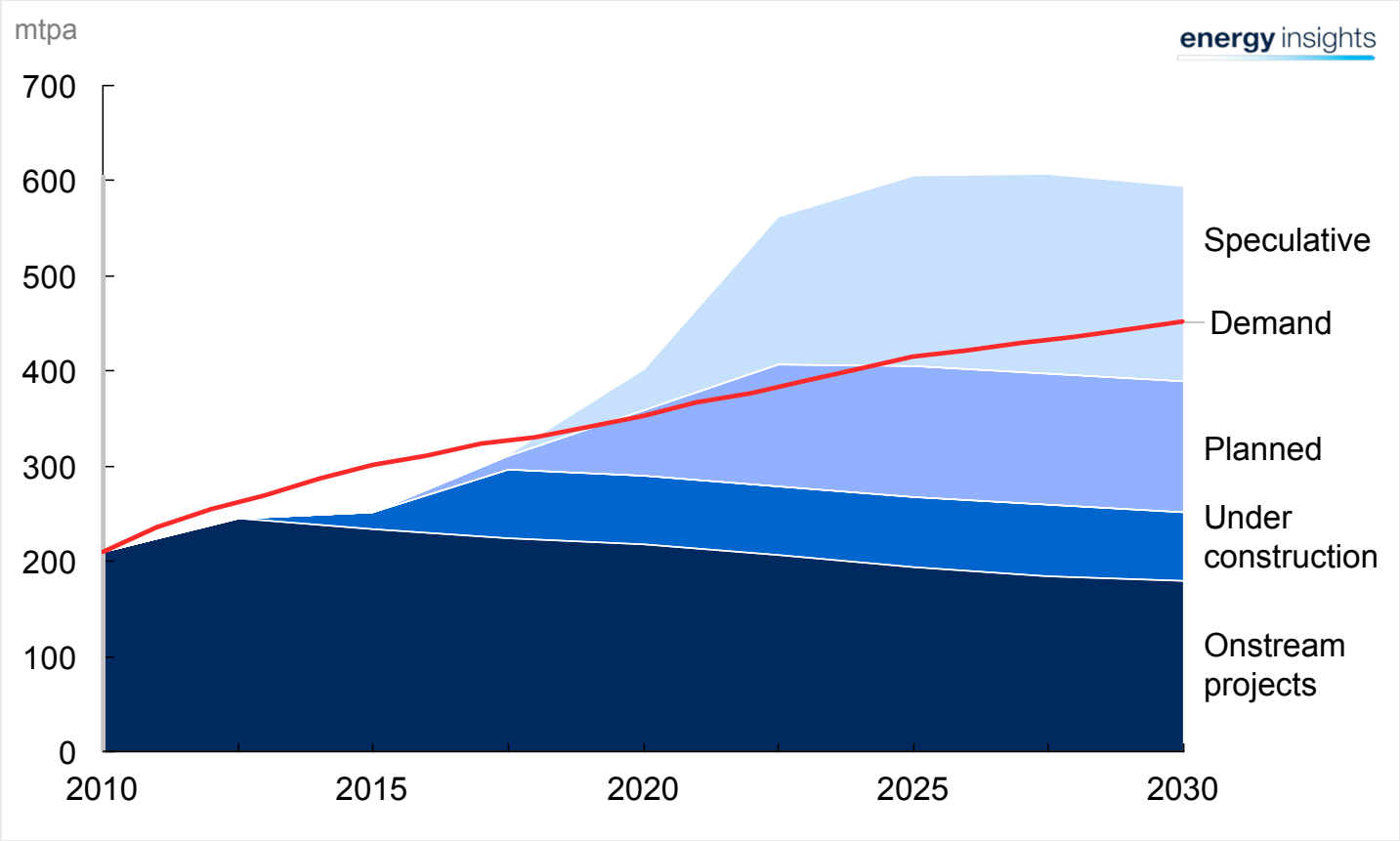


- **India and China to drive demand growth**
- **New demand centers emerging in South east Asia and Middle East**
- **Large and stable demand from Japan, Korea and Taiwan**

1 Middle East includes Saudi Arabia, Kuwait, Israel, Bahrain
2 New Asian markets include Singapore, Thailand, Indonesia, Malaysia, Bangladesh, Pakistan and Philippines

SOURCE: Energy Insights

C1 A consolidated supply and demand picture shows several planned and speculative projects beyond 2018



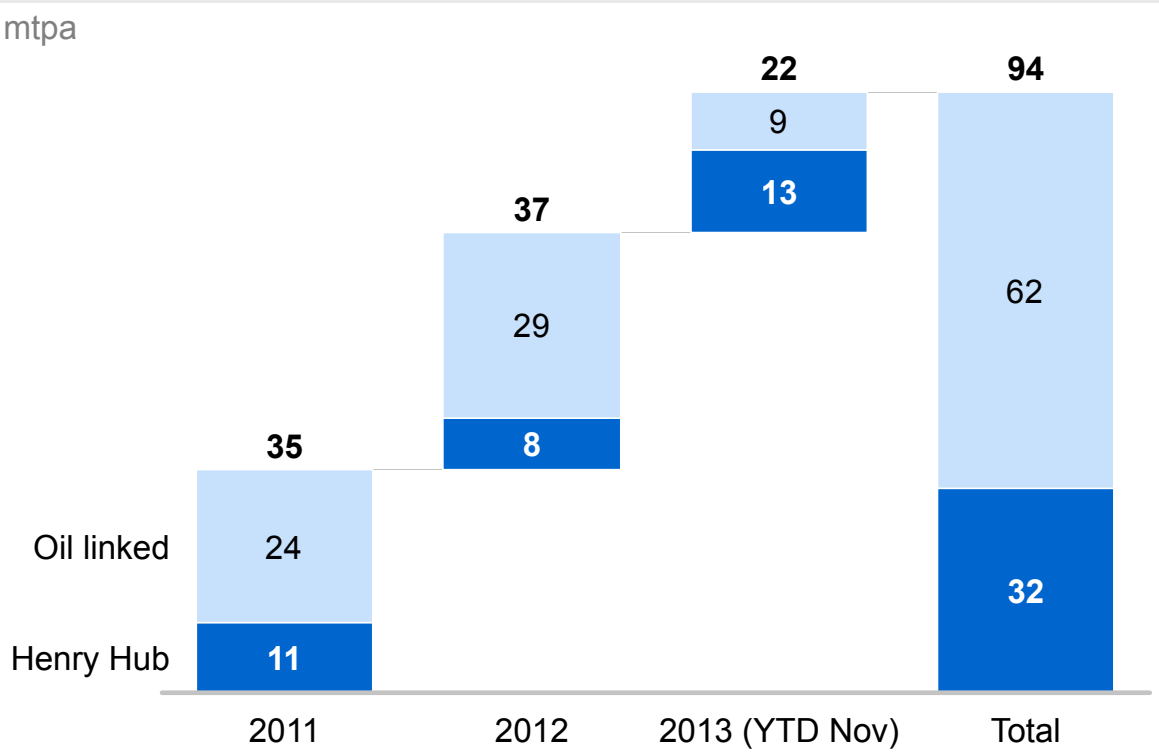
SOURCE: Energy Insights

The LNG market is currently tight and is expected to remain the same in the short term. However, a consolidated demand and supply picture shows several planned and speculative projects beyond 2018. Approximately 200 mtpa of additional LNG capacity is required to meet projected demand in 2030, but plans exist for twice this capacity.

An increasing number of Henry Hub-linked supply contracts is contributing to an softening price expectations in Asia.

C2 The growth in Henry Hub gas contracts is expected to soften prices in Asia

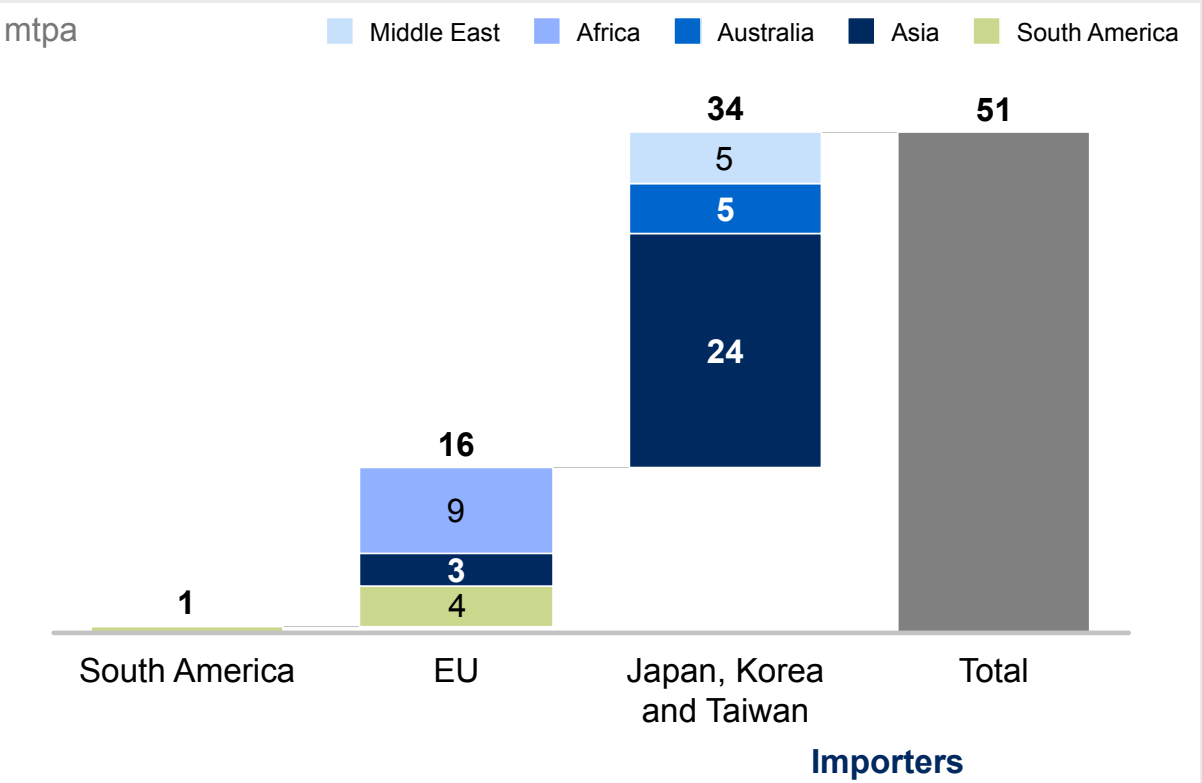
LNG contracts and heads of agreement (HOA) entered into by source



SOURCE: Cedigaz; GIIGNL; Drewry; Global Energy Monitor; Energy Insights

C2 A large number of traditional oil-linked contracts are coming up for renewal

LNG contracts expiring between 2015–2020 by source



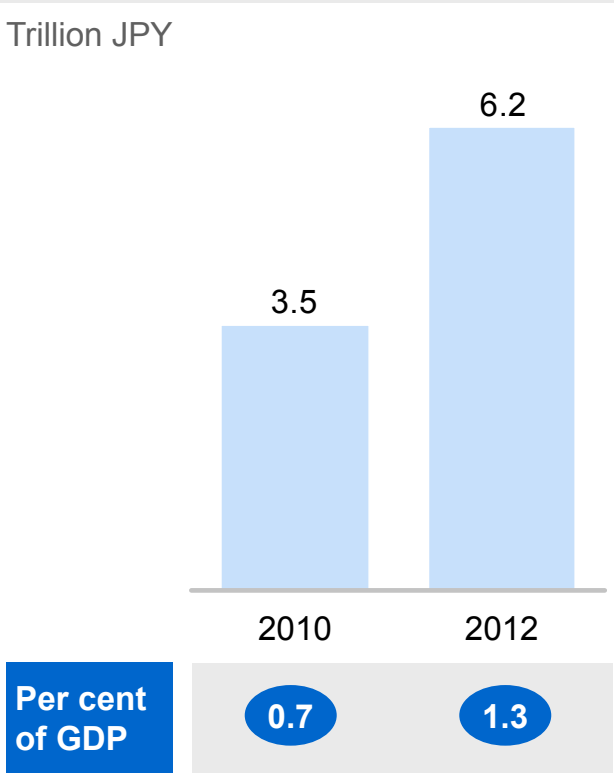
SOURCE: Cedigaz; McKinsey analysis

Further, buyers are expecting to renegotiate favorable terms for the substantial 51 mtpa of contracts that will come up for renewal between 2015 and 2020. Of these, 33 mtpa will be renewed between 2018 and 2020, coinciding with the expected supply surplus.

Japan's LNG imports shot up after Fukushima (a 24 per cent increase between 2010 and 2012), significantly increasing its energy bill. It is now actively looking to reduce its LNG import costs.

C2 Japan has started to make efforts to drive down LNG import prices

Japan LNG import cost



"High gas prices coupled with record demand in the wake of the Fukushima disaster are hurting Japan's trade balance….reducing LNG costs is a crucial policy issue for Japan right now"

– Head, Natural resources and energy agency, Japan

"North American projects will start shipping LNG as early as 2015. If their prices are lower, we may not buy expensive LNG"

– Head, Oil and Gas Department (Ministry of Industry), Japan

SOURCE: Energy Post; World Bank; Wall Street Journal; literature search

C3 Asian players are entering deals across the value chain

Asian players are investing in assets across the value chain to provide secure and hedged access to gas.

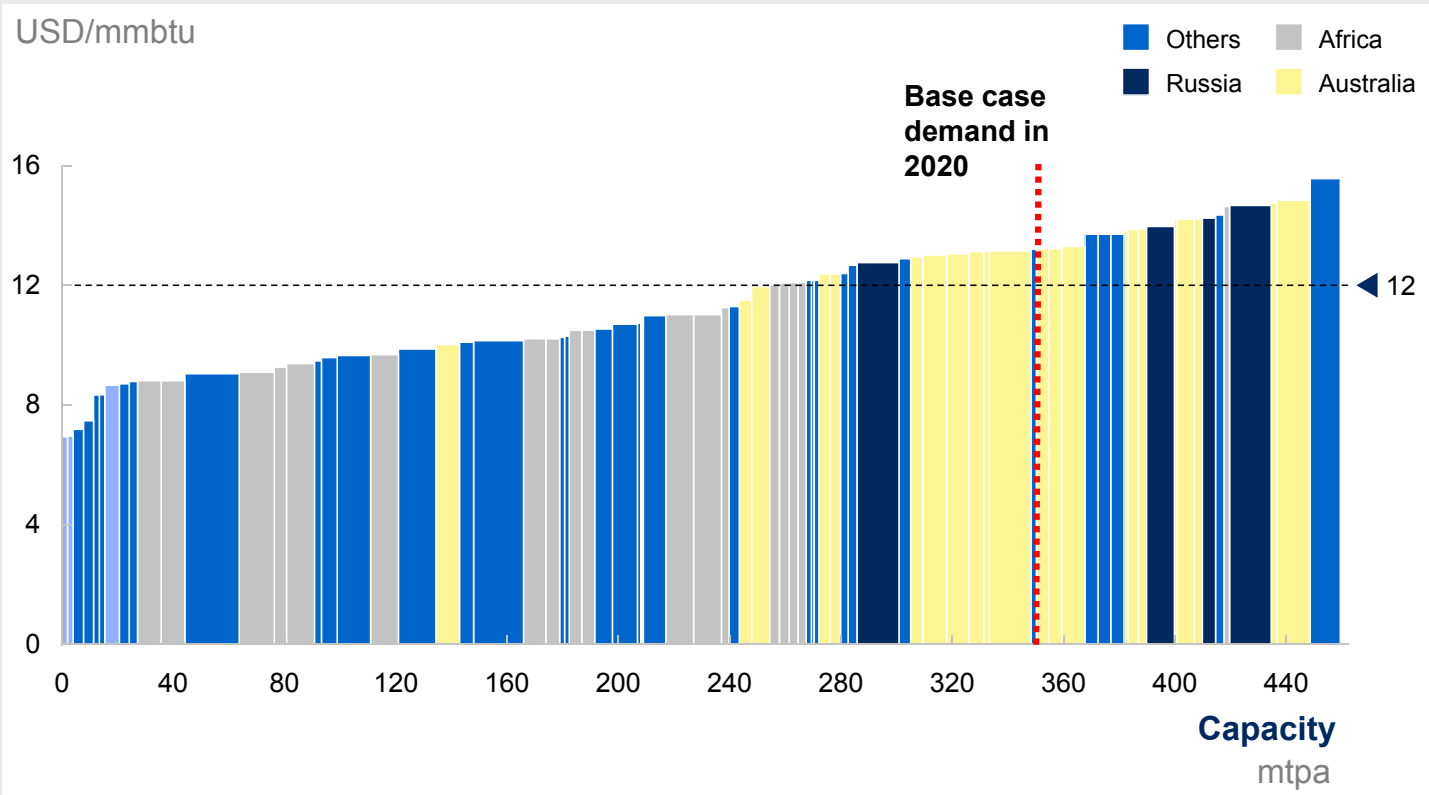
	Buyer	Seller	Deal Value USD million	Equity Per cent	Asset
Upstream	KOGAS	Encana	1,100	40	Horn River shale gas acreage
	Mitsibushi	Encana	2,900	40	Cutback shale gas
	CNPC	Shell	1,000	40	Groundbirch shale gas
	GAIL	Carrizo Oil and Gas	300	20	Eagleford basin shale gas
	Osaka Gas	Cabot Oil and Gas	250	25	Pearshall shale gas
	Reliance Industries Ltd.	Atlas Energy	1,700	40	Marcellus basin shale gas
	Reliance Industries Ltd.	Carrizo Oil and Gas	392	60	Marcellus basin shale gas
	ONGC Videsh Limited	Anadarko	2,640	10	Mozambique Rovuma offshore area 1 block
	ONGC Videsh Ltd and OIL	Videocon Industries Ltd.	2,475	10	Mozambique Rovuma offshore area 1 block
	CNPC	Eni	4,210	20	Mozambique Rovuma offshore area 4 block
	CNOOC	Nexen Inc.	15,100	100	Nexen Inc. acquisition
	Petronas	Progress Energy Resources Corp.	5,100	100	Progress Energy acquisition
LNG	CPC Corporation	INPEX Corporation	NA	3	Icthys LNG
	CNPC	Novatek	NA	20	Yamal LNG Project
	Marubeni Corporation	Rosneft	NA	NA	Russian Far East
	CNOOC	BG	NA	40	QCLNG Train 1

SOURCE: IHS Herald; literature search

A detailed assessment of all proposed LNG terminals and their breakeven costs suggests that new terminals will need to ensure cost competitiveness, especially if prices soften.

C4 New LNG terminals will need to ensure cost competitiveness

Breakeven price for incremental LNG supply



SOURCE: McKinsey Global Gas Model; Energy Insights

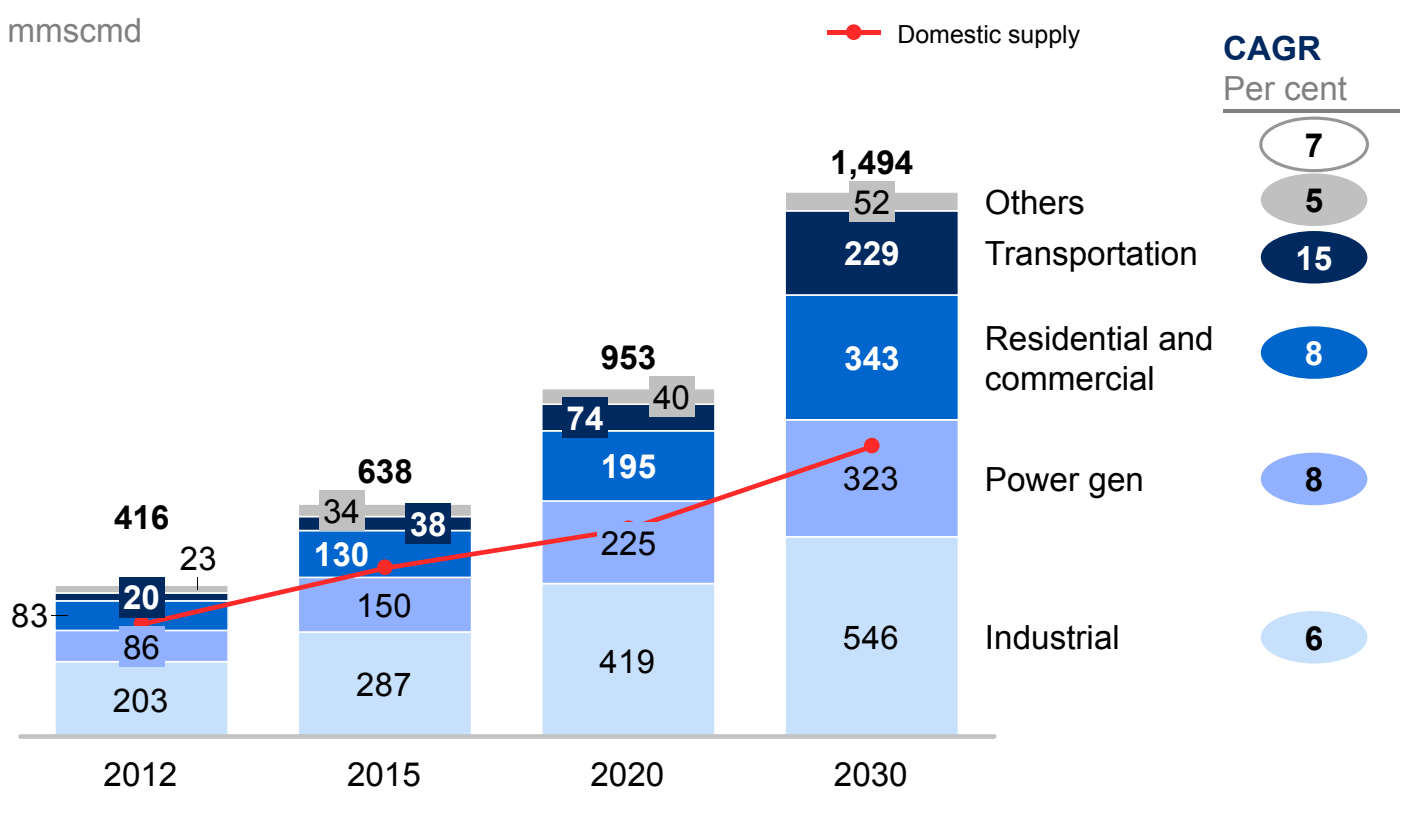
Chapter 2

Affordability and offtake remain concerns

Across most major markets in Asia, volume growth is expected to be strong. However, affordability is likely to be a challenge, given the prices of alternate fuels. In China, for example, demand is expected to continue to outstrip domestic gas supply.

High gas demand growth is expected in China

China gas supply and demand outlook

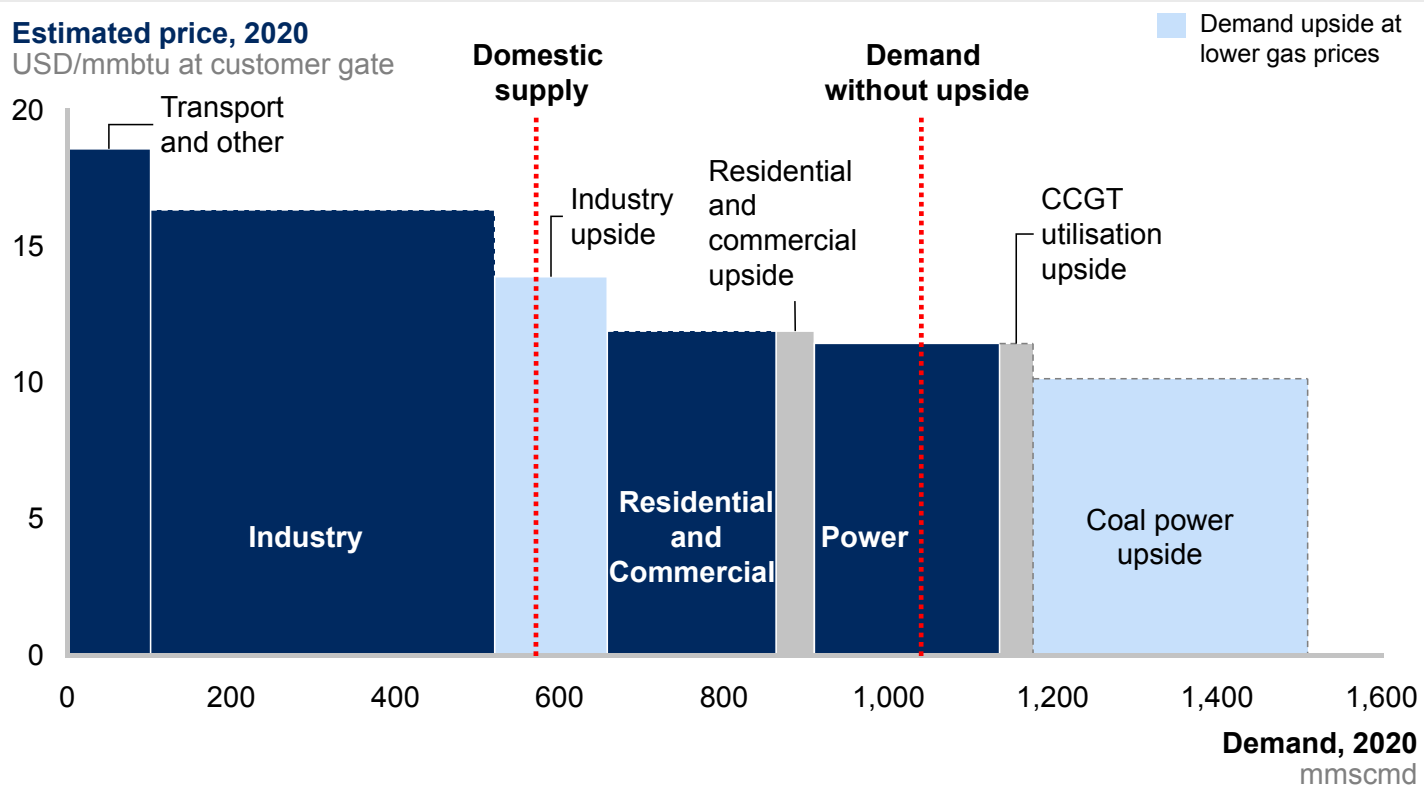


SOURCE: FACTS; Bernstein; IEA; CNPC; MLR (Ministry of Land and Resources of China); Energy Insights; China Gas Demand Model; Gas China 2013

Improving affordability can drive significant demand growth in China

China's gas demand has the potential to grow by an additional 140 mmscmd if affordability improves for industry. A further demand upside is also possible from the power sector if gas prices reduce further.

China demand curve



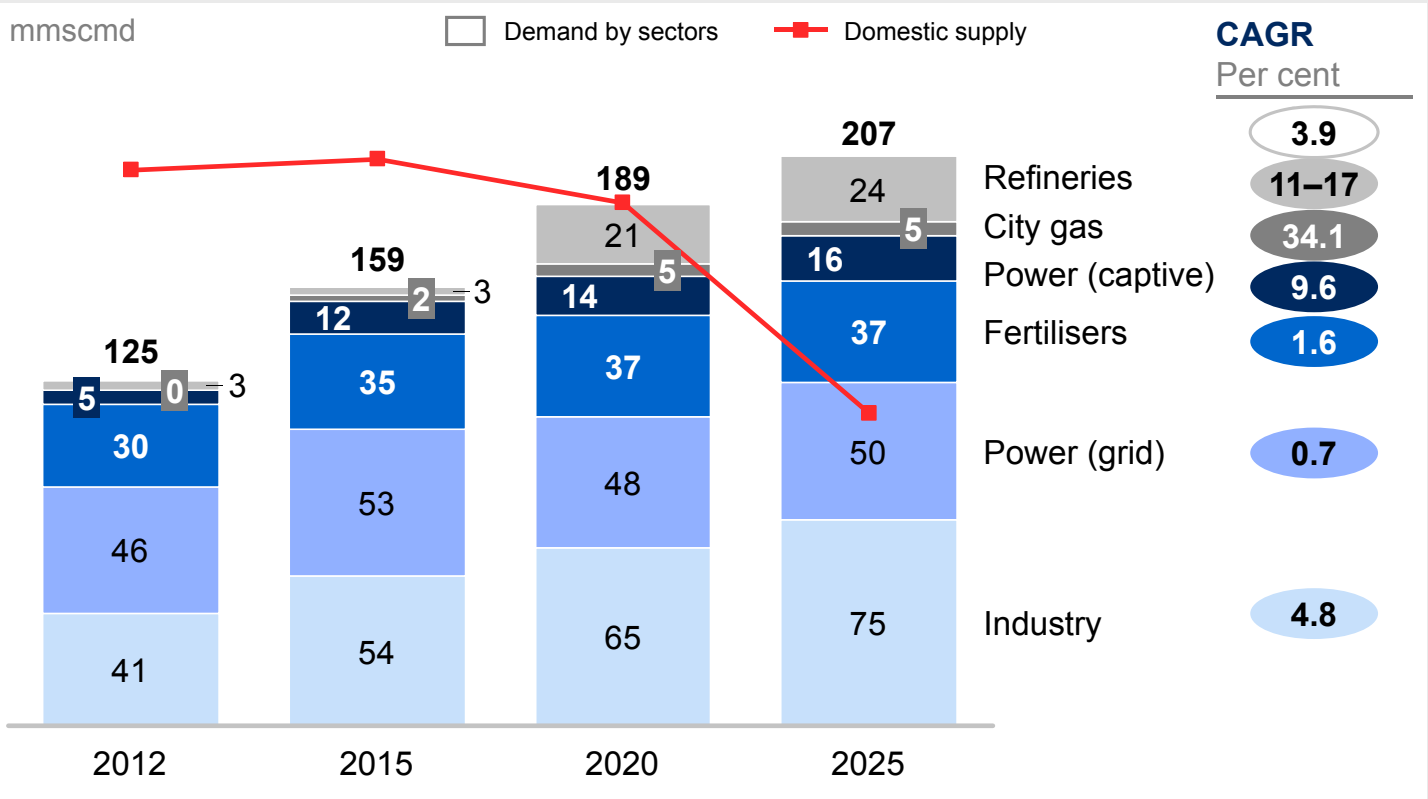
SOURCE: FACTS; Enerdata; CNPC; CEIC; NDRC; McKinsey analysis

Demand for gas in Indonesia is expected to grow at a CAGR of 4 per cent, driven primarily by the industrial sector. However, supply is expected to fall short by 2025, and this may turn the country into a net importer of gas.

Demand in Indonesia is expected to grow, largely driven by industry

mmscmd

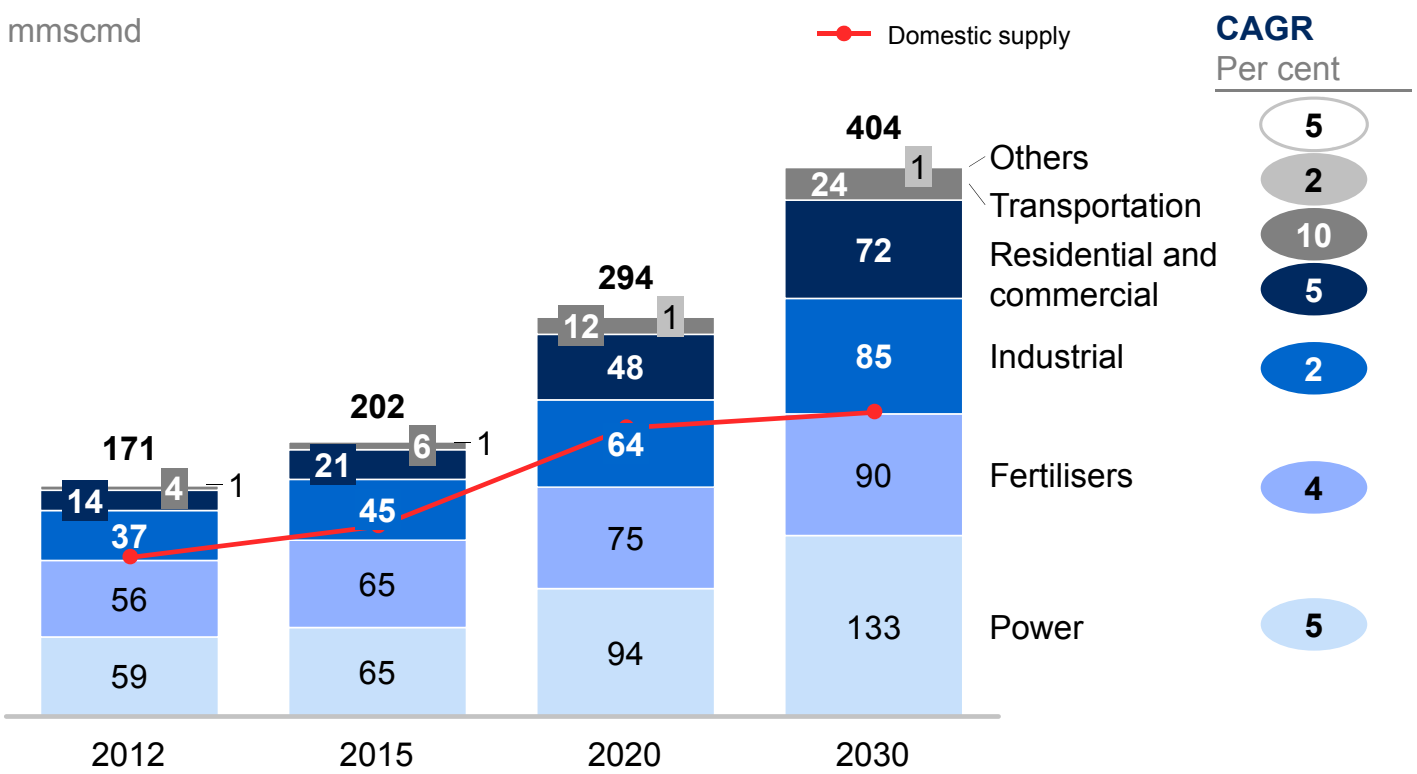
Indonesia gas supply and demand outlook



SOURCE: McKinsey analysis

High gas demand growth is expected in India

India gas supply and demand scenario

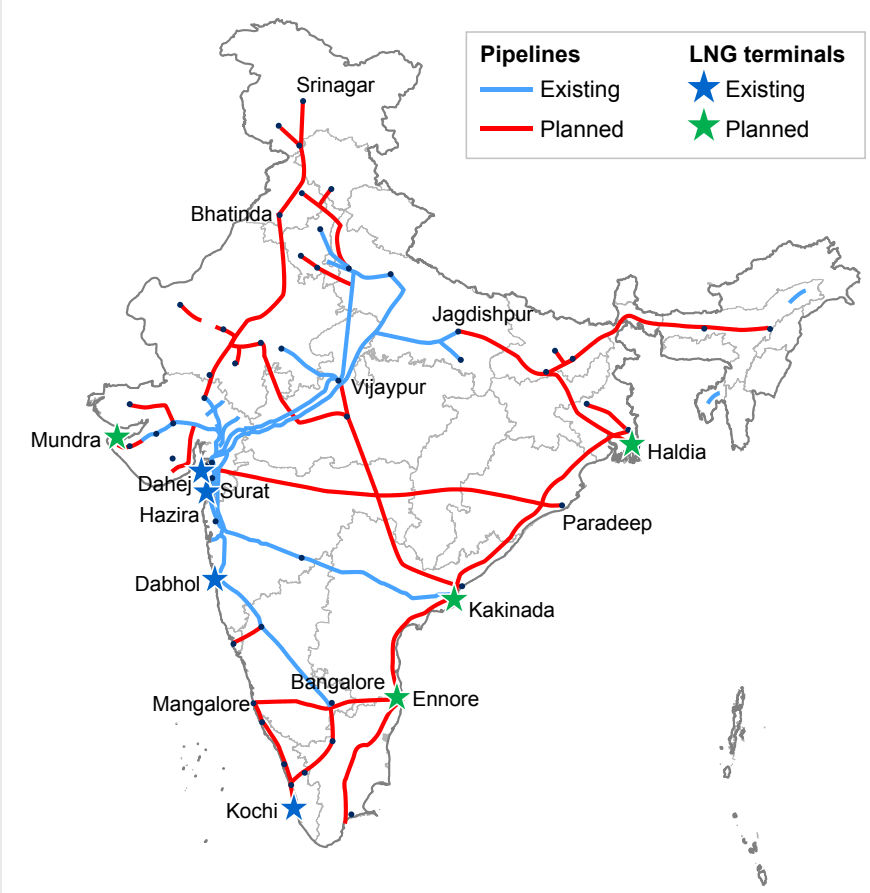


SOURCE: FACTS; McKinsey analysis

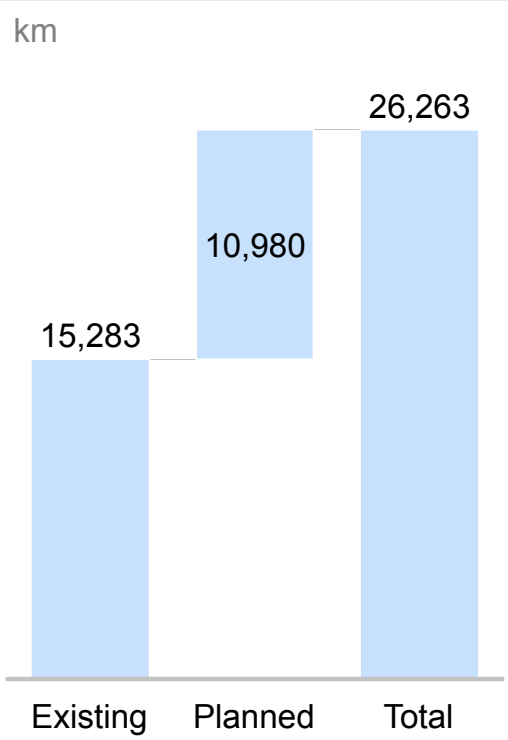
India's domestic gas production is well below demand. Even though supply is expected to increase at a CAGR of 4 per cent between 2012 and 2030, demand will continue to outstrip it.

India's planned trunk pipeline infrastructure will be sufficient to reach most of its major demand pockets.

India's pipeline and terminal infrastructure will reach almost all demand hubs



India's gas pipeline network



SOURCE: PNGRB; expert interviews; literature search; McKinsey analysis

In India, recent regulatory changes are helping accelerate demand growth

		Recent regulations	Expected impact
A	Upstream	▪ Shale gas policy for NOCs announced; policy for private participation expected soon	▪ Increase in domestic gas production
B	Downstream	▪ **Diesel:** Subsidy reduced for retail sales; market prices for institutional buyers ▪ **LPG:** Market prices with only 9 subsidised cylinder per household per year ▪ **Fertiliser:** Gas cost pass through for new projects ▪ **Power:** Pass through of fuel cost mandatory for new plants; new peaking power policy drafted ▪ **CNG:** Freedom to set up CNG stations	▪ Increase in affordability of gas vs. LPG, diesel ▪ Increased LNG demand from fertiliser and power sectors ▪ Proliferation of natural gas vehicles
C	Gas pricing	▪ Gas wellhead prices linked to a composite market index starting April 2014	▪ Improved E&P attractiveness

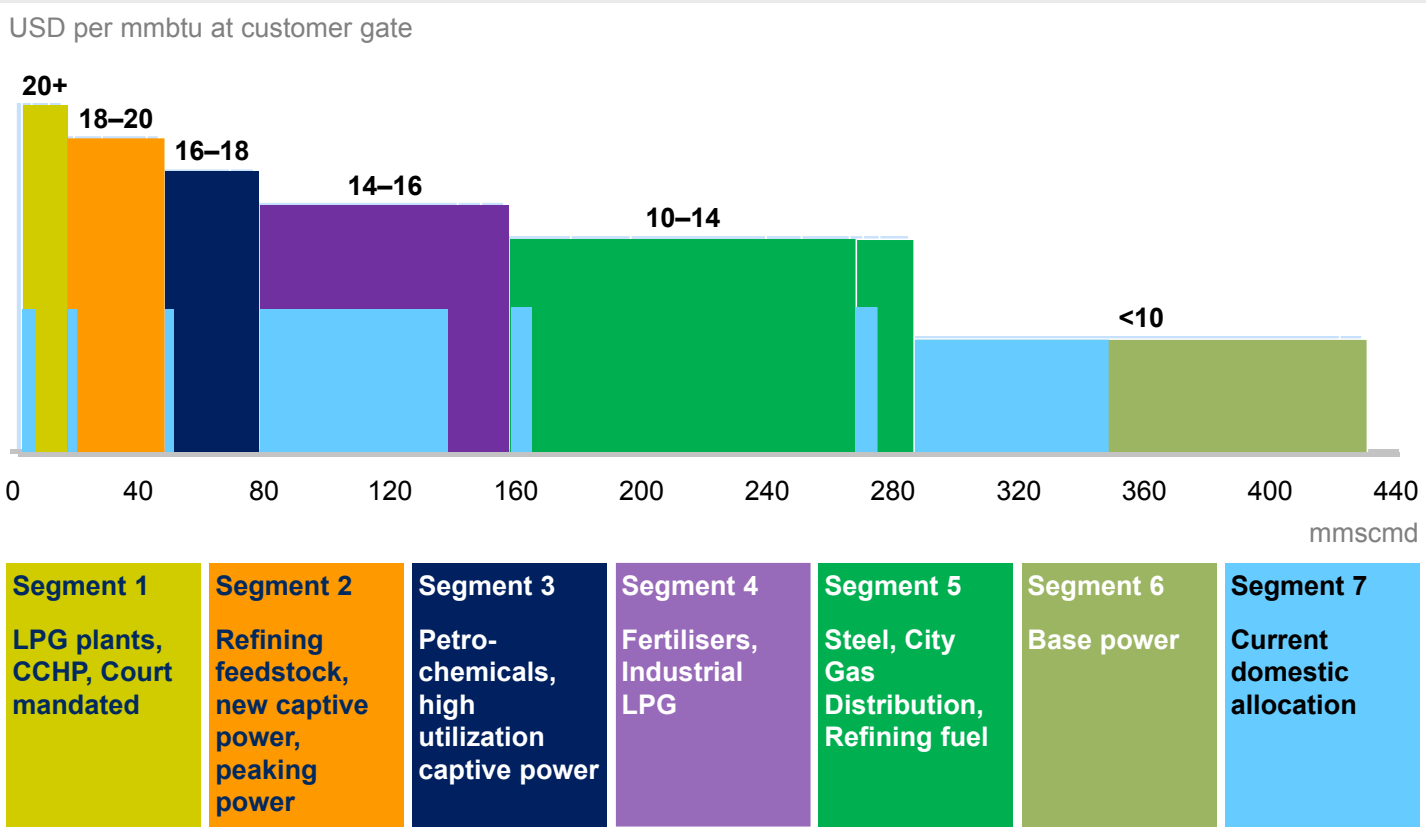
SOURCE: MoPNG; PNGRB; McKinsey analysis

Several regulatory changes have been made in India to incentivise investment in the gas value chain. These include the deregulation of alternate fuel prices, new policies for unconventional exploration and production, linking of gas wellhead prices to a composite market index, and pass through regulations for fuel in user industries.

Despite high gas demand, affordability remains challenging. Additional measures, including tax rationalisation, cost and tariff optimisation, and competitive pricing, will be required to unlock demand.

Securing gas at the right price in India is essential to unlock demand

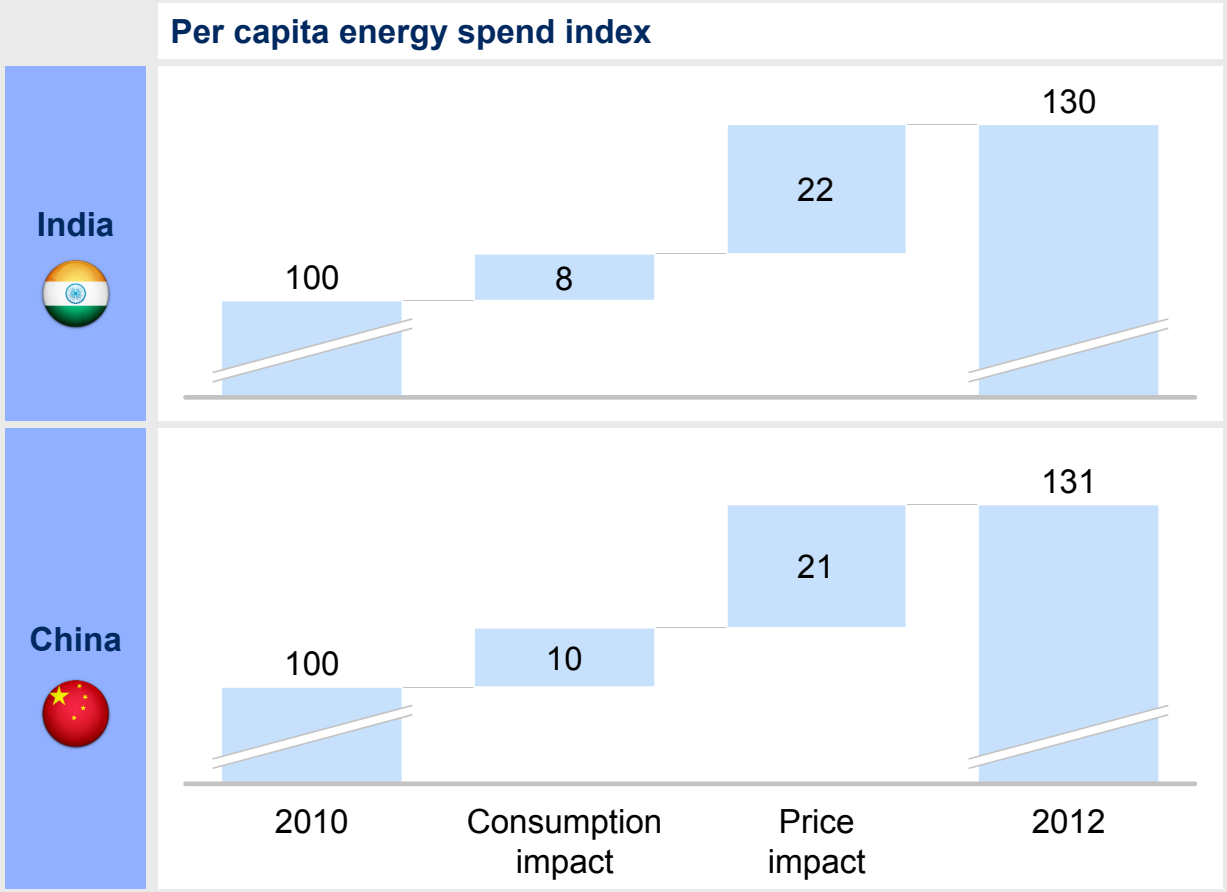
India demand curve based on delivered costs[1], 2017



1 Alternate switching cost at USD 90 per barrel (long term crude price projection)

SOURCE: Planning commission; MoPNG; DGH; McKinsey analysis

Energy cost inflation in Asia is a concern

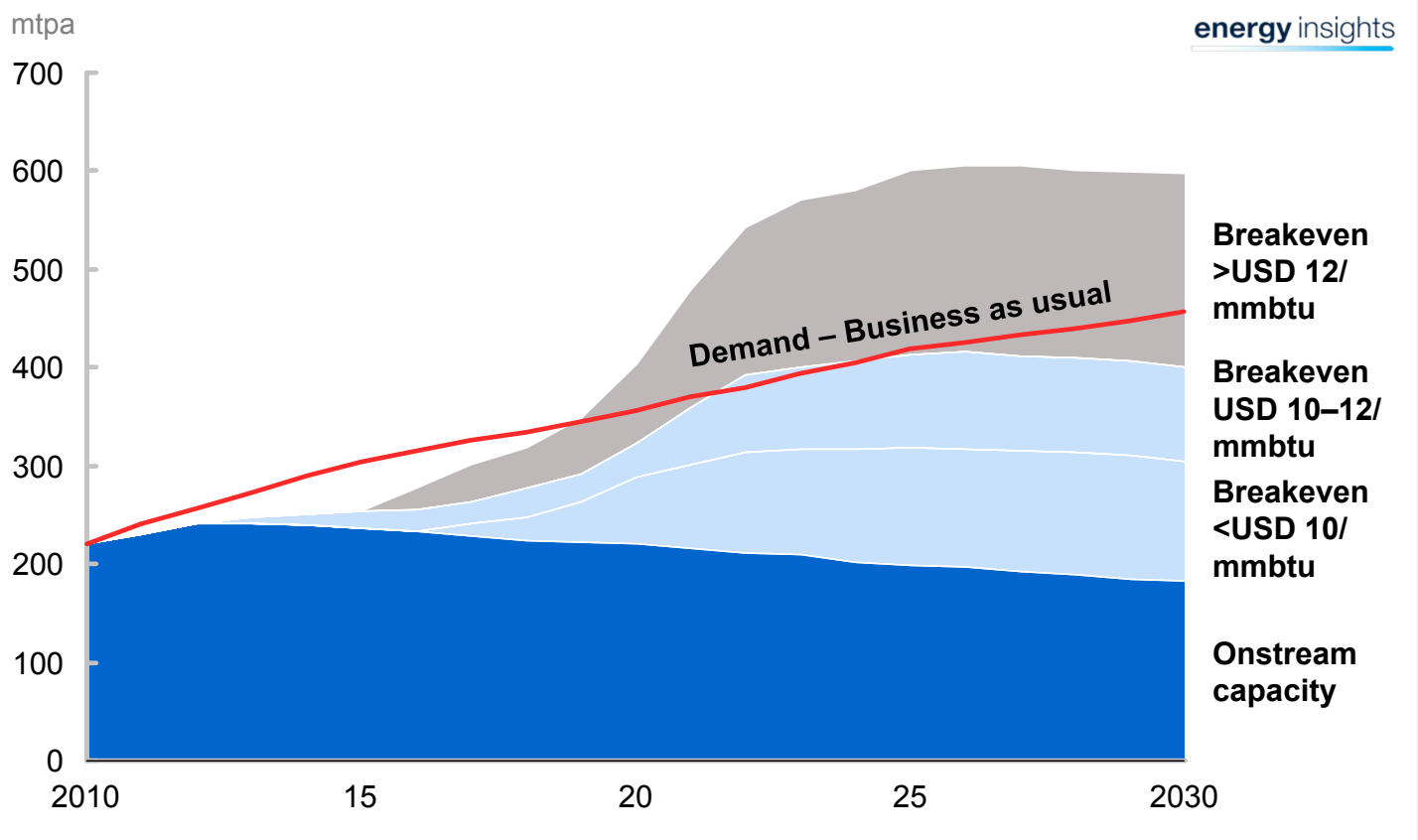


SOURCE: FACTS; MOSPI; IEA; McKinsey analysis

The amount that households spend on energy has been increasing rapidly across Asia. As the examples of India and China show, most of the increase is being driven by the deregulation of prices, and the remaining by increased consumption. As a result, resistance caused by demand elasticity cannot be ruled out across Asia.

Demand and supply are likely to be in balance for the next 5 years. Beyond that, a number of new projects are planned, and a surplus is likely if these materialise. A large proportion of planned LNG projects, including several that are under construction, require prices above USD 12 per mmbtu to break even. In a surplus situation, these projects will be hard pressed to match price sensitive demand with affordable supply.

Offtake would be a concern as supply increases



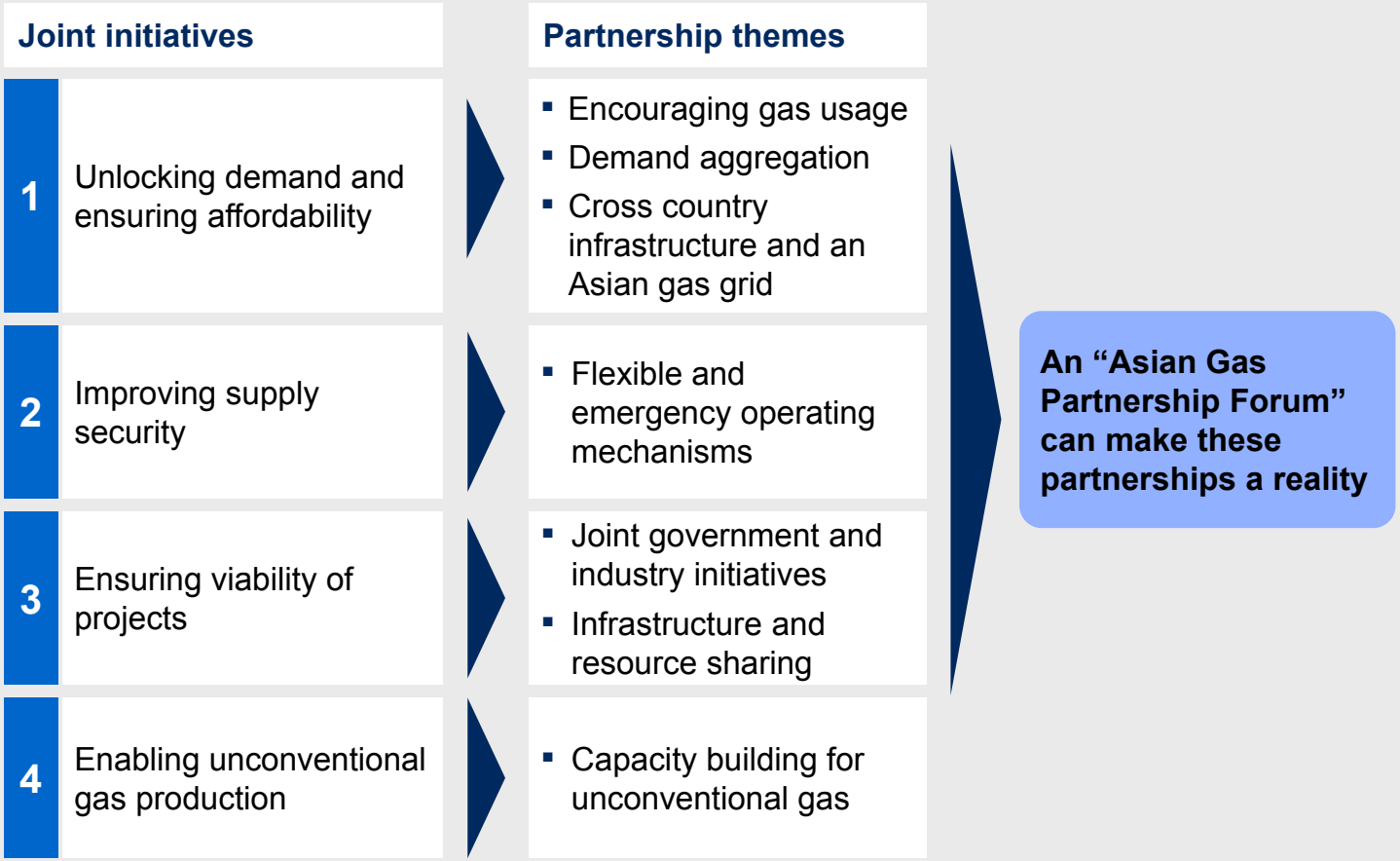
SOURCE: Energy Insights

Chapter 3

Partnerships are critical

Asian markets have limited pipeline connectivity, low market liquidity and high dependence on LNG for gas imports. For the gas market to grow significantly, these industry concerns as well as the core issues of affordability and offtake need to be addressed. Different forms of partnerships between buyers, sellers and governments are required to undertake these initiatives. A multilateral "Asian Gas Partnership Forum" could be considered by industry participants as an institutional mechanism to make these partnerships a reality.

Partnerships can address key industry concerns



1 Encouraging gas usage could unlock demand and improve affordability

Encouraging gas usage could unlock demand and improve affordability. Joint industry efforts can focus on working with governments to enable policy changes (e.g., tax rationalisation), with customers to remove bottlenecks (e.g., technology and infrastructure), on building public opinion (e.g., highlighting environmental benefits), and on driving new technology development and adoption.

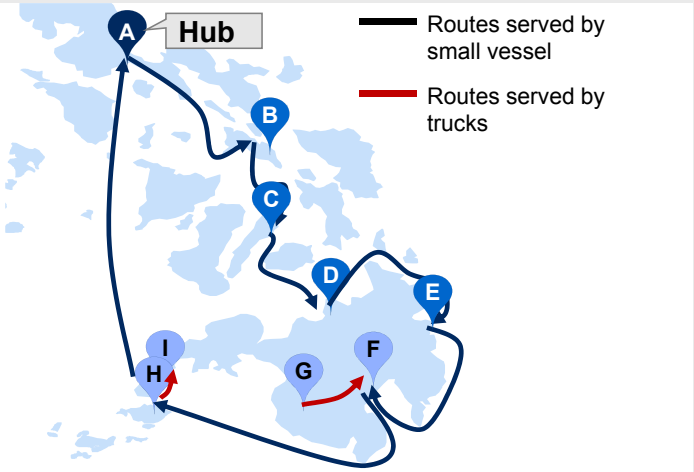
Dispersed demand in remote locations, such as islands and inland clusters, can be unlocked through a hub and spoke model. Regas storage at a port location can serve as the hub, with small vessels, barges and LNG trucks operating on the "spokes". To make this a reality, end users (e.g., industrial customers) will need to work together with regas developers and LNG traders.

1 Efforts to aggregate demand can help access smaller demand centres

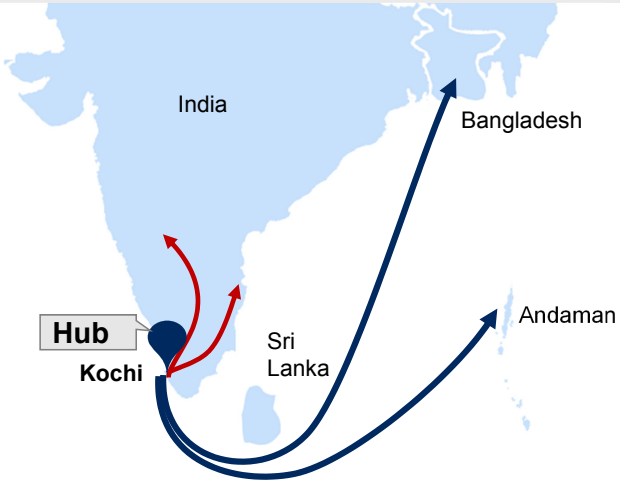
Configuration

- Multiple smaller demand centres with difficult access
- Large LNG storage at regas terminal acts as hub
- Small vessels/barges serve as spokes for islands
- LNG trucks serve as spokes for on-land demand

Schematic – Philippines



Schematic – India



1 An "Asian gas grid" could reduce costs and improve connectivity

"Asian gas grid"

"Asian gas grid" has been conceptualised as an extension of TAPI to connect suppliers and buyers

This would also be beneficial for the gas suppliers as they would get access to such a large and growing market

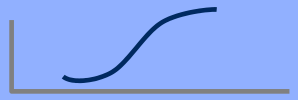
– Minister of Petroleum and Natural Gas, India

SOURCE: Literature search

The "Asian gas grid" concept to develop a 15,000 km pipeline could reduce costs, strengthen the market, and lead to mutual inter-dependence between suppliers and buyers.

As the industry structure and conduct evolves, new pricing mechanisms are bound to follow. A range of new mechanisms are already emerging, that seek to align prices to market conditions and reapportion risk. An Asian gas index, that reflects the supply and demand fundamentals of the region, can provide more flexibility and facilitate investment decisions for industry players. This would require a concerted effort from the industry to develop a trading hub that is connected to the major demand centers, with non-discriminatory access to infrastructure.

1 New commercial terms can improve affordability

Potential commercial terms	Impact	Examples
1 **Use of multiple indices in pricing agreements** 	▪ Improve affordability and reduce volatility	▪ BG–CNOOC
2 **Different medium and long-term slopes in pricing** 	▪ Match pricing with availability and risk	▪ Qatar Petroleum–CPC ▪ Qatar Petroleum–KOGAS
3 **S-curve based pricing** 	▪ Dampen effect of high prices on the buyer and low prices on the seller	▪ Shell–KOGAS
4 **Price review mechanism** 	▪ Opportunity for buyers and sellers to realign prices to reflect market conditions	

SOURCE: Literature search

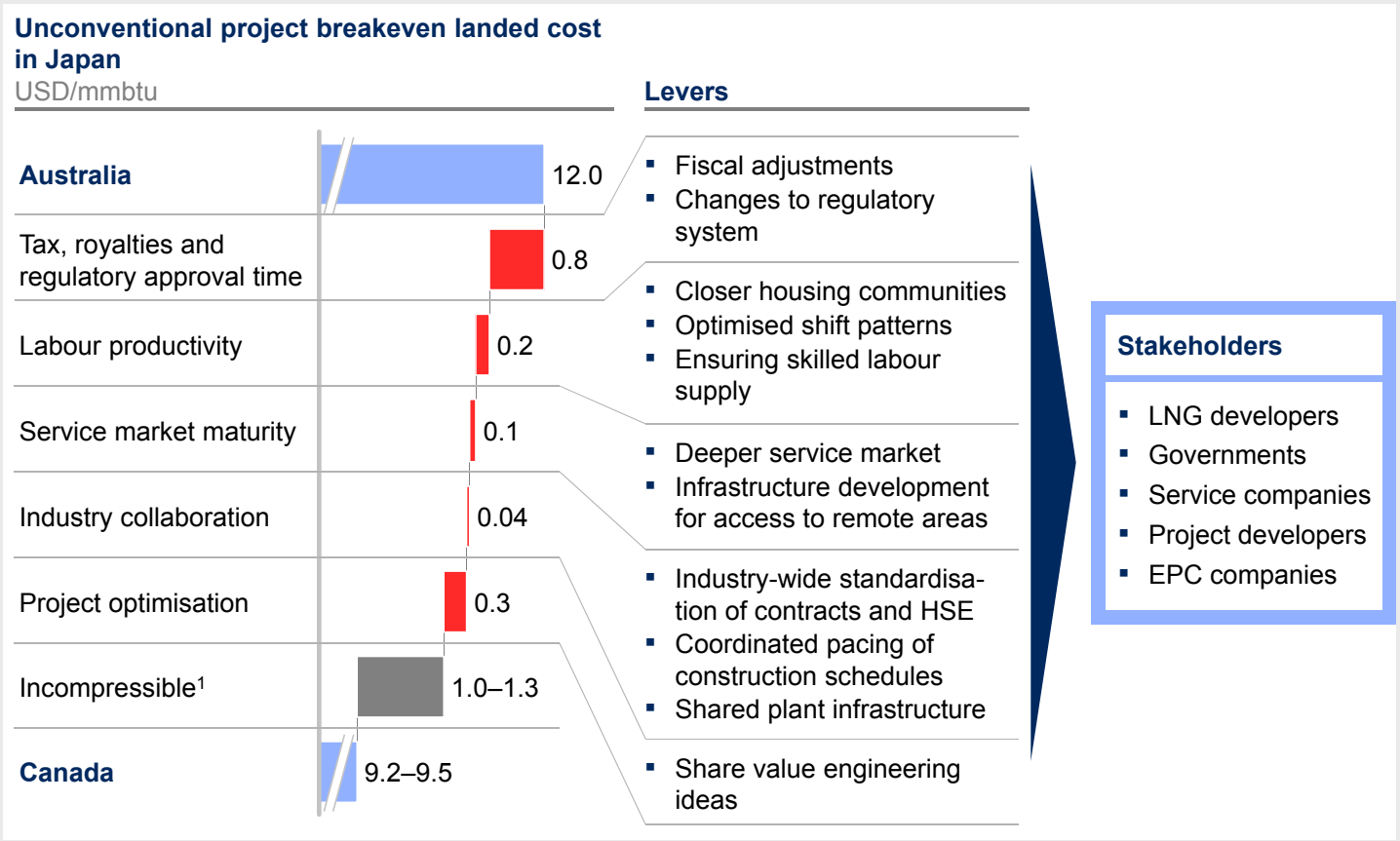
2 Flexible operating mechanisms can improve supply security and reduce costs

Elements		Impact
A	Flexible destination clauses	▪ Reduces penalties, demurrage, and risks of stock outs
B	Information sharing on inventories	▪ Lower information asymmetry enables better planning and scheduling, and reduces speculation
C	LNG loan agreements	▪ Enables emergency response and reduces inventory carrying cost
D	Swaps	▪ Reduces transportation costs and lead times

Several flexible operating mechanisms are possible to improve supply and reduce costs.

Joint initiatives between government and industry can drive targeted interventions to bring down costs and rescue high cost projects. The potential impact of such interventions is sizeable. For example, a recent McKinsey study showed that of the USD 2.5 per mmbtu difference in breakeven landed cost between unconventional gas based LNG projects in Australia and those in Canada, tax and regulation contributed USD 0.8 per mmbtu ad project optimisation and labour productivity together contributed 0.5 per mmbtu.

3 Joint government and industry initiatives can rescue high cost projects – Australia example



1 Includes difference in reservoir characteristics, climate related plant efficiency, inflation, shipping and pipeline length

SOURCE: McKinsey LNG-OMG model; HIS; McKinsey analysis

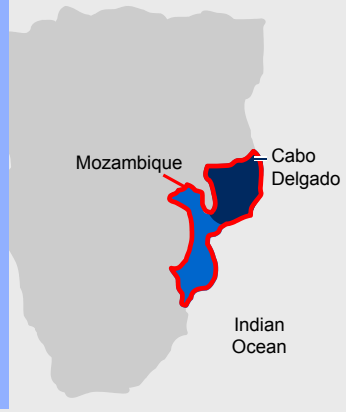
3 Infrastructure and resource sharing can reduce project costs

Potential areas for joint infrastructure development

- **Field development and liquefaction facilities**
- **Production and transportation infrastructure (e.g., platform, pipeline)**

East Africa (Eni and Anadarko example)

- Development of common reservoirs in offshore
- Joint construction of LNG plant
- Resource pooling



Australia (Santos and BG example)

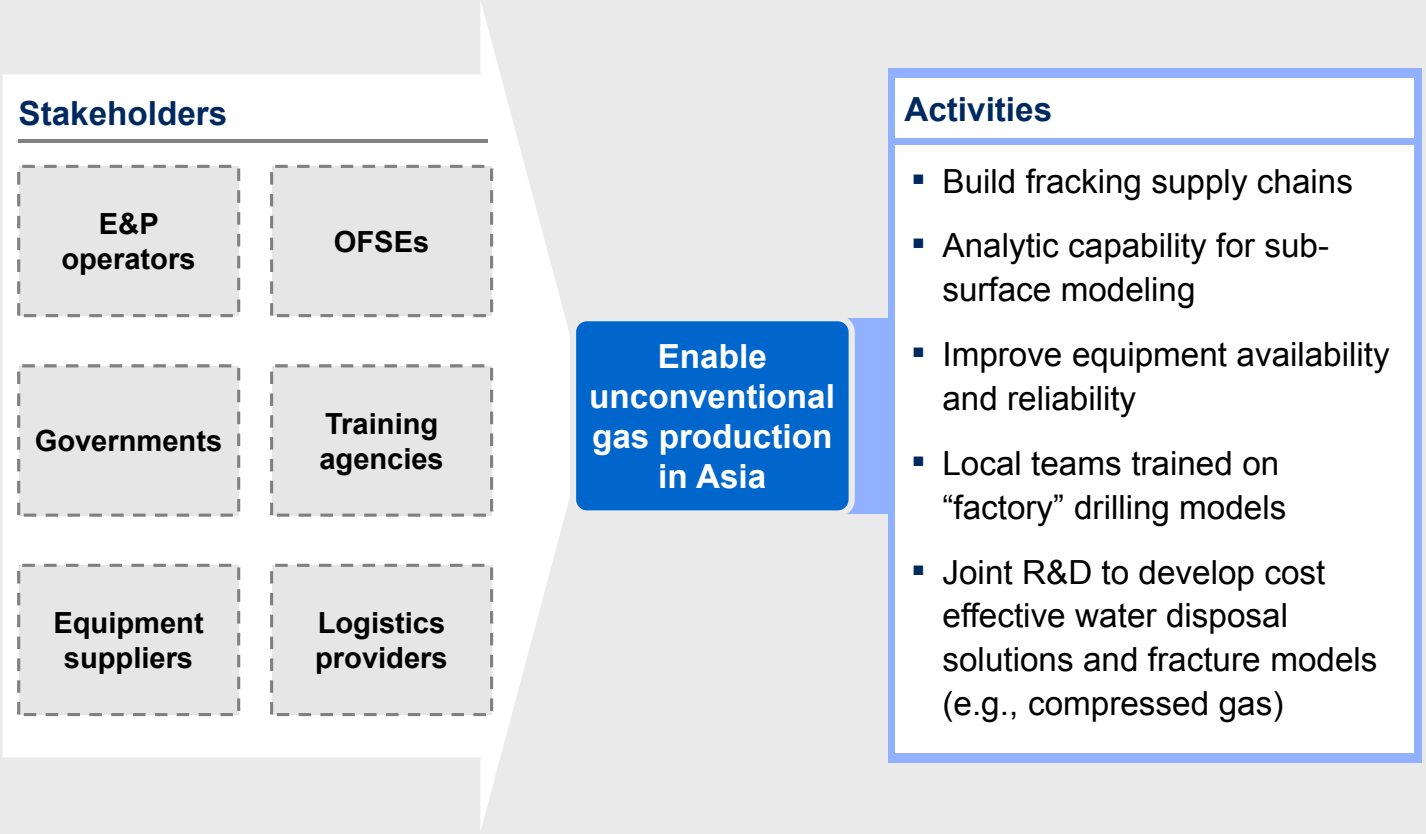
- Joint investment to reduce pipeline cost
- Swaps and gas exchange

SOURCE: Literature search

Suppliers can jointly develop fields and co-invest in production and transportation infrastructure to reduce costs and achieve scale. This is particularly true in new greenfield projects, which are high risk and could be in countries that do not have easy access to local service providers.

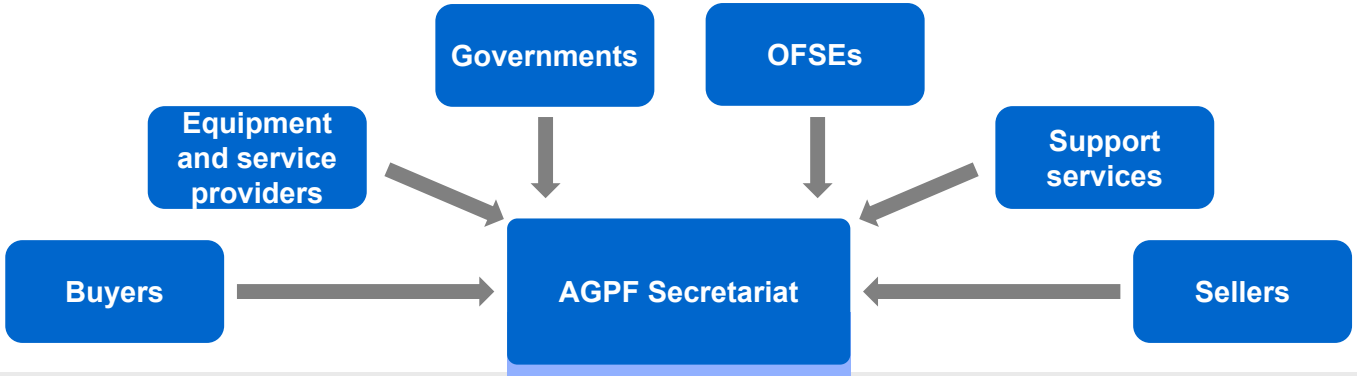
Though the potential is high, there are significant challenges to the development of unconventional gas reserves. Partnerships are needed to build capacity to enable unconventional gas production. As entirely new supply chains for unconventionals are created in Asia, this will also become an attractive opportunity for service and equipment providers.

4 Capacity building to enable unconventional gas production



Establishing an "Asia Gas Partnership Forum" can help make these partnerships a reality

Proposed forum membership



AGPF objectives

- Encouraging the use of gas
- Information sharing on demand, supply and inventories
- Technology development and experience sharing
- Capability building
- Safety and technical standards
- Creating Asian gas grid and an Asian gas index (financial instruments, liquidity, connectivity)

Establishing an Asia Gas Partnership Forum can facilitate partnerships to drive the growth of the gas market. This would need stakeholders to come together and agree on common objectives and activities, provide resources to a full time secretariat, and pursue initiatives of mutual interest.

About Energy Insights

The content of this report draws from insights and data developed by Energy Insights. Energy Insights is a McKinsey Solution which combines proprietary tools and information, advanced analytical models, and specialist expertise to identify key value levers for energy players, working closely with the broader McKinsey consultant network. Energy Insights operates in three areas:

- **Market Analytics:** Analyses the underlying drivers of global and regional energy supply and demand trends. Our integrated tools, proprietary methodologies, and fact based approach allow us to understand how multiple and different market trends interrelate on a global scale. Based on these analyses, we provide detailed and quantitative forecasts to support strategic planning activities.

- **Performance Benchmarks:** Compares companies' practices and performance in exploration and production in oil and gas production basins worldwide. These objective assessments of relative performance and practices can identify performance improvement opportunities that operators can act on.

- **Diligence and Business Intelligence:** Focuses on commercial due diligence, strategic planning, and business development in energy market subsectors and specialises in oilfield equipment and services.

For additional information, see:
http://solutions.mckinsey.com/Index/solutions/energy-insights/

This report draws on one of Energy Insights' Market Analytics tools—the ***Global Gas Model***. The ***Global Gas Model*** covers global gas and LNG markets up to 2030, providing a quantitative mid- to long-term perspective on global demand for gas and LNG, LNG flows, landed cost curves and gas infrastructure utilisation rates. The model takes local supply and demand trends, infrastructure and long-term contracts into account at a very granular level to ensure a comprehensive view on how local trends will play out on a local and global scale.

Oil and Gas
December 2013
Layout by Visual Aids India

www.mckinsey.com