7th

IEF-IGU Ministerial Gas Forum

KUALA LUMPUR, 2020

3RD DECEMBER 2020

TOWARDS RECOVERY AND SHARED PROSPERITY;

NATURAL GAS OPPORTUNITIES FOR A SUSTAINABLE WORLD

HOSTED BY

PRIME MINISTER'S DEPARTMENT MALAYSIA

SUPPORTED BY

IEF IGU PETRONAS MALAYSIAN Gas ASSOCIATION BCG

IEF-BCG Background Materials Session 1

IEF-IGU Ministerial Gas Forum

KUALA LUMPUR, 2020

Panel Session 1:

Opportunities in Growing Gas Markets:

Producer Consumer Perspectives on New Realities

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Disclaimer

The observations presented herein are meant as background for the dialogue at the 7th IEF-IGU Ministerial Gas Forum hosted by the government of Malaysia. They have been prepared in collaboration with Boston Consulting Group and should not be interpreted as the opinion of the International Energy Forum or Boston Consulting Group on any given subject

Market Context

- The Global LNG market is heavily affected by the COVID-19 pandemic, with mixed mid-term outlooks, but strong long-term market fundamentals for gas growth.
- Gas is expected to play a key role in energy transition but requires collaboration and support.

Session Objectives

Exchange perspectives on COVID-19 impacts on projected gas demand and supply and global trade with focus on Asian growth markets

Key Questions

COVID-19 Impact and Market Outlook

- How does COVID-19 impact gas markets across world regions?
- How do natural gas prospects differ in Asia (China, India, ASEAN), the Middle East, and Africa?

Role and Importance of Gas in Energy Transition

- Will the downturn in global economic growth limit gas demand/options for coal to gas switching?
- How can ministers best leverage abundant and more flexible gas supplies in clean recovery strategies?
- Will better economics of coal and renewables or the quest for hydrogen limit or add opportunities?

Enablers for governments to unleash gas potential

- What should governments focus on, to reduce hurdles and advance global natural gas trade?

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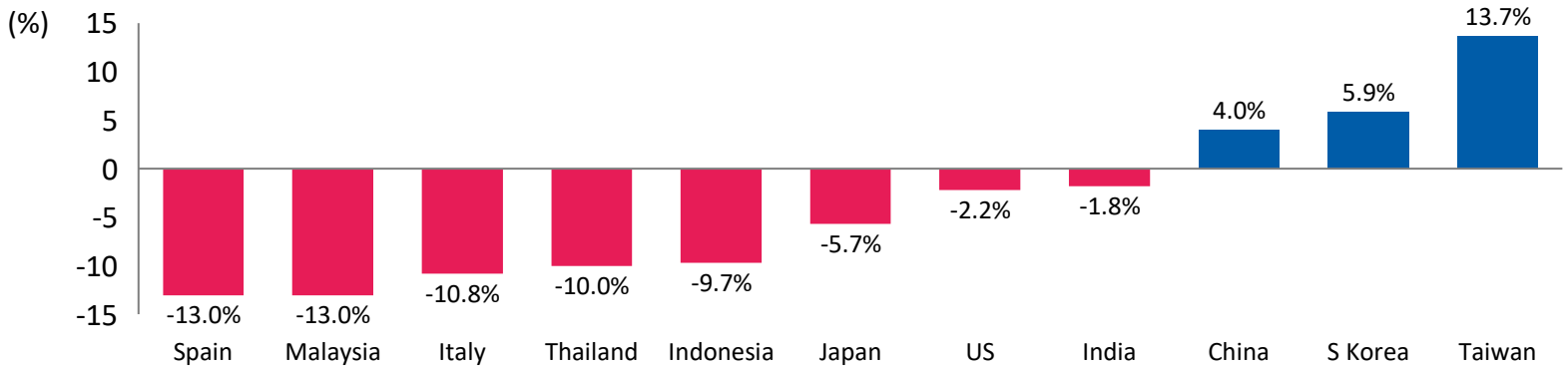
COVID-19 Impact and Market Outlook

COVID-19 pandemic impacted the gas demand differently in each key gas market

H1 2020 vs. H1 2019 gas consumption growth/ decline in key gas consuming markets

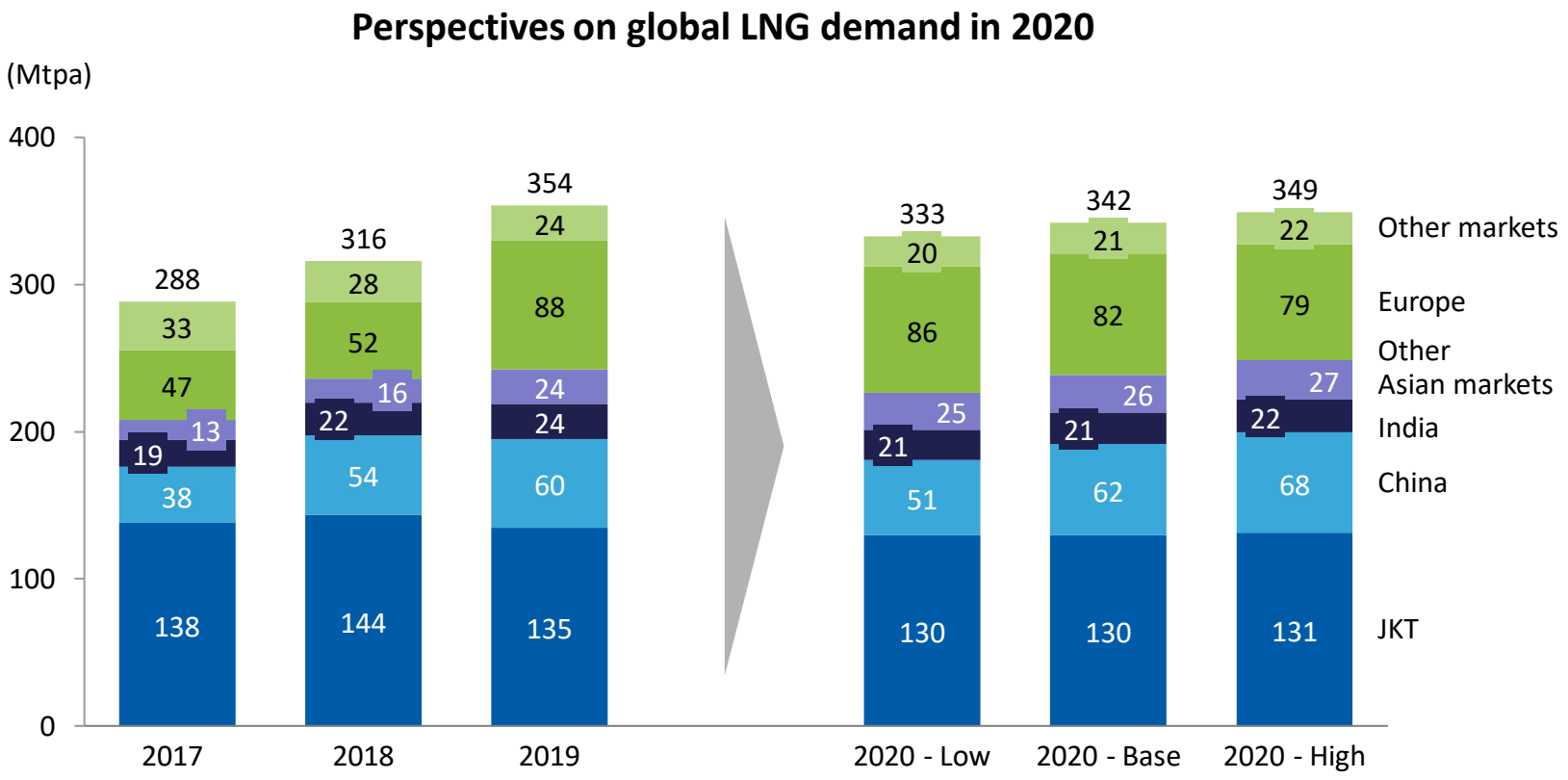


Consumption recovery trend

- **Spain**: No recovery yet due to economic recession and higher renewable contribution
- **Malaysia**: No recovery yet due to resurgence of COVID cases and imposition of lockdown
- **Italy**: Recovery as of June - seasonality of gas demand likely masking full extent of structural changes
- **Thailand**: Demand recovered in August and September; expected to rise to 4Bscf/d by Q4
- **Indonesia**: No recovery yet due to focused lockdown efforts to contain spread, economic impact
- **Japan**: Recovery as of August
- **US**: 2020 gas demand in line 2019 levels
- **India**: Swiftly recovering 2019 levels since July
- **China**: Demand recovering in H2 2020, but slowest pace in last 5 years
- **S Korea**: Coal-to-gas switching policy drove higher LNG imports in H1 2020, however LNG import expected to decline in H2 2020 due to weak economic outlook
- **Taiwan**: Demand of LNG is still moving up (exception market in pandemic) – Least impacted by COVID

Malaysia, Indonesia and Thailand numbers based on Press search and projections
Source: Press search, BCG LNG market model

Global LNG demand for 2020 is expected to stay flat at the best, compared to 2019



Source: BCG LNG market model

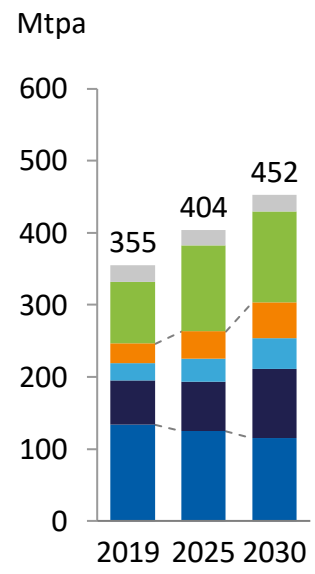
In the longer term some fundamental demand drivers at play as before COVID-19

		Impact on gas demand
Upstream gas producers	**Looming upstream oil and gas investment crisis** • Global gas markets expected to become more volatile and limit exports from US • More stringent ESG and environmental policy requirements can widen the demand gap and deepen gas market deficits	↓
Established LNG-importing countries	**Primary energy demand growth** • Economic development in Asia a critical enabler of market growth • In developed markets stagnating energy demand will slow gas demand growth	—
	Fuel switching, driven by policy and technology developments • Regulatory ambitions to decommission coal-fired power generation and nuclear generation remaining unchanged (particularly in Europe), growing gas relevance within the power and industry mix and possible pressure	↑
	• Open question on strong renewable capacity installation vs. gas growth potential (to replace share of coal in energy mix)	—
	New investments on gas and downstream infrastructure • Capacity and willingness of governments and investors to develop new capacity for gas access and consumption	↑
New Niche markets & new uses	**Investments incurred in new regas capacity in niche markets, to add new destination market** • 20+ Mtpa in regas capacity in new markets under construction or with FID take	↑
	Small Scale LNG businesses and LNG for mobility to continue to contribute • SSLNG in remote areas (e.g. Brazil), LNG bunkering, LNG long-haul trucking, etc.	↑

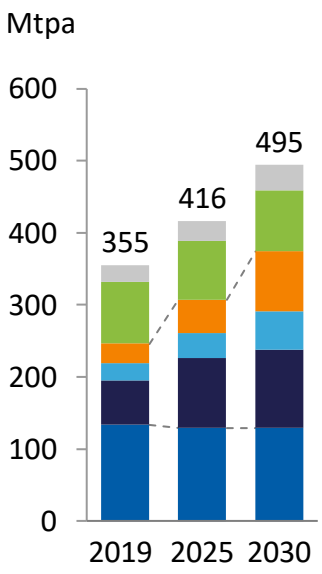
Source: BCG analysis

Non-OECD Asia will remain the greatest but more uncertain driver of demand growth

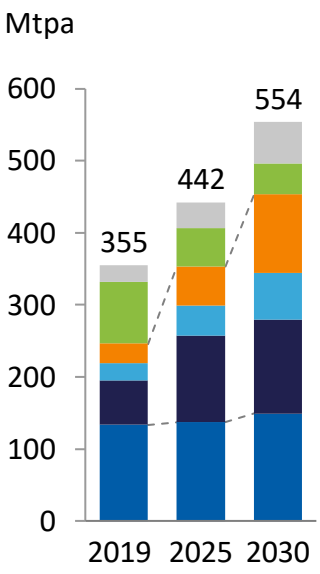
Global LNG demand low case

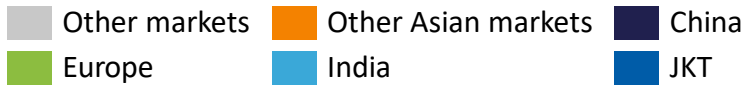


Global LNG demand base case



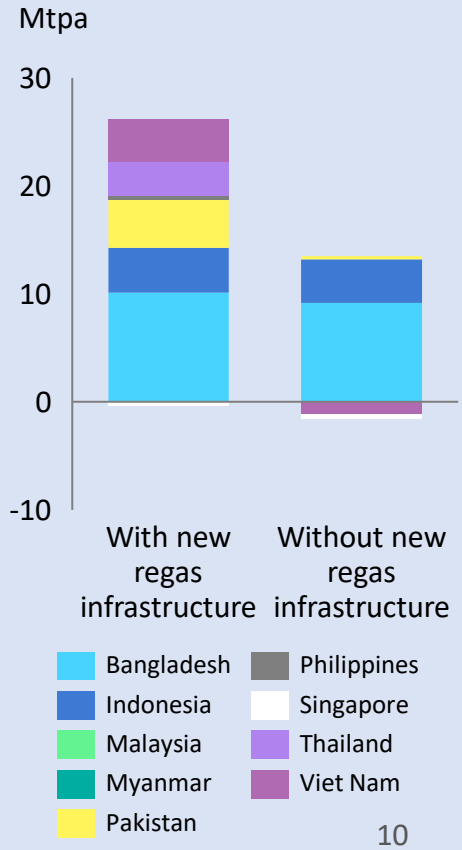
Global LNG demand high case





Incremental gas demand growth in Emerging Asia

2019-2025



Note: European countries defined as EU 28, Norway, Switzerland, Turkey, and Central Europe; non-OECD Asia covers China, India, selected ASEAN countries
Source: IMF, IEA, GIE, Eurostat, Cedigaz, BNEF, BCG analysis

Impacts of COVID-19 on long term outlook are mixed so far (1/3)

	Signposts to watch	Evidence to date is mixed
China	• State of coal switching policy • Pace of infrastructure build out • Success of midstream market liberalization	↓ **Fuel switching slowdown:** China slowed its coal switching program during 2019 trade war; Unclear how govt. will respond in COVID-19 aftermath ↓ **Regas delays:** Five new LNG regasification terminals and two terminal expansion projects have been delayed to 2021
India	• Scale of CGD investment • Level of fuel switching in power sector • Gail spinoff of transmission assets	↑ **Increased fuel switching:** Low LNG prices have stimulated coal-to-gas switching in the power sector; Sustainability unclear ? **CGD investment viability:** Uncertainty around the ability of investors to mobilize capital and around the regulated rates set by Government
Japan	• Scale of coal plant retirements • Nuclear power policy • Local gas distribution liberalization	↑ **Nuclear delays:** Several nuclear restarts faced safety upgrade work delays ? **Coal fleet turnover:** In July Japan announced that it will accelerate the closure of 100 coal units, but replace them with new more efficient coal plants
South Korea	• Pace of coal shutdowns • Nuclear power policy	↑ **Proposed carbon price:** Proposed Korean Green New Deal would create carbon tax, making gas more competitive against coal
Myanmar	• Pace of regasification infrastructure investment • Market deregulation and reform	↑ **Myanmar gas-to-power project: D**eveloping 4,000 MW of LNG-to-power projects as natural gas imports rise in response to reduced hydroelectric supply and declining domestic gas production ? **Fallout of COVID:** Unclear how COVID will affect gas infrastructure development

↑ Signal of higher future LNG demand growth ? Signal unclear ↓ Signal of lower future LNG demand growth

Source: Press reports, BCG analysis

Impacts of COVID-19 on long term outlook are mixed so far (2/3)

	Signposts to watch	Evidence to date is mixed
Malaysia	• Upcoming New Energy Policy • Upcoming Gas Roadmap	↑ **Gas-based growth:** Expected to embrace and develop thermal (gas) power capacity growth for the next decade, focus on renewables, increased gas consumption for industrial and petrochemicals sector ↑ Commitment from energy sector to building sustainable business, delivering clean energy and low carbon solution
Singapore	• Pace of renewables adoption	? **Stable but uncertain:** LNG sector continues to see developments as COVID recovery begins, power sector recovers driving bulk of gas demand, however, mid-term focus could shift towards renewables
Indonesia	• Clean energy policy improvement implementation challenges	↓ **Transition from coal difficult:** Difficult road for gas, coal receives substantial government support: coal price cap, tax exemptions, loan guarantees
Thailand	• Domestic Upstream CAPEX cuts • Carbon pricing	↑ **Increased reliance on LNG:** Gas-heavy nature of the Thai power mix will see the country become ever more reliant on LNG imports going forward as domestic production declines ? **Putting a price on carbon:** Currently considering a national emission trading system (already has Voluntary Emission Reduction programme and Carbon Offsetting Program)
Taiwan	• Denuclearization and coal retirement	↑ **COVID Immune:** Taiwan LNG demand expected to increase as Gas-fired power to grow to 50% of mix by 2025 versus 35% at present

↑ Signal of higher future LNG demand growth ? Signal unclear ↓ Signal of lower future LNG demand growth

Source: Press reports, BCG analysis

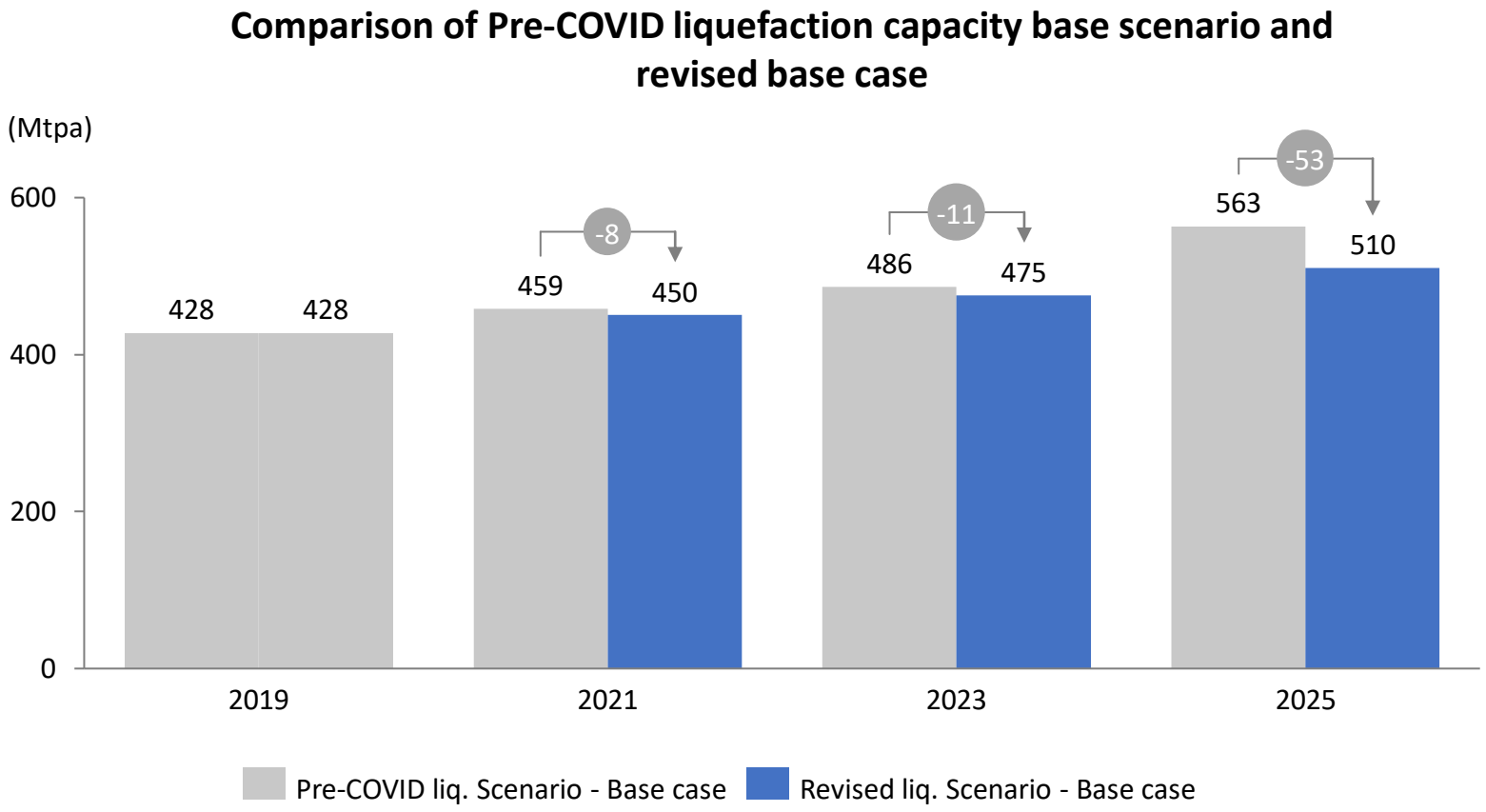
Impacts of COVID-19 on long term outlook are mixed so far (3/3)

	Signposts to watch	Evidence to date is mixed
Brazil	• Strategic initiatives driven by ANP (COVID recovery strategy)	↑ **Infrastructure investment to pick-up:** Expected to expand natural gas infrastructure to comply with new climate commitments; companies exploring LNG tankers to tackle lack of pipeline capacity ↑ **New Gas Market:** Development of Open, Competitive and Dynamic natural Gas market - Monetize natural gas produced at pre-salt and other new discoveries - Increase share of gas in energy matrix (power gen and industrial) - Improve tax regime, foster alignment (federal, state, local)
Argentina	• Shale gas monetization approach • Market regulation	? **Gas production stimulus:** Plans to subsidize Shale Gas production by granting subsidies worth $5.1 billion for its drillers (reduces LNG imports and bolsters investments and tax collections by $2.5 billion) ? **Tariff freeze:** Imposed maintaining low gas prices for end-users to support local economy
Columbia	• Coal to gas switch (power gen) • Upstream commercial attractiveness	↑ **Gas as a strong driver in energy transition:** Natural gas expected to become the transitional fuel of choice as the country focuses on meeting its Paris Agreement emission targets ? **Energy security critical:** Growing optimism to boost reserves and production (requires appropriate incentives), but declining production and reserves, and increasing reliance on LNG imports

↑ Signal of higher future LNG demand growth ? Signal unclear ↓ Signal of lower future LNG demand growth

Source: Press reports, BCG analysis

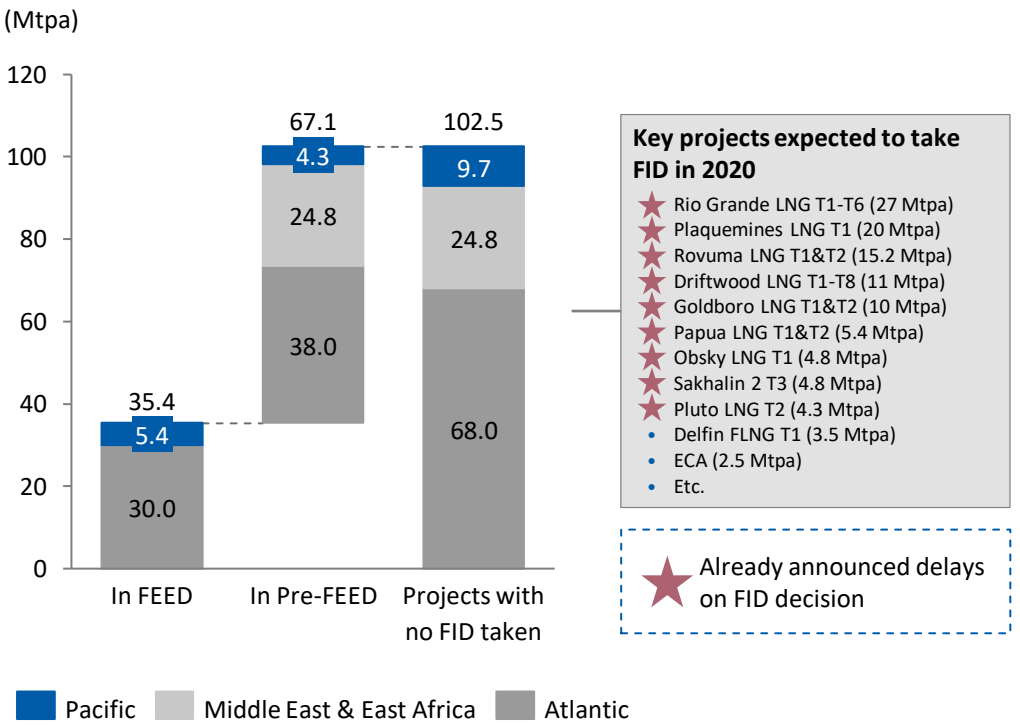
LNG supply growth slowing, but not materially



Source: BCG LNG market model

Substantial incremental capacity available for FID, but delays expected

Capacity build-up from projects with planned FID in 2020 (Start production 2020-2025)



Key projects expected to take FID in 2020

- Rio Grande LNG T1-T6 (27 Mtpa)
- Plaquemines LNG T1 (20 Mtpa)
- Rovuma LNG T1&T2 (15.2 Mtpa)
- Driftwood LNG T1-T8 (11 Mtpa)
- Goldboro LNG T1&T2 (10 Mtpa)
- Papua LNG T1&T2 (5.4 Mtpa)
- Obsky LNG T1 (4.8 Mtpa)
- Sakhalin 2 T3 (4.8 Mtpa)
- Pluto LNG T2 (4.3 Mtpa)
- Delfin FLNG T1 (3.5 Mtpa)
- ECA (2.5 Mtpa)
- Etc.

Already announced delays on FID decision

Reasons to delay FID decision to 2021-2022 mainly depending on facility owner typology

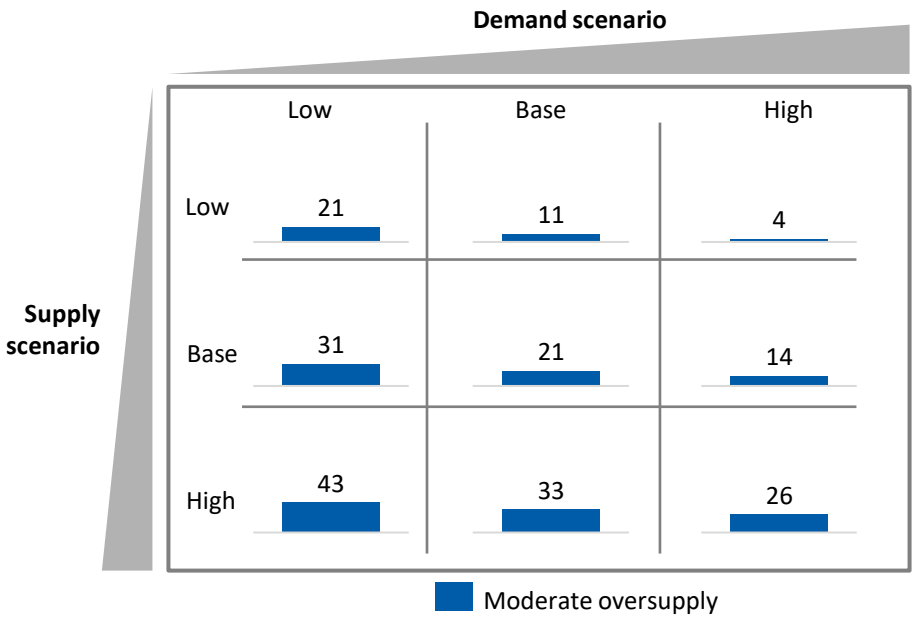
- Projects owned by infrastructure developers are having great difficulties to secure financing in current market environment
- Projects owned by E&P players have been forced to reduce CAPEX due to low oil prices

Delaying FID decision will imply for some of these projects to start production after 2025

- Projects with relatively higher development costs could struggle to reach FID, especially after COVID pandemic
- Moreover, additional competition driven by large expiration of LT contracts linked to existing assets, if LNG demand does not catch up

Moderate LNG oversupply expected in 2020 in all demand scenarios

LNG S/D balance in 2020 (Mtpa)



Key potential impacts on LNG market

1 Lower for longer LNG prices

- Oversupply to lead to high availability of uncommitted volumes (high liquidity) and downward pressure on prices
- Sustained very low oil price environment to flow into oil-indexed LT volumes

2 Rebound expected, but impact on medium-term growth

- Impact of 2020 crisis will have repercussions on medium-term growth potential (lost growth for 2020-2030)
- China and Asian emerging markets expected to drive growth in 2021 – benefitting from attractive gas prices

3 Lower liq. utilization rates due to lack of profitable alternatives

- US exports down 50%+ through the summer due to cargo cancellations

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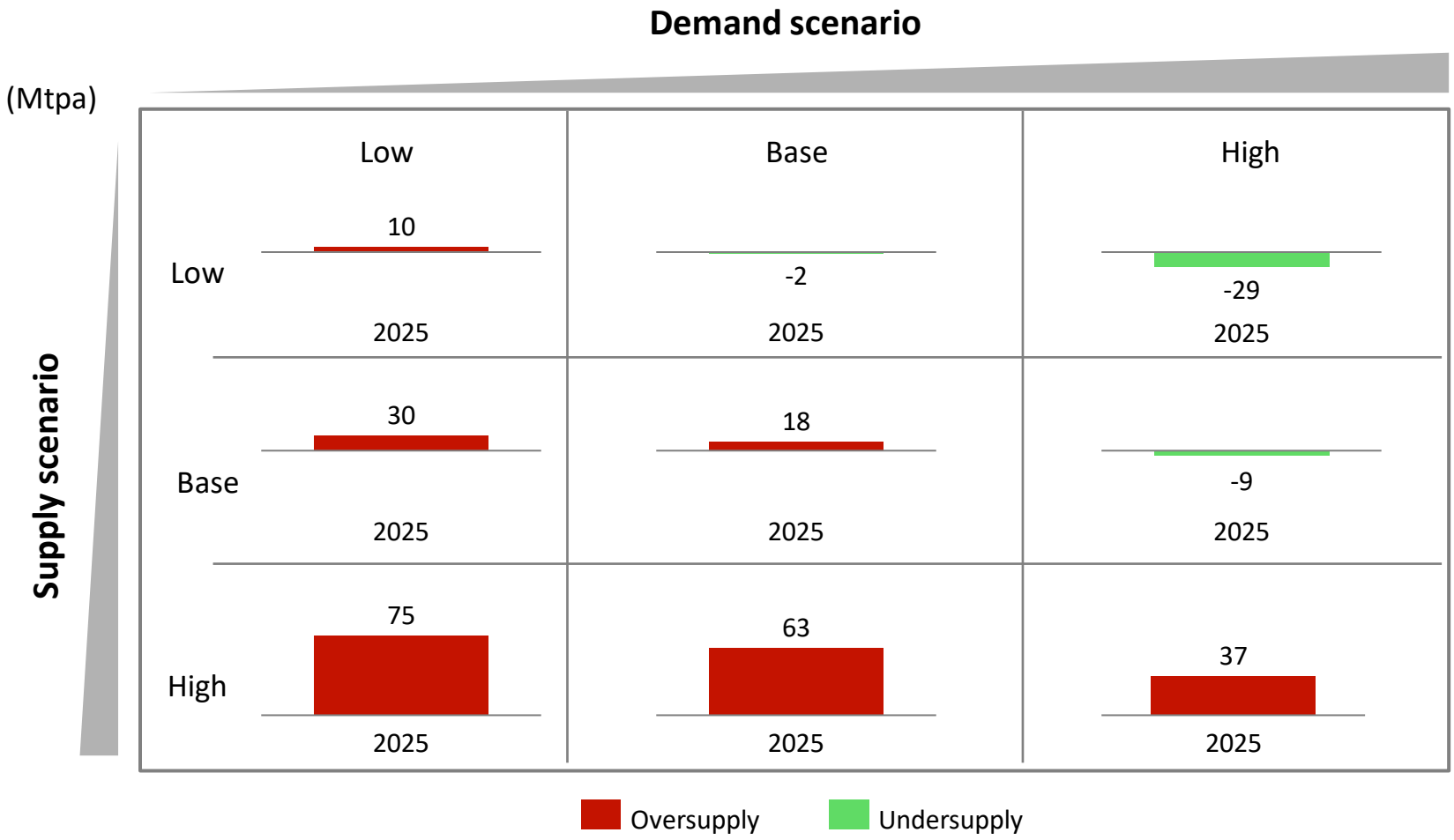
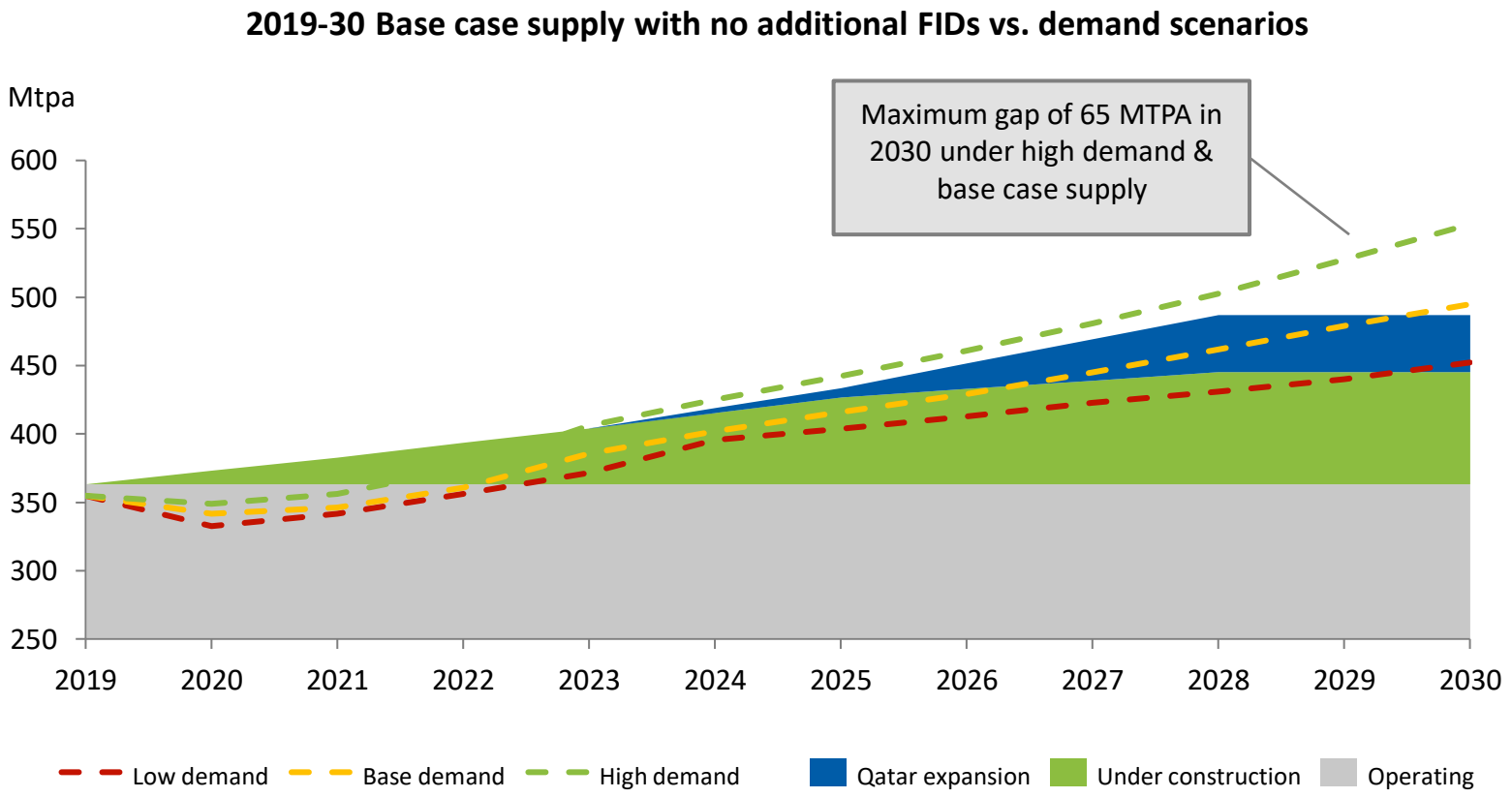
Market likely to still be oversupplied in 2025



Under base case supply and demand the global LNG market may not rebalance until late 2029

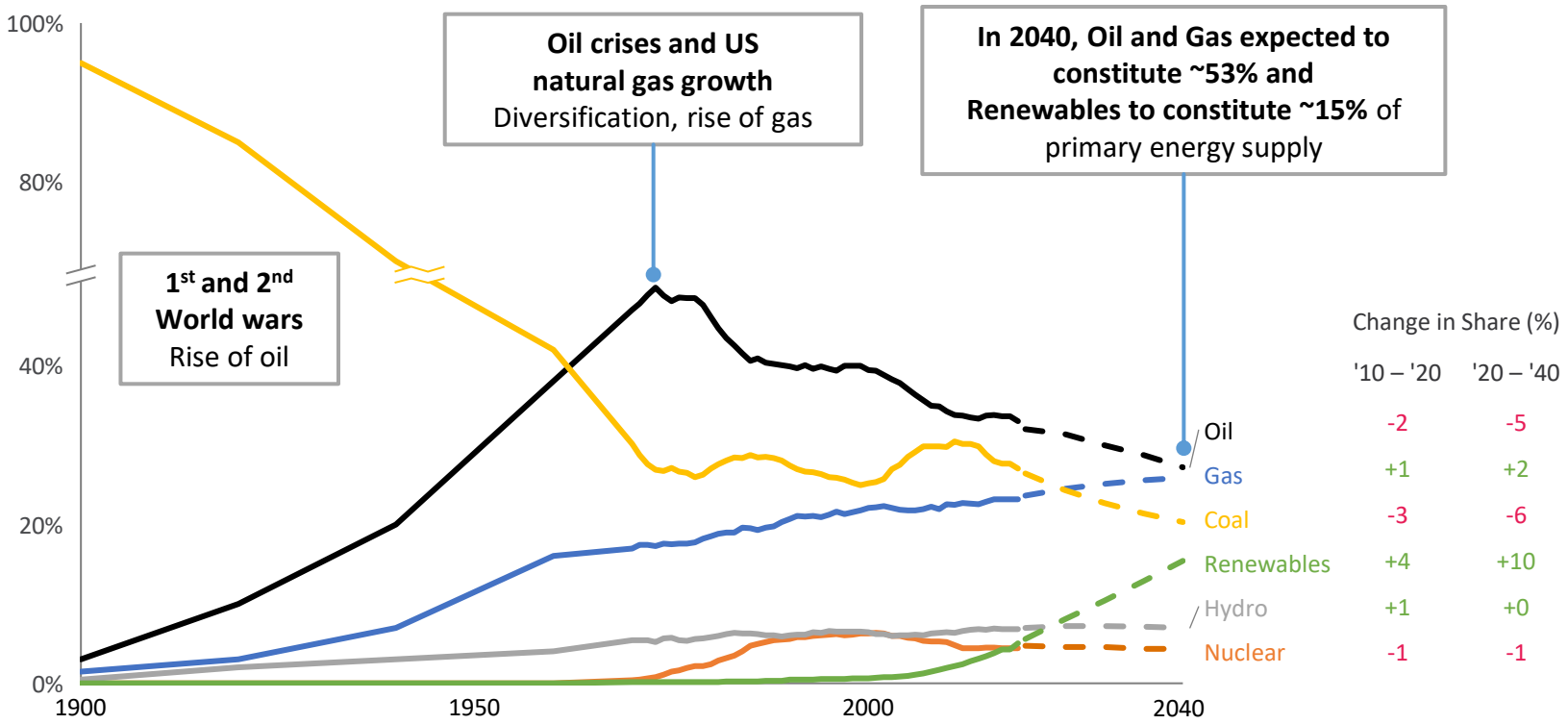


Note: Supply assumes global liquefaction capacity operates at 85% utilization annually
Source: IMF, IEA, GIE, Eurostat, Cedigaz, BCG analysis

Role and Importance of Gas in Energy Transition

Transition to cleaner fuels more rapid than prior energy transitions observed in history

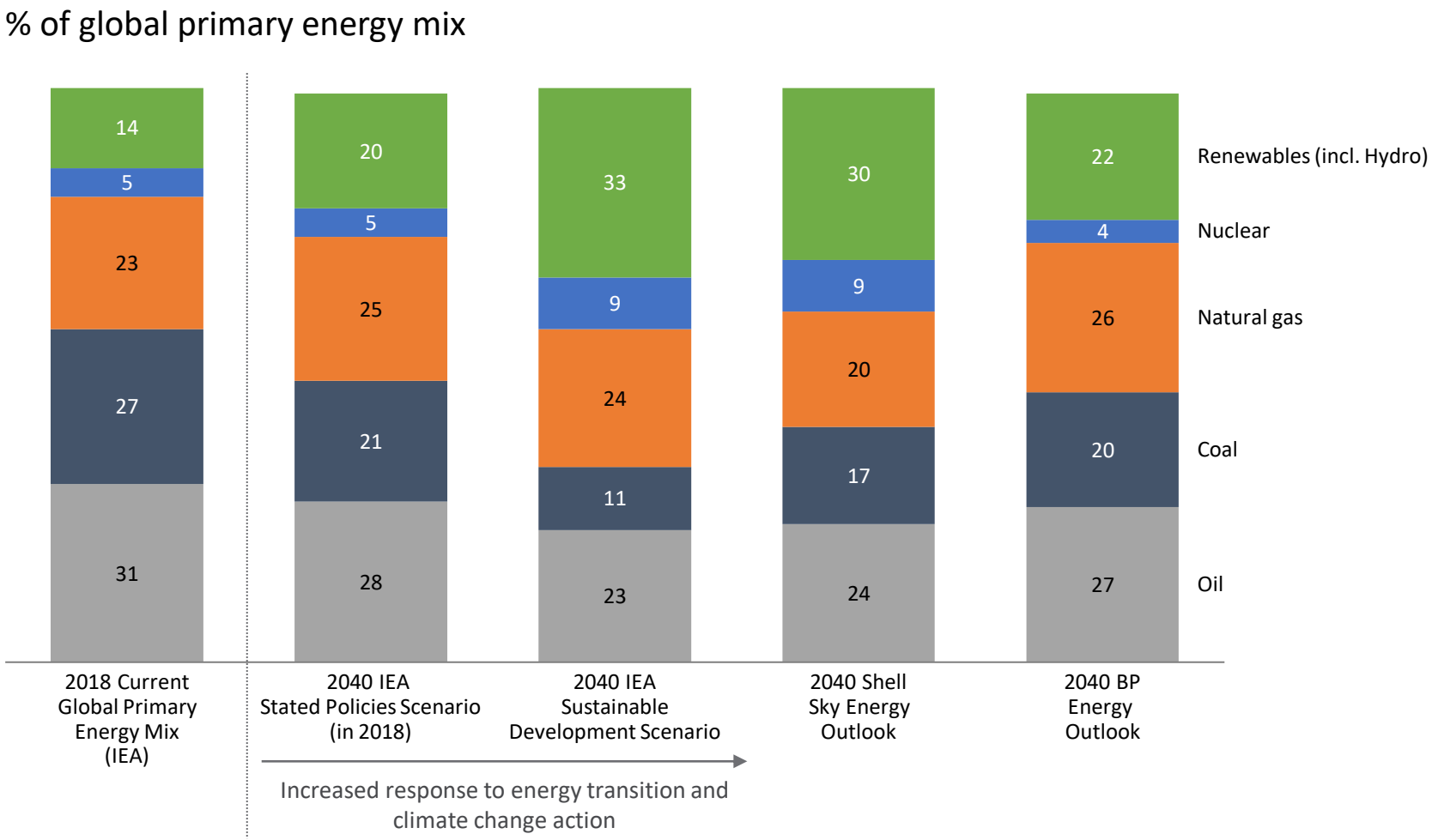
Total global primary energy supply by source (%)



Note: Projections are based on the Energy Transition scenario of the BP Energy Outlook; The nature of the energy transition pathway will differ for various countries

Source: BP Energy Outlook, BCG

Primary energy demand expected to shift away from coal and oil towards cleaner sources of fuel



Source: IEA, Shell Energy Outlook, BP Energy Outlook

Accelerated pace of energy transition creating many new growth opportunities

Energy transition trends and growth opportunities …	… and governments, investors, corporations already responding
 **Future of Mobility** • Electric Vehicles and V2G1 • Autonomous Vehicles • Sharing Economy	Research from Bloomberg New Energy Finance indicates that falling battery costs will mean electric vehicles will be cheaper to buy in the U.S. and Europe as soon as 2025. **Hyundai will start making electric cars in Singapore from 2022** Thailand to have 1.2 million electric vehicles running in streets by 2030
 **New Energy** • Solar, Wind, Bioenergy • Green and Blue Hydrogen • Energy Storage Solutions	Renewable Electricity Levelized Cost Of Energy Already Cheaper Than Fossil Fuels, And Prices Keep Plunging BP warns of oil demand peak by early 2020s Coronavirus pandemic ushers in an earlier than anticipated decline for the fossil fuel era
 **Energy Efficiency Tech** • Smart Homes & Devices • Smart Grid Technologies • Demand Mgmt. Solutions	**Smart Home Market to Rise at 18.4%; Rising Inclination toward Energy Saving Boosts Market** **Smart-grid plan aims to make Thailand the electricity hub of ASEAN**
 **Circular Economy** • Eco & Energy Efficient Design • Industrial Symbiosis • Recycling & Energy Recovery	**Norway uses waste as eco-friendly fuel** UK Government announces new waste strategy for a circular economy
 **Green Economy** • Carbon Capture & Storage • Carbon Tax & Credit Trading • E-S-G Investing2	EU considers tax, emissions trading for carbon border plan **Sustainable investing is set to surge in the wake of the coronavirus pandemic**

1. V2G = Vehicle-to-Grid 2. ESG = Environmental, Sustainability, Governance

Source: Press Searches, BCG analysis

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Countries are recognizing the importance of green COVID-19 recovery, and a deeper focus on environmental sustainability

China aims to hit peak emissions before 2030 and for carbon neutrality by 2060

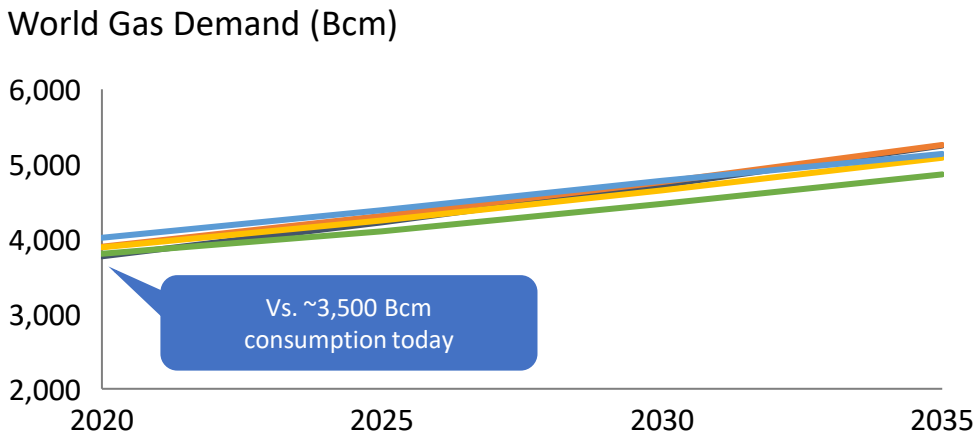
- President Xi Jinping announcement at the 2020 UN General Assembly

- China constitutes 28% of global emissions and consumes half of the world's coal consumption
- Xi said that the COVID-19 pandemic has shown that "humankind can no longer afford to ignore the repeated warnings of nature."
- He called on countries to pursue "scientific and technological revolution and industrial transformation" to achieve a "green recovery of the world economy" in the post-COVID era and to pursue innovative, coordinated, green and open development for all."

Source: Press Search

Gas growth expected to continue

Key global gas consumption growth forecasts



Projections and growth CAGRs

- EIA Intl Energy Outlook 2016 (2.2%)
- Shell LNG Outlook 2017 (2.0%)
- BP Statistical Reivew 2016 (1.8%)
- IEA Golden Age of Gas scenario – 2011 (1.8%)[1]
- IEA - NPS 2016 (1.6%)[2]

Coal demand growth forecast to be between negative and 0.5% per year3

1. 2008-2035 period. 2. 2014-2035 period. 3. Includes forecasts of EIA, IEA, BP. Note: NPS: New Policies Scenario, which is the base scenario used in annual World Energy Outlook Reports

Source: IEA Reports, EIA 2016 Report, BP Statistical Review 2016; BCG analysis

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Expected benefits from gas

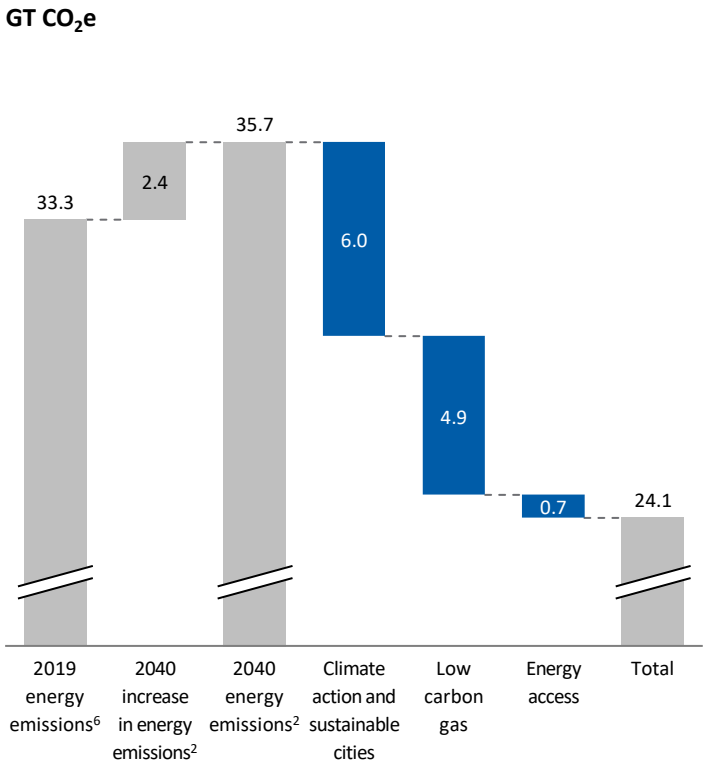
- Immediate reduction in GHG emissions and air pollutants
- Accelerator for Energy Access and Clean Cooking
- Enabling distributed energy systems & increasing efficiency and economics of energy consumption
- Cleanest fossil fuel to support energy transition agenda

Gas technologies can abate up to 30% of global energy sector GHG emissions

GHG reduction potential by 2040[1] (GT CO_2)

	Technology	Base case[2]	Potential[3]
Climate action and sustainable cities	Power switching	0.6	3.3
	Industry switching	0.6	2.0
	Industrial efficiency	0	0.1
	Enabling renewable power	Enables renewables[4]	
	Road transport	0.1	0.4
	LNG bunkering	<0.1	0.2
Low carbon gas	Renewable gas	0	0.9
	Hydrogen		
	CCUS	0.1	4
Energy access	Buildings adoption	0.2	0.5
	Distributed generation	0.1	0.2
	SSLNG	Enables fuel switching[5]	

Global GHG emissions reduction potential[3] from gas technologies by 2040



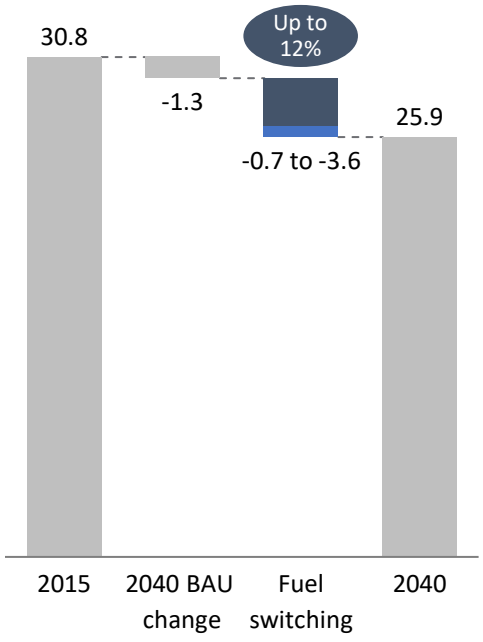
1. Estimated on the basis of gas demand growth multiplied by the average emissions benefit of switching from coal and or oil to natural gas or low carbon gas; 2. Base case is aligned with IEA 2019 Stated Policies Scenario; 3. Potential is based on the economic potential as defined in Chapter 1; 4. Emissions benefit achieved from the adoption of renewable power were not evaluated, as part of this analysis; 5. Emissions benefit accounted for in other categories; 6. Based on IEA data

Natural gas adoption would significantly reduce global emissions of key air quality pollutants

Potential 2040 annual local emissions reduction from gas adoption[1]

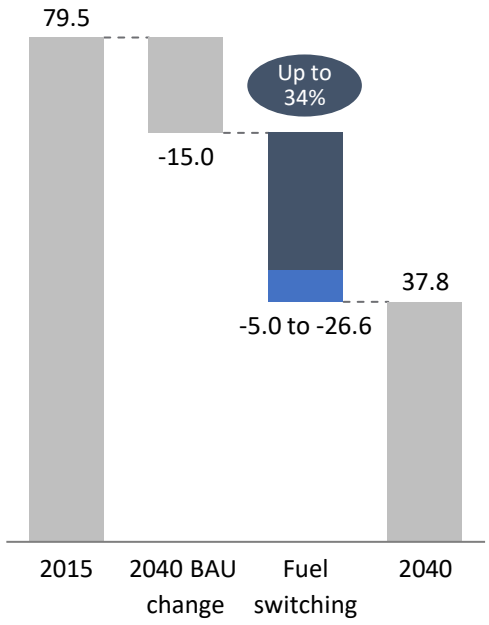
Particulate matter

Global emissions PM 2.5 (MT)



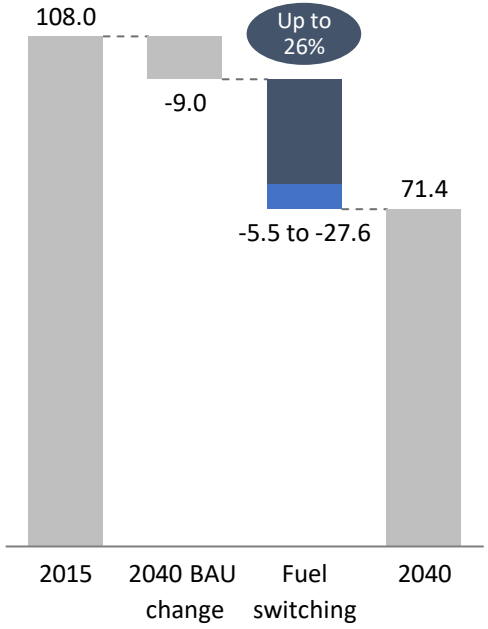
Sulphur dioxide

Global emissions SO_2 (MT)



Nitrogen oxide

Global emissions MT No_x (MT)



Potential[3] Base case[2]

1. Calculated as potential emissions benefit relative to business-as-usual 2040 emissions using Current Policies Scenarios from IEA 2016 WEO report; 2. Base case is aligned with IEA New Policies Scenario in prior WEO reports; 3. Potential is based on the economic potential as defined in Chapter 1

Source: IEA, WHO, BCG analysis

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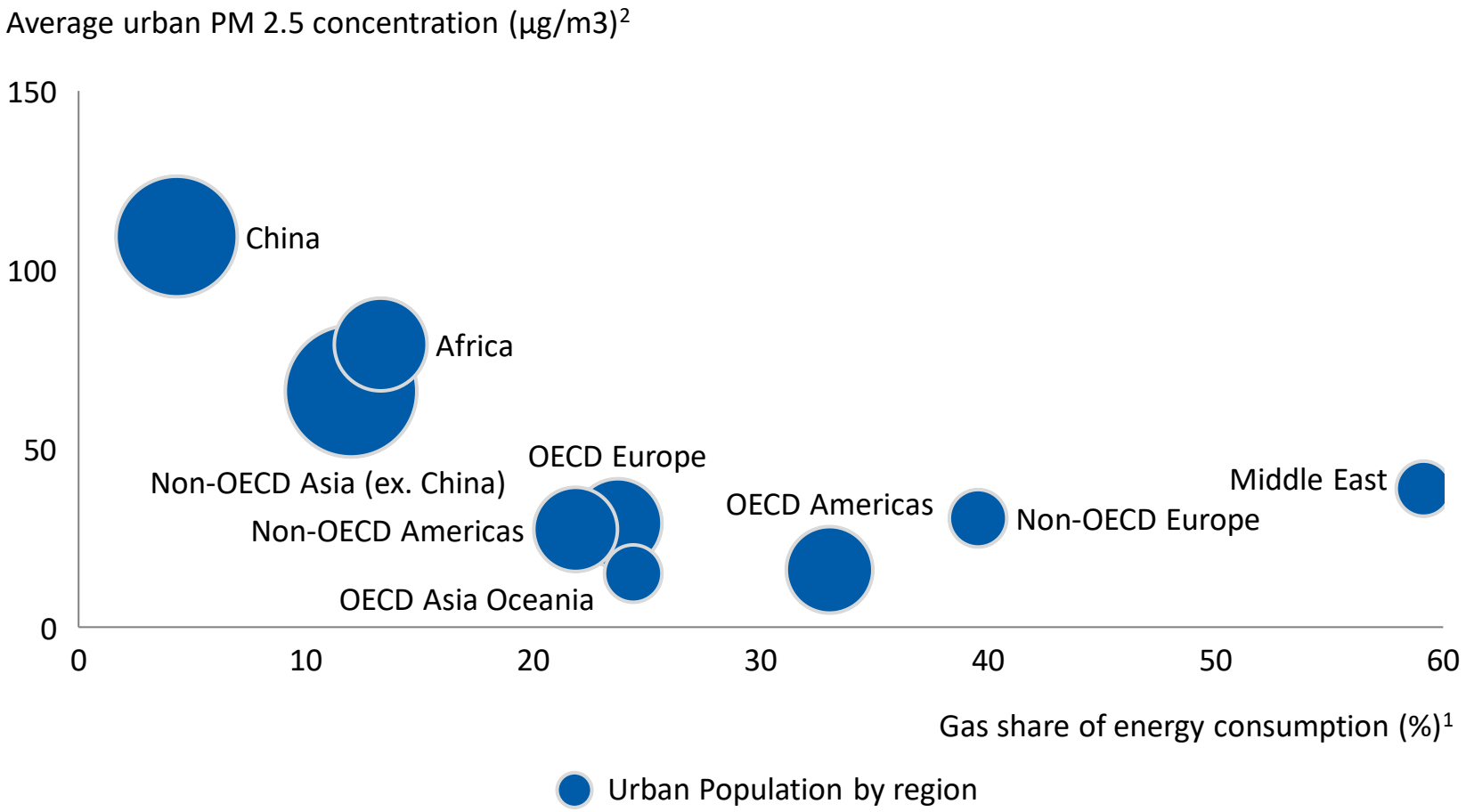
Gas adoption is a key enabler of improved urban air quality

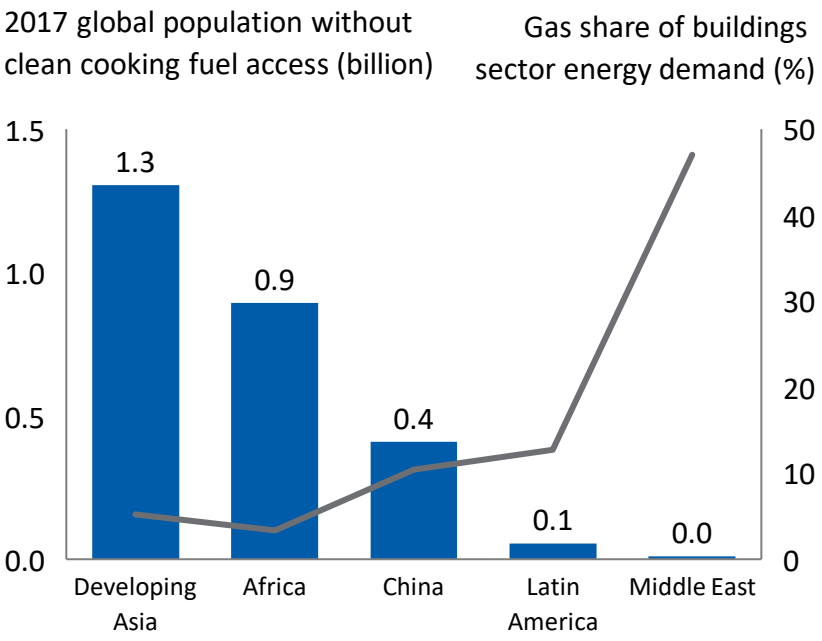


1. Includes weighted average of power generation, buildings, and industry sectors; based on 2015 data; 2. Based on cities in the WHO survey database

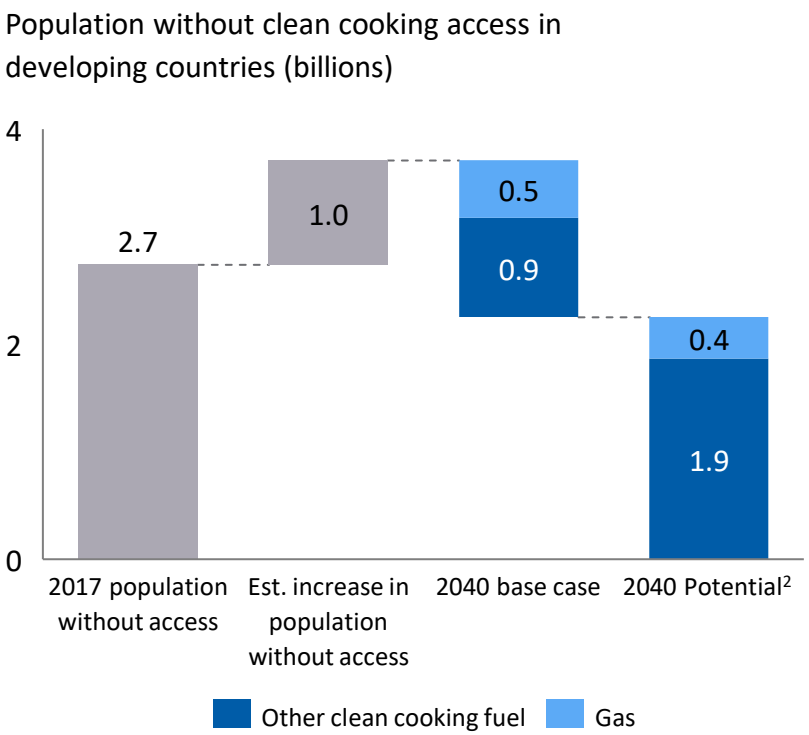
Source: IEA, World Health Organization, BCG analysis

Gas can provide access to clean cooking fuel for up to 1 billion additional people by 2040

Population without access to clean cooking fuels relative to gas access



Access to clean cooking fuels by 2040 with gas contribution for up to 1 billion people



1. Other clean fuels consist of clean biomass, LPG, and solar; 2. Potential is based on the economic potential as defined in Chapter 1
Source: IEA, BCG analysis

Economic potential for natural gas defined based on competitiveness in different segments of use

Sector	Drivers of gas deployment	Economic potential[1]	
		Demand growth by 2040 (BCM)	GHG reduction by 2040[2] (GT CO_2)
Power	• Competitiveness of gas at a national level • **Gas replacing coal and oil generation only at the end of average plant lifecycles**	2,400	3.3
Industry	• Declining cost of gas technologies based on recent innovation trends • Average competitiveness of gas vs. coal in different industrial sub-segments	1,600	2.0
Buildings	• Gas replacing all remaining coal and oil products used to fuel commercial and residential buildings	500	0.5
Transportation	• Road transport: Impact of technology trends, applied by segment (e.g. heavy duty best suited for LNG) • Marine bunkering: Segment of marine consumption most exposed to action on air pollution	900	0.5

Note: In all cases, increasing cost of carbon assumed in line with requirements to limit warming to 2 degrees as included in the IEA SDS from the 2019 WEO; technology cost trends identified in the report are applied, otherwise economic assumption are generally aligned with IEA SPS from the 2019 WEO

1. Potential is based on the economic potential as defined in Chapter 1; 2. Calculated as gas demand growth multiplied the emissions benefit of switching from coal and or oil to natural gas

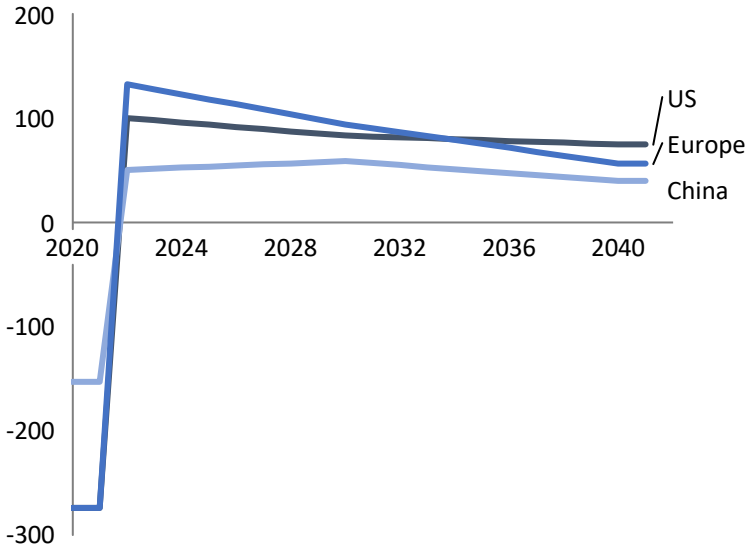
Source: IEA, EIA, BP 2019 Energy Outlook, NGVA Europe, IPCC, BCG analysis

Coal-to-gas switching is NPV positive, even under rapidly rising carbon prices aligned with a 2-degree pathway

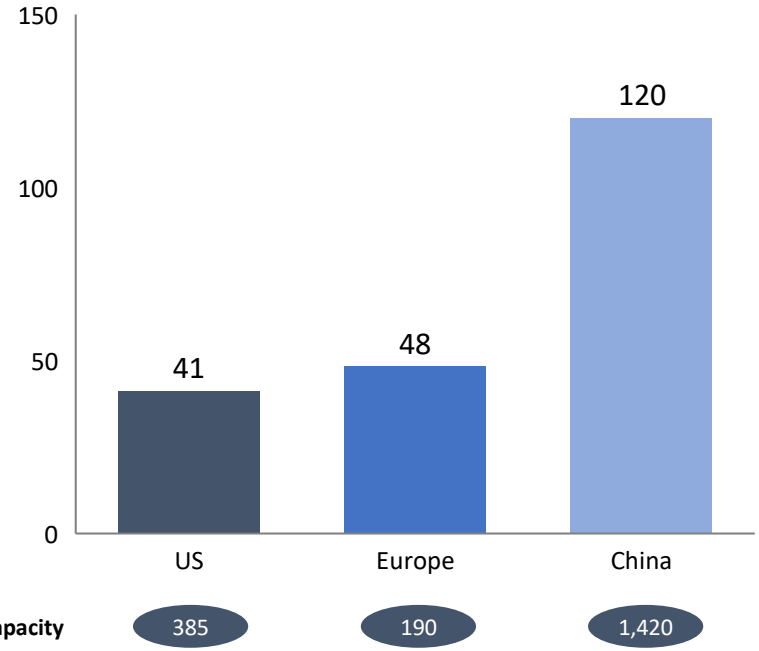
Example project cash flow in the US, EU, and China for an average CCGT plant

Cumulative NPV of gas capacity additions aligned with economic potential for gas

Pre- tax cash flow of a standard US, European and Chinese CCGT[1] ($M)



Estimated cumulative NPV of new CCGT investments 2020-2040 ($B)



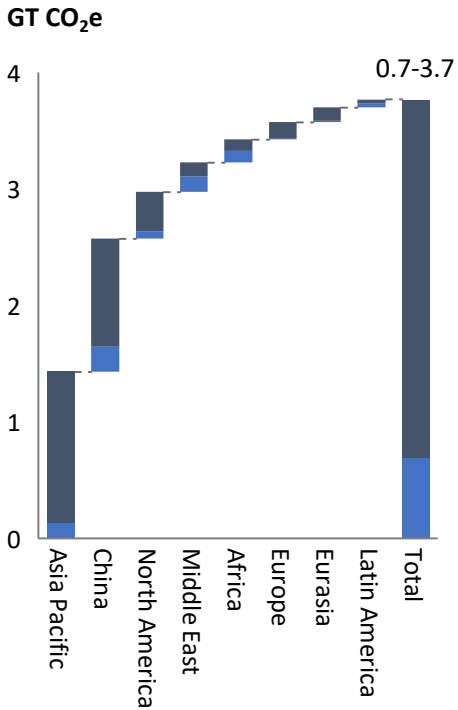
1. Revenue calculated assuming realized prices consist of power plant capital recovery and O&M, fuel costs, and CO2 price recovery as defined by the IEA 2019 WEO; Standard is defined as the averages used for Lazard's LCOE 13.0 study with a 25% discount for Chinese O&M costs; Carbon tax escalates to $140 per metric ton of CO2e by 2040 in US and to $125 per metric ton of CO2e by 2040 in China

Source: Lazard, US EIA, IEA, BCG analysis

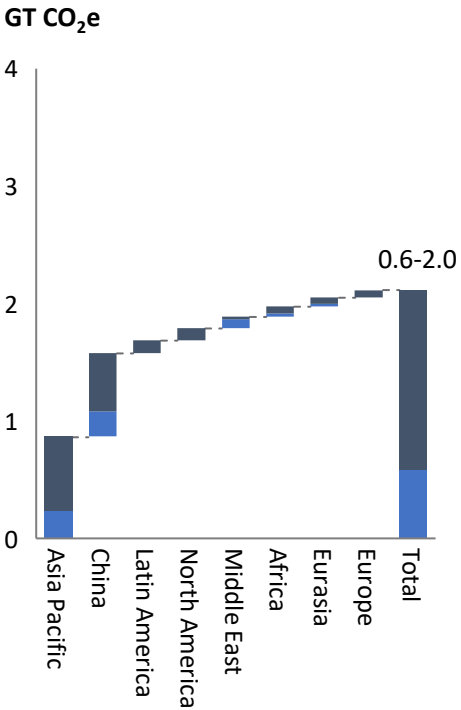
Power sector fuel switching provides the greatest opportunity for GHG emission reduction

Maximum potential annual emissions reduction from gas fuel switching by 2040[1]

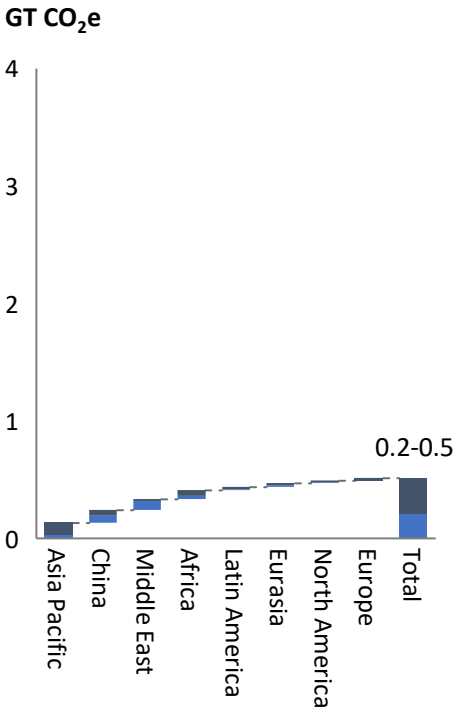
Power sector



Industry sector



Buildings sector



1. Calculated as the emissions reductions identified from the economic potential in this study relative to the IEA 2020 WEO Stated Policies Scenario

Source: IEA, EIA, BP Energy Outlook, NGVA Europe, IPCC, BCG analysis

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Varying challenges across regions to deliver gas ambitions

Competitiveness vs. coal and supply infra remain as key issues for Asia

Regions	1. Cost competitiveness	2. Security of supply	3. Sustainability
Africa	Improving competitiveness vs. coal in some countries	Supply infrastructure critical for expanding gas access	
Asia	Improving competitiveness vs. coal across the region	Supply infrastructure critical for expanding gas access	
CIS			
Europe	Ensuring sustained competitiveness vs. coal and renewables	Diversified supply key for managing geopolitical concerns	Low carbon applications needed for long term carbon targets
Latin America	Improving competitiveness vs. coal in some countries	Supply infrastructure critical for expanding gas access	
Middle East			
North America		Expanding infrastructure to access gas for transport	Low carbon applications needed for long term carbon targets

Critical for achieving growth | Moderate priority for gas growth | Achieved/not a high priority

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Enablers for Governments to Unleash Gas Potential

Three key enablers to deliver full gas potential

Government policy

Carbon pricing as a market incentive is growing; yet only covers ~20% global GHG emissions

Infrastructure investment

Investment in gas infra is well below the level needed to achieve the full potential of gas

Industry innovation

Recent advancement in new business model, as well as new technology (e.g. small-scale LNG)

Policy plays a critical role for shaping gas market development

Examples of successful policies

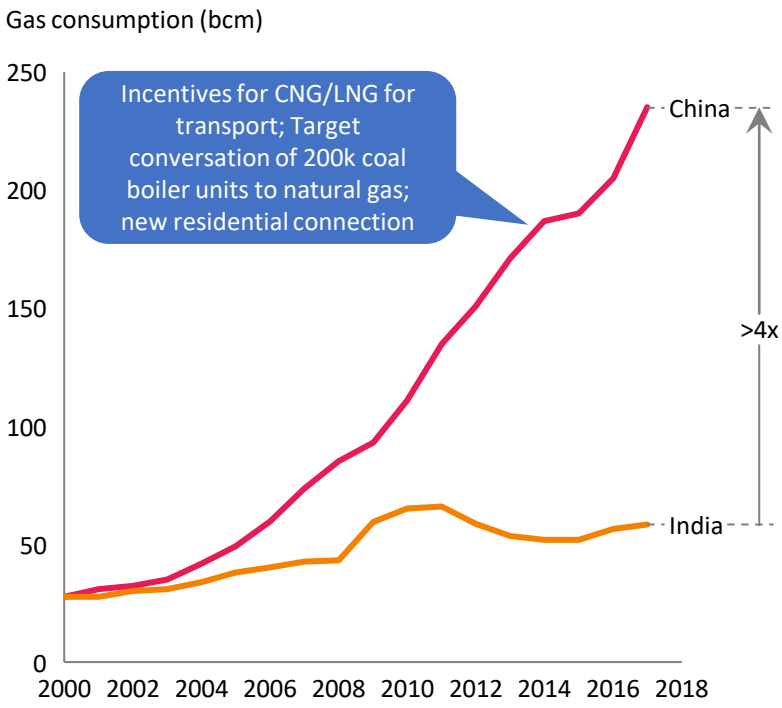
Production
- Production targets
- Priority upstream licensing
- Market-based pricing

Trade
- Competitive tariff structures
- Foreign gas trade agreements
- Anchor agreements by public utilities

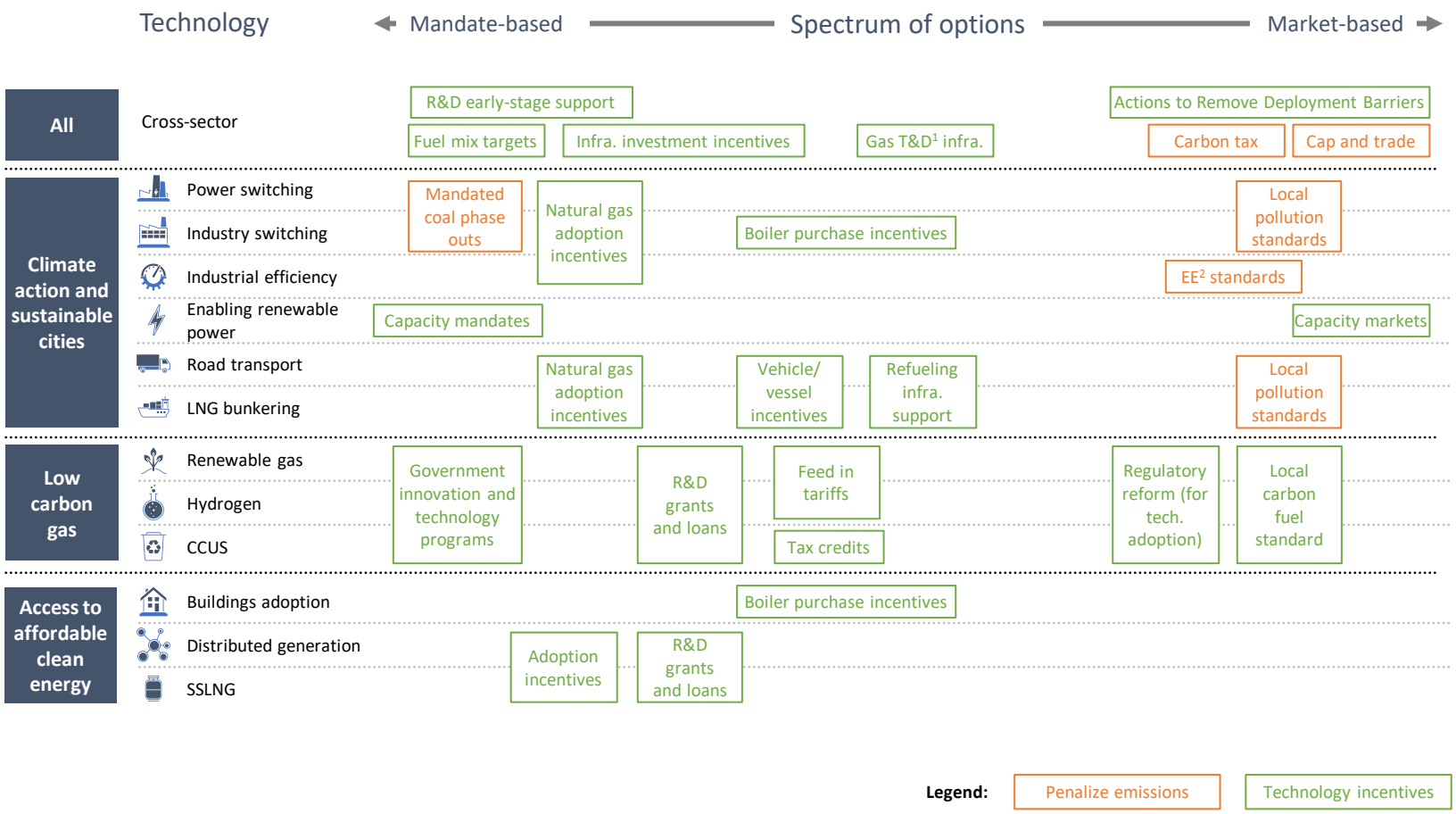
Infrastructure
- Capacity development targets
- Expedited permitting
- Capex support/lending programs

Consumption
- Pricing of environmental externalities
- Fuel switching requirements/incentives
- Priority sector-based incentives

Example: Divergence between China and India



Wide range of policy options available to enable gas technology development



1. Transmission and distribution, 2. Energy efficiency
Source: BCG analysis

Significant impact seen from advancement of industry innovation

Non exhaustive

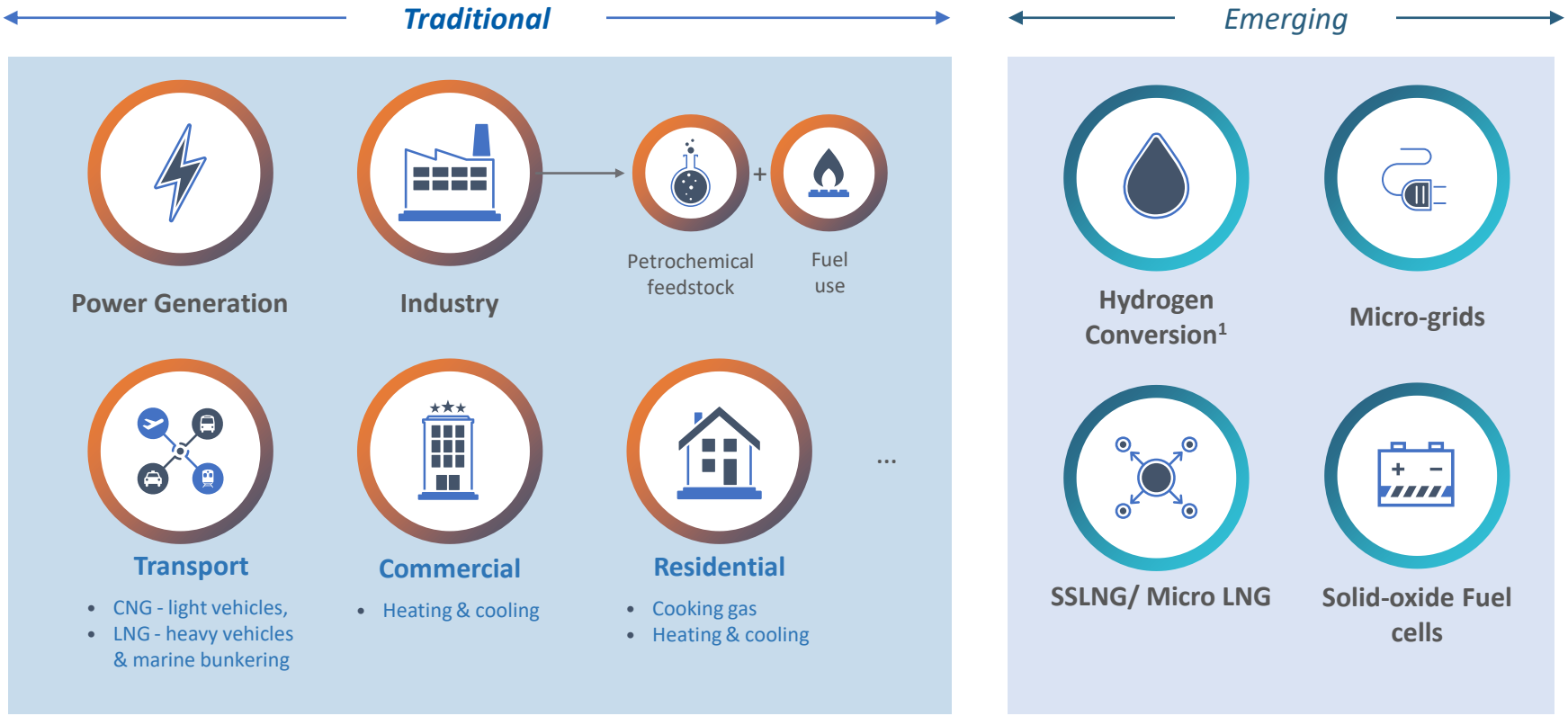
20%+ efficiency in gas consumption for combustion apps.

10%+ efficiency in gas equipment CAPEX

50%+ reduction in upfront CAPEX through distributed & small-scale LNG

40%+ improvement in plant ramp times

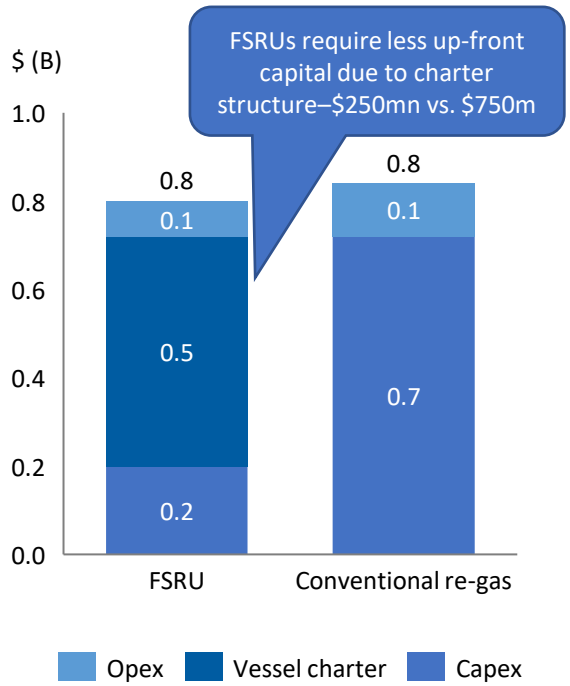
Range of innovative gas applications – from traditional to emerging



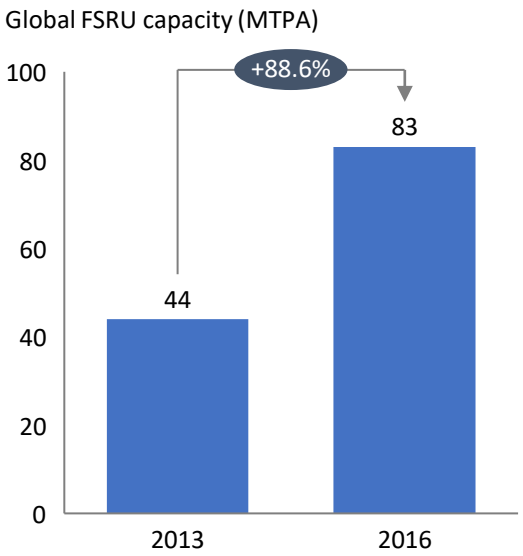
1. Grey and blue hydrogen

Flexible and low capital business models are critical - Example of FSRUs

FSRUs provide more flexible, lower capital gas supply …



… FSRU capacity is growing …



… And is helping countries to diversify supply

Argentina: FSRUs quickly added nine bcma capacity to offset domestic production decline

Jordan: FSRU capacity restored gas supplies after Egyptian imports dropped given domestic supply shortages

Bangladesh: Plans currently in place to develop FSRU import aligned with new CCGT plants

Source: IGU, BCG analysis

Regional trends indicate Asian suppliers increasing transporting LNG through containerized cargo

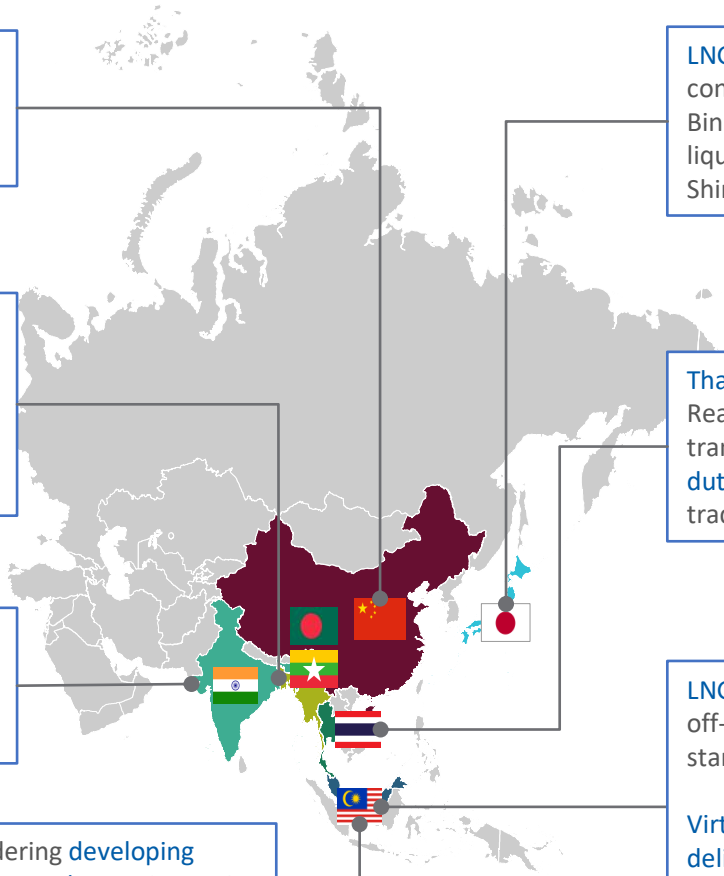
Non-exhaustive

China has developed a network of 200 LNG producing and loading stations across the country that delivers the fuel to industries without a grid connection

LNG terminal in East India to help supply gas to Bangladesh, Myanmar, capable of reloading LNG to service proximate markets via the marine route and will also have truck-loading gantries to help grow the nascent LNG by truck market

Growth in containerized LNG in India: Truck loading facility at liquefied natural gas (LNG) terminal on India's west coast to meet demand from industrial users

Sarawak is considering developing Virtual Pipeline network covering LNG supply Miri, Bintulu and Kuching



LNG sales by ISO tanks in Japan, signed contracts with buyers.
Binding agreement with China to deliver liquefied natural gas (LNG) from its Shimizu terminal in western Japan

Thailand Regional LNG trading plan: Ready in terms of gas infrastructure and transport via marine vessels and heavy-duty trucks, as well as manpower for LNG trade

LNG trucking in order to supply LNG to off-grid customers in Peninsular Malaysia started in the second half of 2020

Virtual Pipeline Network in Sabah delivering LNG to customers in Sipitang, Tenom, Nabawan, Tawau, Kunak, Lahad Datu and Sandakan

Source: Desktop research, BCG analysis

SSLNG: Distribution by truck now a material segment of the Chinese market

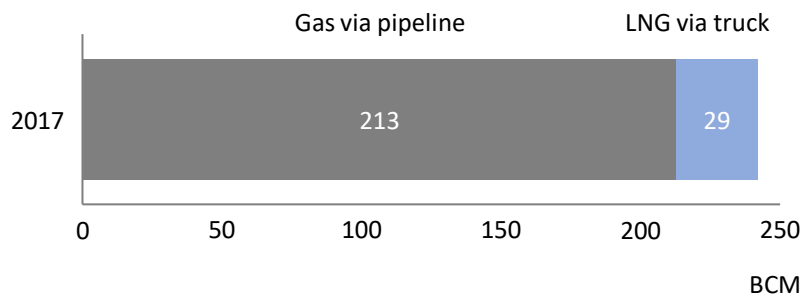
Impact: LNG trucks provide off grid access—now supply 10% of Chinese gas market

Trucked LNG market expands access and fosters market competition

LNG trucks bring natural gas to off grid industrial customers, allowing them to comply with Chinese fuel switching policies

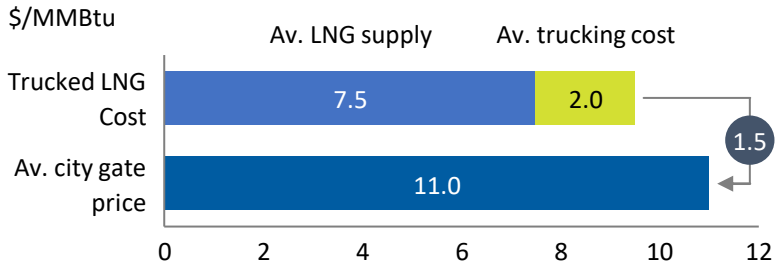
Both pipeline natural gas and off grid customers can check market prices and trading volumes on WeChat groups, improving competition and liquidity

Over 10% of Chinese natural gas consumption distributed by truck



Drivers & lessons: Attractive margin and ability to quickly expand drove market growth

Unit margins on trucked LNG distribution can be attractive



Organic market developed to meet policy-driven demand growth

Pipeline expansion could not keep up with rapid policy-driven demand growth

The speed with which truck loading infrastructure can be built helped LNG trucking grow quickly and meet excess demand

An organic trucking market quickly developed in an otherwise heavily regulated market

Sources: IEA, Wood Mackenzie, National Bureau of Statistics of China, OIES, BCG analysis

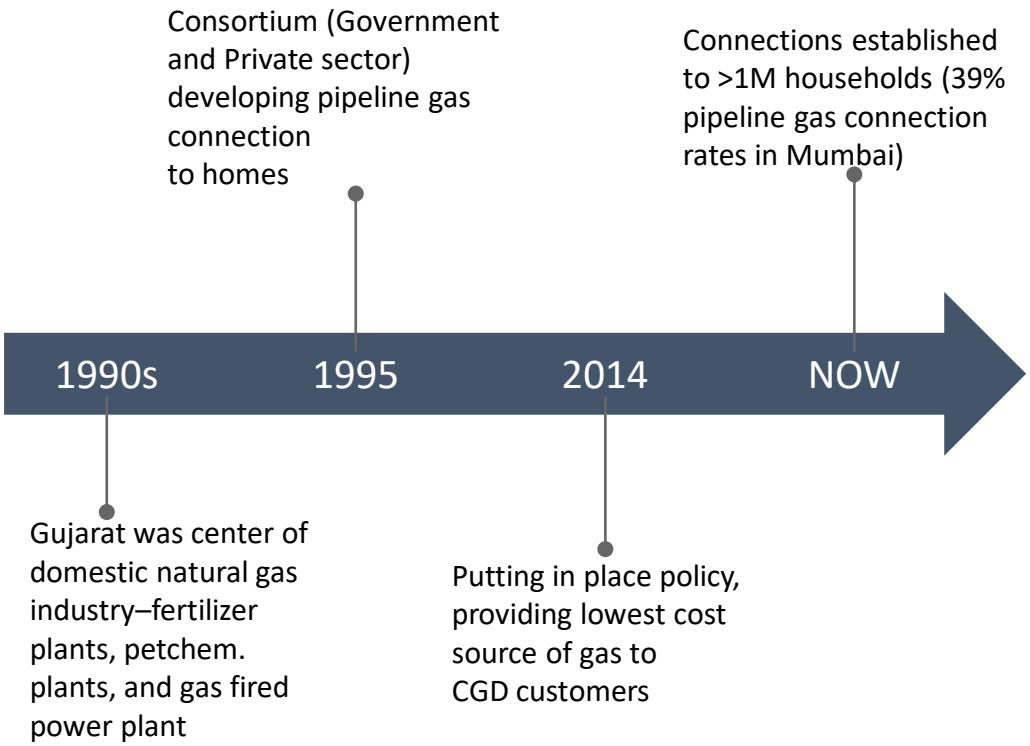
Extending gas infrastructure to cities

Gas provides specific advantages for cities

- **Air pollution:** nearly zero sulphur dioxide, nitrogen oxide, and no particulate matter emissions
- **GHG emissions:** 40% less than coal and 20% less than oil
- **Heat intensity:** Most heat intensive (and thus highest efficiency) fuel source
- **Scalability:** Ease of adding customers to existing networks once infrastructure is developed

Source: Business Insider

Journey from deploying gas first to industry and power applications, then extending infra to cities over time



Energy mix: Three strategies

Objective	Access to industry, switch from diesel to gas	Coal to gas (200K boilers, 44 GW, 120M conn.) in power & RCA	100% EV/Hydrogen vehicles by 2025
Competitive advantage	Private sector interest to invest and high capability to operate	G2G deals and SOEs to negotiate gas imports and implement	Government has high willingness and capacity to invest
Liberalization	Deregulated diesel prices (Gas 20% cheaper)		
Infrastructure	Private sector bids for concessions on gas sales in city	Invest heavily in extending pipeline, new regas terminals	High gov. investment in recharging stations
Taxes and subsidies		Targeted subsidies in 28 cities (Despite wider liberalization)	25% sales tax removed, import duties and road tolls waived
Regulations	Rule to ensure residential connections		Free use of road ferries and bus lanes
Gov. directive		Import contracts G2G and B2B (e.g., US, Russia, Australia)	
Cost Impact	Industry Low increase	Government > $100B	Government $1B p.a.
Success metric	CGD 16% of total gas demand within 9 years	130Mt CO2 reduction versus 2011	>60% EV market share

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Maximizing value: Three strategies

			
Objective	Boost domestic gas production	Maintain competitive advantage of port and develop gas trading hub	Maintain gas production to meet power demand
Competitive advantage	Long-term production decline, assume already 'peaked'	Ability to absorb upfront costs to "lock in" port customers	Belief that consumers able to bear higher price of gas
Liberalization	Private sector allowed to do new drilling		Liberalizing gas to market prices to promote supply
Infrastructure		Retrofit LNG Vessels ($2M) $2B mega-port expansion	Pipeline and power plants in South Vietnam
Taxes and subsidies		Port dues discounted, craft dues waived	
Regulations	Law enabling private individuals to own O&G under their land		
Gov. directive		International cooperation (e.g., Japan, Norway)	
Cost Impact		Government >$3B in next 20 years	
Success metric	Largest producer of natural gas, competitive gas prices	Expected to be largest LNG bunkering hub	N/A

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