The 7th Asian Ministerial Energy Roundtable

AMER7

Bangkok | Thailand

Plenary Session 2:

Natural gas: Market and policy hurdles to the golden age of gas

Background Paper

BCG ENERGY

IEF INTERNATIONAL ENERGY FORUM

Disclaimer

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

Introduction

Market context

- Asia is home to the world's largest new gas consuming markets, and counts among its number the world's most rapidly growing economies that seek to embrace the "Age of Gas"
  - Despite already high growth rates, infrastructure and market hurdles remain
- Liquified Natural Gas technologies have made global gas markets more competitive
- As Asia weighs the costs and benefits of gas bilateral producer-consumer relations built up over the past decades have never been more critical for longer term gas market security

Session objectives

- Discuss which policy and market levers will enable gas to shape healthy and affordable energy matrices in support of clean energy technologies to underpin sustainable growth and development in Asia
- How will Ministers help enhance gas market penetration, and overcome market and policy hurdles to achieve healthier energy matrices in Asia?

Key Question:
How can hurdles be overcome in the Gas sector in Asia?

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Contents

What is the future role of natural gas globally?

What is the natural gas balance in Asian Pacific (APAC) countries?

Key questions and discussion

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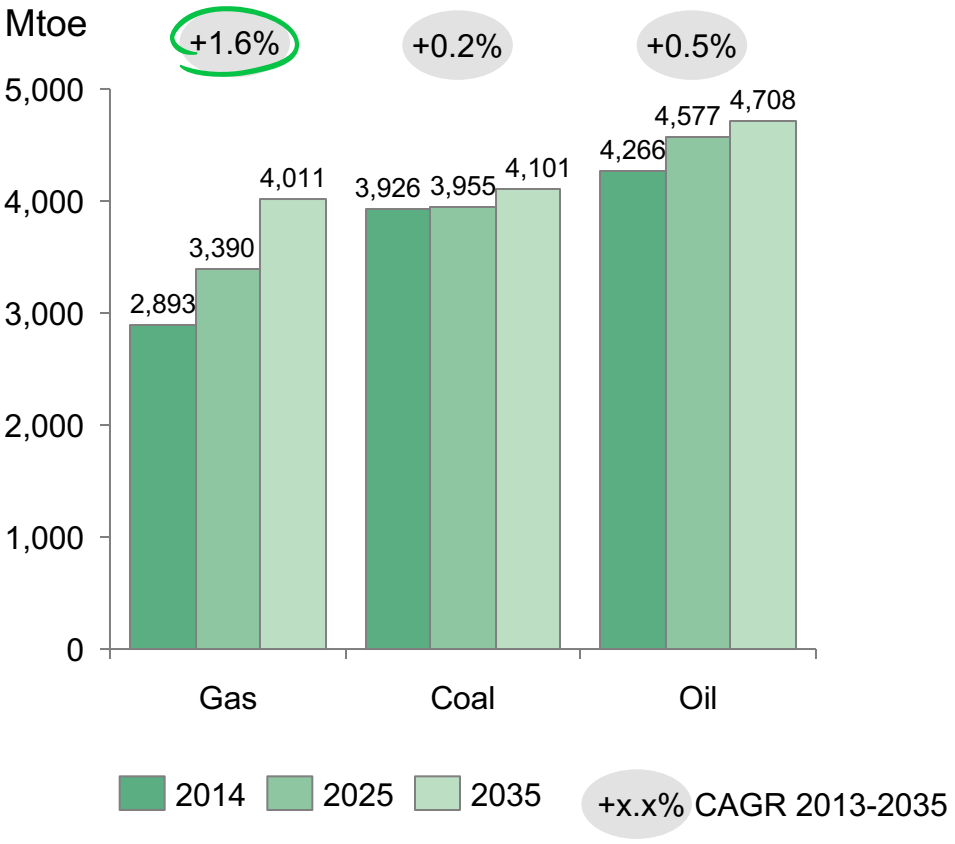
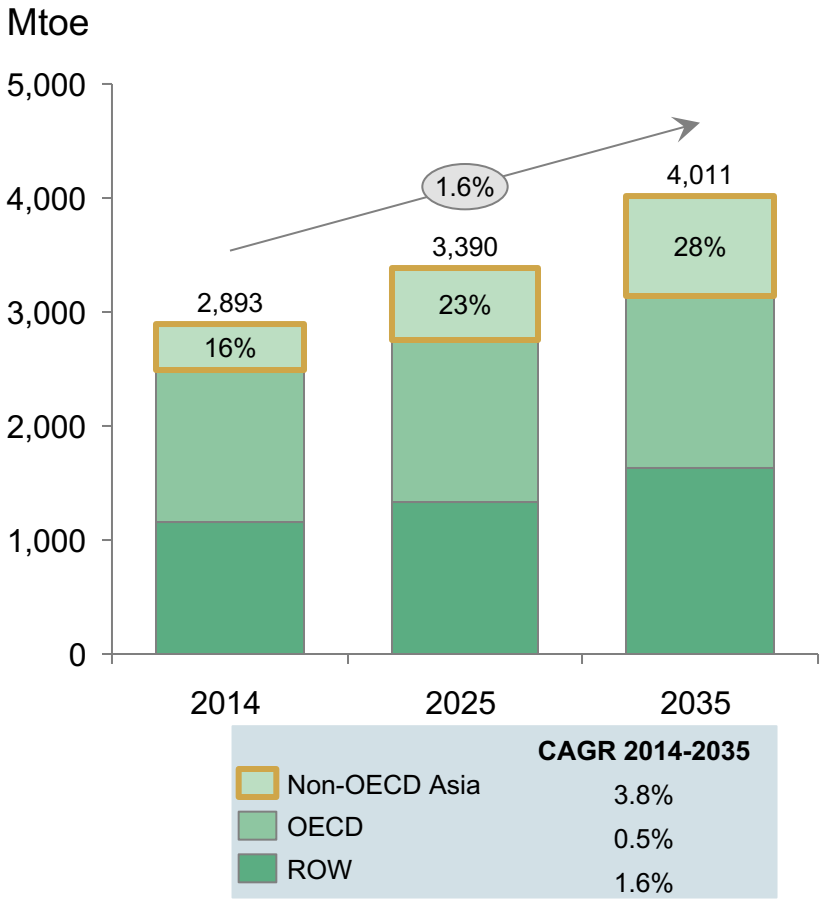
Natural gas: the greatest growth fossil fuel

Demand expected to be driven by non-OECD Asia

Predicted demand growth for natural gas leads other primary energy sources[1]



Growth expected to be driven by non-OECD Asia



1.New Policies Scenario
Source: IEA, BCG LNG Market Model

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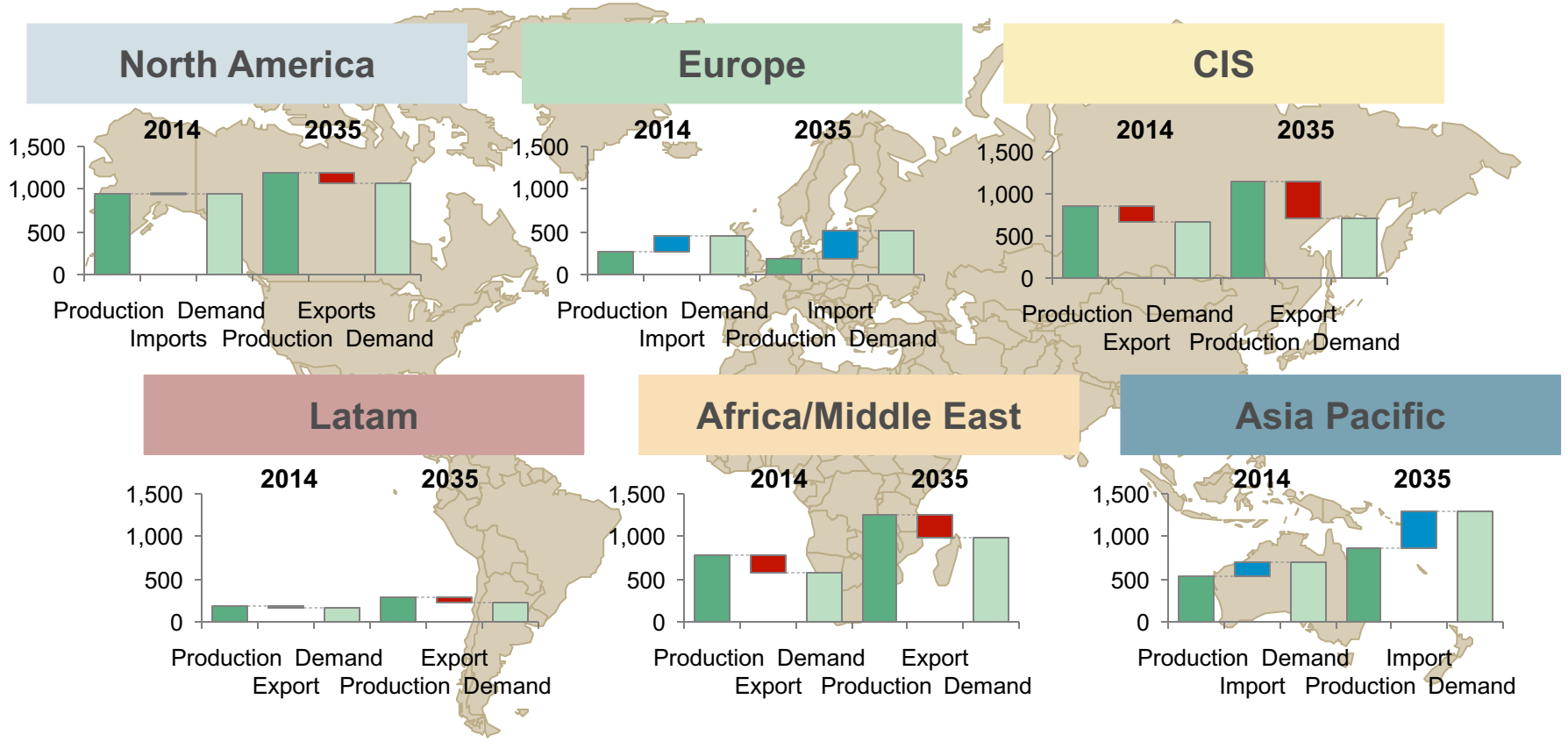
Separation between the major future demand sinks and producing regions will necessitate the increased flow of LNG

World wide regional Natural gas balance 2014-2035 (Mtoe)



LNG flow expected to increase from 325Mtpa in 2015 to ~700Mtpa in 2035; gas demand becomes an LNG story

Source: IEA WEO 2016

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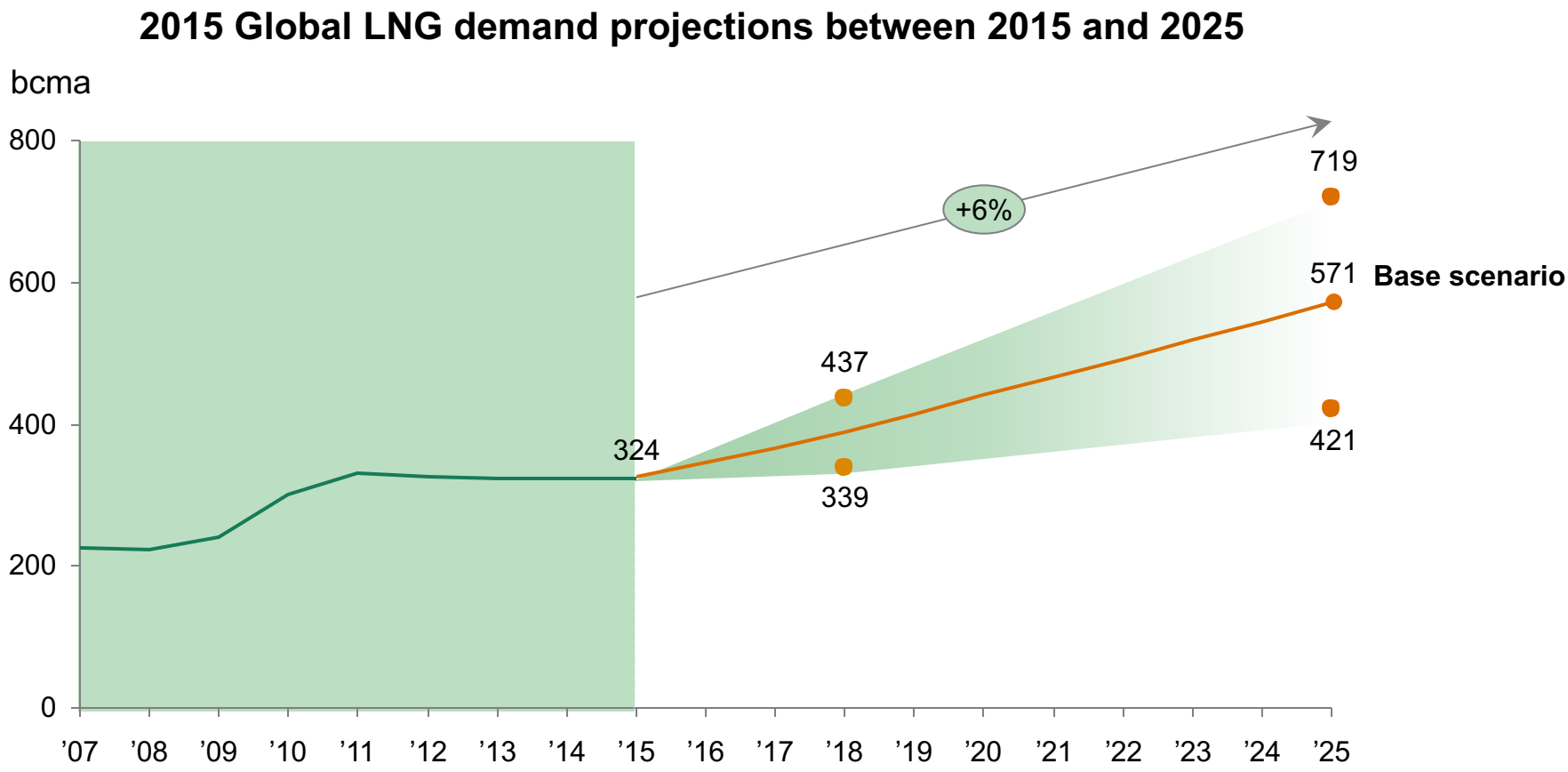
LNG demand is expected to grow at 5-6% p.a. between 2015 and 2025 under the base scenario



Source: BP Statistical review of world energy, Cedigaz, WoodMackenzie, BCG analysis

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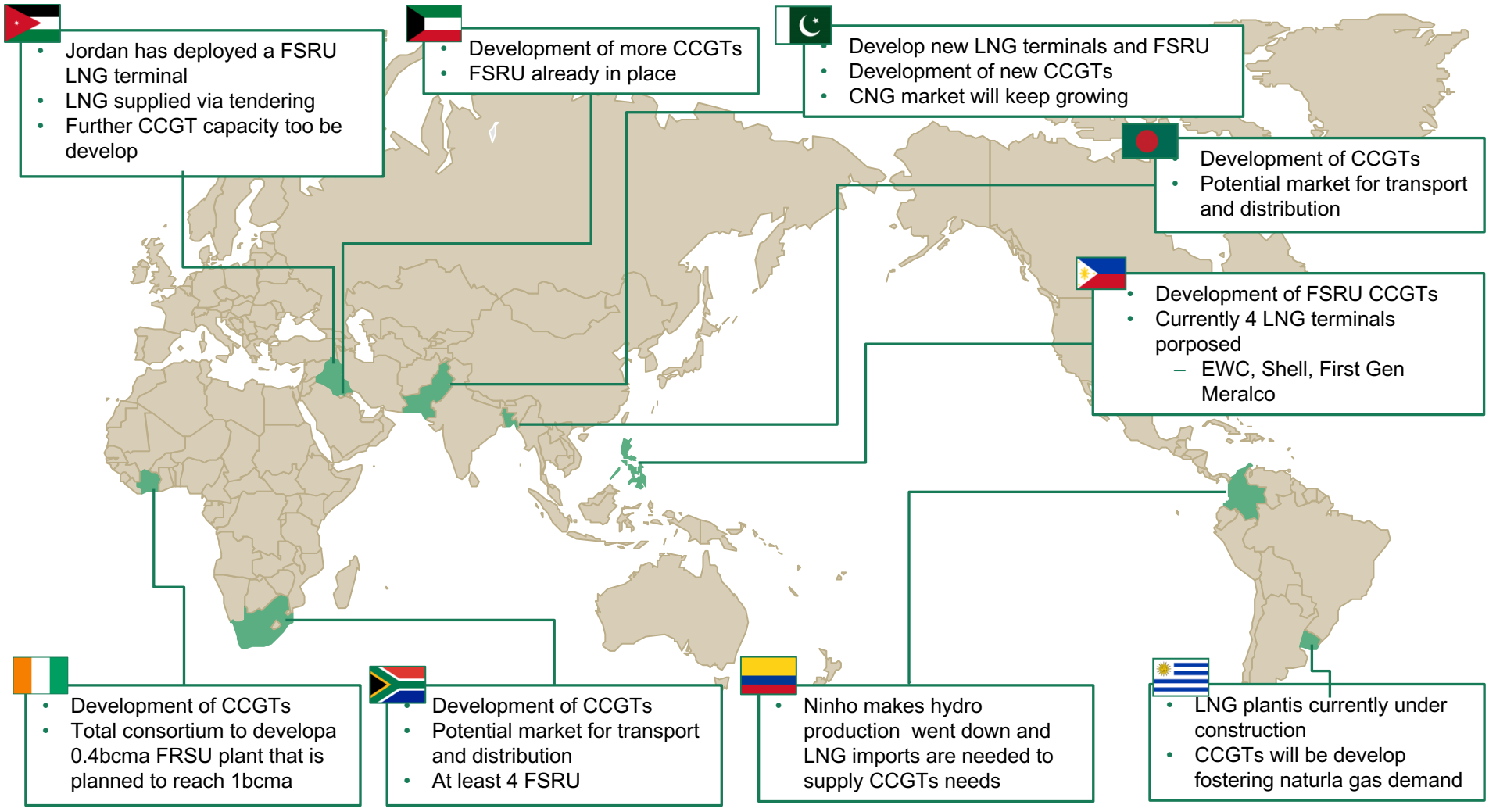
More countries can join supporting a higher demand growth rate



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There are also three new market segments that has potential to increase natural gas consumption

Criteria	Marine transport	Road transport	Off-Grid and small scale LNG
Regulatory Compliance	• Emissions Control Areas (ECA)	• Euro VI • India Bharat 3 • PNLT 2009 Japan • National V standard China • US EPA standards	• Environmentally friendly emissions with lower carbon content
Economic	• Fuel pricing, compliance, and reduced maintenance costs	• Fuel pricing, compliance, and reduced maintenance costs	• Fuel pricing, multi-fuel capabilities, and reduced maintenance costs
Practical	• Technological advances in LNG bunkering	• Natural gas engines operate at lower noise levels – facilitating access to urban zones	• A means of creating gas distribution networks where no pipeline supply current exists
Market potential 2030	• 120-180bcma	• 400-600bcma	• ~40bcma power • 30-50bcma industry

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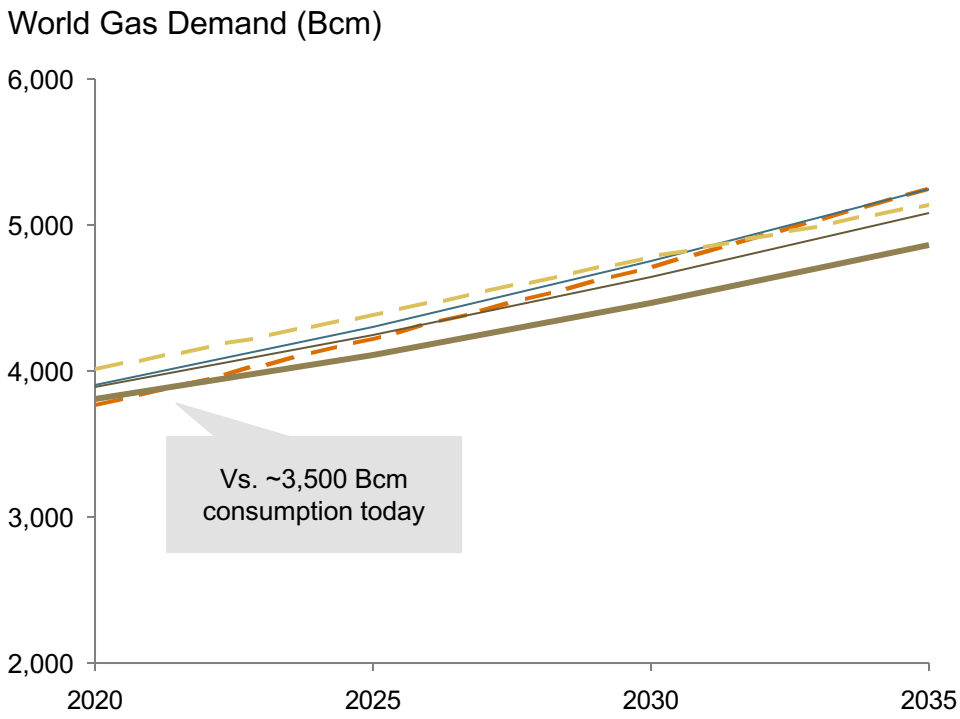
A new 'bullish' industry consensus has emerged on the growth of gas between now and 2035

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 year[3]

Gas expected to be the fastest growth fossil fuel, surpassing coal by 2035

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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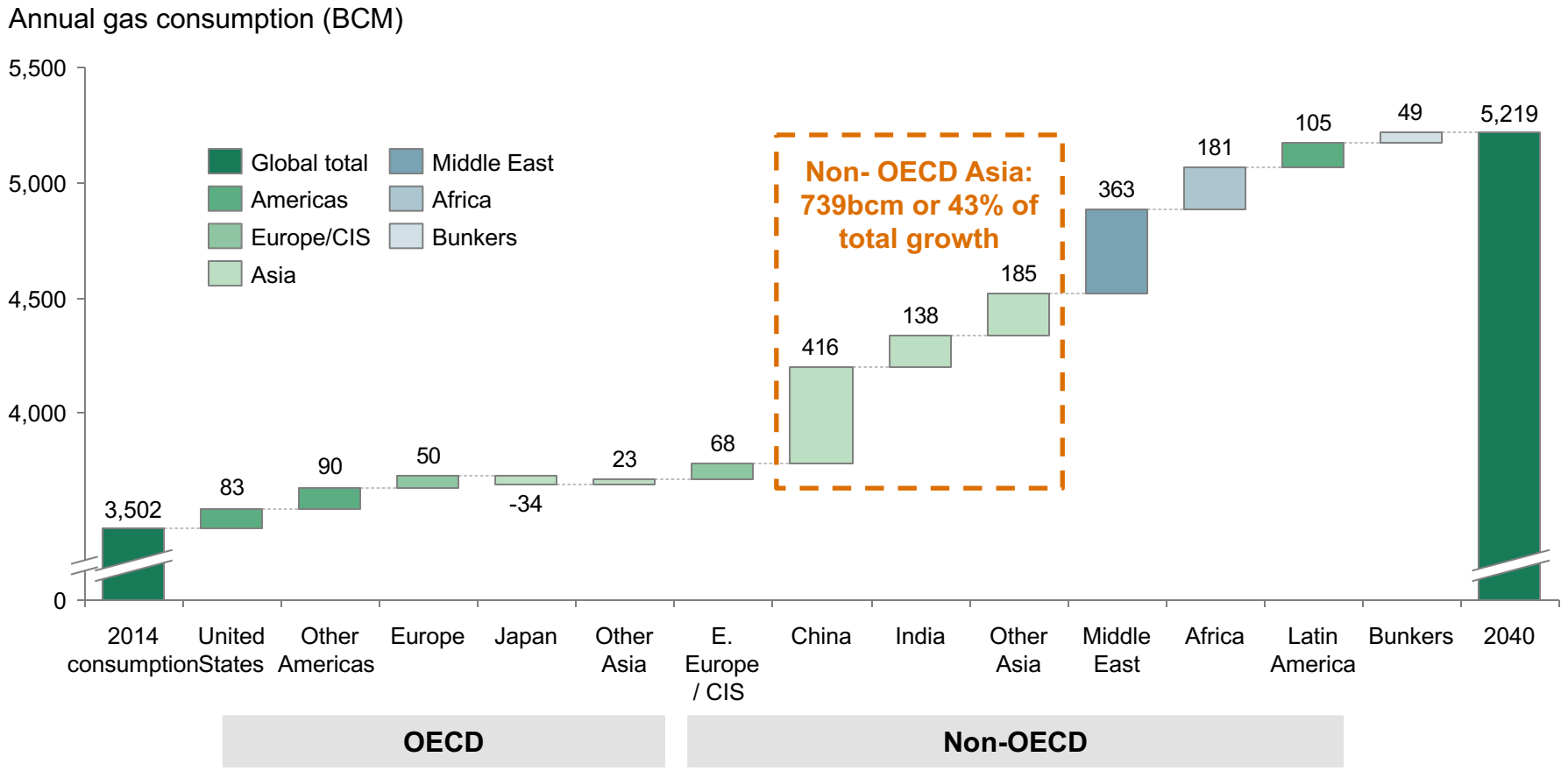
Non-OECD Asia is a critical driver of global gas growth

Projected gas consumption growth to 2040 (2016 IEA NPS)



Source: IEA, BCG analysis

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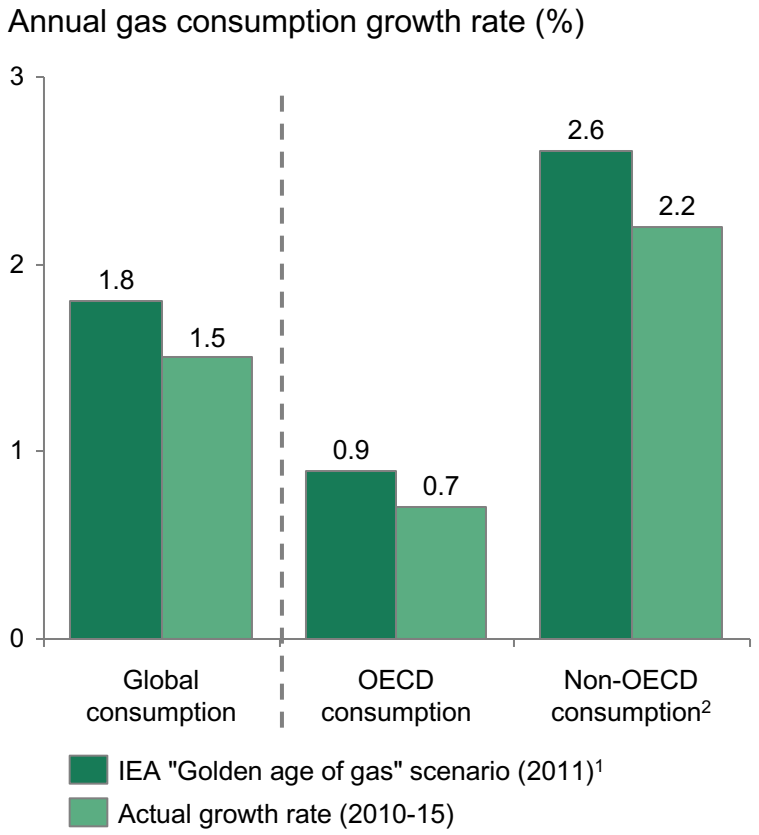
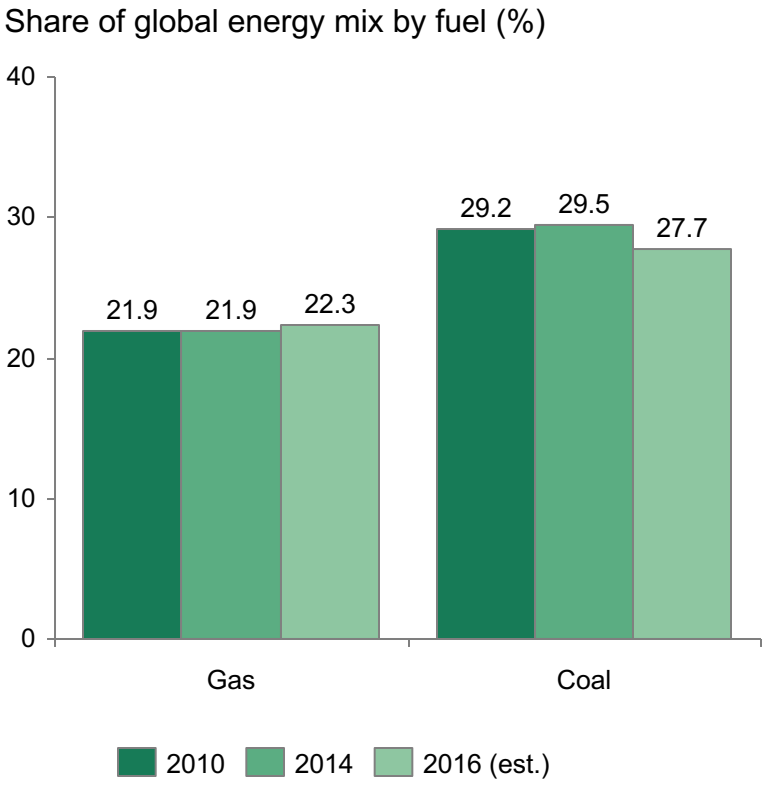
But natural gas consumption growth has been slower than anticipated

Gas consumption growing slower than anticipated...



... Though gas has started to gain share against coal since 2014



1. 2008-2035 Period. 2. Non-OECD 2015 demand calculated using 2014 IEA demand data and 2014-2015 CEDIGAZ growth rate; Source: IEA data (Natural gas balance, Consumption by fuel), IEA WEO 2016, IEA Golden Age of Gas Report, BCG analysis

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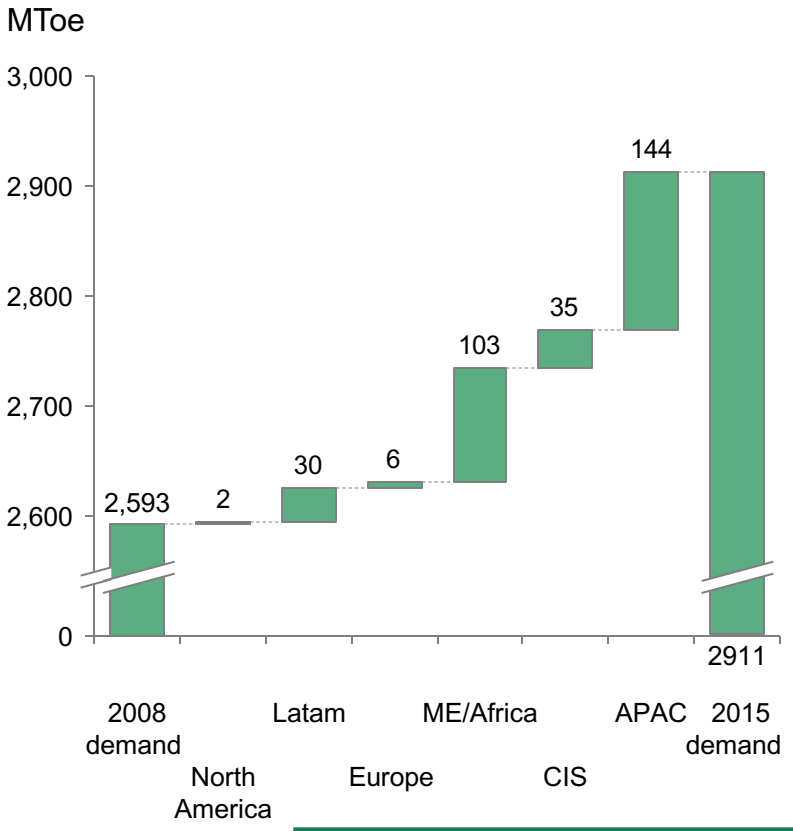
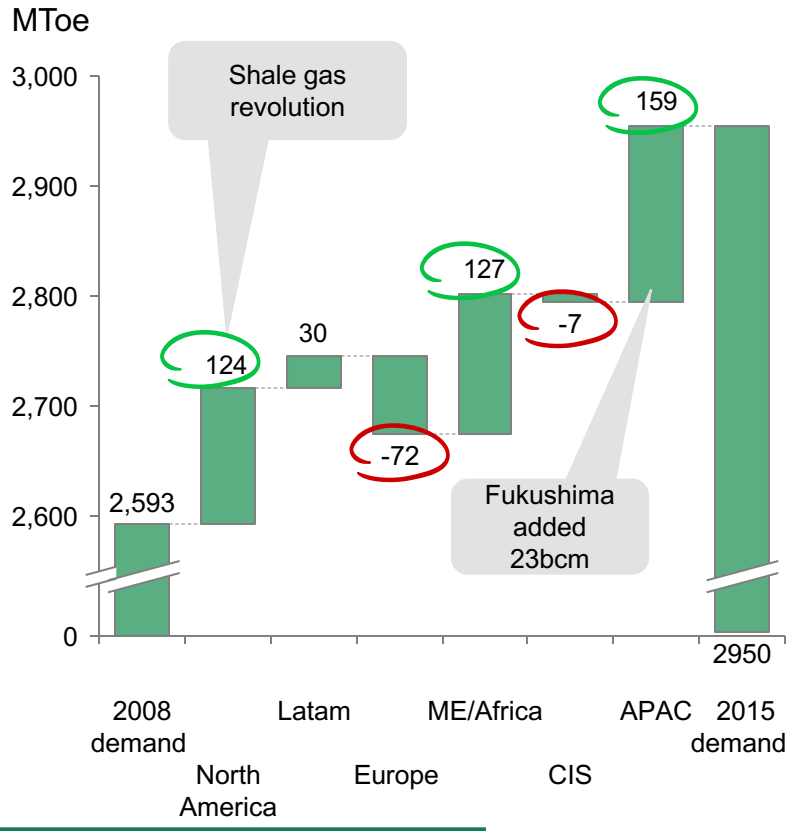
... And for different drivers than the ones anticipated by the golden gas era

WEO 2010 Expected growth by region



Real demand growth by region



Greater growth than expected in domestic N. Am & ME consumption; Asia growth driven in large part by Japan

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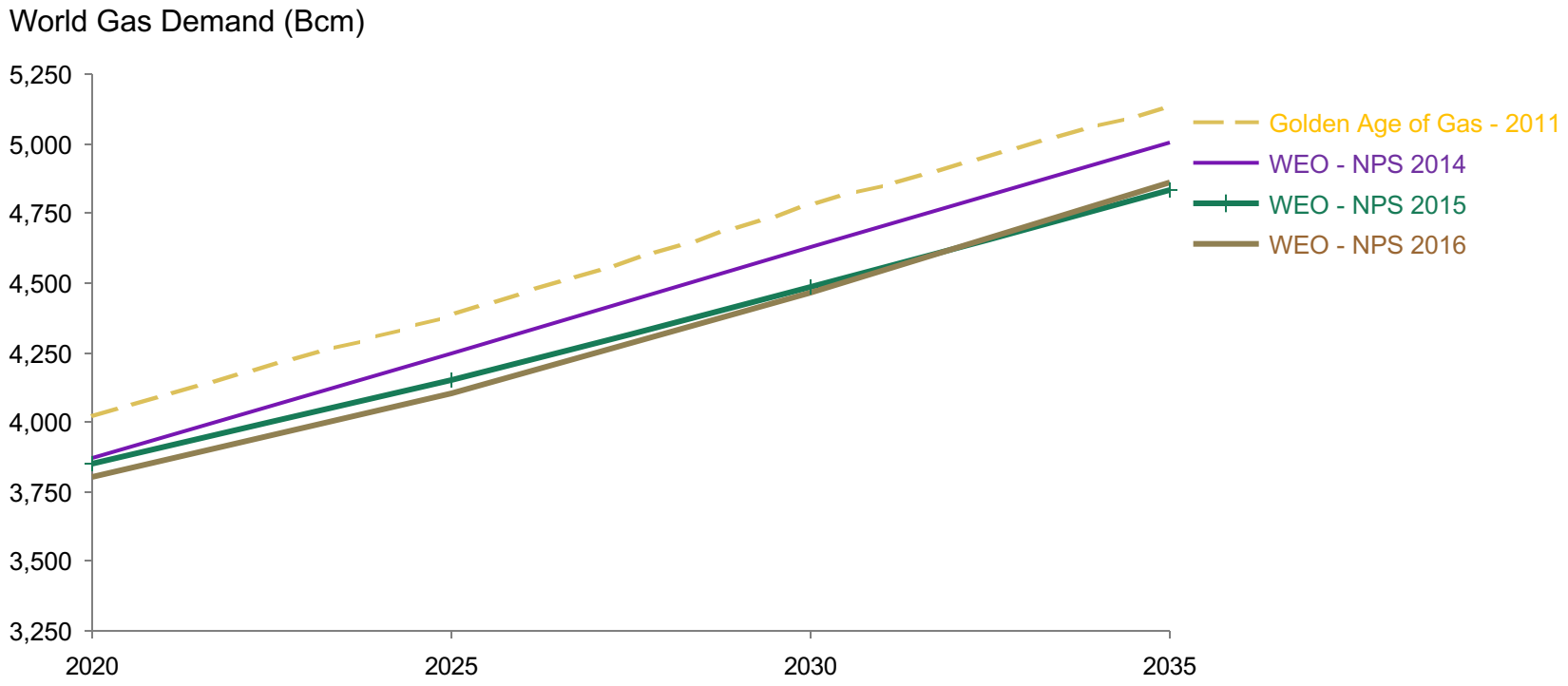
As actual gas consumption was growing less than forecasted, projections have been lowered

IEA – World Gas Demand Forecasts



Note: NPS: New Policies Scenario, which is the base scenario used in annual World Energy Outlook Reports
Source: IEA Reports, EIA 2016 Report, CEDIGAZ 2016 report, BCG Analysis

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ASEAN governments have set very ambitious targets for renewable energy penetration but more policy support is needed

	Hydro	Solar PV	Wind	Geothermal	Biomass	Tidal	Total
Indonesia	5.3 GW in 2016 18 GW by 2025	80 MW in 2016 5 GW by 2020	7 MW in 2016 100 MW by 2025	1.6 GW in 2016 12.6 GW by 2025	n/a	n/a	25% of generation by 2025[2]
Thailand	3.5 GW in 2016 6.1 GW by 2021	2.1 GW in 2016 3 GW by 2021	507 MW in 2016 1.8 GW by 2021	~0 MW in 2016 1 MW by 2021	3.4 GW[1] in 2016 5.8 GW[1] by 2021	0 MW in 2016 2 MW by 2021	25% of generation by 2021[3]
Malaysia	30 MW[5] in 2016 490 MW[5] by 2020	295 MW in 2016 1 GW by 2020	n/a	n/a	124.39 MW[1] 2016 1.4 GW[1] by 2020	n/a	11% of generation by 2020[4]
Singapore	n/a	126 MW in 2016 350 MW by 2020	n/a	n/a	n/a	n/a	8% (no date)
Philippines	3.6 GW in 2016 9 GW by 2030	0.4 GW in 2016 0.6 GW by 2030	490 MW in 2016 2.3 GW by 2030	2 GW in 2016 3.5 GW by 2030	290 MW in 2016 315 MW by 2030	70 MW by 2030	3.5 GW in 2016 15 GW by 2030 (50% power mix)

1. Includes biogas and municipal waste. 2. Share from primary energy of renewables sources. 3. Share from final energy of renewables sources. 4. Share of renewables in generation mix.
5. Mini-hydro only.
Sources: BMI, Indonesian Presidential Regulation No 22 Year 2017, SEDA – Sustainable Energy Malaysia Magazine Vol. 1 Issue 1 2017, SEDA - National Renewable Energy Policy and Action Plan 2010, SEDA Presentation – Malaysia Updates on RE Program (April 2016), press search (link)

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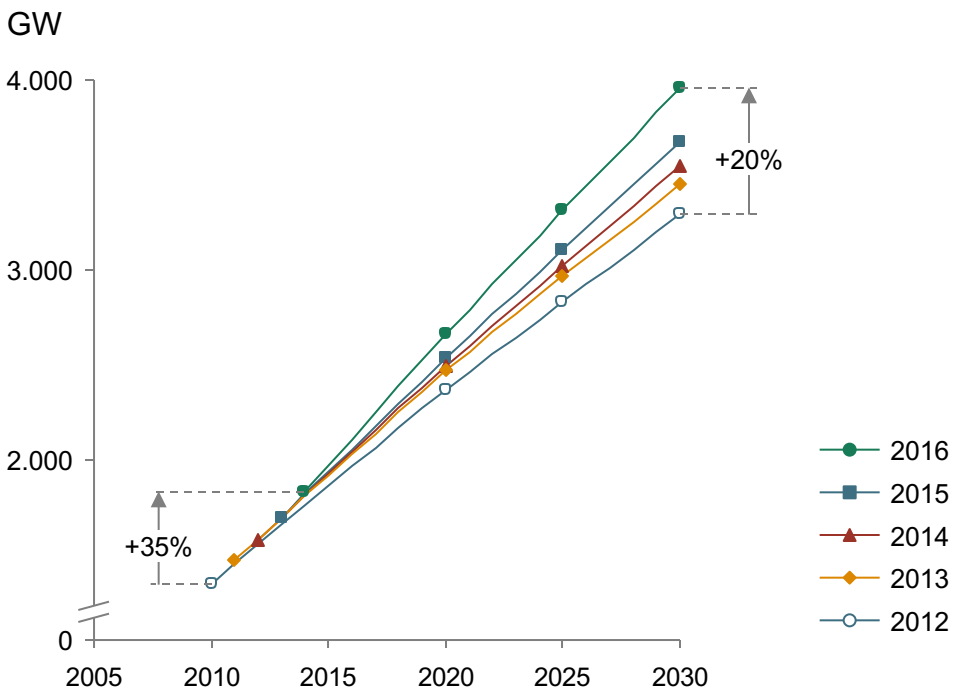
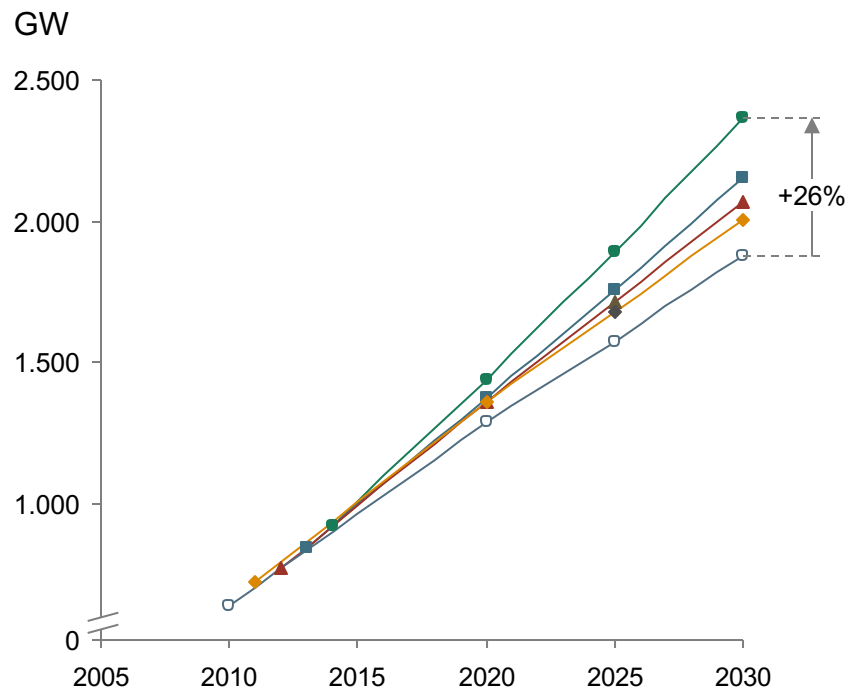
On the other hand forecasts have often been over pessimistic on renewable deployment

World New Policies Scenario forecast



Non-OECD New Policies Scenario



Renewable in Non-OCDE countries to lead renewable deployment

Source:IEA WEO 2012-2016

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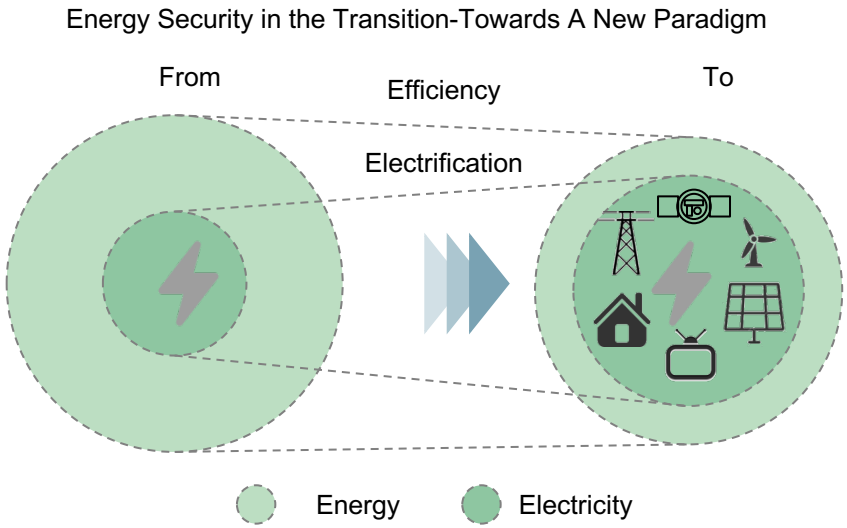
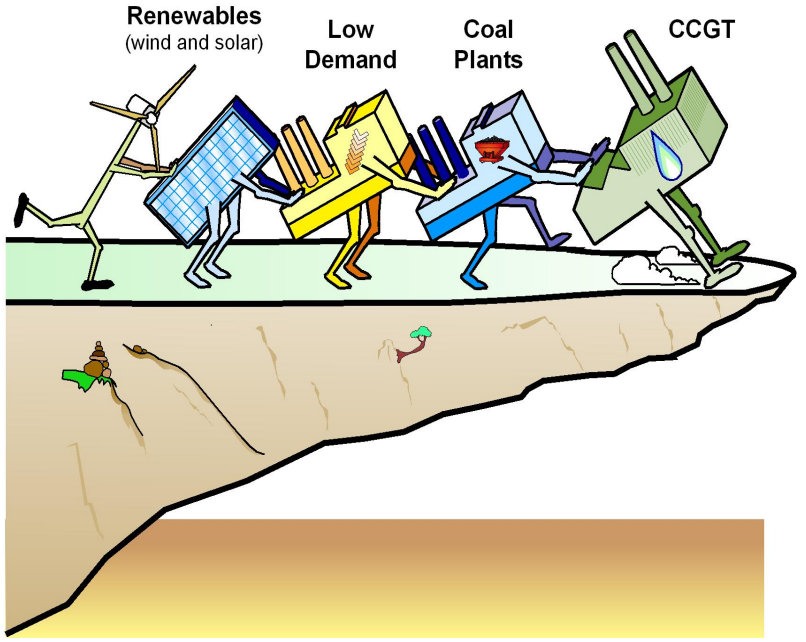
Energy efficiency policies and cheap coal have also reduced natural gas demand growth

Energy efficiency and energy demand electrification ...



...With renewable and Coal pants competitiveness[1]



1. Due to low CO2 prices
Source: CERA, BCG analysis

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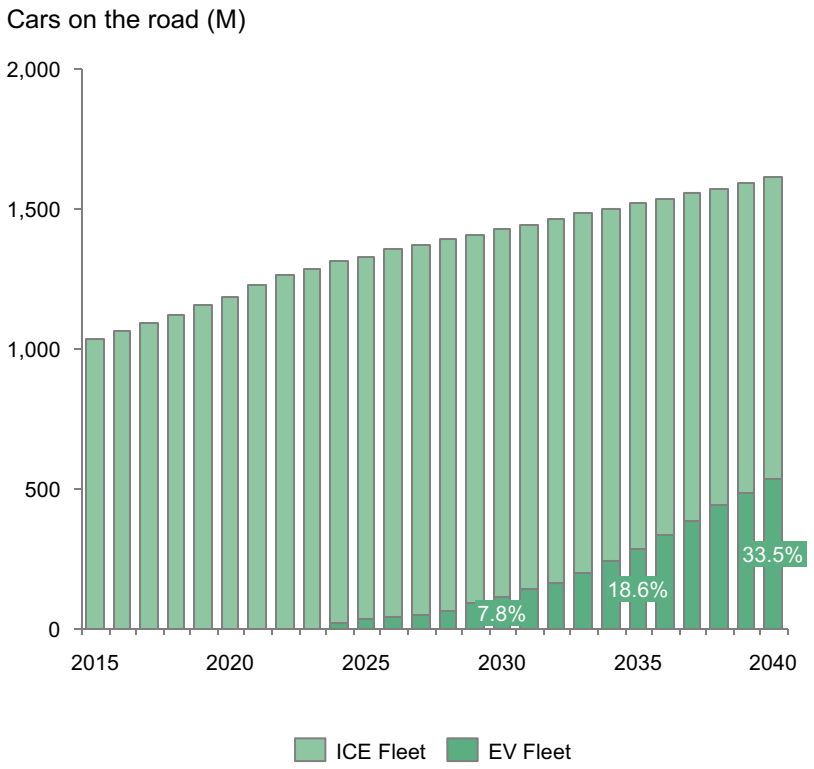
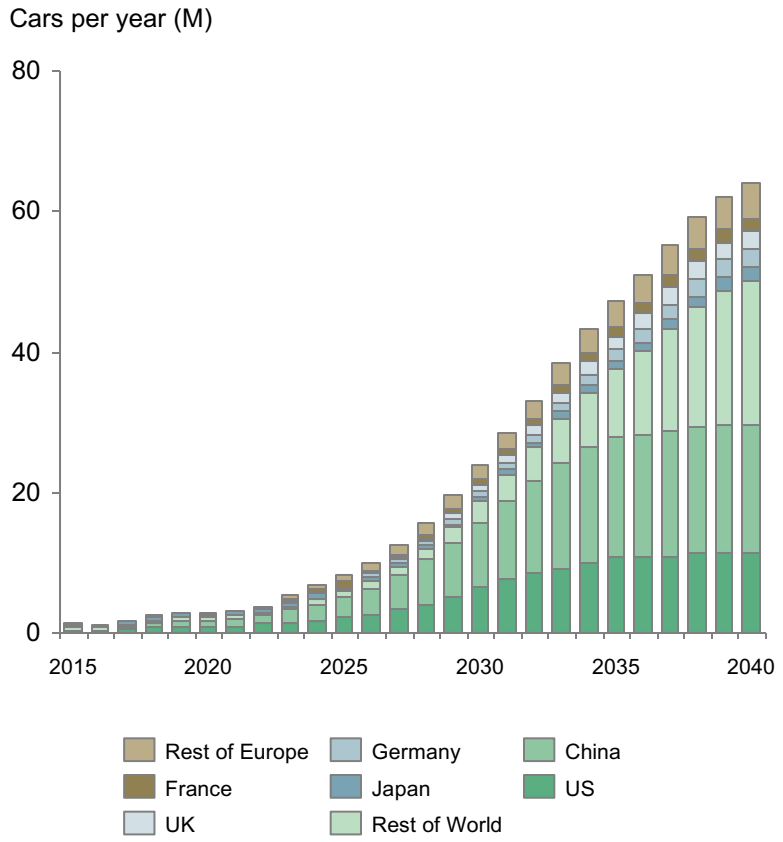
Is natural gas use in the transport sector also being over-optimistic given the EV outlooks?

Global light duty vehicle fleet



Annual global EV sales by market



Source: Bloomberg new energy finance

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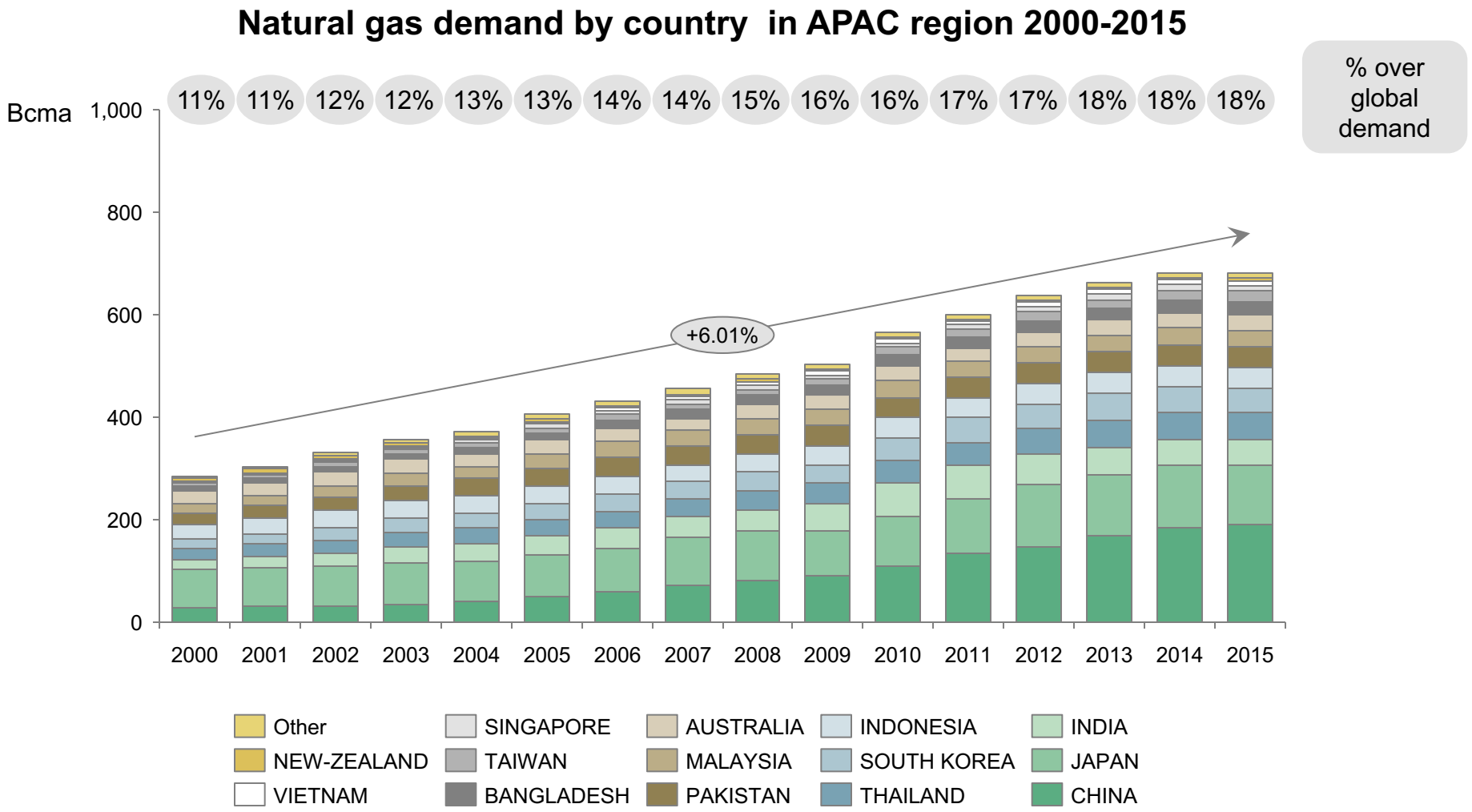
Natural gas demand has soared (>6%CAGR) in APAC region since the beginning of this century



1. Papua New Guinea, Philippines Brunei And Myanmar
Source: Cedigaz

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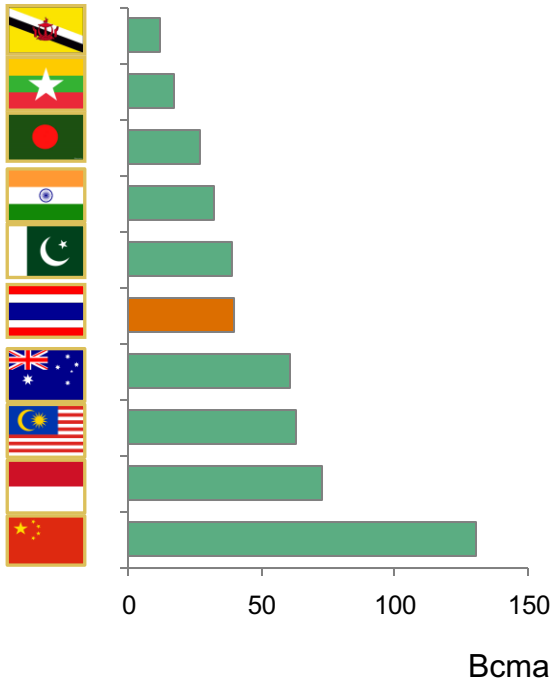
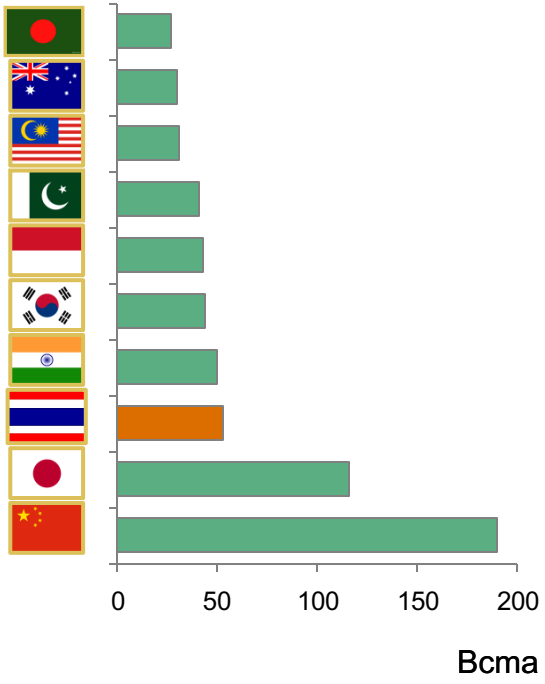
APAC countries natural gas supply and demand is diverse, which stimulates cross border trade and investment

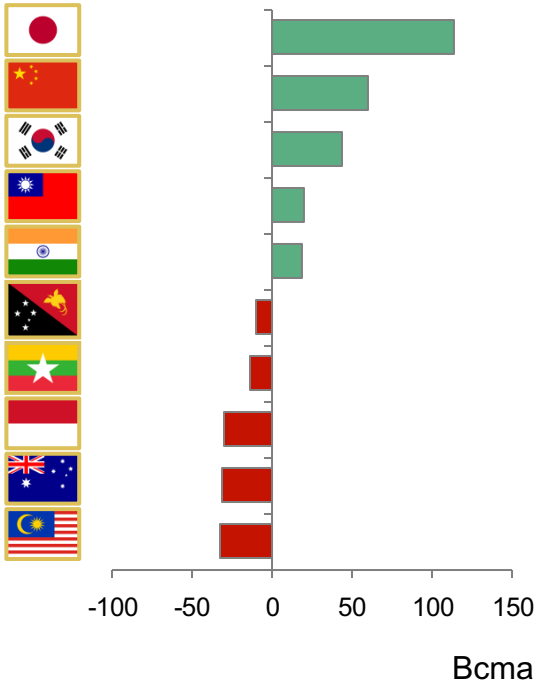
10 largest APAC producers



10 largest APAC consumers



Top exporters and importers in APAC



Source: Cedigaz

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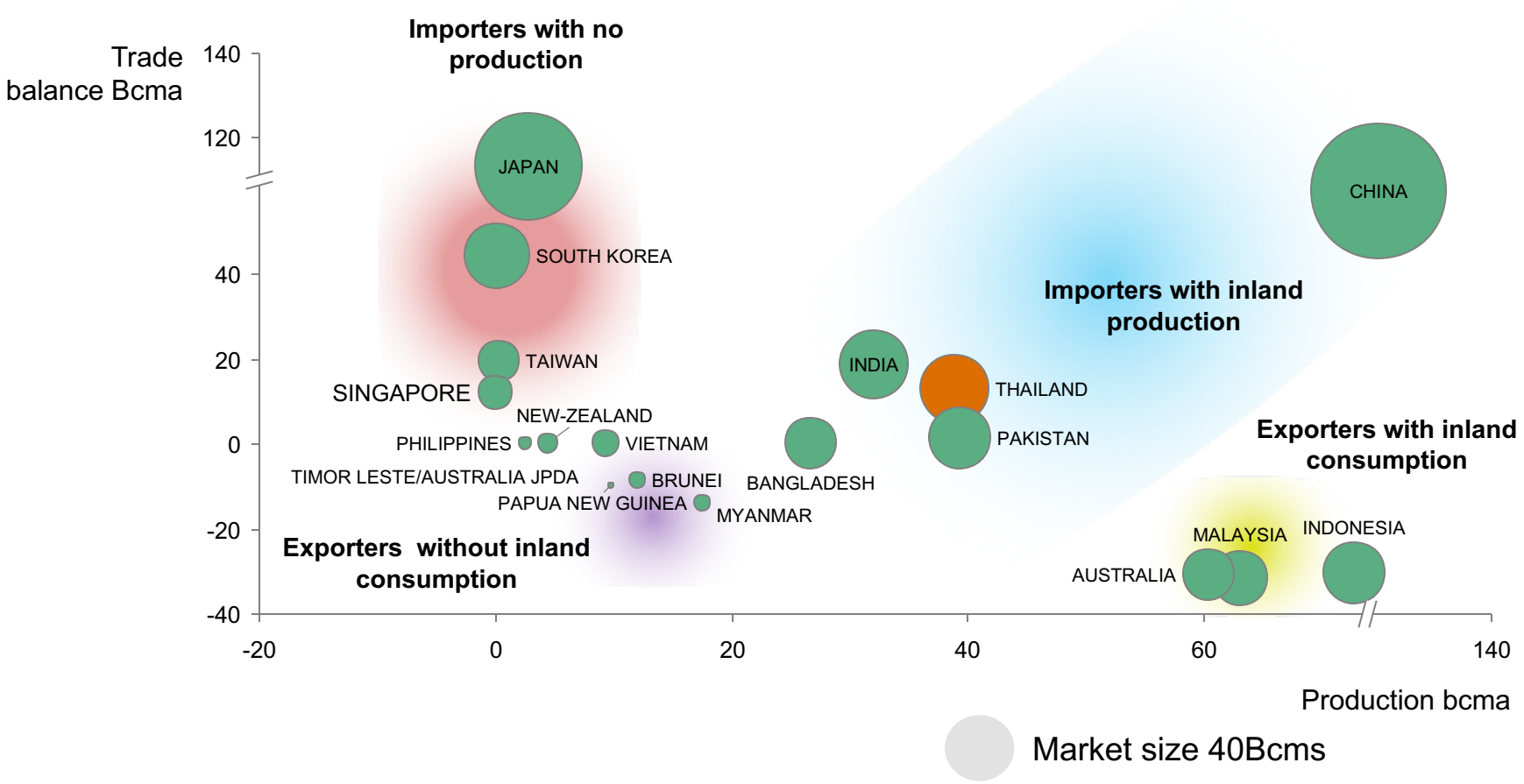
APAC countries can be identified by 4 supply and demand balance categories

APAC countries production, consumption and trade in 2015



Source: BCG analysis and Cedigaz

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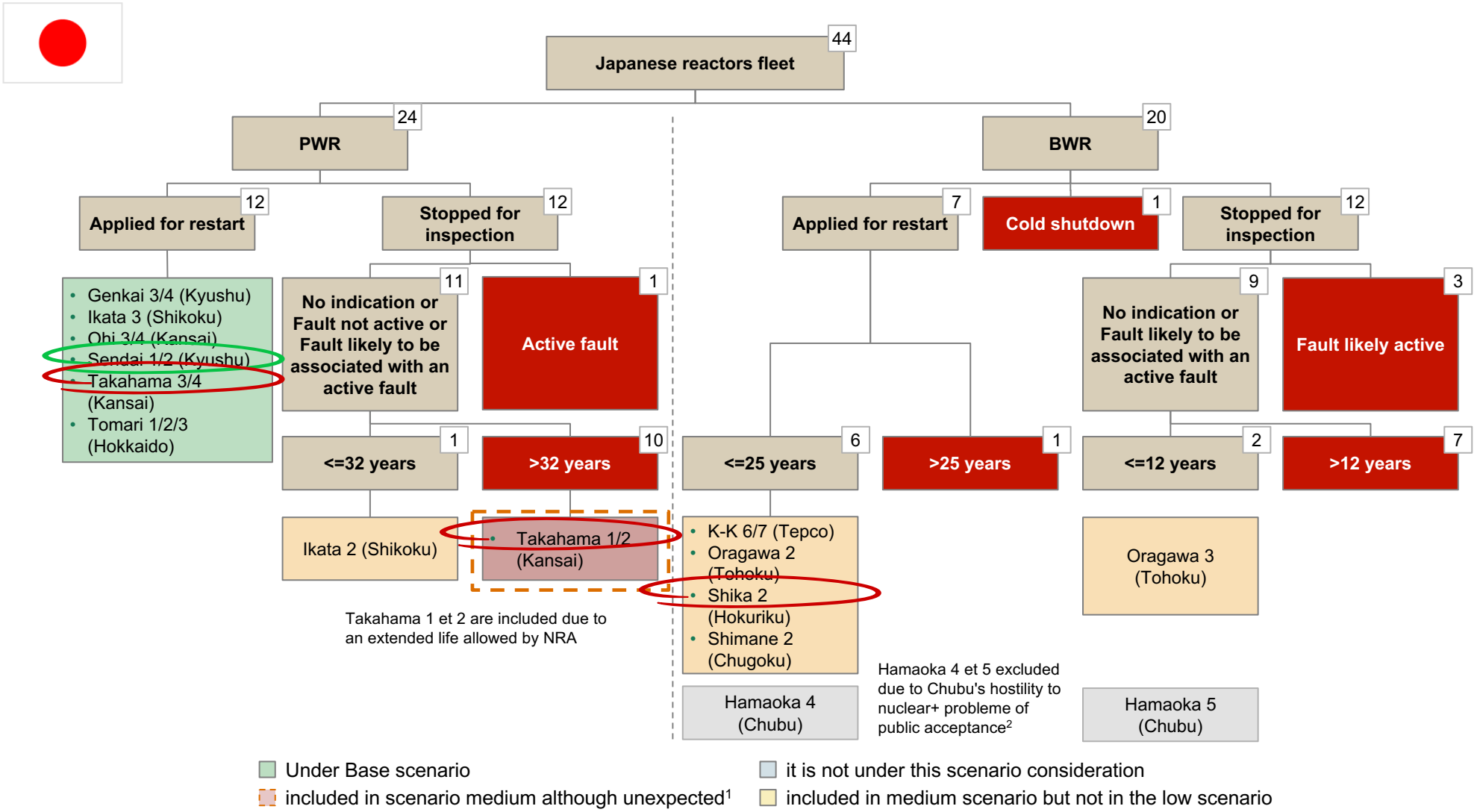
Japan shut down most of the nuclear fleet after Fukushima, but is now considering restarts



1. under the criteria of this model this should not be consider for re-start, nevertheless due to other reasons they have been included (extended life) 2.these are particular cases as they are both pretty younge reactors economically profitable

Source: BCG Nuclear Power Model.

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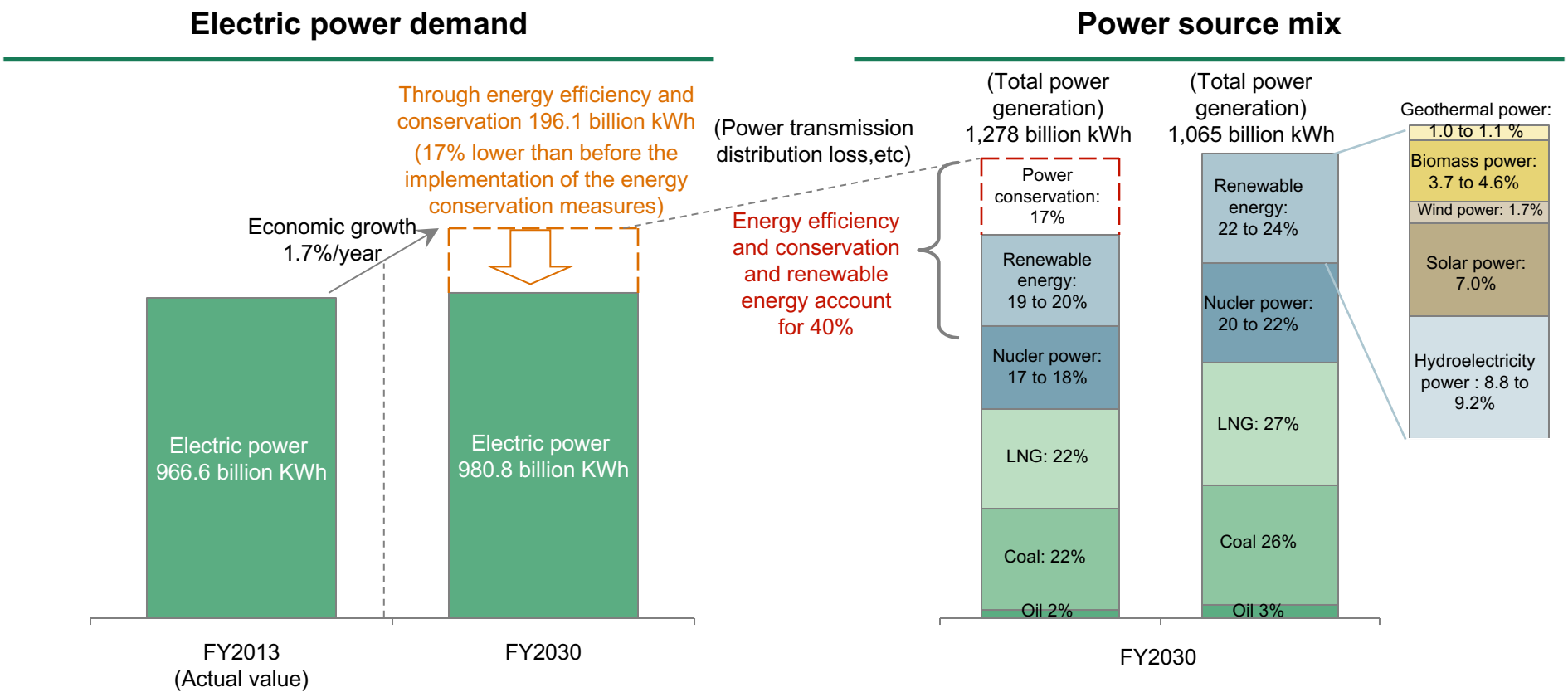
METI has already published an outlook which is optimistic on Efficiency, Renewable, LNG, Nuclear, and Clean Coal



Renewables will grow mostly on account of Solar PV and Hydro

Note: Values are approximate

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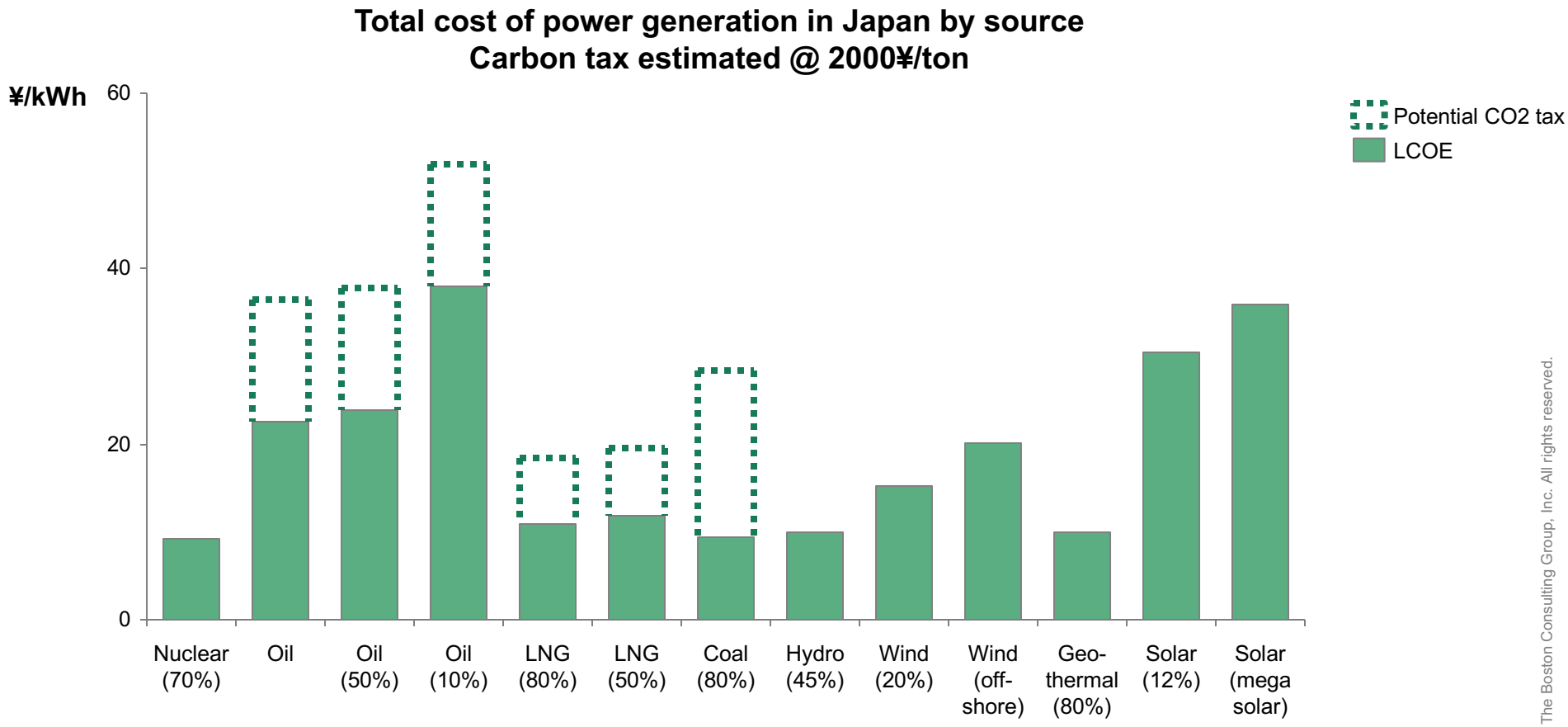
Renewable technology may challenge coal and gas technologies in Japan if a Carbon tax is added



Note: METI coul try to add a carbon tax in order to meet 27% emmision reduction target
Source:Macquarie Research Japan's energy choices

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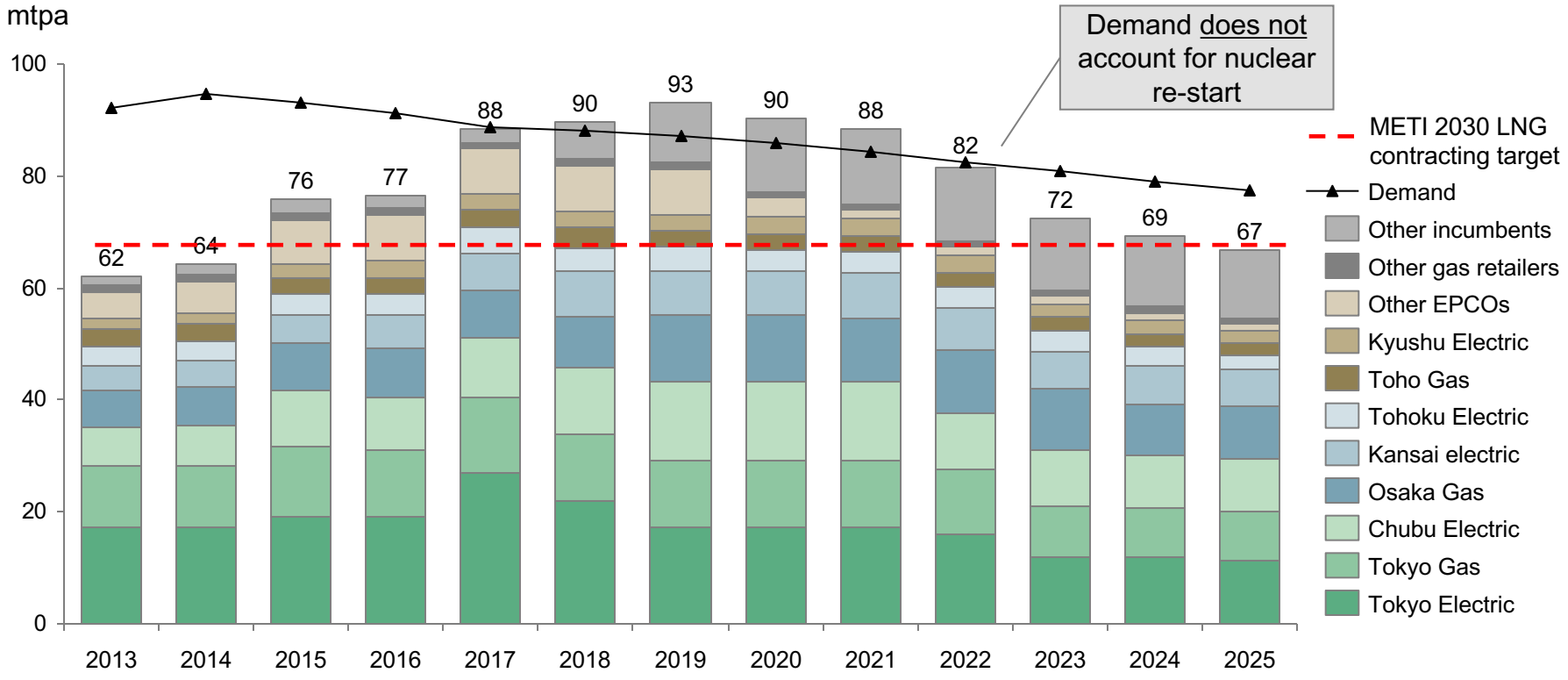
No urgency for new LNG long term contracts in Japan

Current long term contract volume exceeds expected demand 2018-21

Long-term LNG supply contracts (>4 years) in Japan, 2013-2025 (mtpa)



The country's top-8 consuming companies make up ~80% of the long-term contracted volume in 2013-2018

1. Includes traditional Japanese producers (INPEX, JAPEX) as well as corporations/trading houses (Mitsubishi, Mitsui, Toshiba, Itochu, etc.) 2. Includes Chukoku Electric, Okinawa Electric and Shikoku Electric's contracts 3. Essentially includes the contracts of Shizuoka Gas, Saibu Gas, Hokkaido Gas, Nippon Gas, Hiroshima Gas and Sendai Gas
Source: GII, company annual reports, broker reports; BCG analysis

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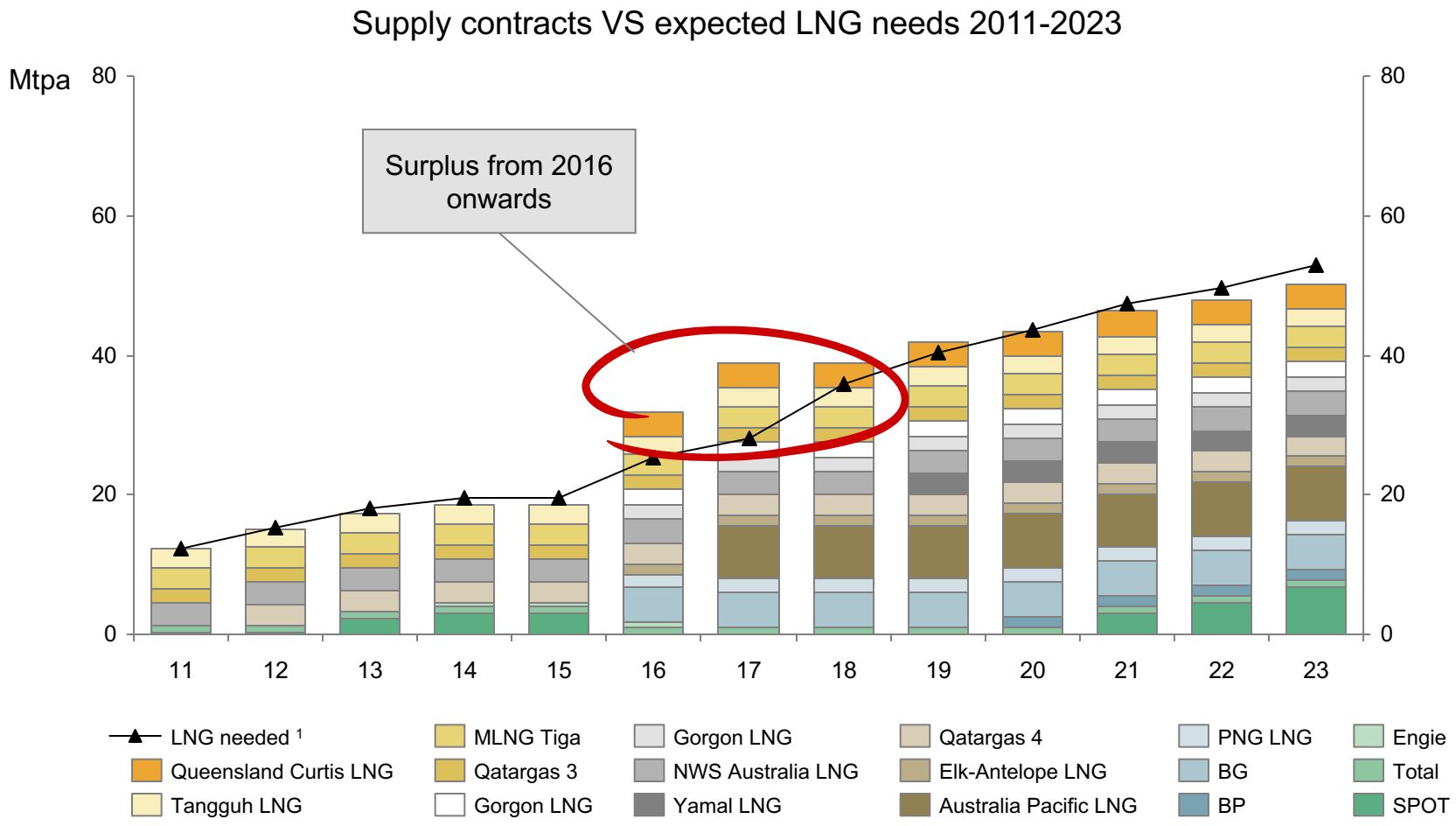
China will also have a surplus of contracted LNG from 2016



1. Demand based on bottom-up forecast of needs for each of Gas Distribuion, Storage and transmission, Commercial, Residential, Petrol. E&P, Power, District heating, Transport, Industry; minus expected local gas supply
Source: BCG analysis, Cedigaz, UBS, Deutsche Bank, Rystad

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China and multiple policy measures driving rapid growth of gas across all sectors

Multiple policies supporting gas consumption are in place

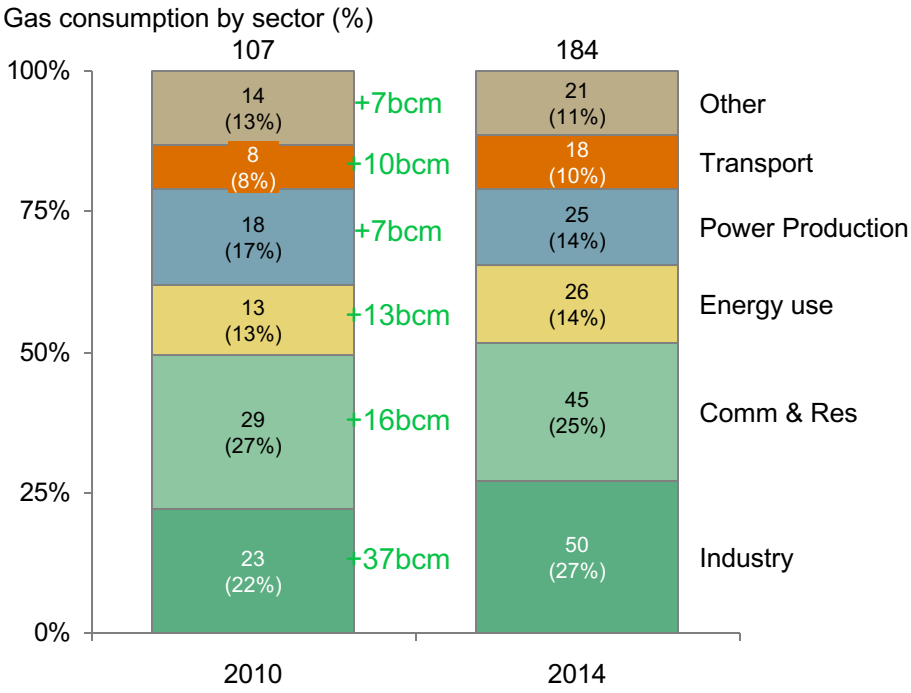
Coal boiler conversation to gas
- Target conversation of 200k coal boiler units to natural gas

New residential connections
- Target to increase penetration from 35% to 85%, adding >120m new connections

Incentives for CNG/LNG for transport
- Discounts provided on prices in gas price formula
- Gas consumption of cars targeted to more than double from 2014 to 2020

New 5 year plan prioritizing gas power
- Targeting 44GW of new gas-fired capacity...
- ... Though also targeting 200GW of new coal capacity

Share of industry and transport increase in total gas consumption



Despite a higher price vs. coal, policy makers have supported a greater role for gas in China

Source: CEDIGAZ data (Terminals and Plants), IEA data (Natural gas balance), analyst reports, BCG analysis

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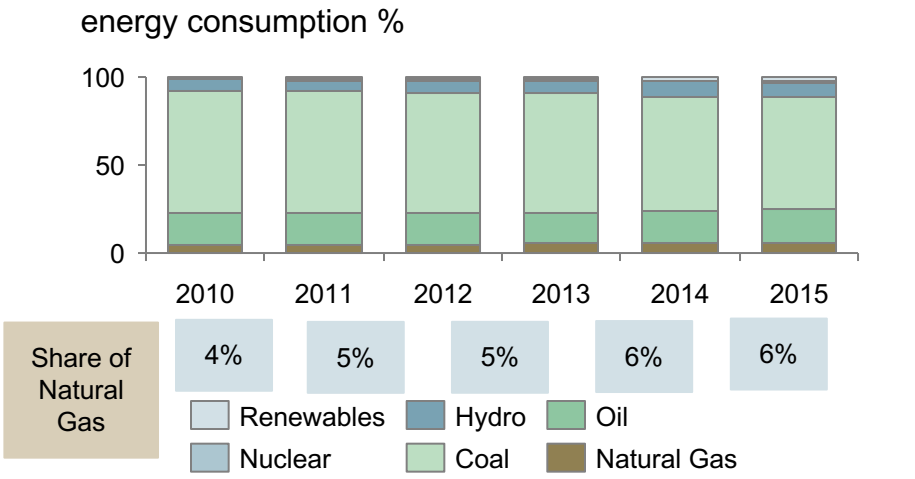
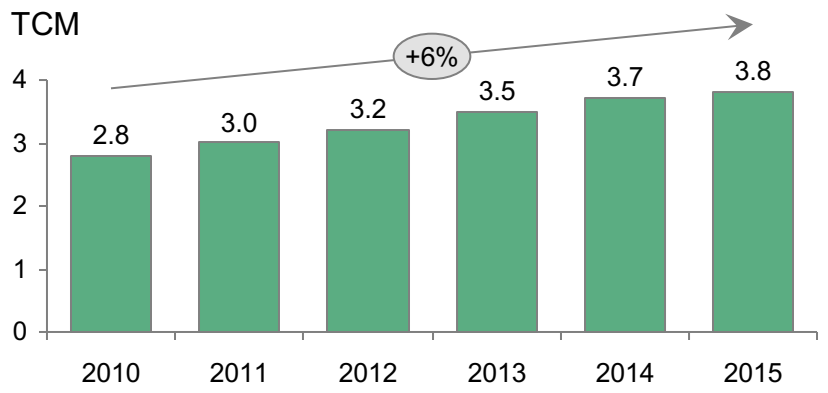
China gas consumption has outpaced domestic production growing at over 10%

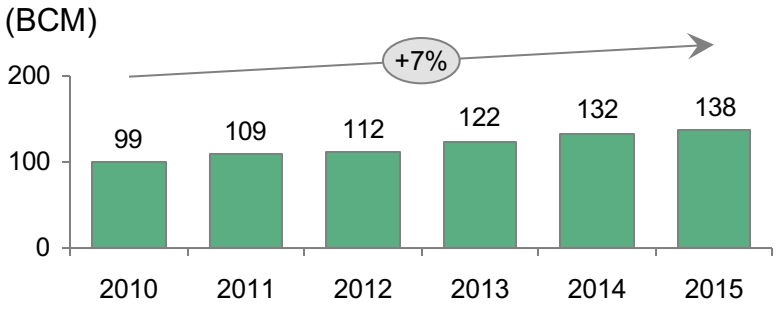
Share of natural gas in energy basket, %, 2010-15



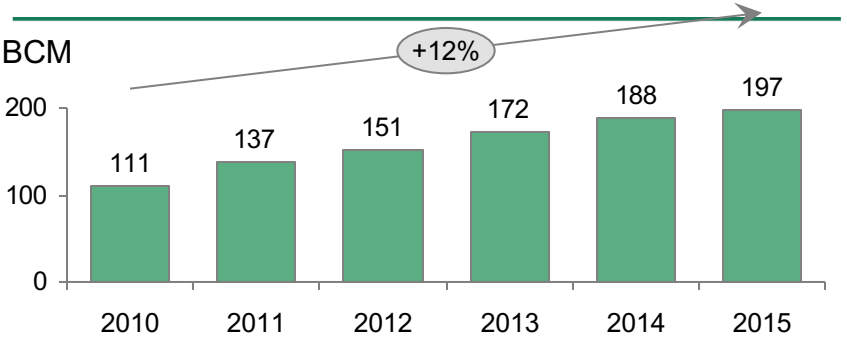
China natural gas reserves, TCM, 2010-15



China natural gas production, BCM, 2010-15



China natural gas consumption 2010-15



Source: BP Statistical Review of World Energy 2016, EMIS China Natural Gas Sector 2016/17 Report, 13th Five year plan

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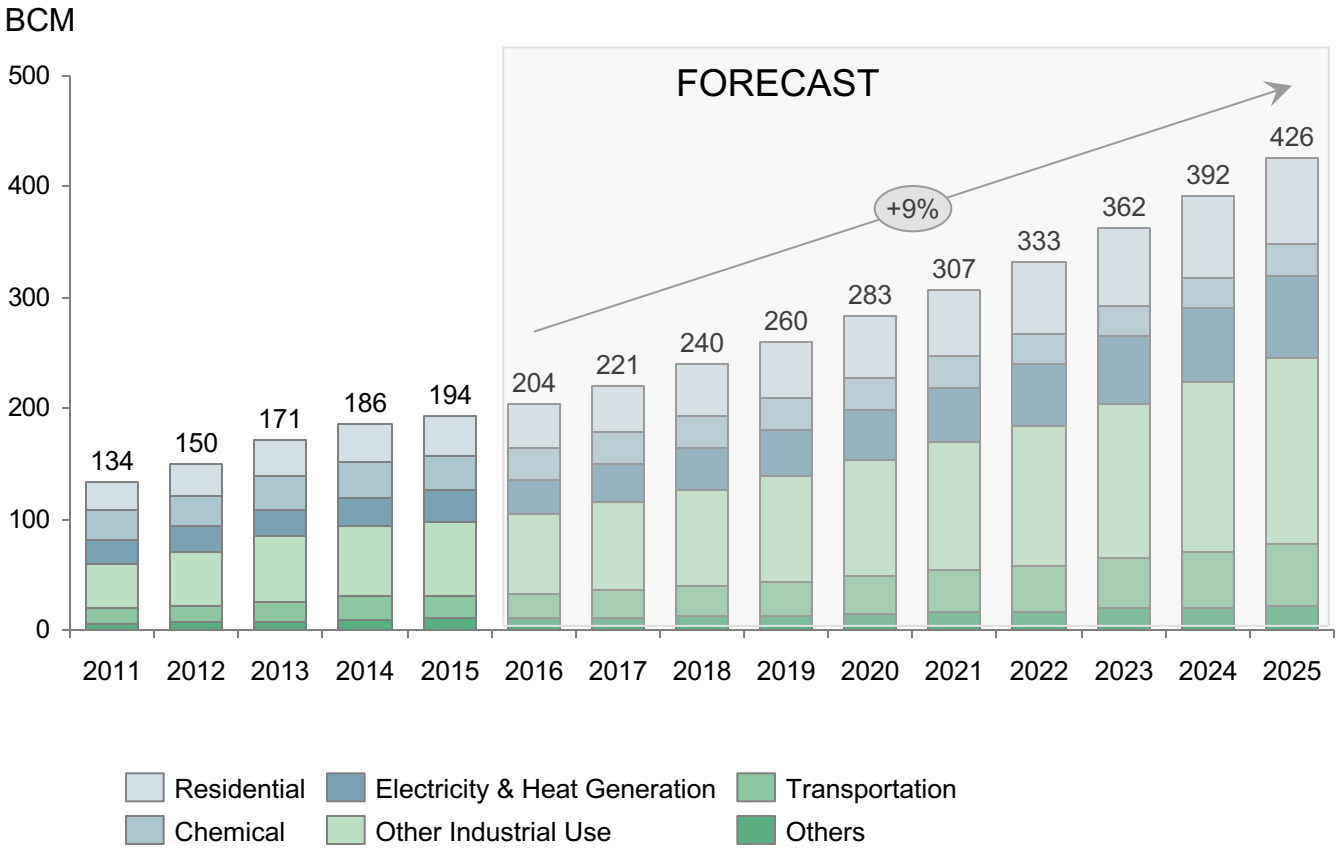
Gas demand is expected to double over the next decade driven by the use of clean fuels in industries

China Gas Demand by Sector, 2011-25



	CAGR 2016-205
Residential	**8%**
Electricity & Heat Generation	**9%**
Transportation	**10%**
Chemical	**1%**
Other industrial use	**11%**
Others	**10%**

Source: China National Bureau of Statistics, Morgan Stanley, BCG Analysis

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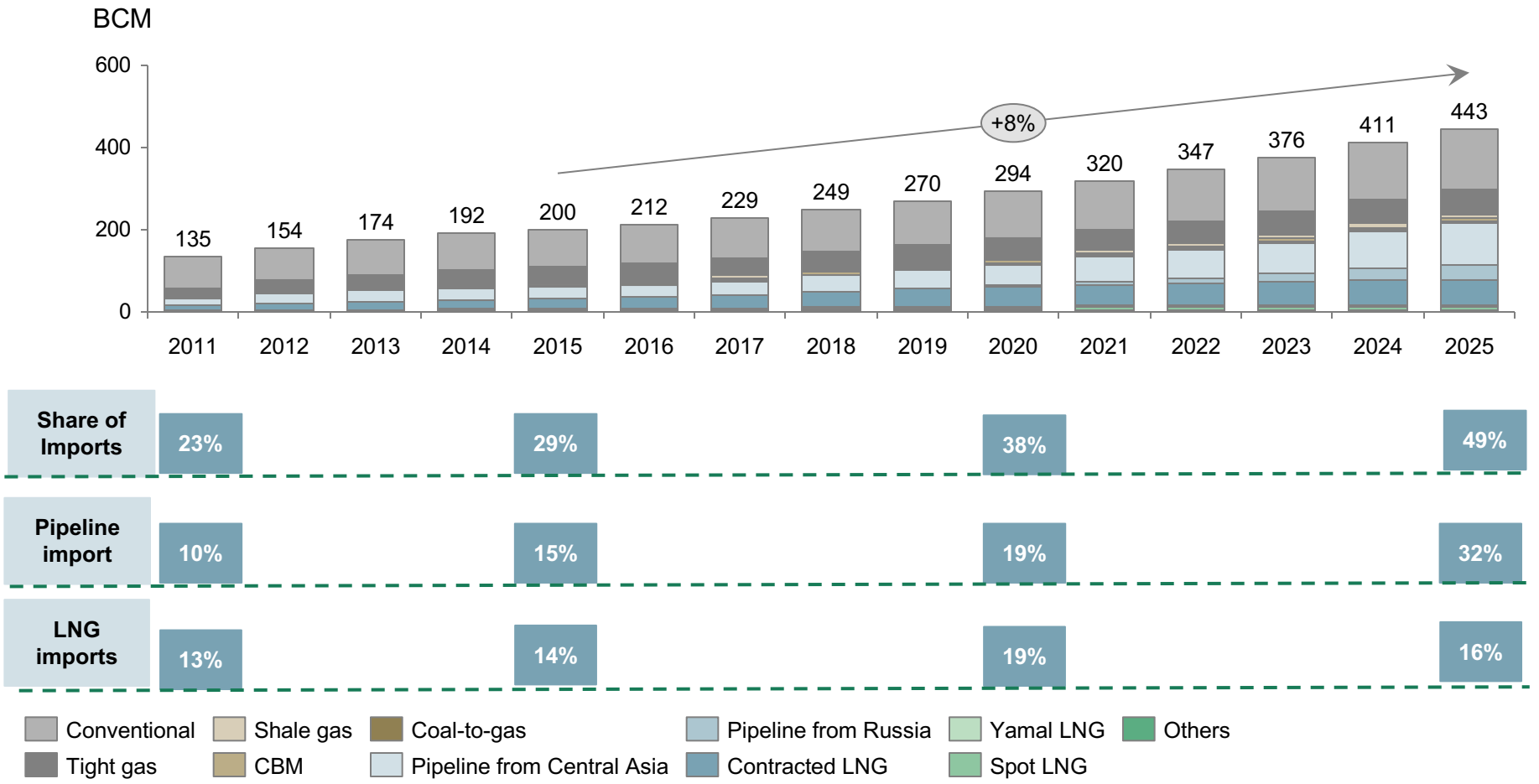
Share of imports expected to increase to almost 50% by 2025; pipelines imports play an increasingly important role

China Gas Supply by Source 2011-25



Source: China National Bureau of Statistics, Morgan Stanley, BCG Analysis

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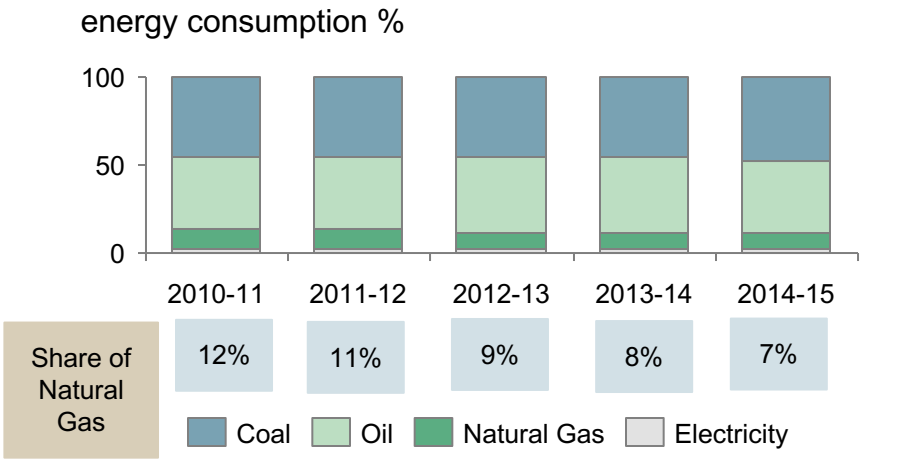
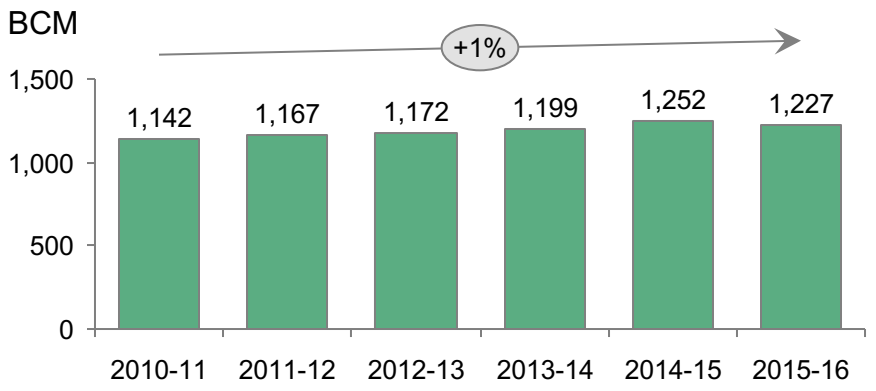
Indian gas sector has witnessed a slowdown over the last five years as domestic production fell significantly

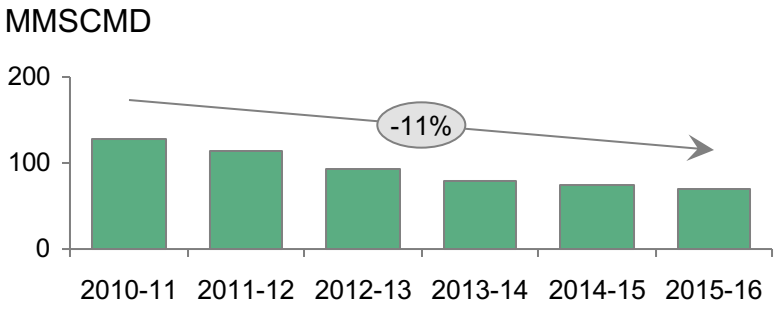
Share of natural gas in energy basket, %, 2010-15



India natural gas reserves, BCM, 2010-15



India natural gas production, MMSCMD, 2010-15



India natural gas consumption 2010-15

Source: Ministry of Petroleum and Natural Gas

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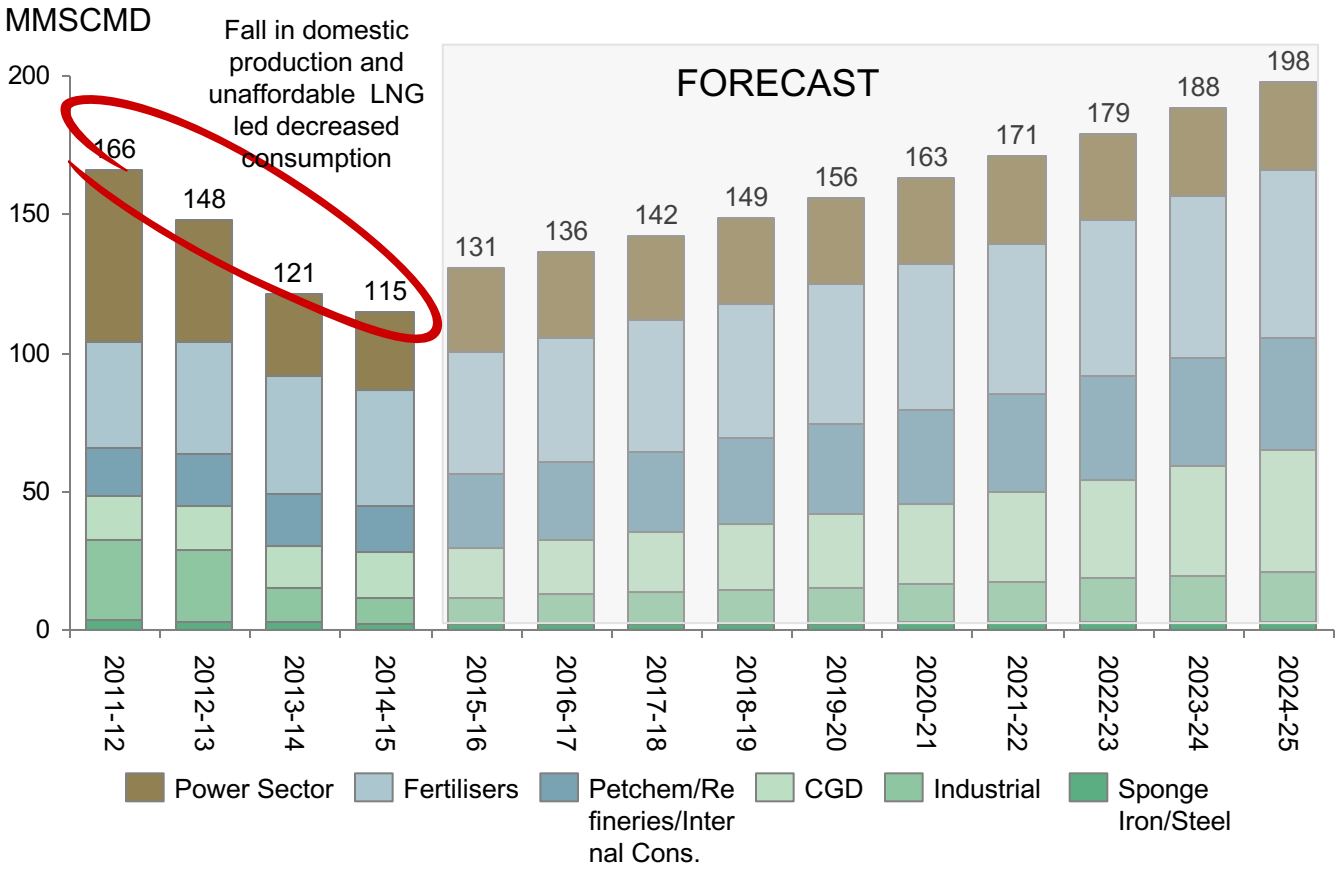
Demand impacted by low ability of affordable natural gas for key sectors; Future growth comes from City Gas Demand (CGD)

India Gas Demand by Sector, 2011-25



CAGR

Power	**0.5%**
Fertilizers	**3.3%**
Petchem/Refineries/Internal Cons.	**4.3%**
CGD	**9.5%**
Industrial	**6.3%**
Sponge Iron/Steel	**3.6%**

Source: Ministry of Petroleum and Natural Gas, BCG Analysis

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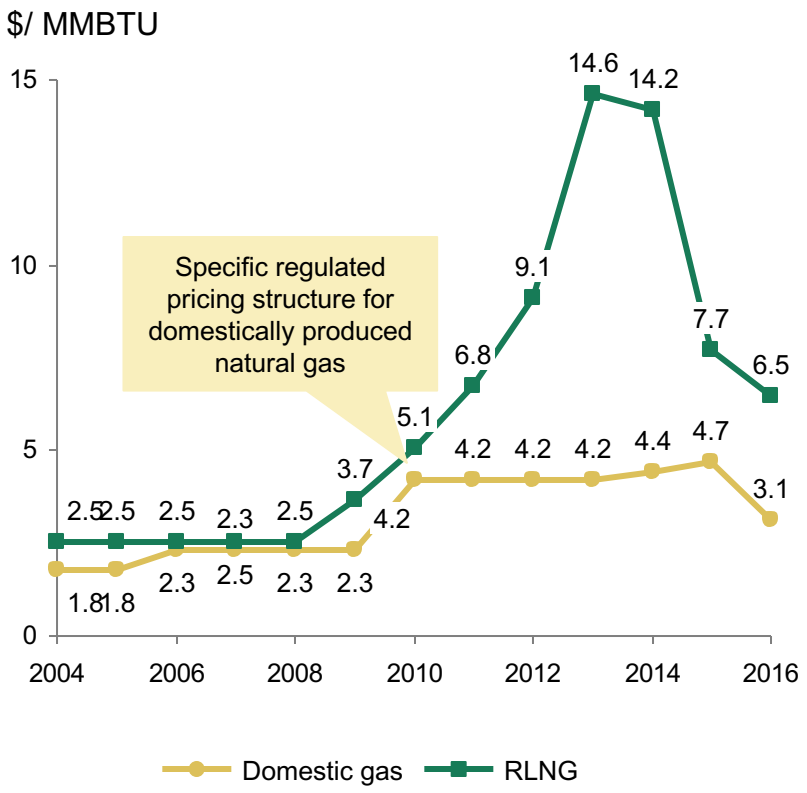
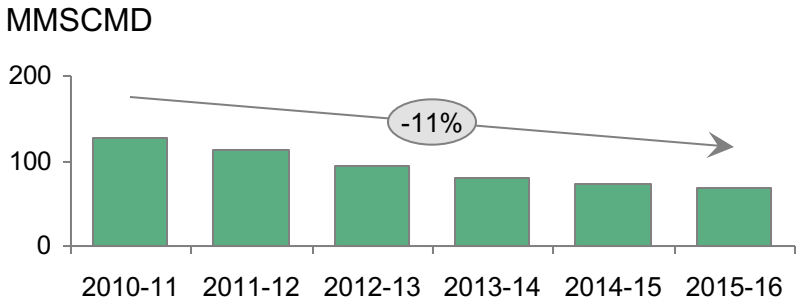
Regulated pricing structure resulted in significant decline in domestic production and consumption

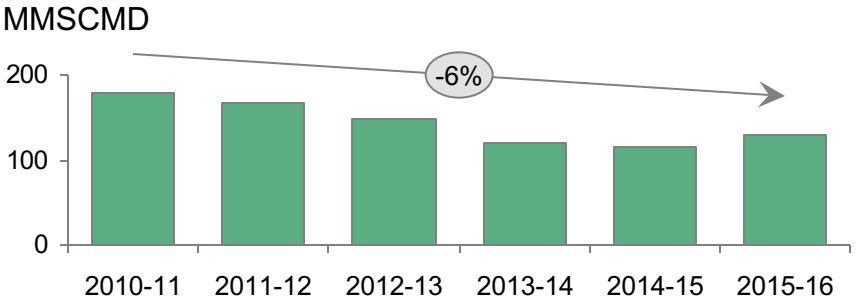
Regulated price structure resulted in artificially low domestic prices...



... Resulting in significant gas production decline...



... And declining consumption



Source: India Ministry of Petroleum and Natural Gas, BCG analysis

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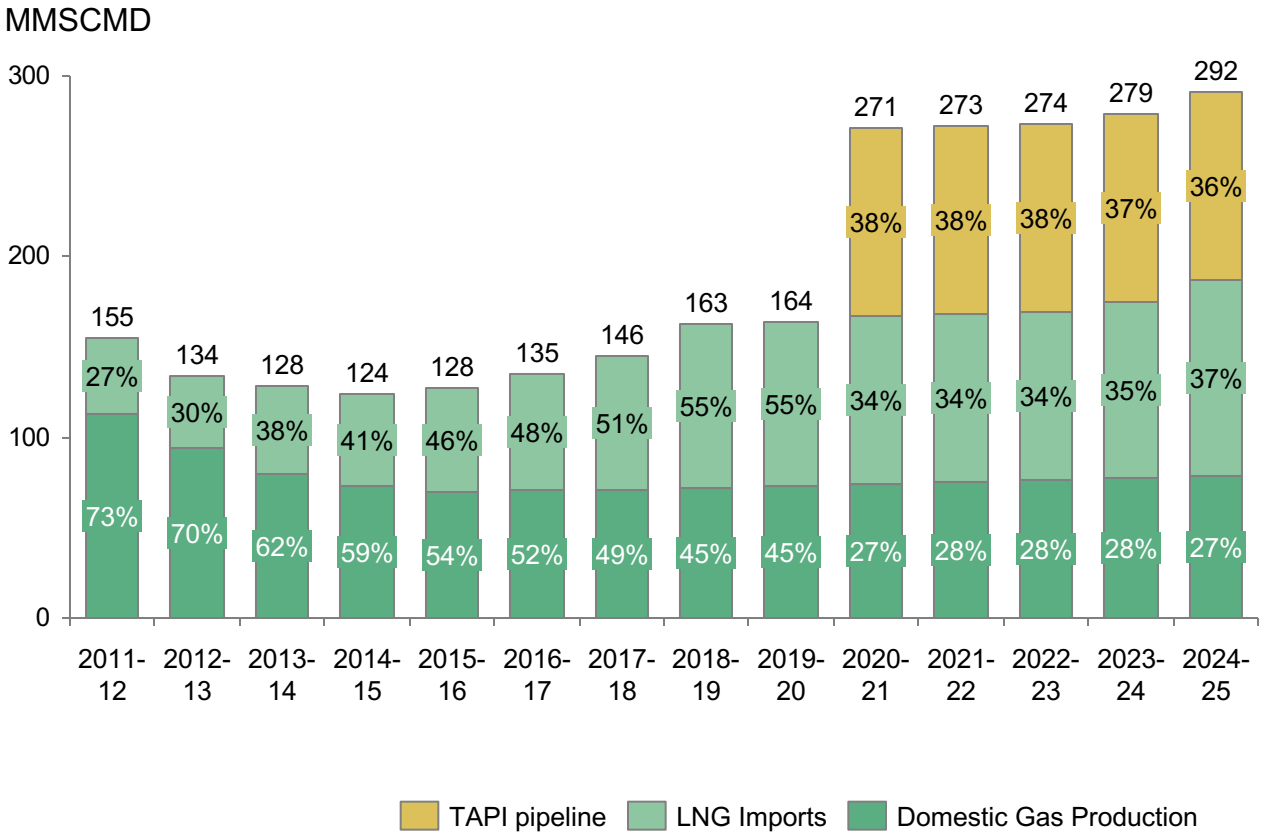
Gas supply expected to rise significantly if TAPI is confirmed; Share of domestic gas to go below 30%

India Natural Gas Supply from Source, 2011-2025



TAPI Pipeline

- TAPI will run 1,800 km, starting from Turkmenistan (through Afghanistan, Pakistan to at Punjab India
- Pipeline will carry 90 MMSCMD of gas with India, Pakistan, and Afghanistan originally set to have received 38, 38, and 14 MMSCMD respectively
- Construction of pipeline work in Turkmenistan has already been awarded to a Chinese Firm
- The pipeline is expected to be completed by 2019 and may change paradigm of gas sector in India

Source: Ministry of Petroleum and Natural Gas, BCG Analysis

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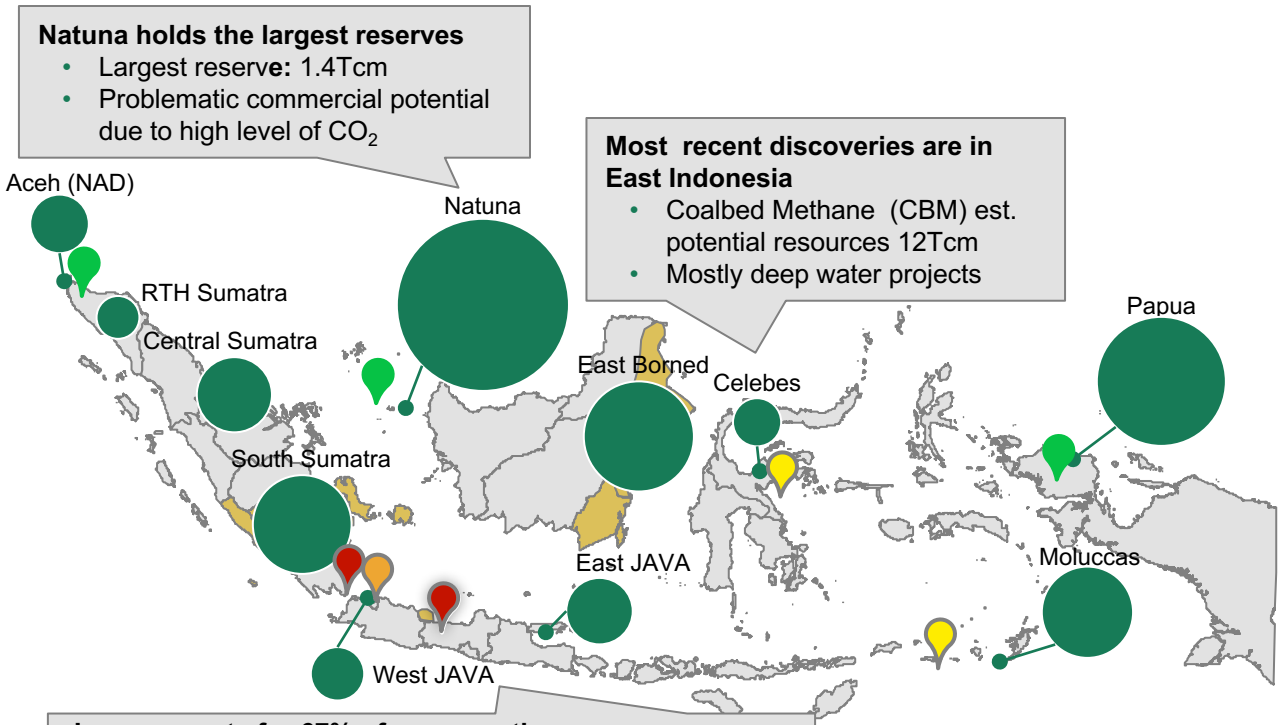
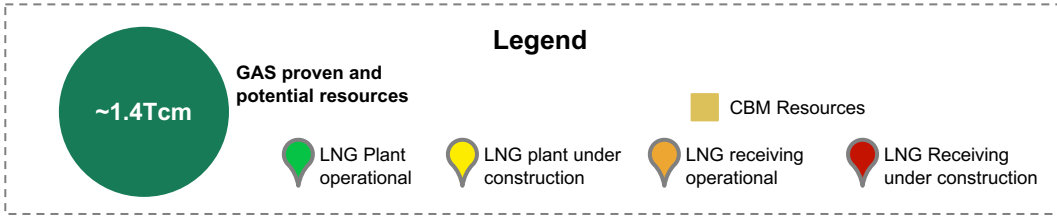
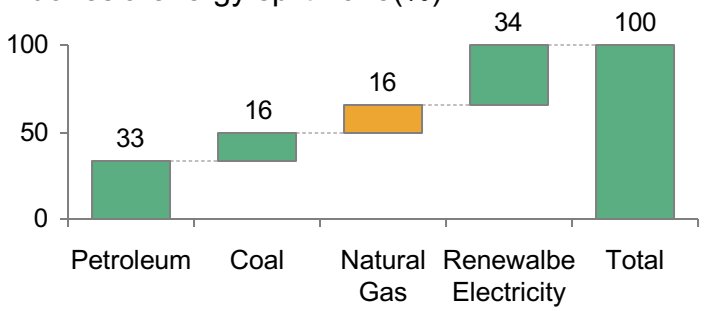
Indonesian natural gas market suffers from a geographical supply/demand mismatch





NG accounts for 16% of energy consumption



Overview and challenges

Geographical supply demand mismatch

- Many small fields in remote and distributed locations
- Present pipeline capacity insufficient to deliver demand: Need to use LNG domestically

Significant "costly" reserves with mixed qualities require high investment

- Future potential lies in non conventional gas reserves - CBM and shale gas
- High level of CO_2 in main fields

Source: Regulatory reform in the Indonesian Natural Gas Market Aldi Hutagalung, Maarten Arentsen and Jon Lovett University Of Twente 201, EIA, iGU

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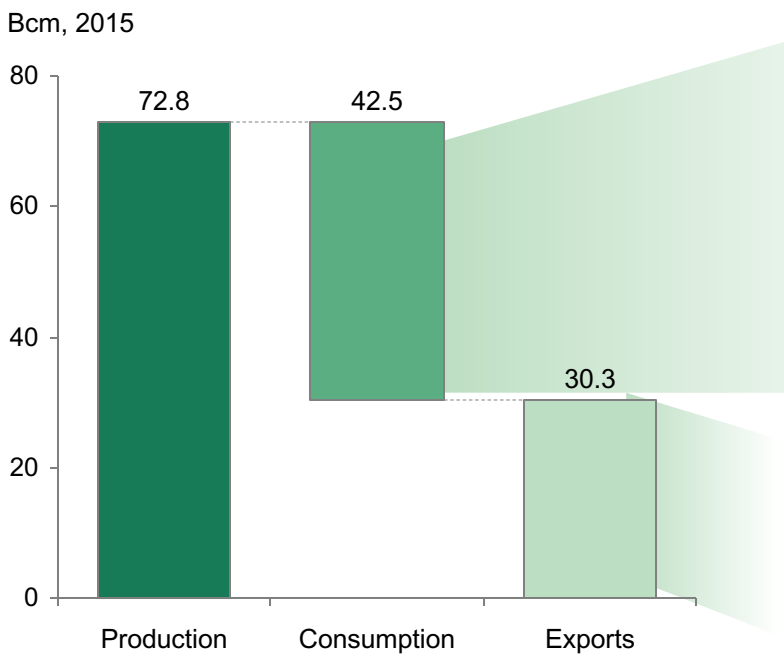
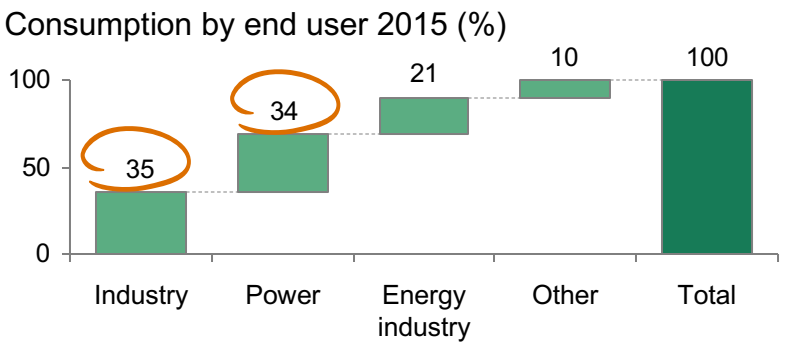
Indonesia is a large scale natural gas producer and exporter

c.60% of production consumed domestically

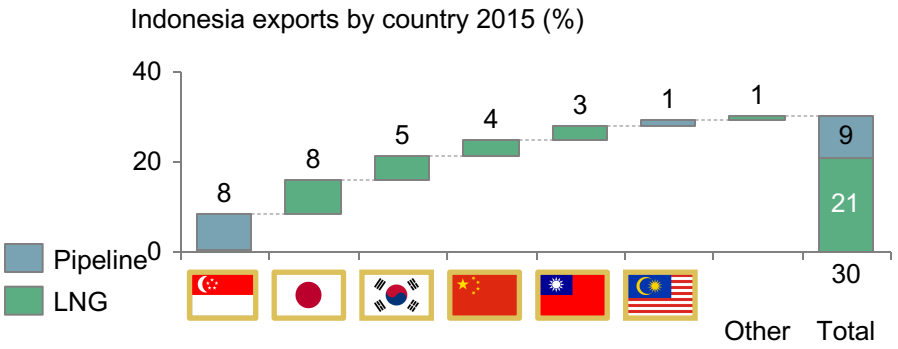


Reserves – 2.7 Tcm #14 in the world
Production- 72.8Bcm #11 in the world
LNG exports- 21 Bcm #5 in the world

Consumption: mostly industrial and power



Exports: mostly LNG to Asia



Geographical mismatch between production and consumption and lack of pipeline infrastructure forces Indonesia to consume LNG domestically

Source : BP Statistical Review of World Energy June 2013; EIA, PGN Indonesia's Gas Transportation and Distribution Infrastructure The Perspective of PGN 2013

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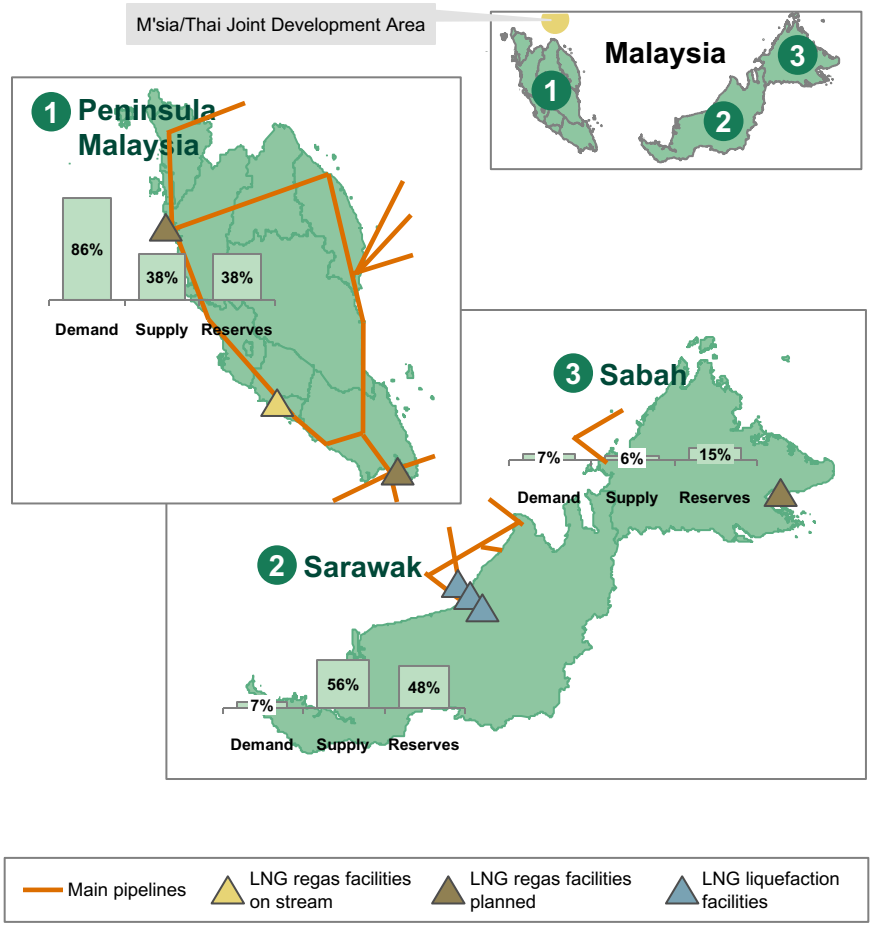
Malaysian natural gas market divided in 3 distinct areas

Malaysian market divided into 3 areas



Key highlights about industry structure

216 gas fields discovered in total

Sarawak is the largest production area, and is the only LNG export gateway in Malaysia

- The world's largest LNG complex w. ~27.6 mtpa capacity: MLNG Satu (3 trains), Dua (3 trains), Tiga (3 trains)

Peninsula Malaysia represents ~86% of consumption, with gas distributed via 'PGU'

- 'Peninsular Gas Utilization' pipeline: ~2500 km

No pipeline linking the Peninsula with East Malaysia, causing supply-demand mismatch and the need to import

- Despite being an LNG exporter, Malaysia imports gas via pipeline from Indonesia, Vietnam and Thailand
- Additionally, Malaysia imports LNG, although they expect to avoid this from 2016, when the country's first floating LNG facility is ready to supply the Peninsula from Sarawak

First LNG regasification facility completed in 2012 in Melaka for supplying the Peninsula

- 2 more confirmed, and 1 being contemplated

Joint-Development Area (JDA) set up by Malaysia and Thailand in 1979 for E&P on the overlapping continental shelf claimed by both countries (north-east of Peninsula)

- 0.3Tcm of proved plus probable natural gas reserves

Source: Malaysia Economic Monitor - Harnessing Natural Resources, June 2013; Maybank, Malaysia sector update 2012 - data on map refers to 2011, except demand which refers to 2010; EnergyQuest; press search; EIA

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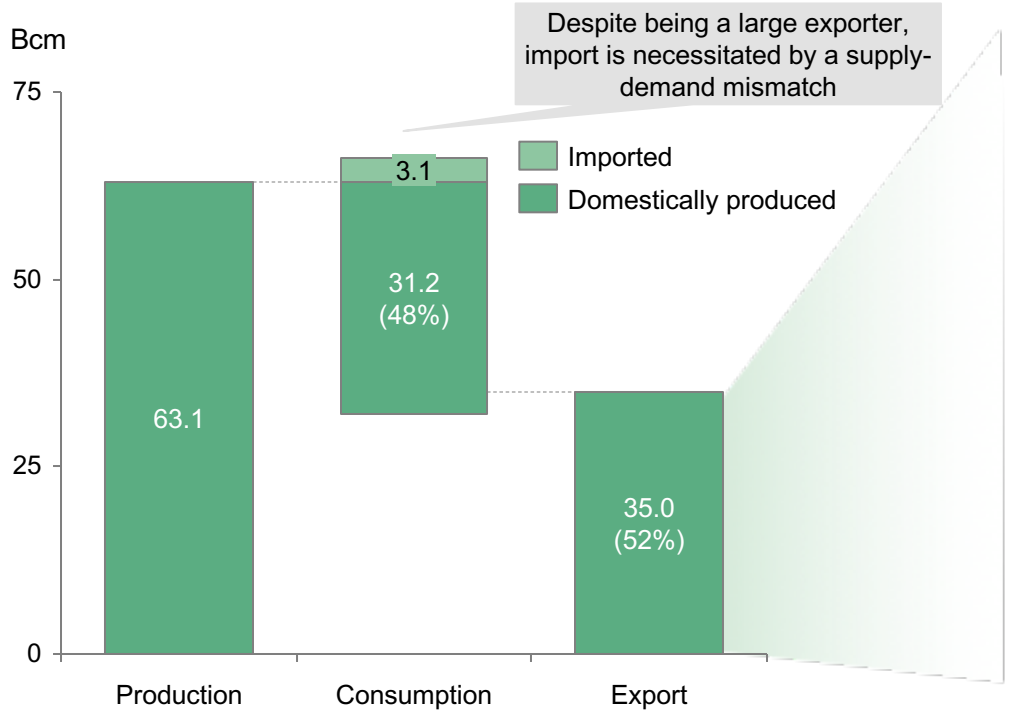
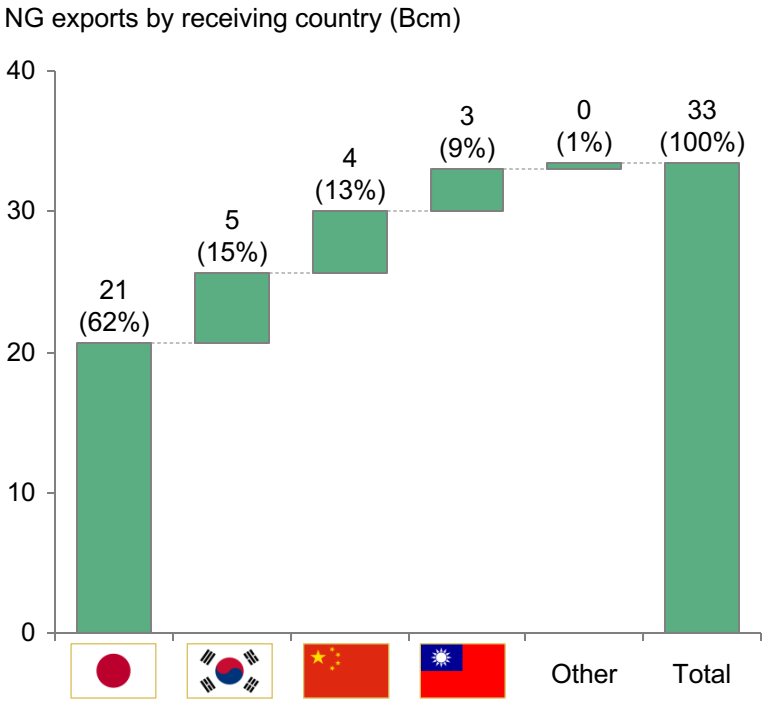
Malaysia is a large natural gas producer, and the 3rd largest LNG exporter in the world, since Australia surpassed it lately

63.1 Bcm natural gas produced of which 52% for export in 2015



All export goes to Asia, with Japan making up ~60% in 2015



Reserves – 2.7Tcm, #13 in the world
Production – 63.1Bcm, #12 in the world
Exports – 33.4Bcm, #3 of LNG in the world

Source: Cedigaz

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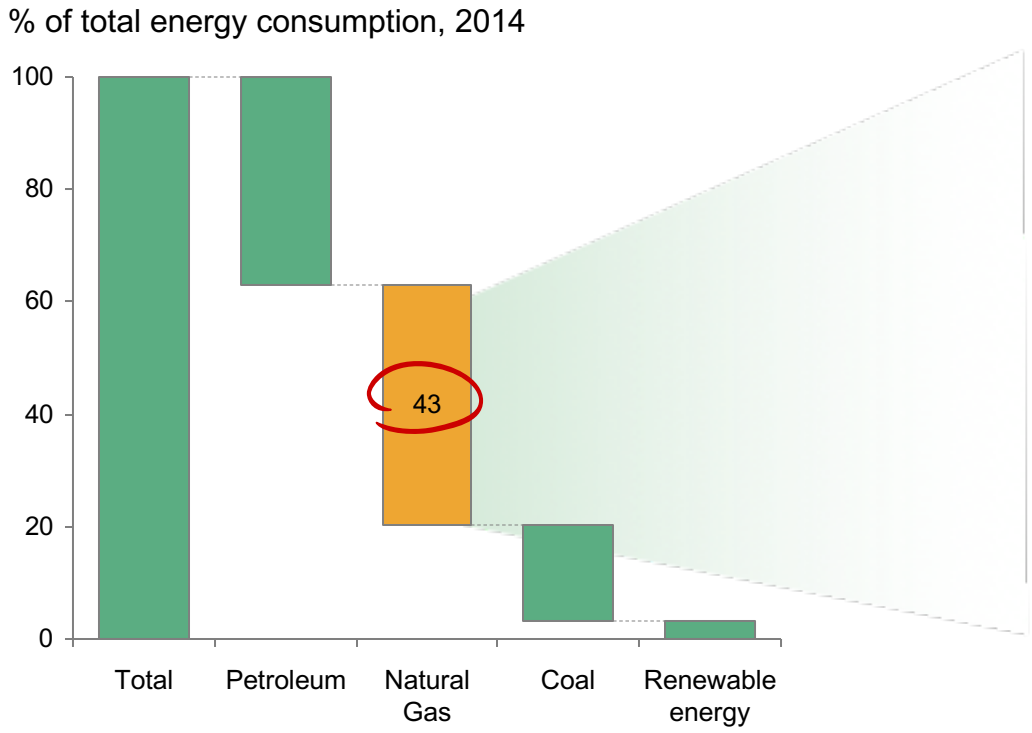
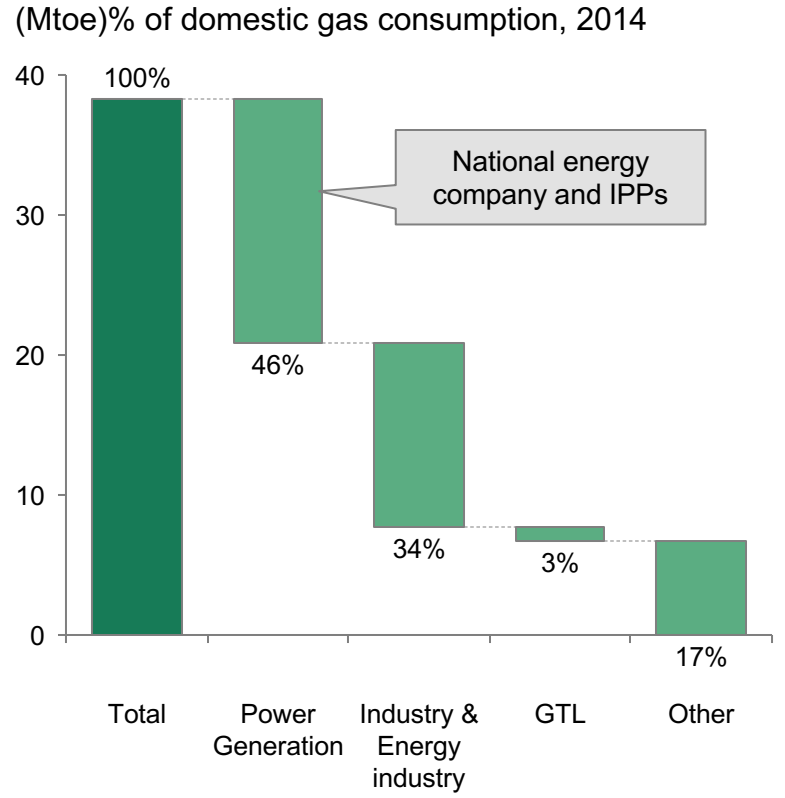
Gas represents ~40% of domestic energy consumption, power generation stands as the main gas consumer

43% of energy came from NG in 2014 ...



... with 46% dedicated to power generation



Source: IEA world energy balance 2016

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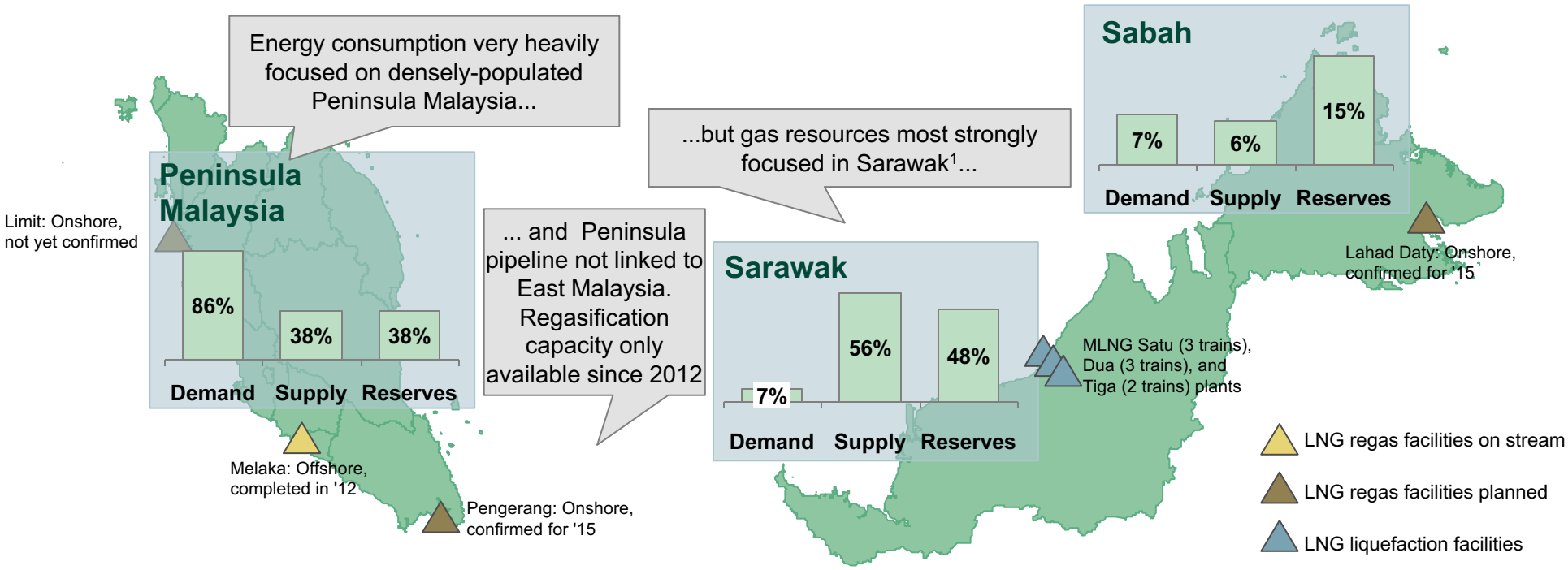
Despite being a large exporter with material resources, Malaysia has recently become a gas importer



With local demand outstripping supply, imports have gained importance

- Imports via pipeline from Indonesia started in 2002, followed by Vietnam in 2003 and Thailand in 2005
- With the first LNG regas terminal in Melaka, other LNG suppliers will be able to access the Malaysian market under TPAs
- 2 more LNG regasification facilities confirmed: 1 on the Peninsula and 1 in Sabah. 1 more contemplated for the Peninsula. Additionally Malaysia expects to finish their first floating LNG facility by 2015
- LNG imports, however, expected to cease by 2016, as Malaysia will supply the Peninsula with LNG from Sarawak
- The expected decrease in LNG available for exports will cause PETRONAS to have to use LNG production from elsewhere in the world to meet their long term export contracts

1. Government planning to develop industries in Sarawak to use local resources (petrochem and aluminum)
Source: Maybank, Malaysia sector update 2012 - data refers to 2011, except demand which refers to 2010; EnergyQuest; Reuters

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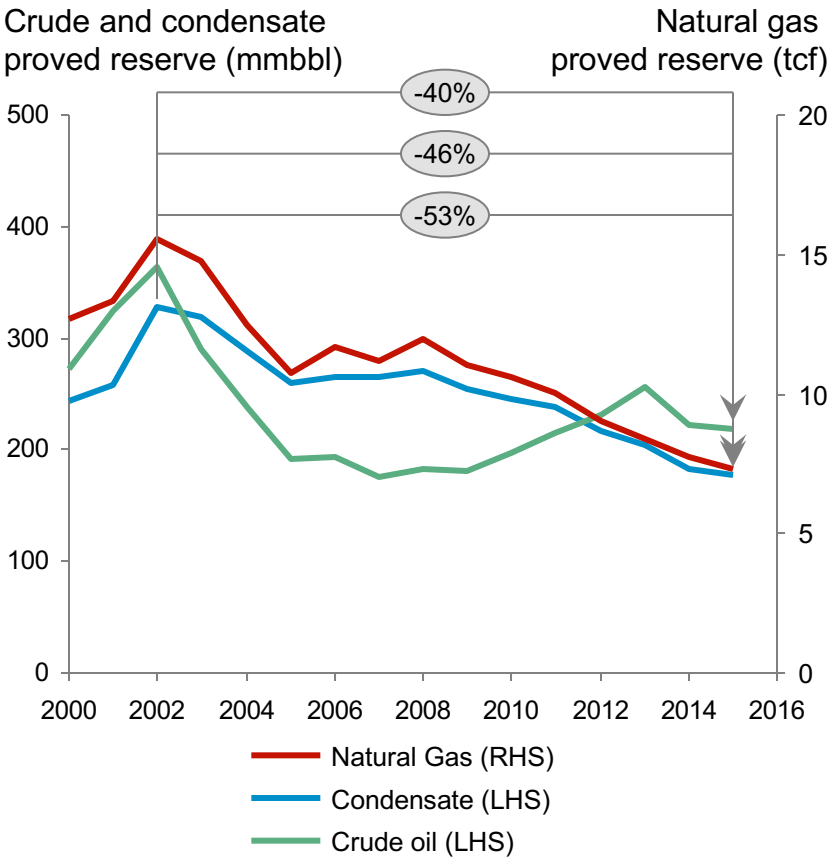
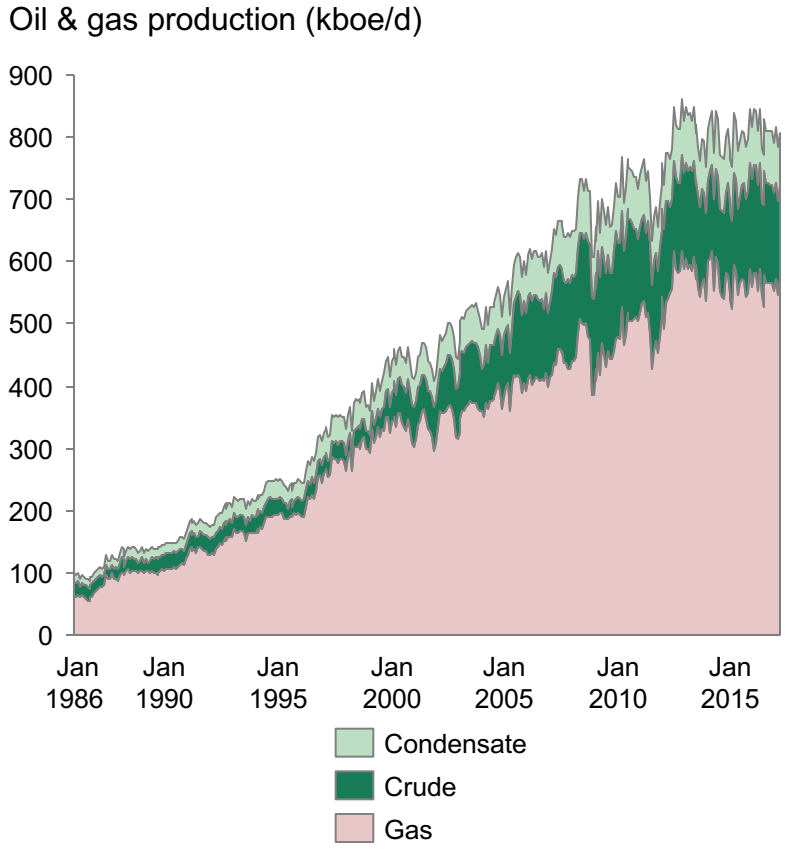
Thailand: Upstream reserves and production

Proved reserves have declined 40-50% between 2002 and 2015



Around 70% of Thailand's upstream production is gas



Note: Proved reserve includes only quantity of petroleum which is has a clear production plan approved by the Government and is expected to be commercially viable . 1bbl of condensate is equivalent to ~0.9bbl of crude oil; 1mmcf of gas is equivalent to ~174.5bbl of oil. Exclude JDA production
Source: EPPO, Department of Mineral Fuels (DMF), BCG analysis

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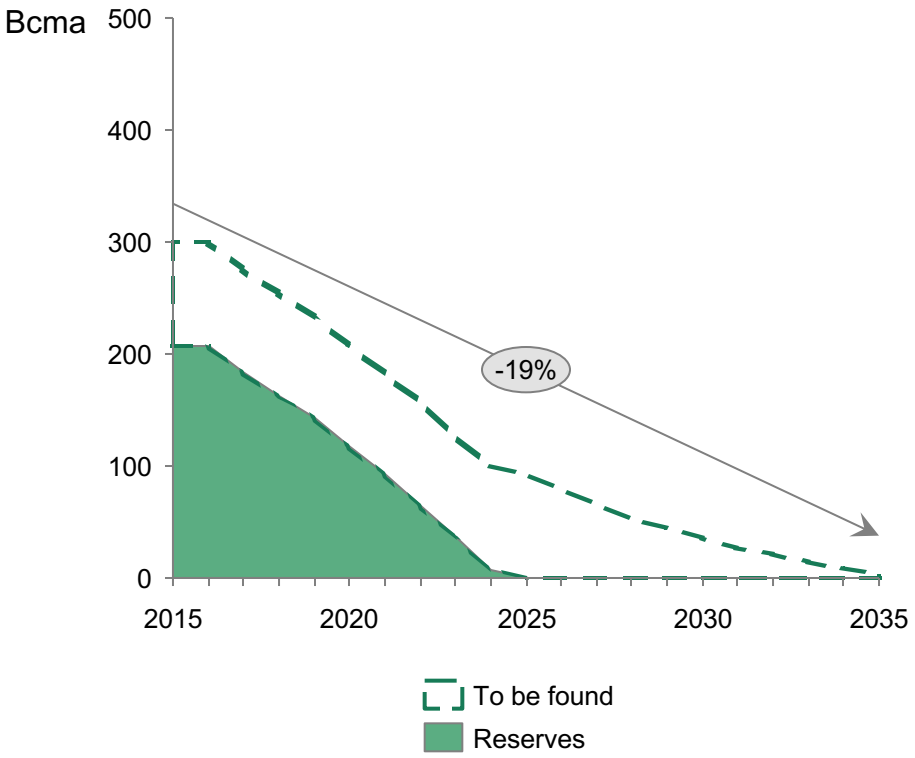
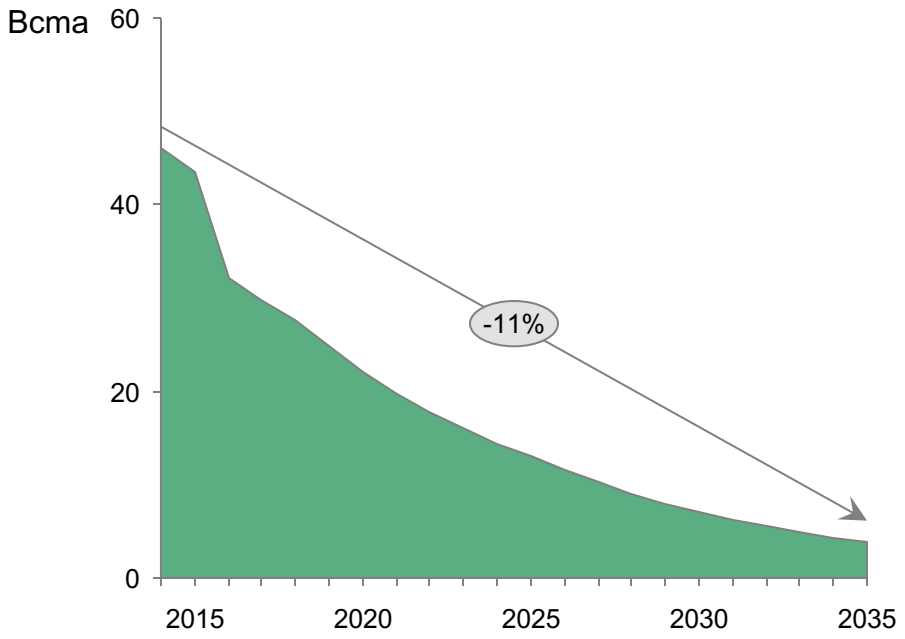
Thailand is running out of gas and no new development is expected

Expected reserves evolution 2015-2035



Expected production profile 2015-2035



Source: Rystad

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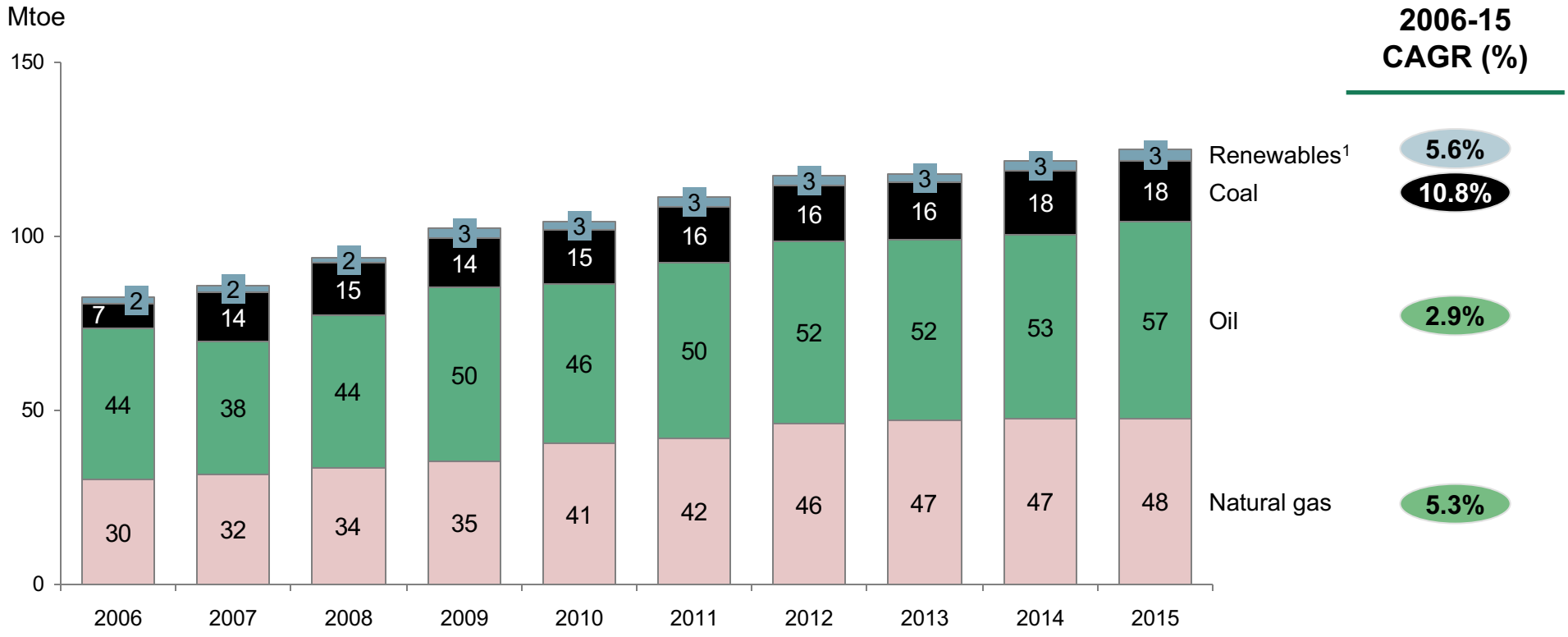
Thailand: Evolution of energy demand mix

Primary Energy Demand by Fuel Type (Mtoe) from 2006 to 2015



1. Includes hydro, nuclear, geothermal, wind, tidal, bio-energy and solar energy
Source: BP Statistical Review, BCG analysis

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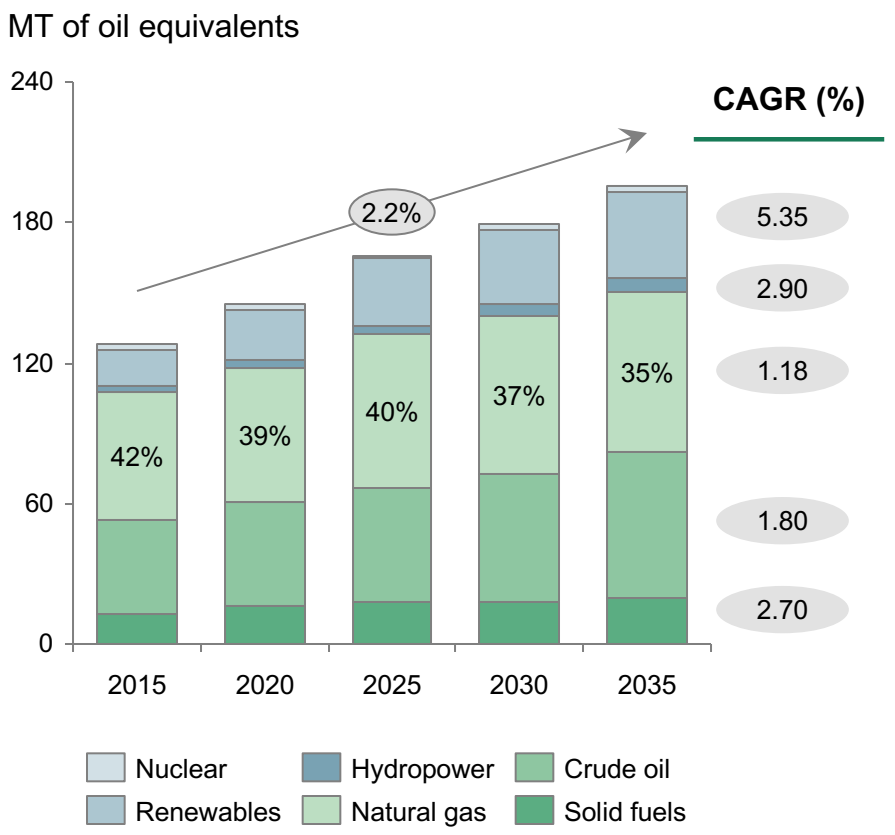
Thailand energy outlook counts on renewables and energy efficiency to curb emissions and import dependency

Blueprint scenario primary Energy demand 2015–35



Thailand ministry expected to drive this plan around 5 pillars

PLAN	Objective
Energy Efficiency Plan	Decrease energy intensity by 30% vs 2010
Alternative Energy Development Plan	Renewable energy to achieve 20%
Power Development Plan	Improve generation mix keeping a 15% reserve and accounting for environmental cost
Gas plan	Reduction in power generation use and improve supply
Oil plan	Manage change to biofuels and renewables energy while increasing oil quality standards

Source: Thailand Energy Outlook 2016

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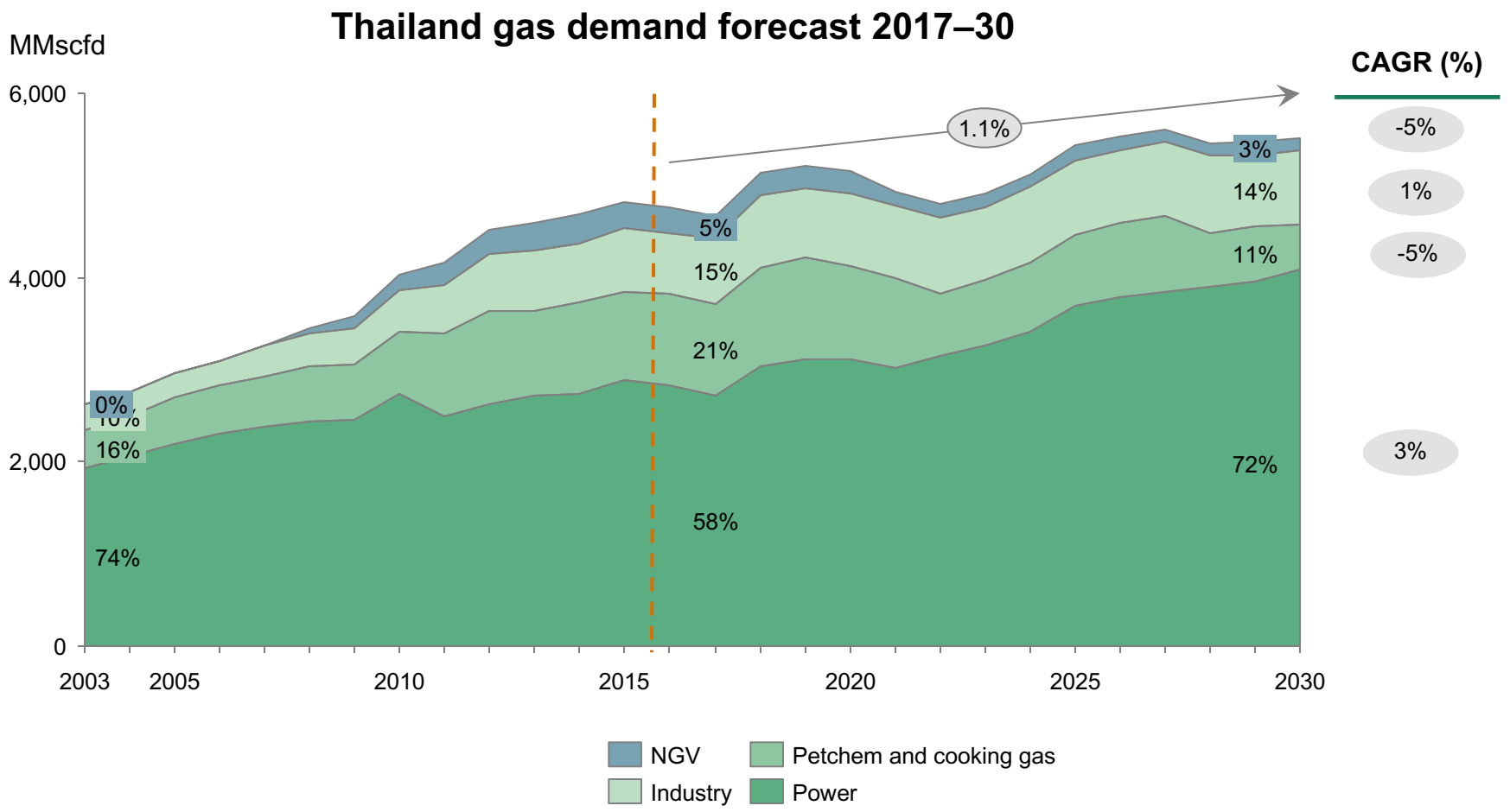
Natural gas demand in Thailand will be reduced from previous plans towards ~1% growth



Source: PTT Analyst Meeting 1H2017

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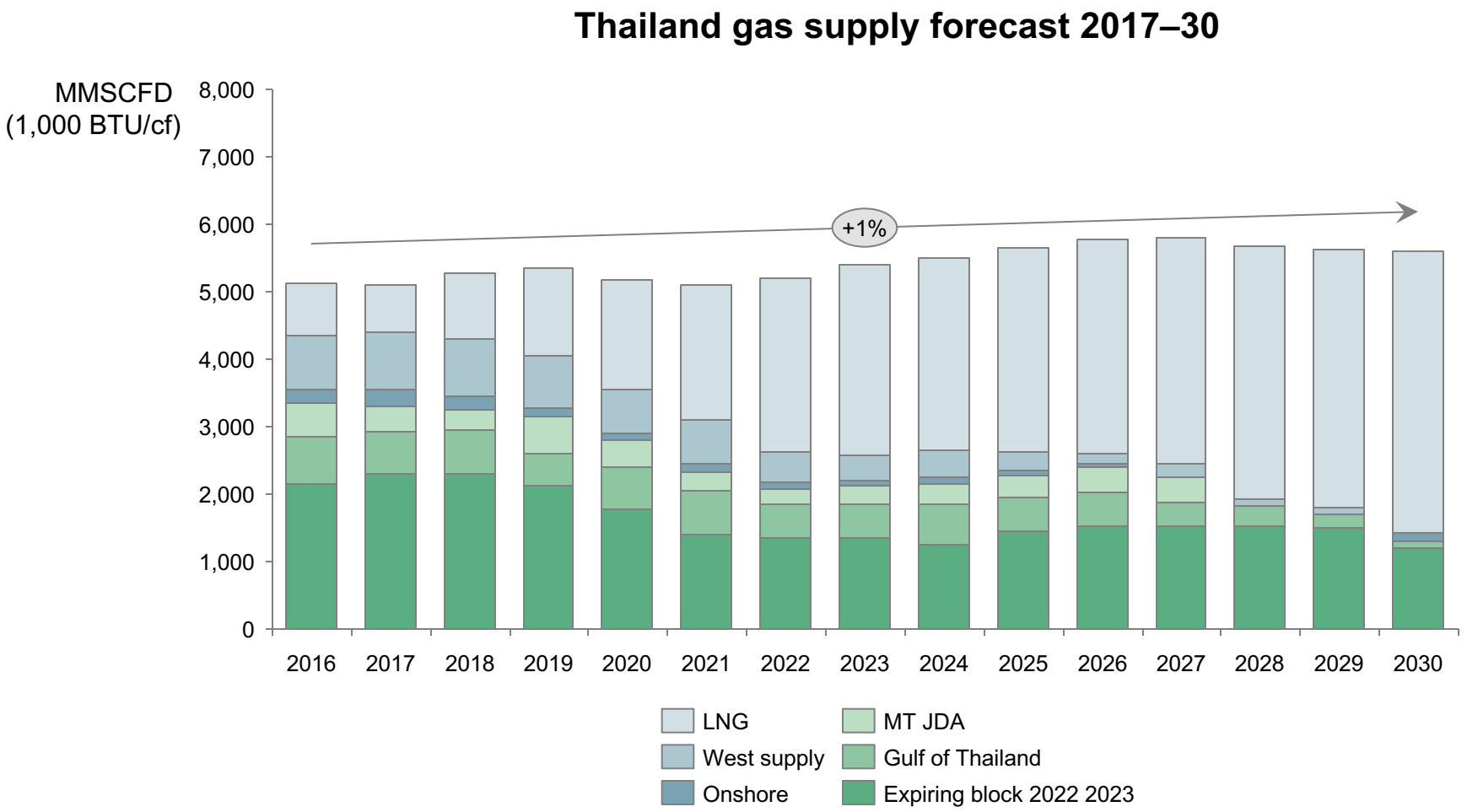
LNG seem to be the only solution for Thailand to meet natural gas demand



Note: Assumptions: Base on 5 year plan production, Domestic supply (2P) excluding the expiring blocks (3P+2C), Keep production after end of two majors concession at 1,500 MMSCFD JDA and Myanmar base on keep production expanding to the end of contract
Source: Minister of Energy Thailand; Producer Consumer Cooperation towards Developing LNG Market in Asia

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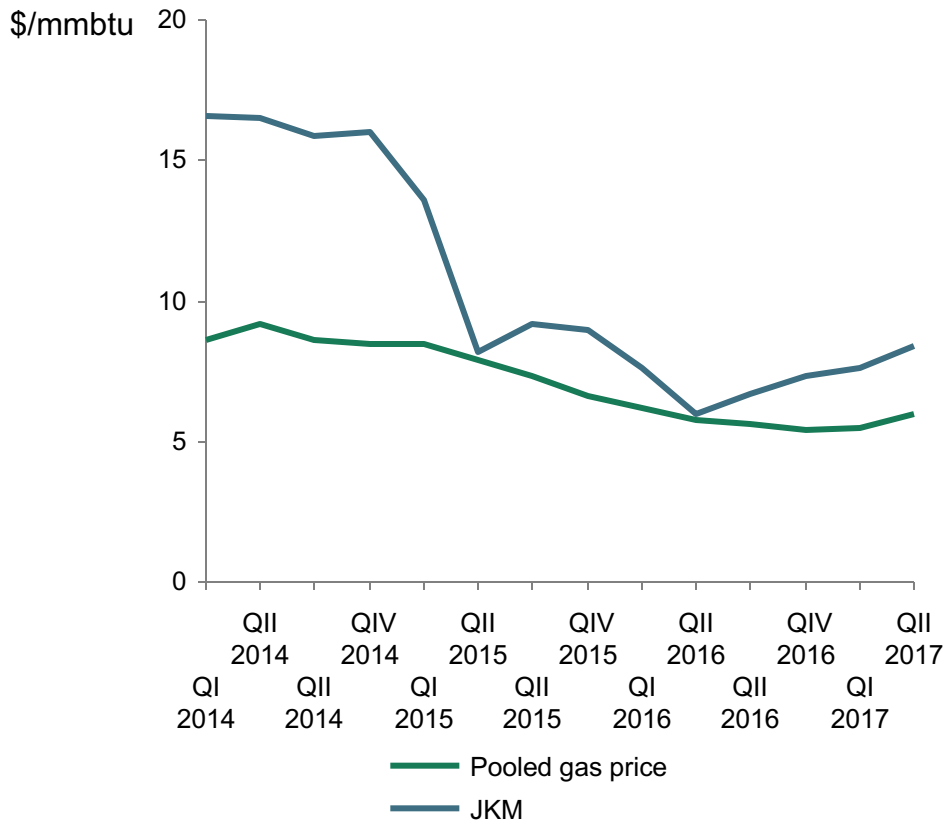
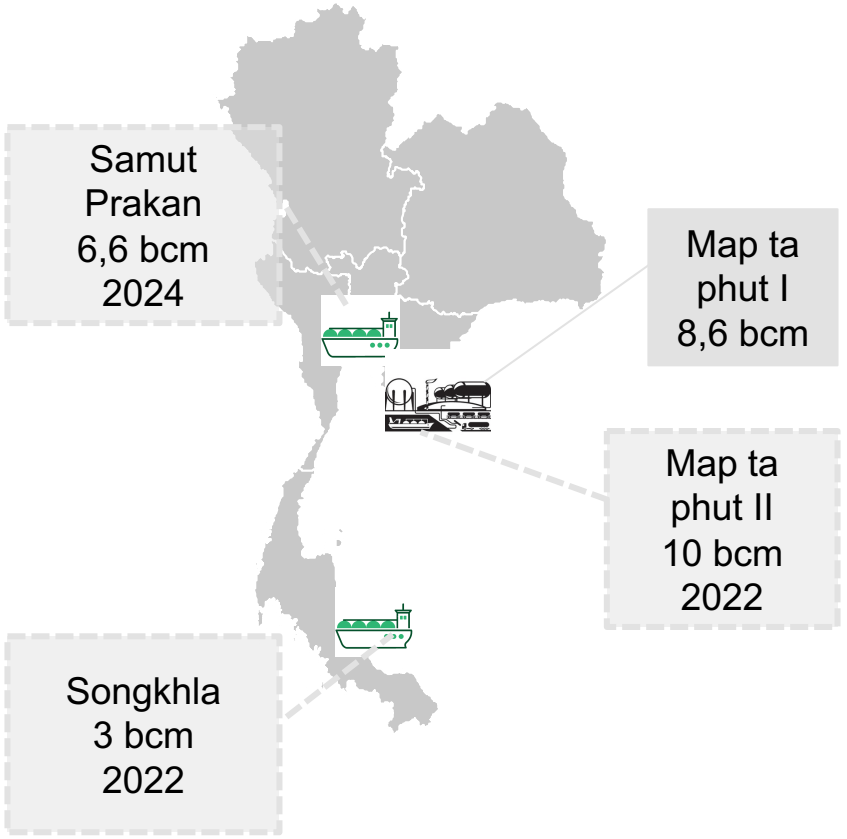
Low natural gas prices are one of the risks faced to develop new reserves and accomplish gas import plans

JKM vs Thailand pooled price recent evolution



Source: PTT analyst meeting several presentations, Cedigaz and Bloomberg

2 FSRU terminals proposed to complement Map Ta Phut



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Contents

What is the future role of natural gas globally?

What is the natural gas balance in APAC countries?

Key questions and discussion

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Challenges to enhance gas market penetration in APAC region

Key questions

1. **Greater LNG market integration among the world's three main regional gas markets – North America, Europe, and Asia will impact price formation and contracts globally**
   - How can Asian Ministers cooperate to enhance natural gas liquidity on gas trading hubs?
   - What are the prospects for long-term contracts, destination clauses, and oil indexation in Asia?
   - How will Ministers facilitate cross border and downstream gas infrastructure investment?

2. **Greater natural gas market flexibility comes with new risks and opportunities**
   - How do Asian Ministers evaluate gas market security in terms of storage, connectivity, and spare capacity?
   - What role can the Joint Organization Data Initiative Play to improve natural gas market data transparency?
   - Will greater gas market flexibility result in more volatile gas prices

3. **Upstream gas sector investment, deeper downstream gas penetration and market security in Asia will continue to depend on well established, and new producer consumer country relations**
   - How can the IEF platform be used to advance gas market integration in Asia?
   - Should Ministers set new benchmarks to help industry to retain efficiency gains and lower cost of transportation?
   - How is digitalization affecting gas sector costs and industry performance?

4. **Despite comparatively high prices for importers, Asia's appetite for natural gas is robust to overcome pollution and capitalize on its versatility across economic sectors**
   - How can Ministers strengthen the value proposition of gas in Asian markets?
   - What lessons have been learned from carbon pricing and subsidy reforms?
   - Are synergies between renewables and natural gas markets sufficiently explored?

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