



AMER6

The 6th Asian Ministerial
Energy Roundtable

Doha | Qatar

Plenary Session 2:

Gas and coal in Asia's energy mix: interactions and uncertainties.

Background Paper



Disclaimer

The observations presented herein are meant as background for the dialogue at the 6th 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

- Asian natural gas trade is expected to intensify in the near term as new pipeline and LNG projects come on-stream.
- Such an evolution of the gas industry has motivated greater interest in its possible impact over the regional energy mix, most notably in the prospects for coal, which to date is the backbone for electricity generation and supports a high share of industrial processes.
- Coal, it is said, is the real competition for gas, not renewables.
- What does the evolution of the regional gas market imply for coal and vice-versa?

Session objectives

- To exchange perspectives on projected gas and coal supply and demand with a focus on the main Asian markets, especially the expected intensification of regional gas trade
- To explore implications of the evolution of the regional gas market for the regional energy mix, with a focus on the implications for coal
- To discuss what shifts in domestic policies and international cooperation initiatives might be required in the current environment, for instance, to facilitate intercontinental gas pipeline development

Key Question:
What is the future of gas and coal in Asia?

Contents

Key observations

How do gas and coal compete in power generation?

Climate change negotiations: Kyoto vs. Paris

How will gas and coal demand evolve in Asia?

What challenges and opportunities does gas have in the region?

Questions and Discussion

Contents

Key observations

How do gas and coal compete in power generation?

Climate change negotiations: Kyoto vs. Paris

How will gas and coal demand evolve in Asia?

What challenges and opportunities does gas have in the region?

Questions and Discussion

Key Observations

Depending on country specifics, coal vs gas economic advantage varies

- Pure economics tend to show coal advantage for power generation new builds
- But country by country analysis reveals more diverse picture
- Government policies and international agreements have potential to influence coal vs gas dynamics

India, ASEAN and China will be the major energy demand growth drivers

- World energy demand forecasted at 1.3% CAGR to 2040, with Asia representing the bulk of the growth
- India and ASEAN countries will show strongest relative energy growth in Asia, China will grow moderately but remains largest

Share of gas and renewable to increase in Asia but absolute coal imports forecasted to grow as well

- Gas energy demand in Asia to grow fast at 3.2% CAGR, driven by flexibility and policy objectives
- Share of gas to increase in China and India at the expense of coal & oil, ASEAN to have larger share of coal
- Share of coal falls but still the largest in Asia energy mix in 2040 driven largely by strong in India and resilience in China where coastal plant closures offset by inland construction and reinforcement of HV lines

Asia will overcome Europe as largest gas import region, in a market with more diverse/competitive supply

- Nearly all Asian countries will import gas in 2040
- > 5x growth in China and India's gas imports expected to 2040, China to be the largest gas importer in 2040
- Multiple large gas exporters in 2040 – higher fragmentation in gas supplier market and more liquid LNG market

Asia will accentuate its status of largest coal import region, with continuing intra-regional flows

- India to be largest coal importer in 2040, followed by China & rest-Asia
- Indonesia and Australia continue to be world's largest exporters of coal

Contents

Key observations

How do gas and coal compete in power generation?

Climate change negotiations: Kyoto vs. Paris

How will gas and coal demand evolve in Asia?

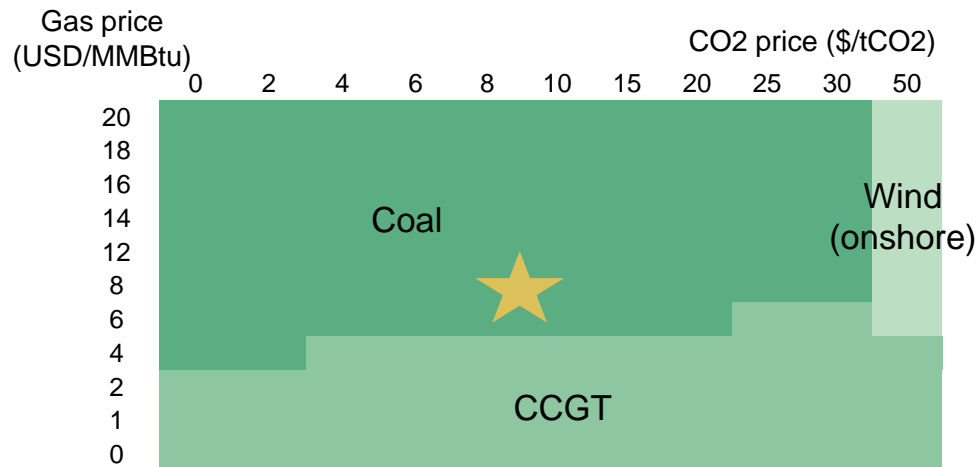
What challenges and opportunities does gas have in the region?

Questions and Discussion

On average, at current prices, coal is the economic choice for new power plant builds – assuming no subsidies for wind

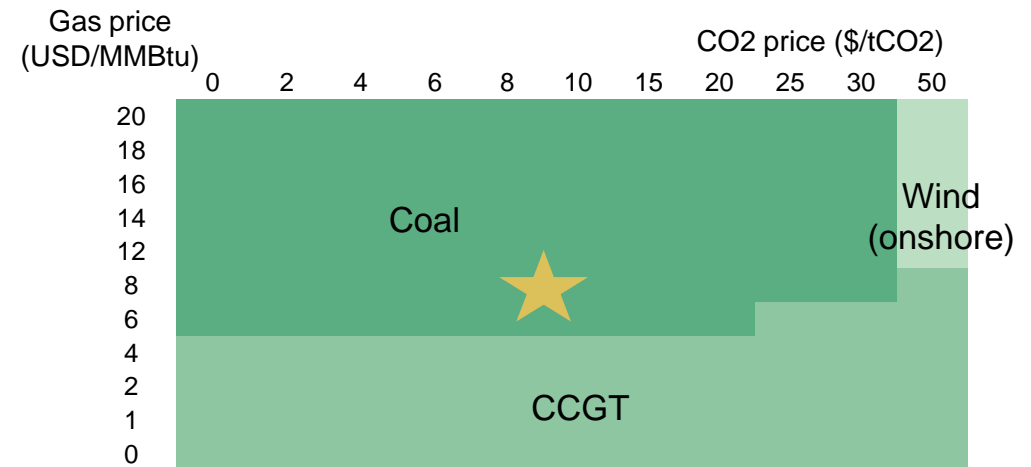
Centralised power
New build - unsubsidised wind

At low load factor



- No wind subsidy
- Coal price: 59 USD/T
- Load factor
 - Coal 58%
 - CCGT 28%
 - Wind 100% (with availability 23%)

At higher load factors



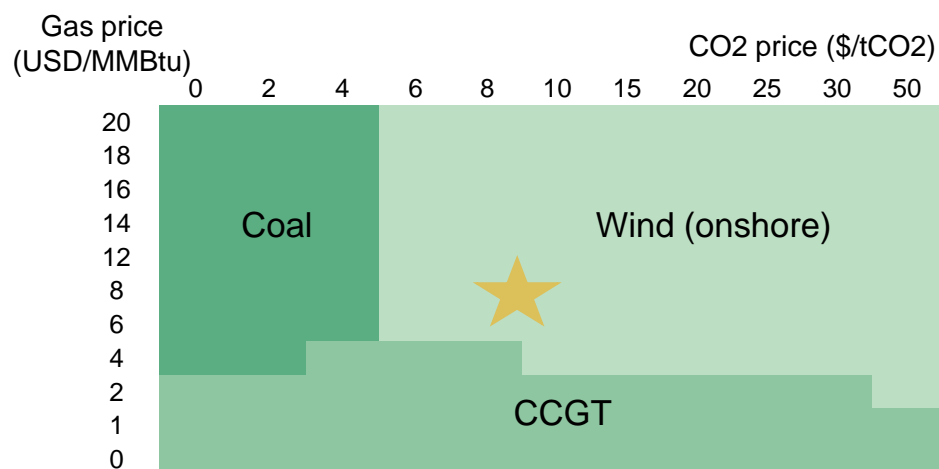
- No wind subsidy
- Coal price: 59 USD/T
- Load factor
 - Coal 75%
 - CCGT 40%
 - Wind 100% (with availability 23%)

Note: Charts show most economic energy source by levelised cost of electricity, with plant efficiencies, lifetimes, availability and load factors representative of European fleet. CoC = 10%

With subsidies, wind power becomes more attractive than coal and gas

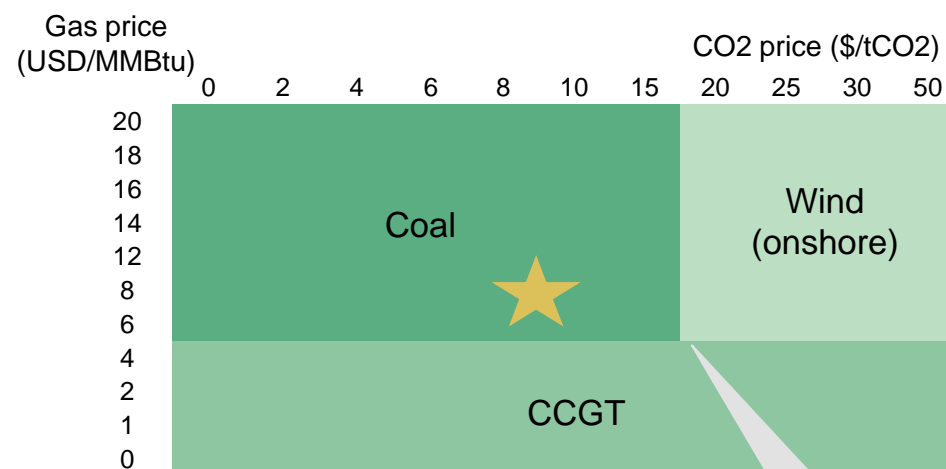
Centralised power
New build - subsidised wind

At low load factor



- Wind subsidy 24% premium to LCOE
- Coal price: 59 USD/T
- Load factor
 - Coal 58%
 - CCGT 28%
 - Wind 100% (with availability 23%)

At higher load factors












- Wind subsidy 24% premium to LCOE
- Coal price: 59 USD/T
- Load factor
 - Coal 75%
 - CCGT 40%
 - Wind 100% (with availability 23%)

Note: Wind subsidies estimated based on 2012 Ecofys' data; Charts show most economic energy source by levelised cost of electricity, with plant efficiencies, lifetimes, availability and load factors representative of European fleet. CoC = 10%





Country-by-country, specifics lead to more diverse assessment of economic advantage

The average power generation cost of coal/gas fired power plants (including capex & opex) (US cents/kWh)

Country		Gas	Coal	Trend
China		13.9	5.9	Cost advantage for coal but new build focused on inland areas <ul style="list-style-type: none"> Closure of old coal city plants, growth in transmission ('coal by wire')
India		7.3	5.9	Gas to gain share in power mix, but coal to remain dominant <ul style="list-style-type: none"> More coal plants being built given concern on gas supply security
Indonesia		7.2	8.9	Both coal and gas to gain share in power mix, coal to remain dominant <ul style="list-style-type: none"> Govt. promoting coal to reduce use of oil fuels, and gas shortage concerns
Thailand		7.5	6.2	Share of coal in power mix to increase <ul style="list-style-type: none"> Govt. promoting coal – concern on gas supply security and higher gas prices
Malaysia		4.4	6.9	Gas price reforms and coal supply security to decide share in power <ul style="list-style-type: none"> Gas plant cost advantage dependent on gas price reforms by Govt.
Vietnam		6.1	6.8	Gas & coal import prices to decide share in power, coal likely to dominate <ul style="list-style-type: none"> Currently 13 GW of coal plants being built, and only one gas plant (750 MW)
Philippines		8.4	8.4	Share of coal in power mix to increase <ul style="list-style-type: none"> Coal based plants likely to have cost advantage as gas prices expected to rise
Japan		9.9	7.5	Share of gas in power mix to increase <ul style="list-style-type: none"> Current and under construction capacity: gas-based higher than coal based
S Korea		12.3	6.3	Share of coal in power mix to increase <ul style="list-style-type: none"> Coal based generation significantly economical

Source: Coal and gas competition in power generation in Asia, IEA Feb-15 ; Press search ; BCG analysis

Government policies affect relative advantage of gas vs coal vs other technologies

	"Over-installed"		"Under-installed"	
Driver	Policies & subsidies	Network tariff cross-subsidies	Economically viable	Unpriced Externalities
Detail	<ul style="list-style-type: none">• Subsidies (e.g., feed-in tariffs) make technology cost effective, but without cost is prohibitive• Leads to over-installation, compared to economically viable alternatives	<ul style="list-style-type: none">• Positive cross subsidies• If price structure changes, technology no longer cost effective (e.g. annual connection fee in place of grid cost build into unit price of energy)• Leads to over-installation, compared to economically viable alternatives	<ul style="list-style-type: none">• Cost of generation less than current price of electricity regardless of policies and pricing distortion	<ul style="list-style-type: none">• Negative cross-subsidies• If price structure changes, technology becomes cost effective (e.g., if price assigned to externalities such as CO₂)• Leads to under-installation, compared to economically viable alternatives
Examples	<div><p>Middle East subsidised oil / domestic gas</p></div> <div><p>Japan Strategic Energy Plan supporting nuclear energy</p></div>		<div><p>China Coal cheapest per unit of energy (including capex and opex)</p><p><i>In general, coal is economically viable</i></p></div>	<div><p>Australia Fringe of grid (e.g., standalone solar PV)</p></div>
Government policies (e.g., ITCs, PTCs, carbon prices, import taxes) can be used to drive energy technology choices				

Contents

Key observations

How do gas and coal compete in power generation?

Climate change negotiations: Kyoto vs. Paris

How will gas and coal demand evolve in Asia?

What challenges and opportunities does gas have in the region?

Questions and Discussion

COP 21 represents first opportunity for renewed "protocol"

Significant increases in official commitments may drive investment in gas over coal

BCG view

1997 Kyoto Protocol

2015 Paris Protocol objective

Reduce carbon by 30% below 1990 level by 2020

Vs.

Firm emissions reduction target by 2050 to avoid "2 degrees" scenario

Fight global climate change

Vs.

Fight global and local climate change

Quantitative reduction targets agreed to in a wide range of countries

Vs.

National contributions defined per country in light of its national circumstances

Carbon market as the most fitting mechanism for controlling emissions

Vs.

Different mechanisms being developed (taxes as the most used mechanism)

Possibility of generating profits through emissions reduction projects (CDM)

Vs.

No outside support for emissions reduction projects

Climate change strategies based on mitigation

Vs.

Climate change strategies based on both mitigation and adaptation

Contents

Key observations

How do gas and coal compete in power generation?

Climate change negotiations: Kyoto vs. Paris

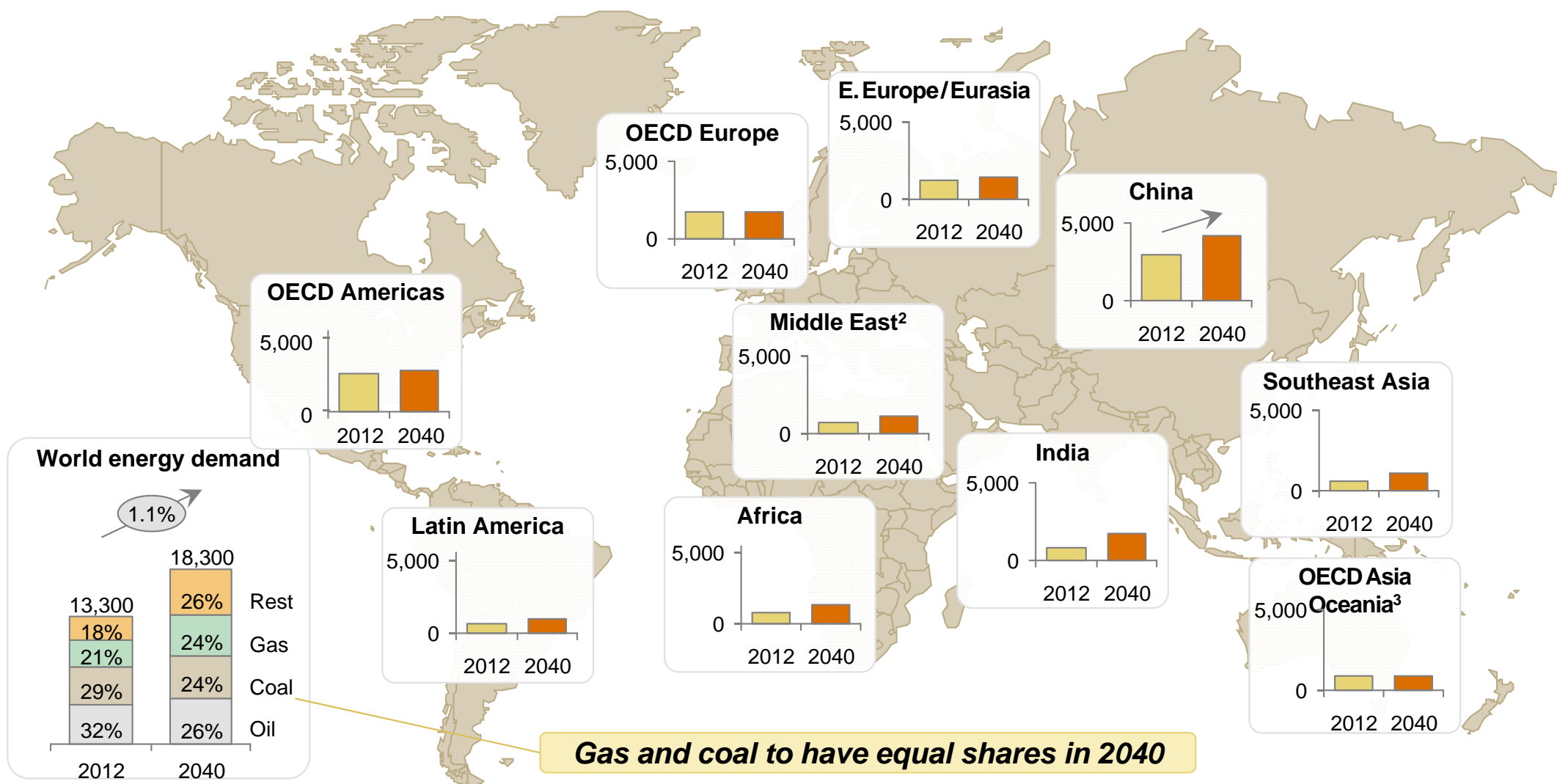
How will gas and coal demand evolve in Asia?

What challenges and opportunities does gas have in the region?

Questions and Discussion

World energy demand to grow, primarily driven by China, India, and South East Asia

World primary energy demand¹ in the New Policies Scenario (Mtoe)



1. Total Primary Energy Demand includes power gen and total final consumption in industry, transport, buildings, others. 2. Middle East includes Syria, Lebanon, Jordan, Iraq, Saudi Arabia, Kuwait, Bahrain, Qatar, Oman, UAE, Yemen, Iran. 3. OECD Asia Oceania includes Australia, Japan, Korea and New Zealand
Source: IEA World Energy Outlook 2014 ; ADB Energy Outlook for Asia and the Pacific Oct-2013 ; IEE Japan The 3rd Asian Energy Outlook 2011 ; Press search ; BCG research

High growth in gas demand in China, India, ASEAN, and Middle East

China



India



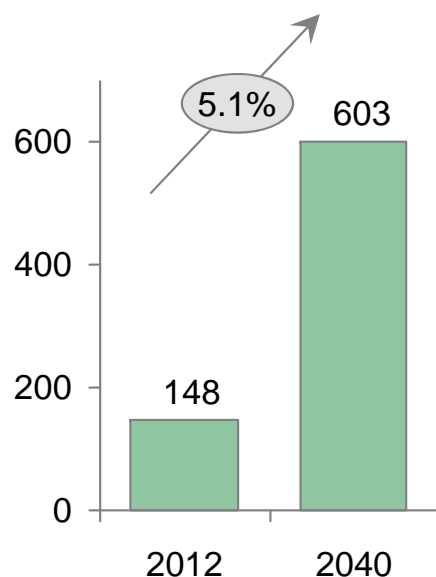
ASEAN



Middle East¹

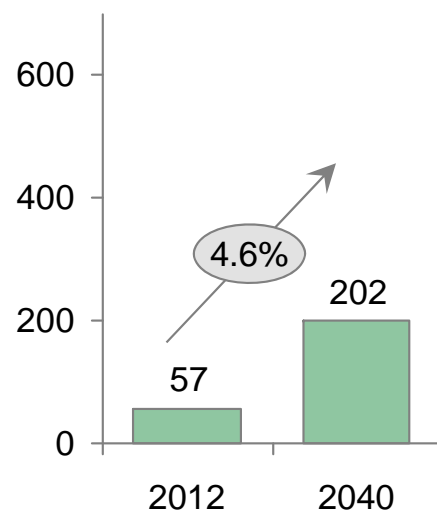


Natural Gas Demand (bcm)



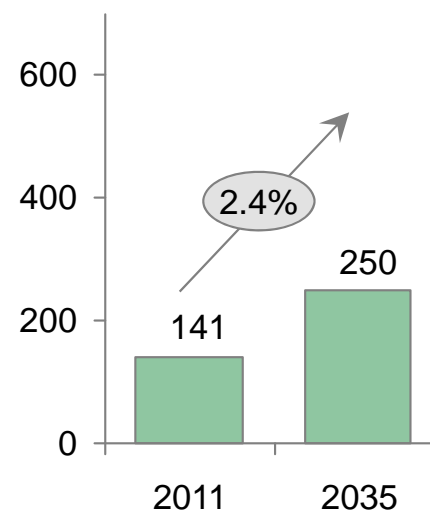
Govt. focusing on air quality

- Gas reform initiatives launched in recent yrs
- New coal plants to be prohibited in key industrial areas



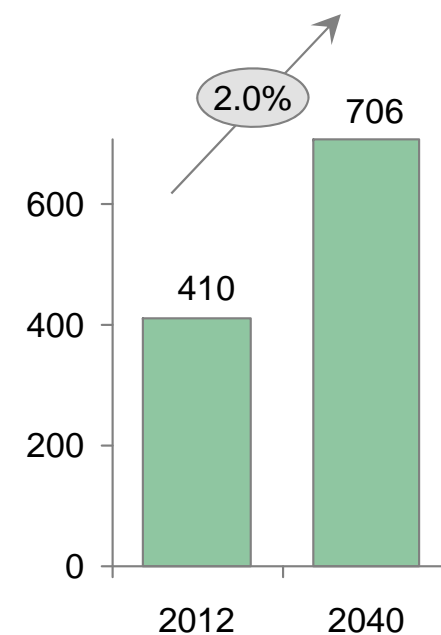
Govt. introduced pricing reforms in 2014

Other reforms like gas pooling policies for power and fertilizers sectors to drive demand



Infrastructure availability (transmission/liquefaction) to drive gas energy demand

- Ramp up of LNG capacity in Indonesia



Gas continues to represent largest piece of demand

- Greatest demand growth seen in renewables and nuclear being brought online

1. Middle East includes Syria, Lebanon, Jordan, Iraq, Saudi Arabia, Kuwait, Bahrain, Qatar, Oman, UAE, Yemen, Iran.

Source: IEA World Energy Outlook 2014 ; IEA South East Asia Energy Outlook Sep-2013 ; IEE Japan The 3rd Asian Energy Outlook 2011 ; Press search ; BCG research

Low growth in gas demand in Eurasia and OECD Asia Oceania

Japan



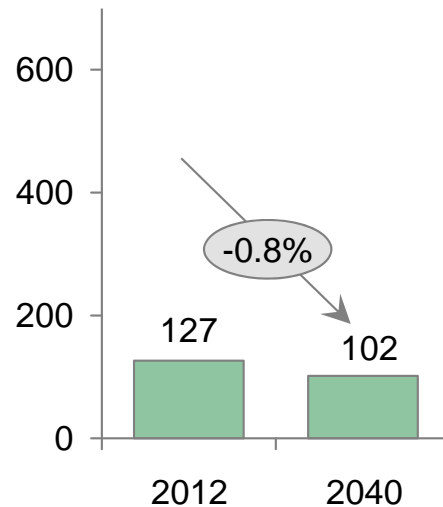
Eurasia¹



OECD Asia Oceania²

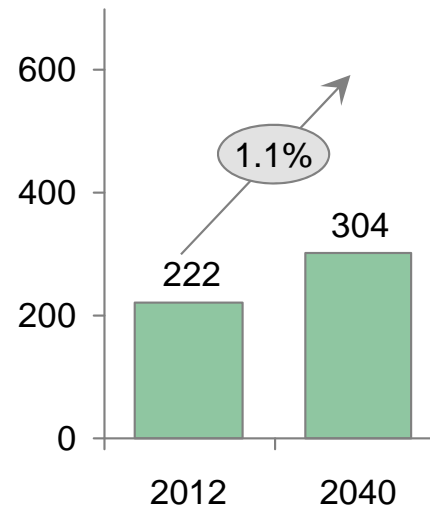


Natural Gas Demand (bcm)



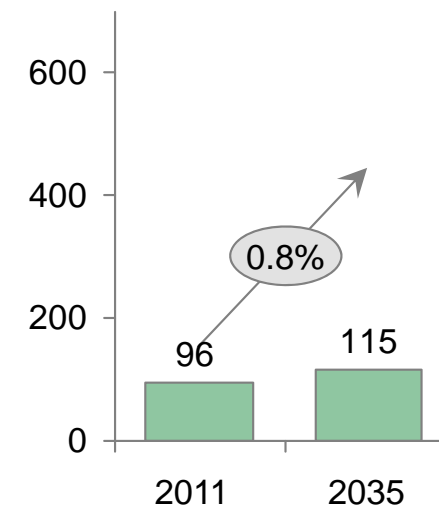
Gas demand to drop as nuclear gains share

- Govt. approved Strategic Energy Plan supporting nuclear energy



Gas constitutes large share of energy mix

- Emphasis on gas for energy security
- Large Caspian oil and gas reserves



Gas is only fossil fuel with (slightly) increasing demand

- Growth in energy demand covered by increases in renewables and nuclear

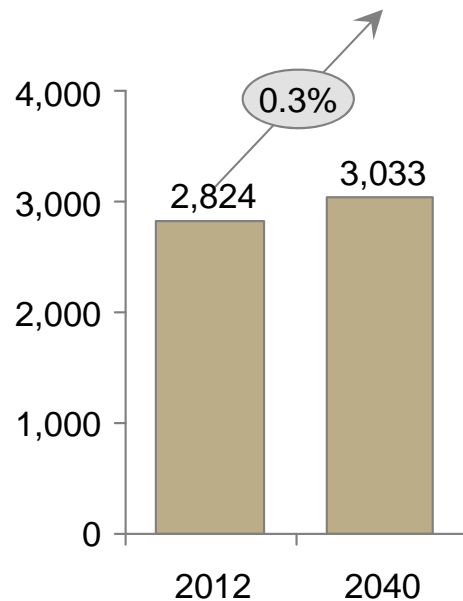
1. Eurasia (excluding Russia) includes Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Georgia, Kazakhstan, Kosovo, Kyrgyz, Latvia, Lithuania, Macedonia, Moldova, Romania, Serbia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan. 2. OECD Asia Oceania (excluding Japan) includes Australia, Korea and New Zealand.

Source: IEA World Energy Outlook 2014 ; Press search ; BCG research

High growth in coal demand in India and ASEAN

Low growth, but absolute demand to remain high in China

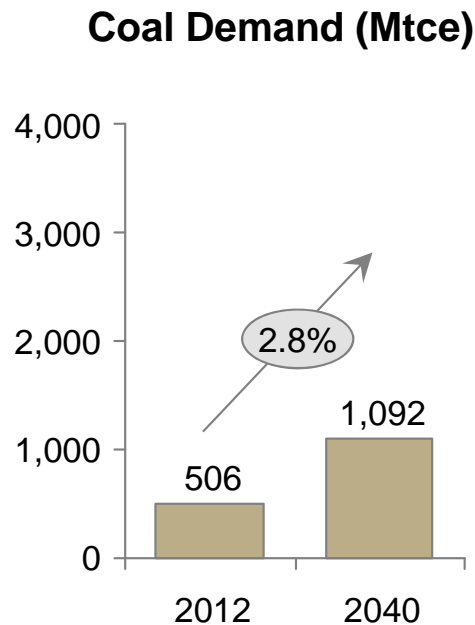
China



Coal demand peaks around 2030, driven by

- slowdown in economic growth beyond 2030
- policies to reduce CO₂ emissions

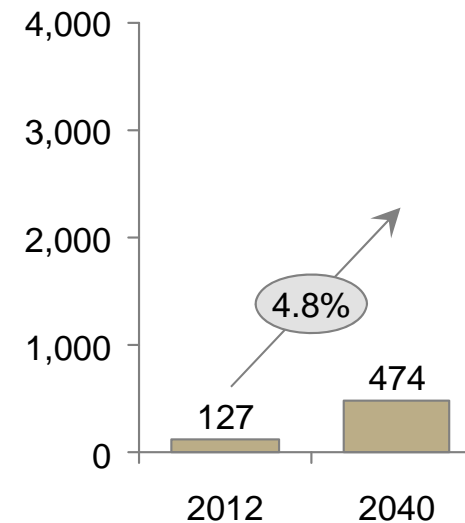
India



Driven by continued growth of electricity demand

- Current per capita consumption very low at ~900 kwh

ASEAN

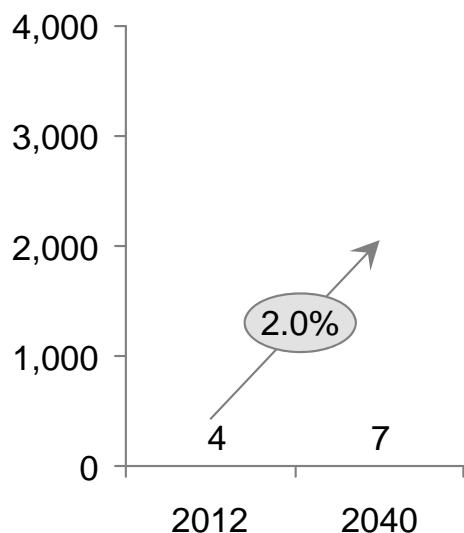


Coal demand driven by

- Reduction in gas subsidy in Malaysia
- Recent disruptions in gas supply in Thailand

Low growth in coal demand in Eurasia, OECD Asia Oceania, and Middle East

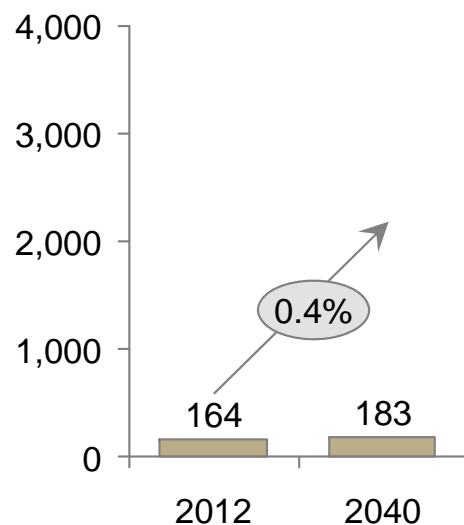
Middle East¹



Coal demand remains trivial

- Energy consumption dominated by oil & gas
- Increase in renewables and nuclear, sums to only ~5% of demand

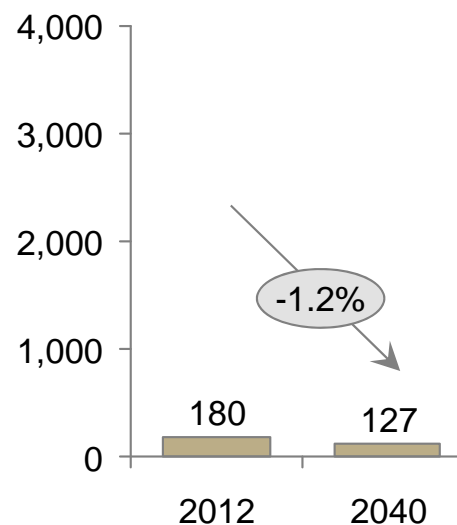
Eurasia²



Low coal demand growth

- Emphasis on gas for energy security
- Large Caspian oil and gas reserves

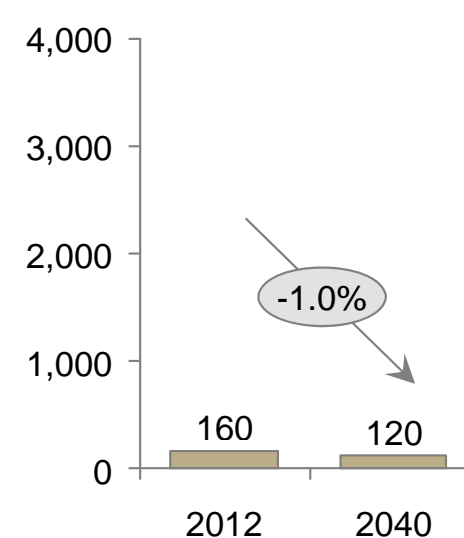
OECD Asia Oceania³



Coal demand declines

- Low growth in consumption, requires ramping of power plants
- Increasing air pollution concerns

Japan



Coal demand to steadily decline

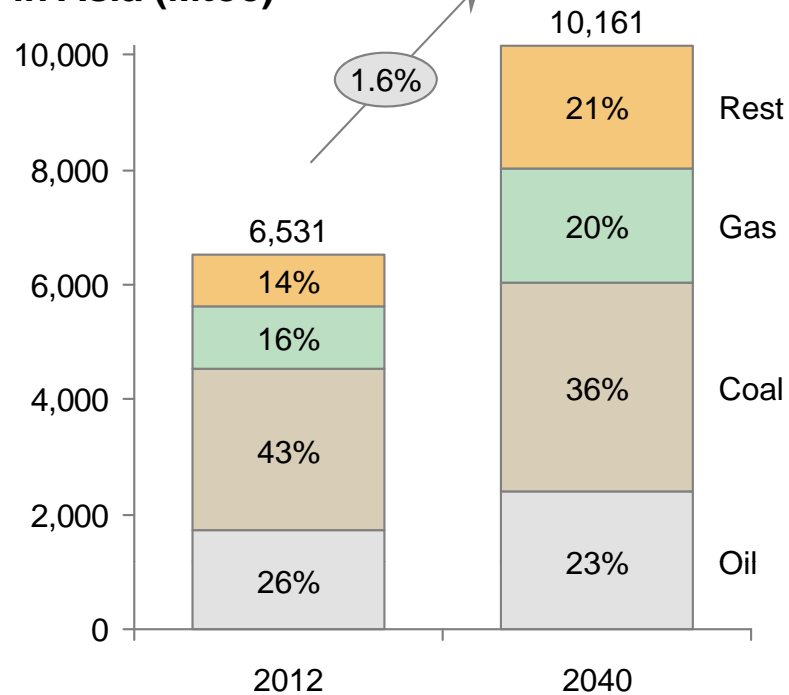
- Low energy intensity
- Energy efficiency targets

1. Middle East includes Syria, Lebanon, Jordan, Iraq, Saudi Arabia, Kuwait, Bahrain, Qatar, Oman, UAE, Yemen, Iran. 2. Eurasia (excluding Russia) includes Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Georgia, Kazakhstan, Kosovo, Kyrgyz, Latvia, Lithuania, Macedonia, Moldova, Romania, Serbia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan. 3. OECD Asia Oceania (excluding Japan) includes Australia, Korea and New Zealand. Source: IEA World Energy Outlook 2014 ; Press search ; BCG research

Strong primary energy demand growth expected in Asia, driven by gas and renewables

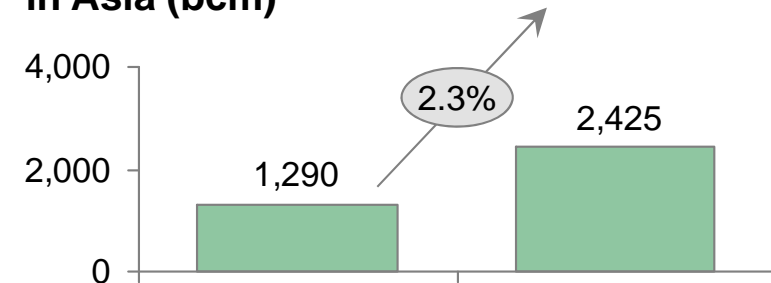
Asia primary energy demand¹ to grow stronger than world energy demand

Primary energy demand¹ in Asia (Mtoe)

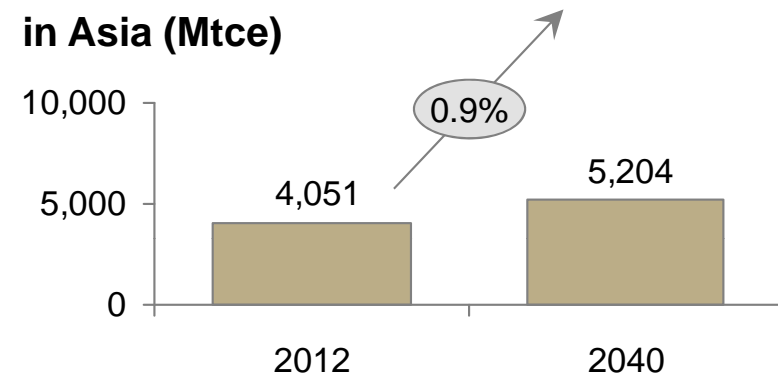


Strong growth in gas demand in Asia², slow growth in coal

Natural gas demand in Asia (bcm)



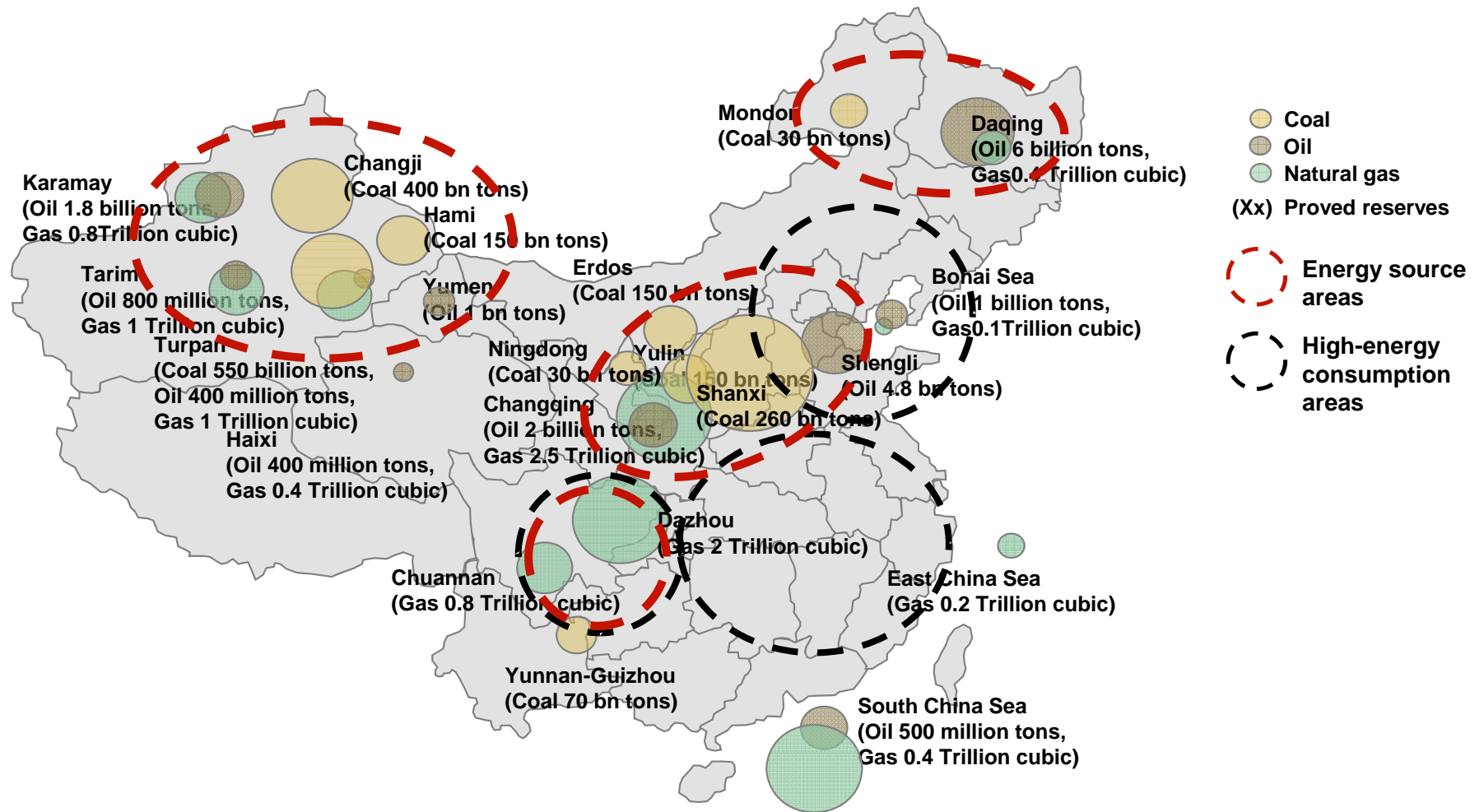
Coal demand in Asia (Mtce)



Share of gas and renewables to increase in Asia, share of coal to decrease but coal remains the largest in Asia energy mix

1. Total Primary Energy Demand includes power gen, total final consumption in industry, transport, buildings, others ; 2. Includes OECD Asia Oceania, non-OECD Asia, Middle East, Eurasia (including Russia)
Source: IEA World Energy Outlook 2014 ; ADB Energy Outlook for Asia and the Pacific Oct-2013 ; IEE Japan The 3rd Asian Energy Outlook 2011 ; Press search ; BCG research

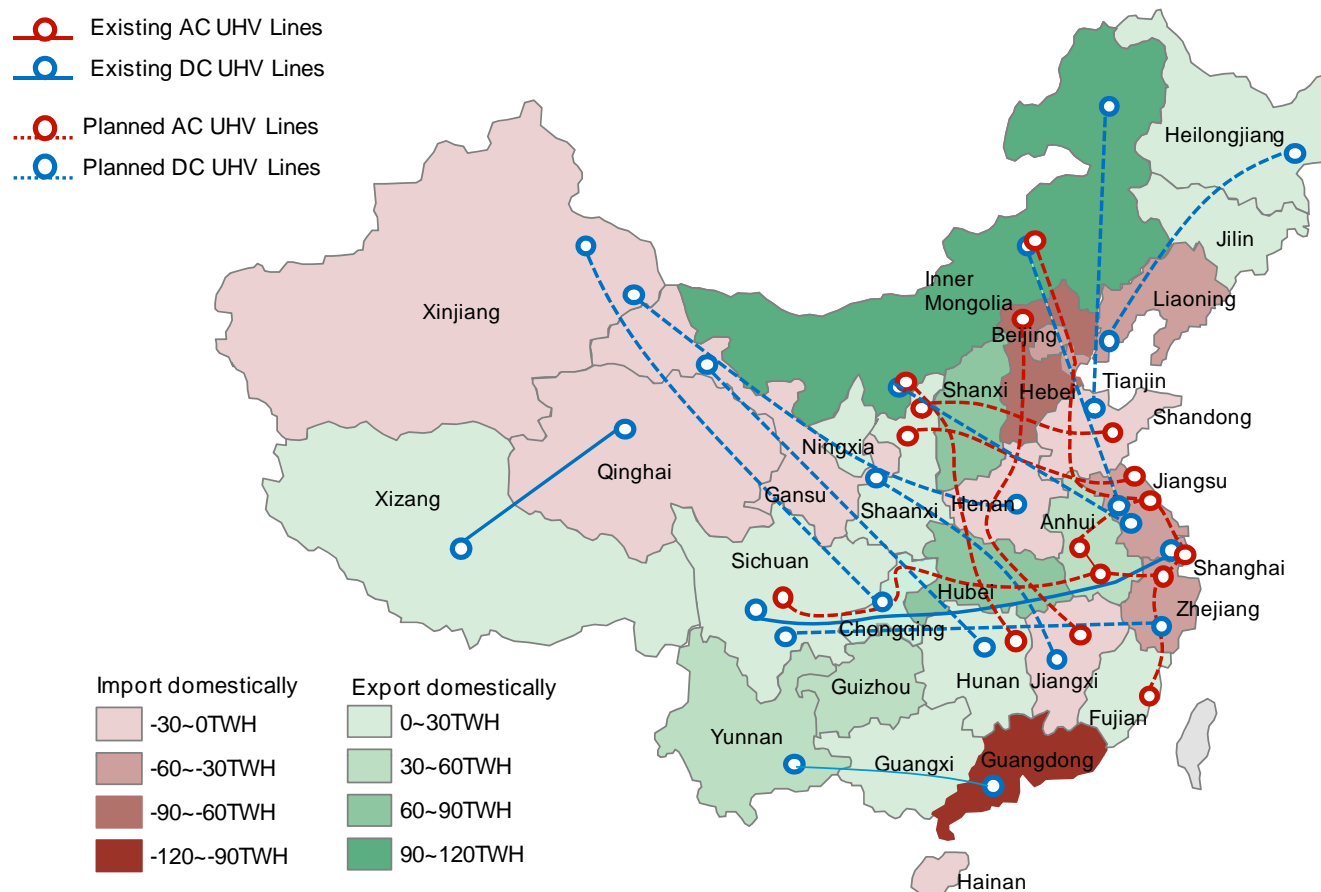
China: Geographical imbalance of energy production and consumption



Large investment is required to transport energy from sources in the Northern and Western regions to the Eastern regions for consumption

China: Coal consumption expected to remain strong with "coal-by-wire" development

Existing and planned UHV lines in China



Context

Significant urban pollution concerns in coastal provinces

- Largely driven by particles emission from old coal plants

Political resolve to address those issues while preserving affordability and relative energy independence objectives

- Leverage large domestic coal reserves

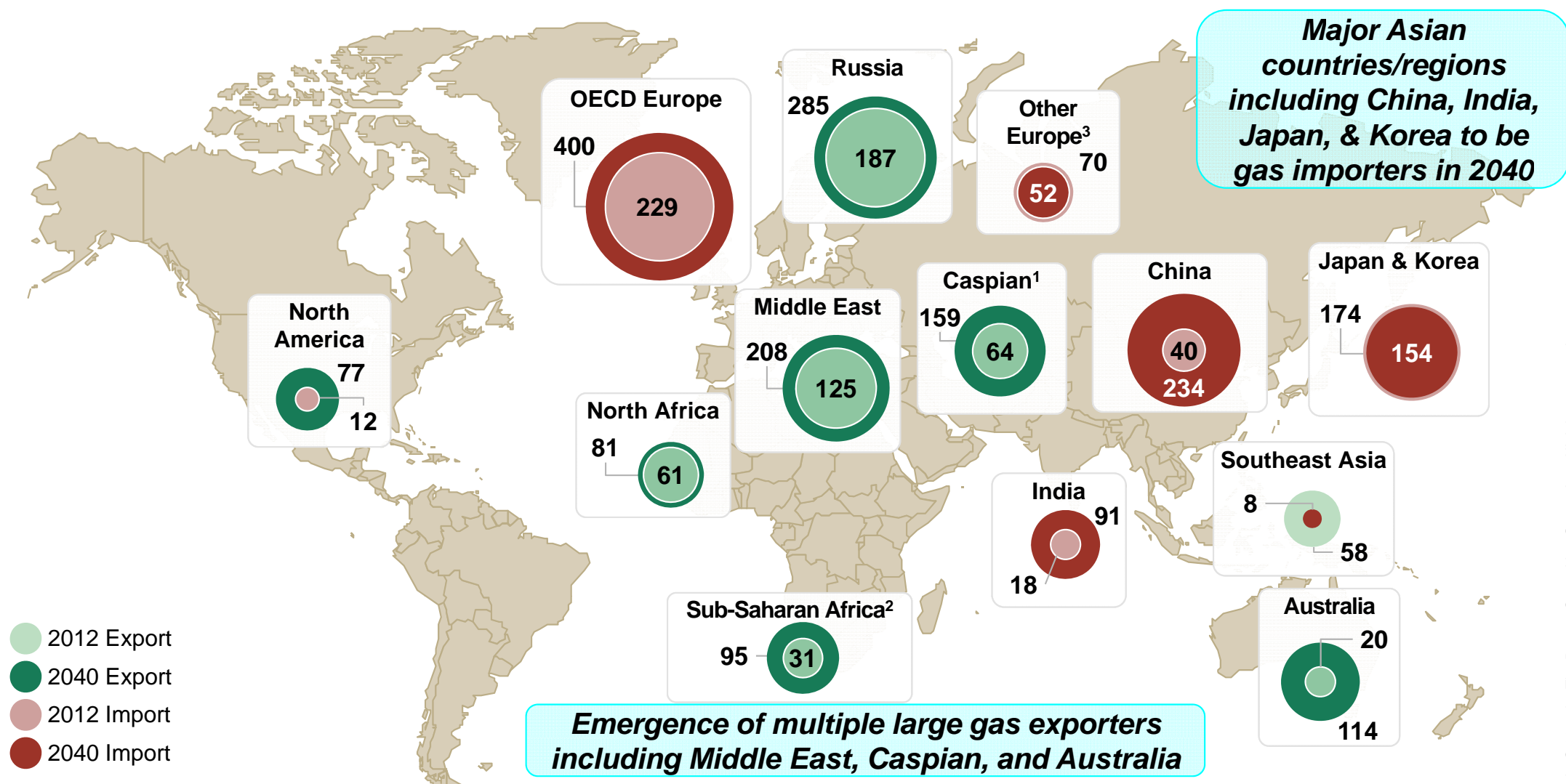
Significant coal plant new build underway in Central provinces combined with massive development of transmission lines to supply coastal provinces

- Strong dispatch constraints to apply to coastal urban plants going forward

China and India to become large global gas importers

OECD Europe and Japan & Korea to continue to be large importers

Natural gas net trade by region in the New Policies Scenario (bcm)



Notes: 1- Caspian includes Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan and Uzbekistan; 2- Africa regional grouping excluding the North Africa region; 3- Other Europe- European countries not a part of the OECD 4-non-OECD Asia excluding India and China

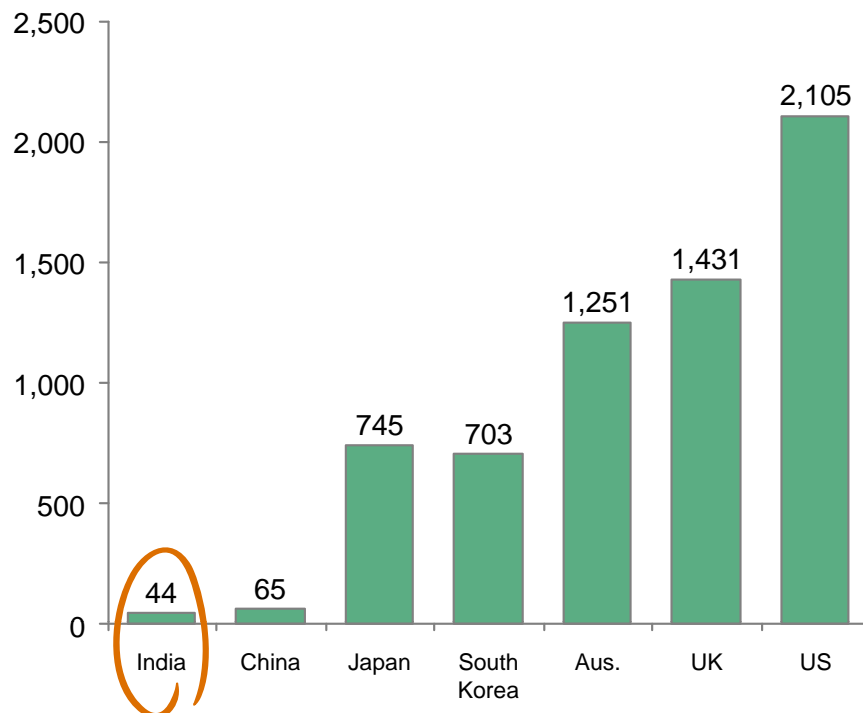
Source: IEA World Energy Outlook 2014 ; ADB Energy Outlook for Asia and the Pacific Oct-2013 ; IEE Japan The 3rd Asian Energy Outlook 2011 ; Press search ; BCG research

India: Gas market is currently under penetrated

Low base and increasing penetration provide strong fundamentals for long term growth

India's gas consumption per capita is low compared to other countries

SCM per Capita



Increase expected as a result of several growth drivers

City Gas Distribution

- CGD expected to penetrate ~300 cities by 2030 resulting in huge demand from residential / commercial segments

Industrial usage

- Industrial clients shifting to gas given its price advantage vs. other feedstock (Naphtha, FO)

Power sector

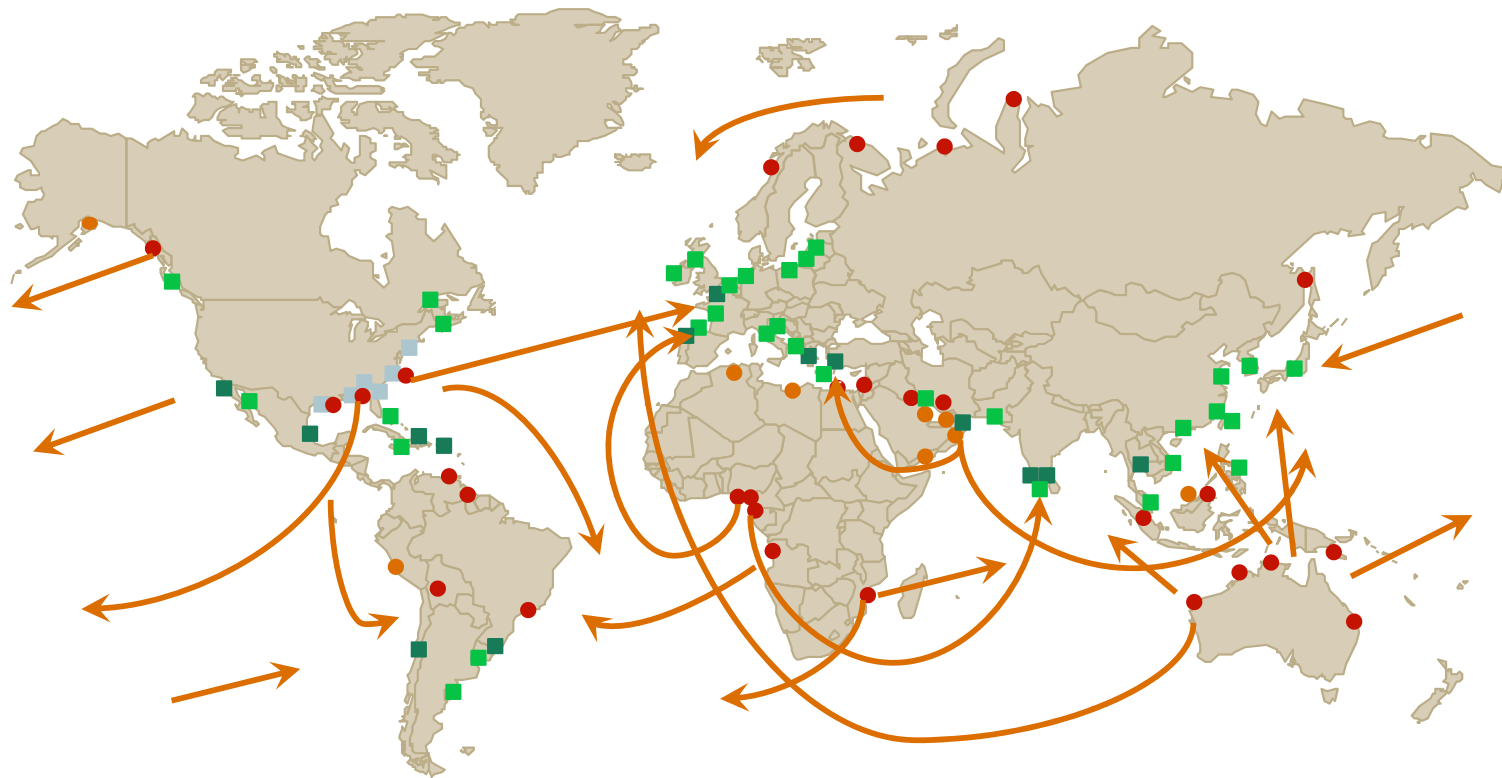
- Growing demand from power sector during the 2000s, however expected to slow down in the future

Infrastructure improvement

- 2.5 fold growth expected in pipelines
- Expansion of pipeline network on a pan India basis with increased network in South India

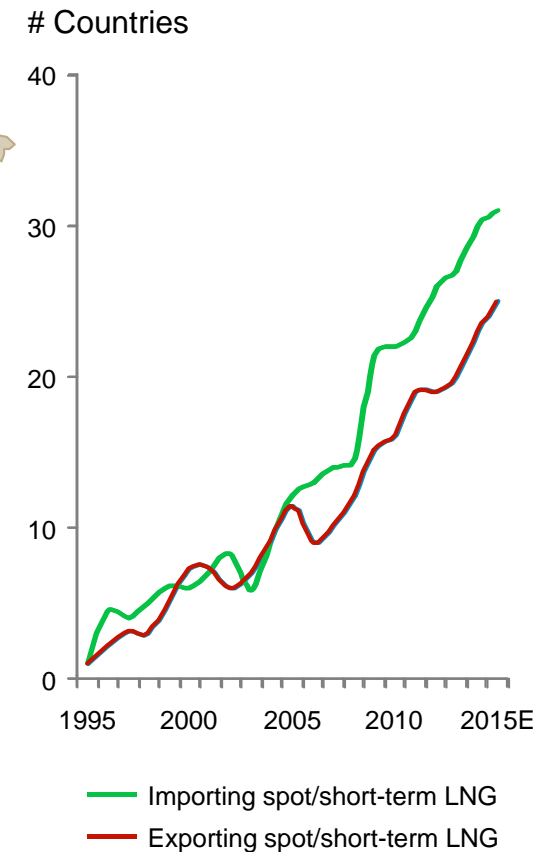
Gas demand growth will be supported by an increasingly liquid LNG global market, reducing the risk for buyers

Illustration of possible 2022 supply/demand flows



- Liquefaction
- Regasification
- Former Import demand
- New/↑ Liquef.
- New/↑ Regas

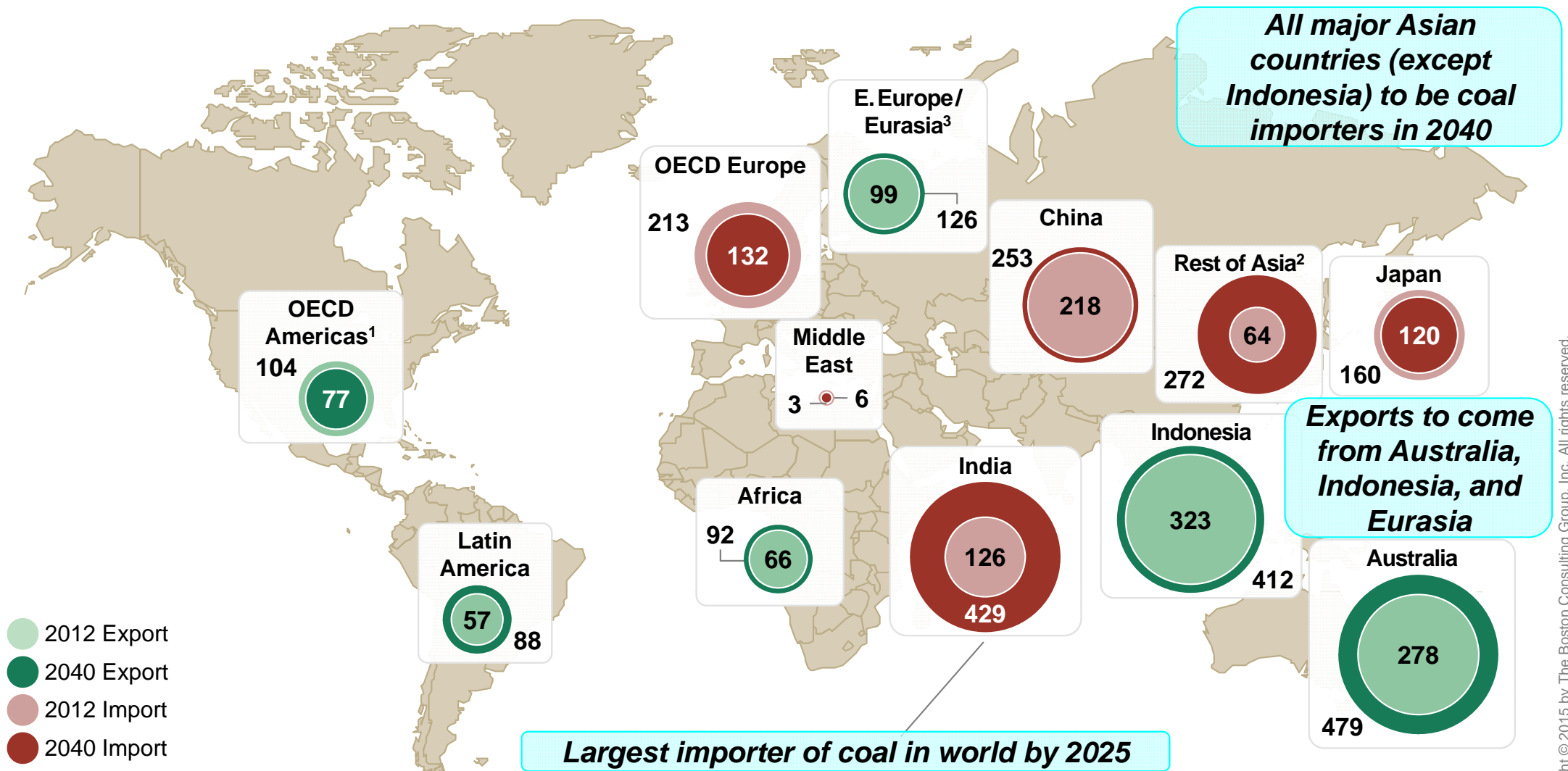
Number of LNG importing/
exporting countries



Source: BCG LNG database, public research

India to be largest coal importer, followed by China & rest-Asia

Inter regional coal trade in the New Policies Scenario (Mtce)



Note- 1-Canada, Chile, Mexico and the United States 2. Rest of Asia = Asia except China, India, Indonesia, Japan and Korea 3. Eurasia=Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Georgia, Kazakhstan, Kosovo, Kyrgyz, Latvia, Lithuania, Macedonia, Moldova, Romania, Russia, Serbia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan
Source: IEA World Energy Outlook 2014 ; ADB Energy Outlook for Asia and the Pacific Oct-2013 ; IEE Japan The 3rd Asian Energy Outlook 2011 ; Press search ; BCG research

Contents

Key observations

How do gas and coal compete in power generation?

Climate change negotiations: Kyoto vs. Paris

How will gas and coal demand evolve in Asia?

What challenges and opportunities does gas have in the region?

Questions and Discussion

Challenges and Opportunities

Challenges

- Limited opportunities for gas production, imports and usage including international pipelines
- Inconsistent global gas pricing mechanisms – Asia is the only major region with a dominant oil indexation for gas pricing
- Coal continues to be less expensive than gas, even amid the low oil price environment, making it difficult to reduce rate of emissions
- Demand for fossil fuel-produced energy continues to grow as climate change goes higher on the global agenda – tightening emission limitations.

Opportunities

- International collaboration to to remove constraints in planned development of gas pipelines and other infrastructure
- Potential to create an Asian price hub(s) to provide a gas-indexation pricing mechanism
- Gas-to-gas competition opens up the potential to increase its use with respect to coal and thus reduce the rate of emissions
- Global commitment to new ‘protocol’ with climate change strategies based on mitigation and adaptation, driving innovation, efficiency and competition.

Contents

Key observations

How do gas and coal compete in power generation?

Climate change negotiations: Kyoto vs. Paris

How will gas and coal demand evolve in Asia?

What challenges and opportunities does gas have in the region?

Questions and Discussion

Questions for discussion

- How do consuming nations in Asia Pacific develop a long-term gas supply security strategy?
- Is coal supply security a challenge as well?
- Could the reductions in demand in Europe and the US impact the liquidity of the global coal market and create a need for more bilateral contracts?
- Could technology changes re-open a global growth opportunity for coal?
- Are sustainability challenges likely to drive regulation revision and change relative merits of coal vs gas vs other energy sources? tightening emission



bcg.com | bcgperspectives.com