Coal – Lessons from the rest of Asia for India

PowerGen India

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THE LANTAU GROUP
strategy & economic consulting

Is the key question coal vs gas… or power vs not having power?

In this presentation we look at:

1. Coal vs natural gas
   - Economics
   - Environment
   - Gas availability

2. Power vs non-power
   - Emission characteristics
   - Scale and efficiency advantages of power boilers
   - Advanced clean coal technologies in power and heat sector

See:

"*The Myth of Sisyphus China Style: Will Large Amounts of Domestic Gas Ever Get into Power?*" December 2012
http://www.lantaugroup.com/files/pique_sisyphus.pdf

"China's Air Quality Problem is Not Coal" November 2013
http://www.lantaugroup.com/files/pique_china_enviro.pdf

Coal vs gas vs renewables … or “what fuel should you use to power your industry”?

Many conferences will show charts of how much their technology costs compared with their competitors

- “Coal is cheaper than gas or LNG”
- “Renewables do not require you to buy any fuel”

Technologies that are not competitive on price will tell you you that you should use their technology or suffer terrible consequences

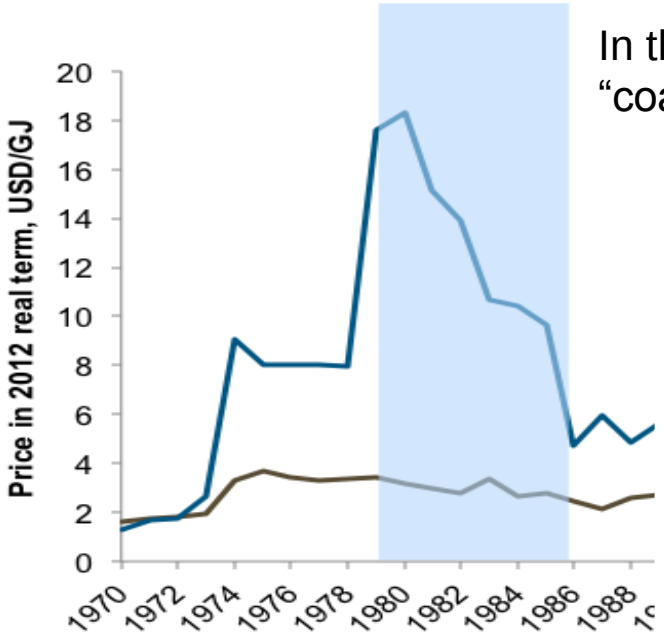
- Major gas and LNG companies will show presentations about the health benefits of using gas and how coal emissions kill people
- Renewable generators will talk about how carbon will kill the planet

How confusing for business people and policy makers. Who’s right?

The answer of course is always “It all depends”

Is coal cheaper than gas?

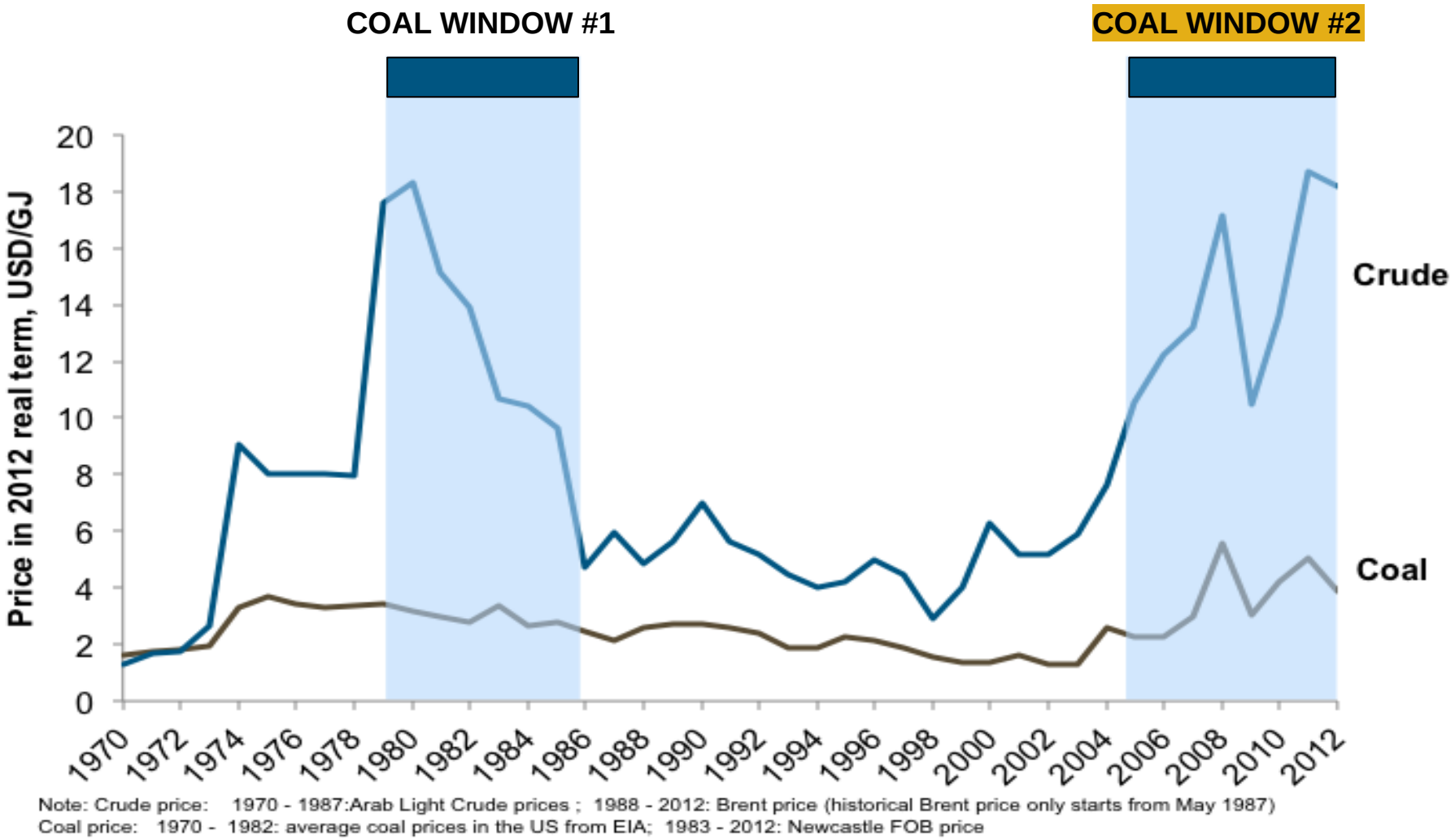
- It depends where you are.
- It depends if you have domestic coal or domestic gas.
- And importantly, it depends when you ask the question!



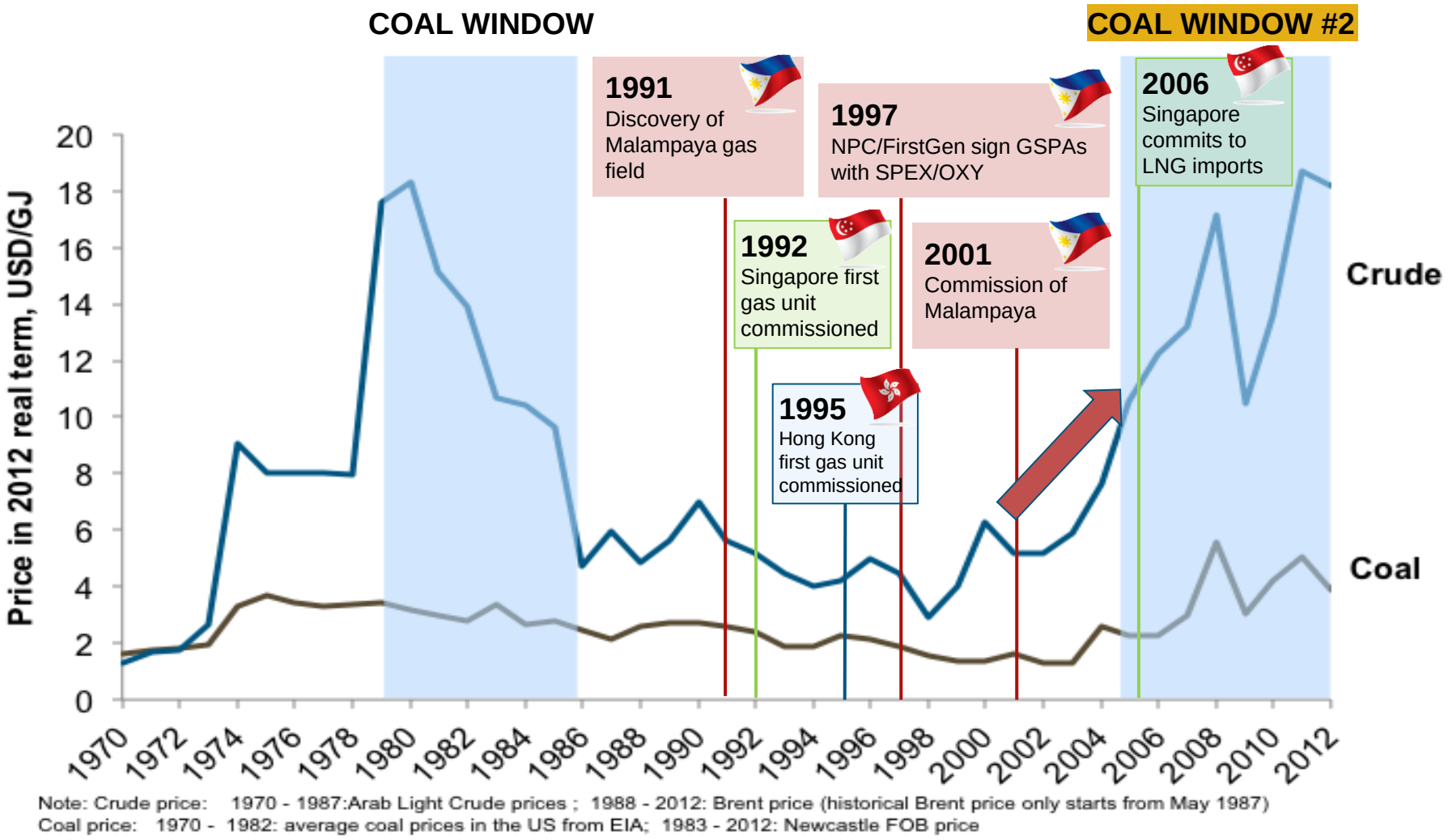
In the late 1970, oil prices shot up, creating a “coal window”

Note: Crude price: 1970 - 1987:Arab Light Crude prices ; 1988 - 2012: Brent price (historical Brent price only starts from May 1987)
Coal price: 1970 - 1982: average coal prices in the US from EIA; 1983 - 2012: Newcastle FOB price

Around 2005, a second coal window opened and continues to this day



Asian gas prices are linked to oil – so many Asian countries developed gas-based strategies in between the two coal windows….



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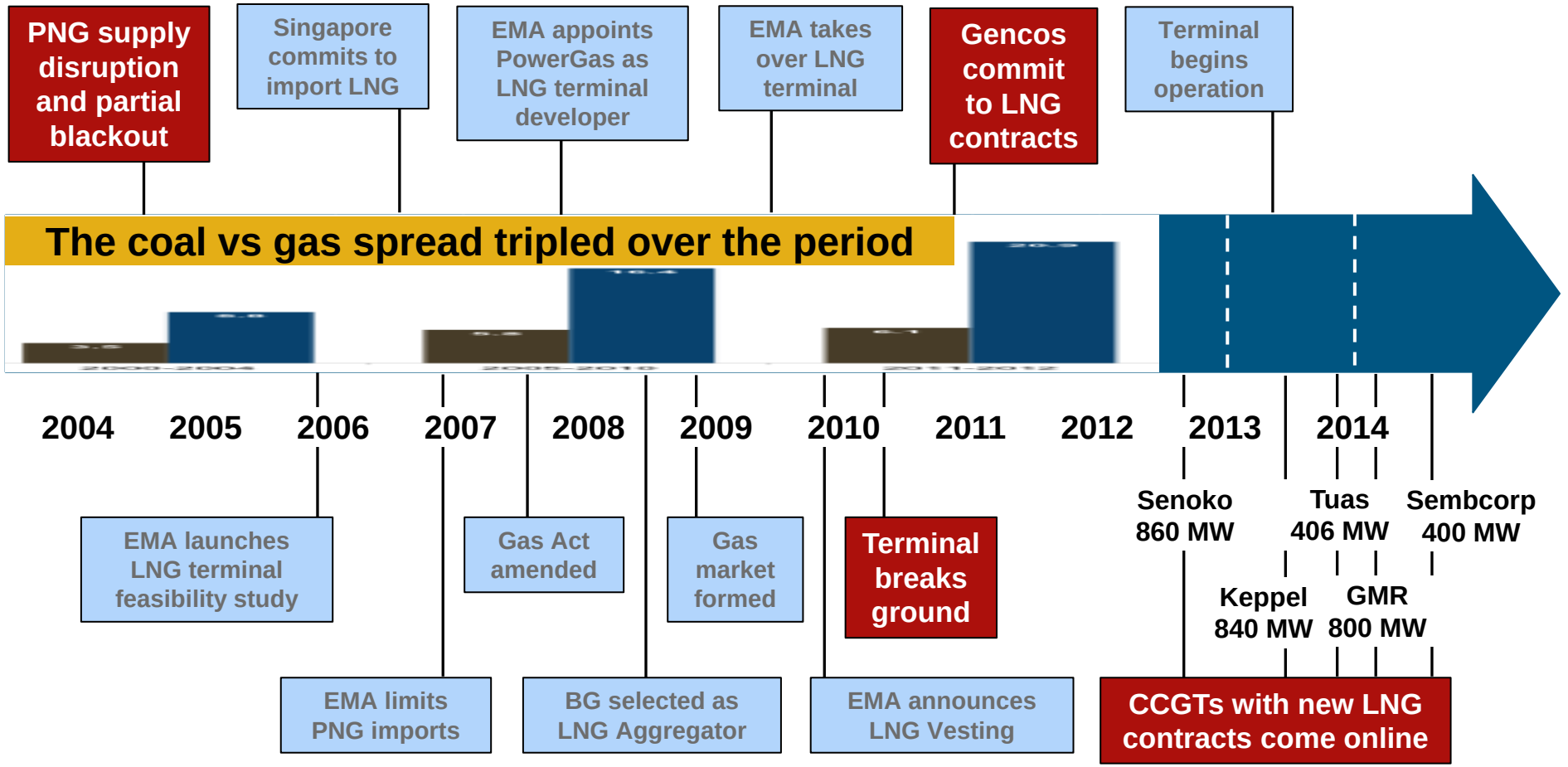
Coal price: 1970 - 1982: average coal prices in the US from EIA; 1983 - 2012: Newcastle FOB price

Unfortunately, some countries started moving late and spent too long planning their move to LNG

For example, Singapore studied LNG and then commissioned a terminal

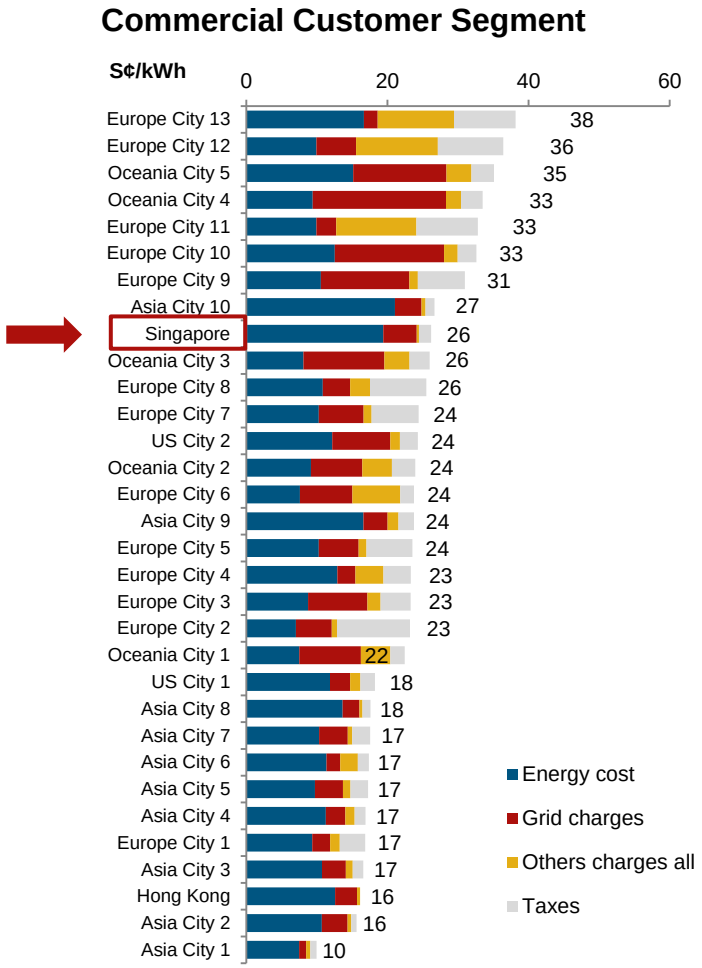


Lesson 1: Fuel prices are moving all the time

- Coal and gas windows continue to open and close
- A renewables window is starting to open in locations where domestic coal or gas is not available or where infrastructure constraints mean large scale generation is difficult to distribute
- Fuel mix policies need to be flexible enough to manage fluctuating prices and also different geographical realities

Lesson 2: Domestic resources are often much cheaper than relying on imports

Singapore has some of the highest electricity prices in Asia as a result of high dependency on imported gas and fuel oil



Coal has been key to keeping tariffs reasonable in Asia and other developing countries

But what about the environment?

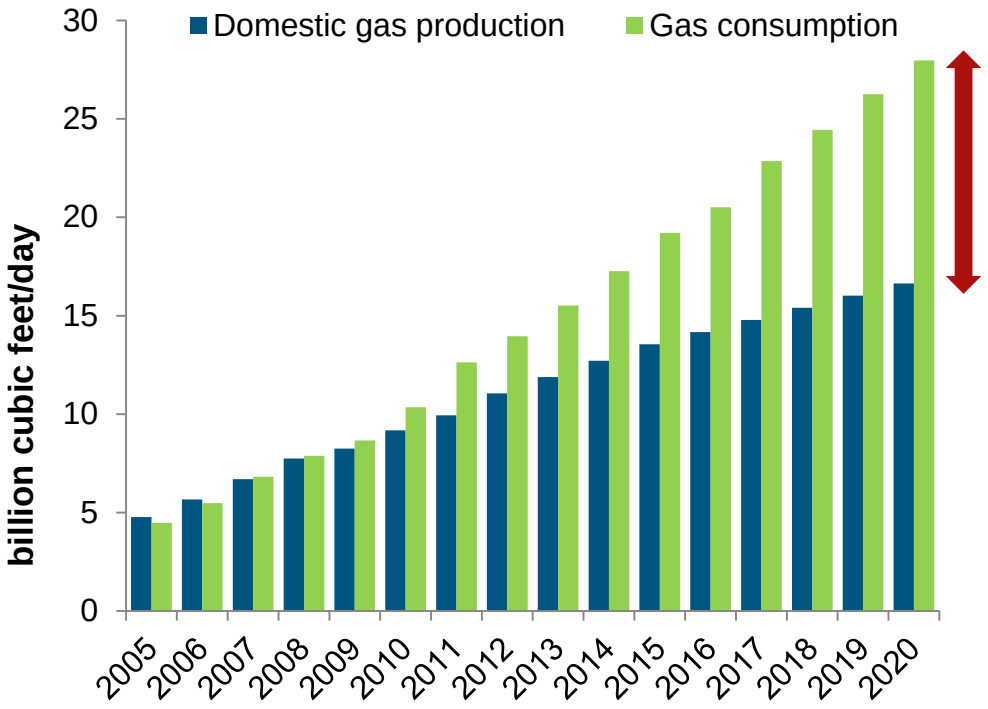
- Gas is clean and green, with low emissions
- Even in a coal window, should we not be using more gas in generation for these reasons?
- Let us take a look at China now, to see how they have been tackling this part of the issue

China is aggressively tackling air pollution and there may be lessons for India

But first, why use China as an example for India?

- India and China are often grouped together in the minds of the global community because they are both:
  - Large
  - Developing fast, with a potentially global impact of economic growth
  - In Power, are both coal based economies
- Moving away from coal is has issues in both countries because:
  - It is domestic – meaning no FOREX issues
  - It is cheap - keeping costs down for economic growth and social benefits
  - It is capable of large scale deployment, meeting the needs of a fast growing economy
- But there are also air pollution issues associated with coal
- Improving coal emissions is necessary in both countries to keep the benefits but tackle the downsides

Partly in response to environmental concerns, China is increasing its use of natural gas, but most new gas has to be imported



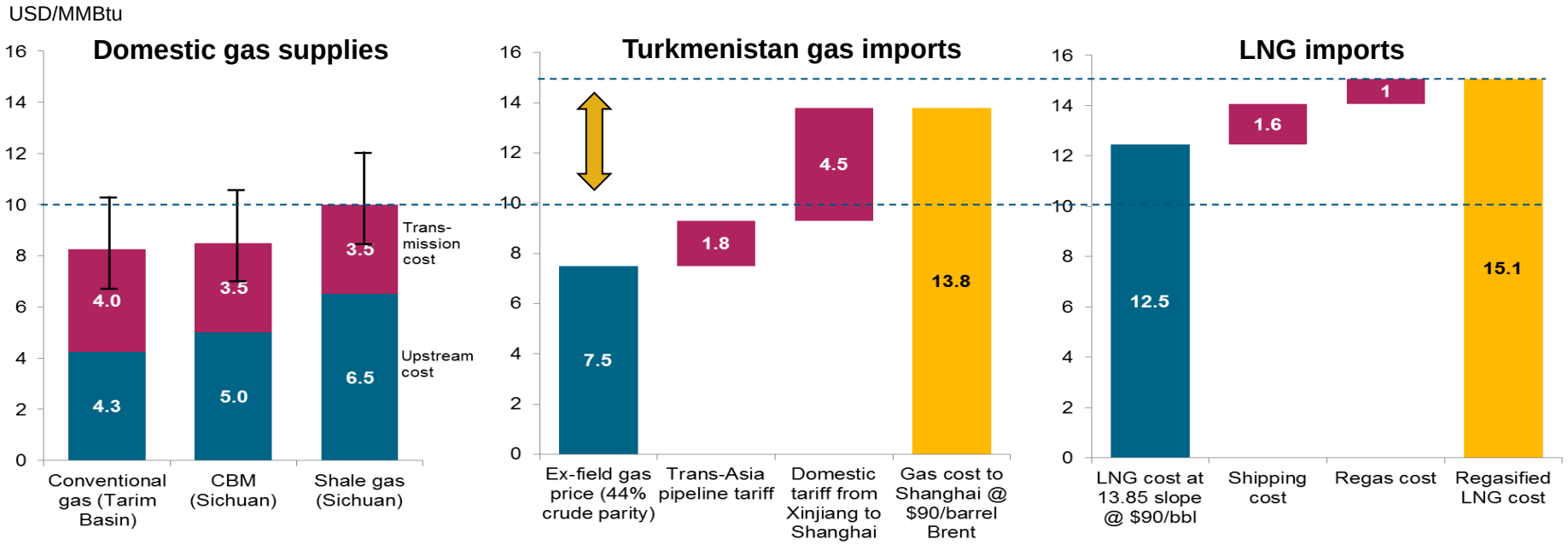
Source: 2005-2011 – data are from China Annual Statistical Book; 2012-2013 data estimated by TLG; 2014-2020 are forecasted by TLG

- Domestic production growth lags much behind the demand growth. Development in CBM and shale gas is slow due to policy, engineering and cost factors.
- Development of coal to gas projects is also slow due to concerns of environmental issues themselves and water constraints and lack of clear regulations.
- China natural gas import sources:
  - Liquefied natural gas (LNG): CNOOC, PetroChina and Sinopec have signed a total of 12 Sale and Purchase Agreement (SPA) with total contracted amount of about 37 million tonnes/year.
  - Pipeline gas imports: Central Asia – signed 30 billion cubic meters/year SPA contract; Myanmmar – signed 5 billion cubic meters/year SPA contract; may sign more contracts from Central Asia and Russia.

Imported piped gas and LNG are much more expensive than domestic production – just like in India

China's imported gas has much higher costs than existing domestic gas

Comparison of costs for different sources of gas supplies to Shanghai

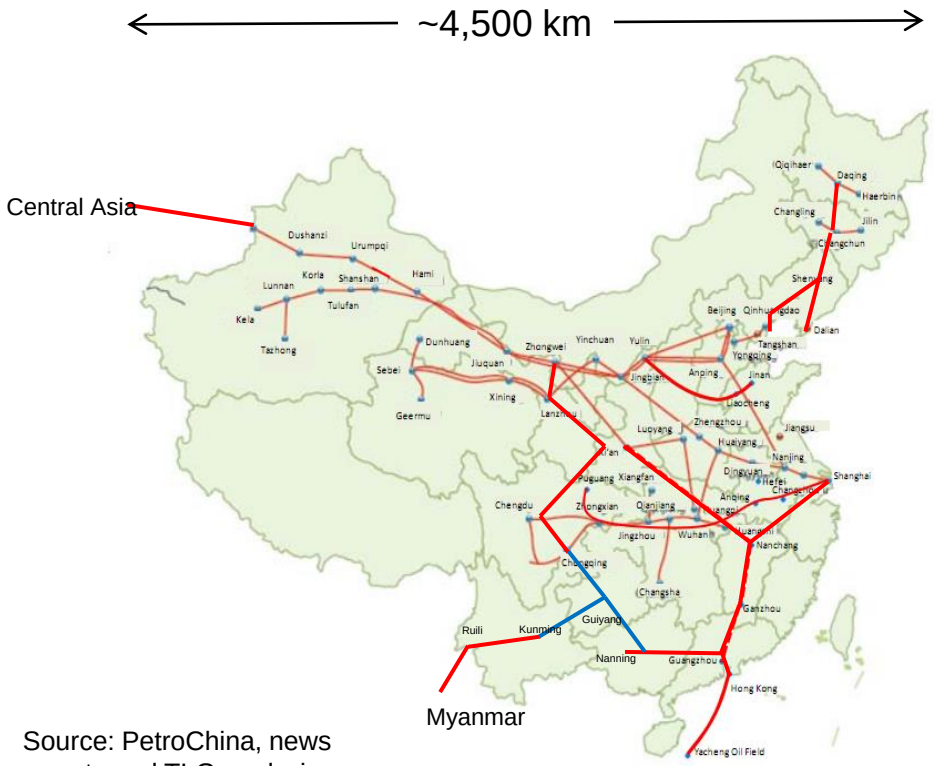


Source: Annual reports, China Custom Statistics, news sources and TLG Analysis

The very low shale gas prices in the US are almost impossible to replicate elsewhere.. Just like in India!

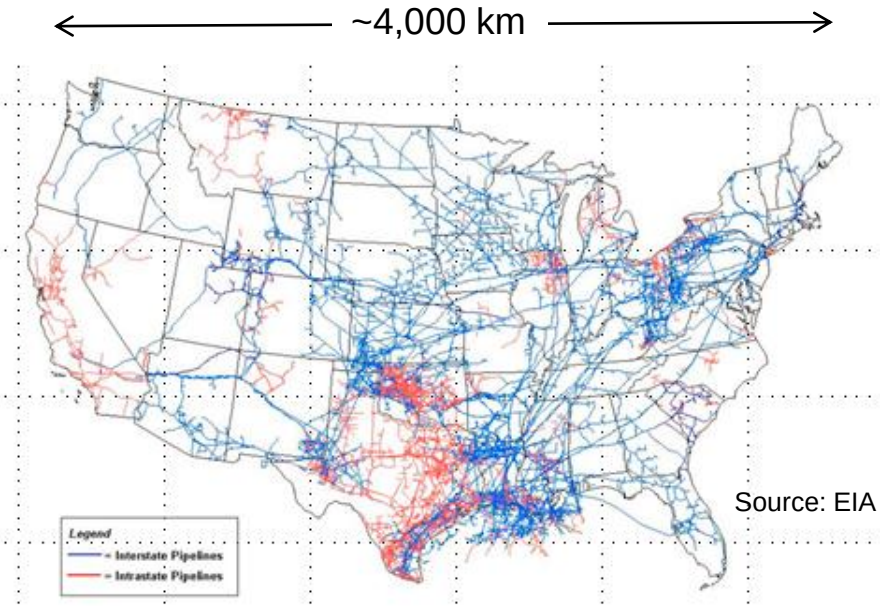
To develop new domestic gas, China's gas infrastructure needs much more investment and development

China gas infrastructure, 2012
45,000 km



Source: PetroChina, news reports and TLG analysis

US gas pipeline infrastructure
Inter-state pipeline length – 360,000 km



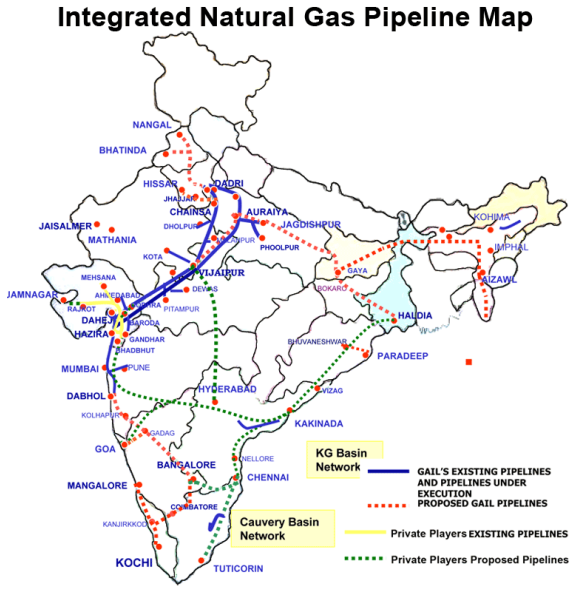
Source: EIA

China's gas network is still in a very early stage…

Just like in India

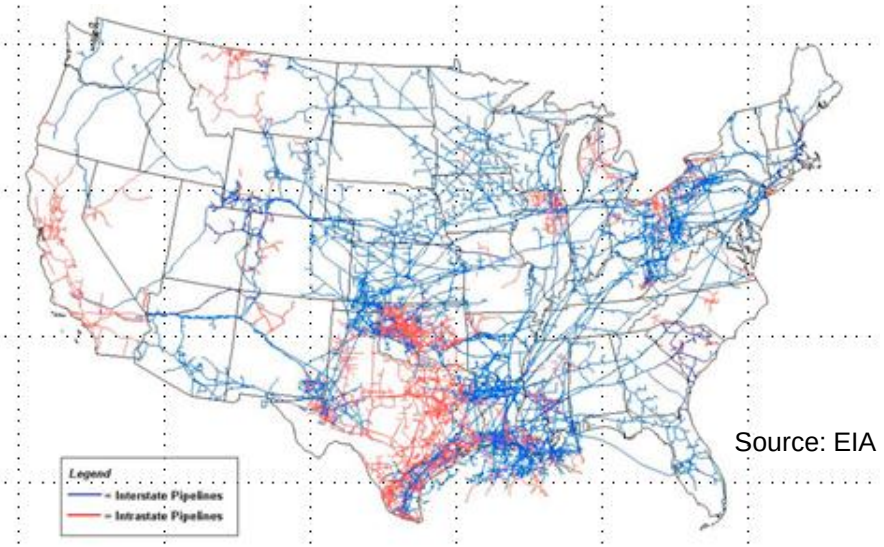
India current and planned gas pipeline infrastructure

~3,000 km



US gas pipeline infrastructure
Inter-state pipeline length – 360,000 km

~4,000 km

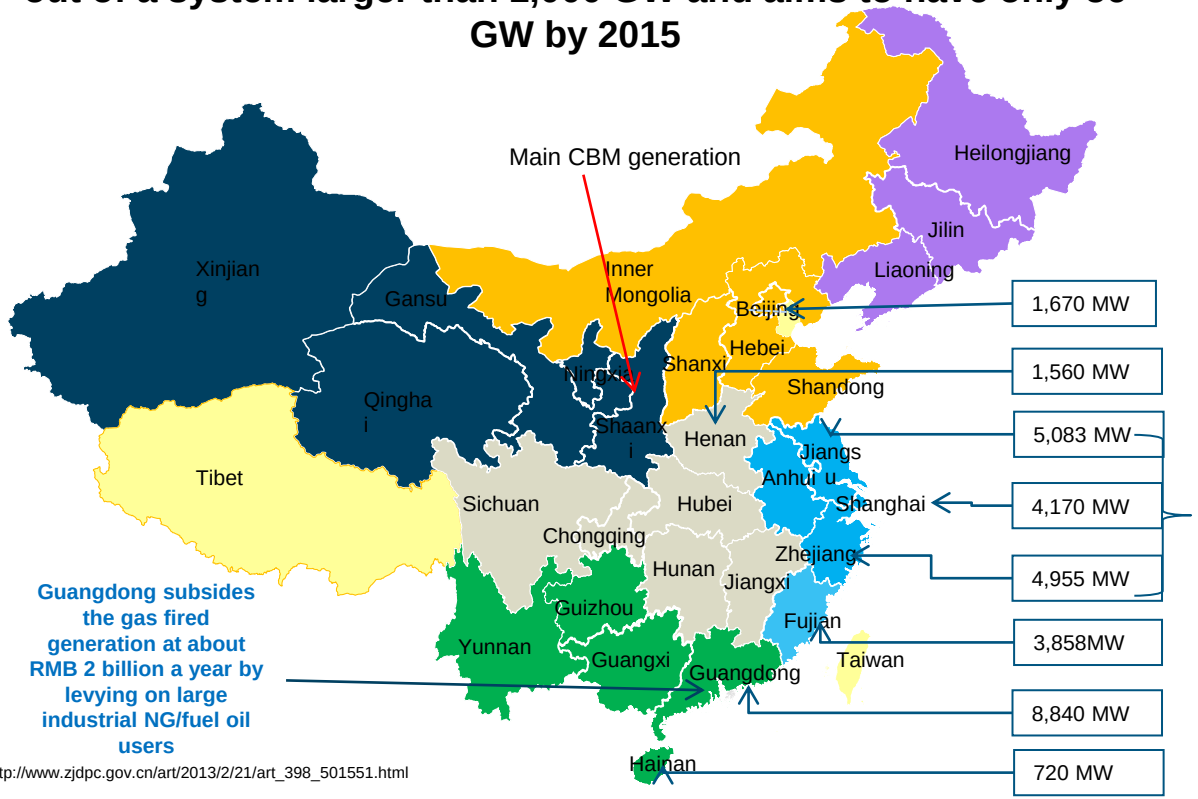


Source: EIA

Like China, India's gas network is still in a very early stage…

The power sector has not been a driver of China's gas demand as gas-based generation on-grid prices are too low

China has very little (only about 32 GW) of gas fired generation out of a system larger than 1,000 GW and aims to have only 56 GW by 2015



Guangdong subsides the gas fired generation at about RMB 2 billion a year by levying on large industrial NG/fuel oil users

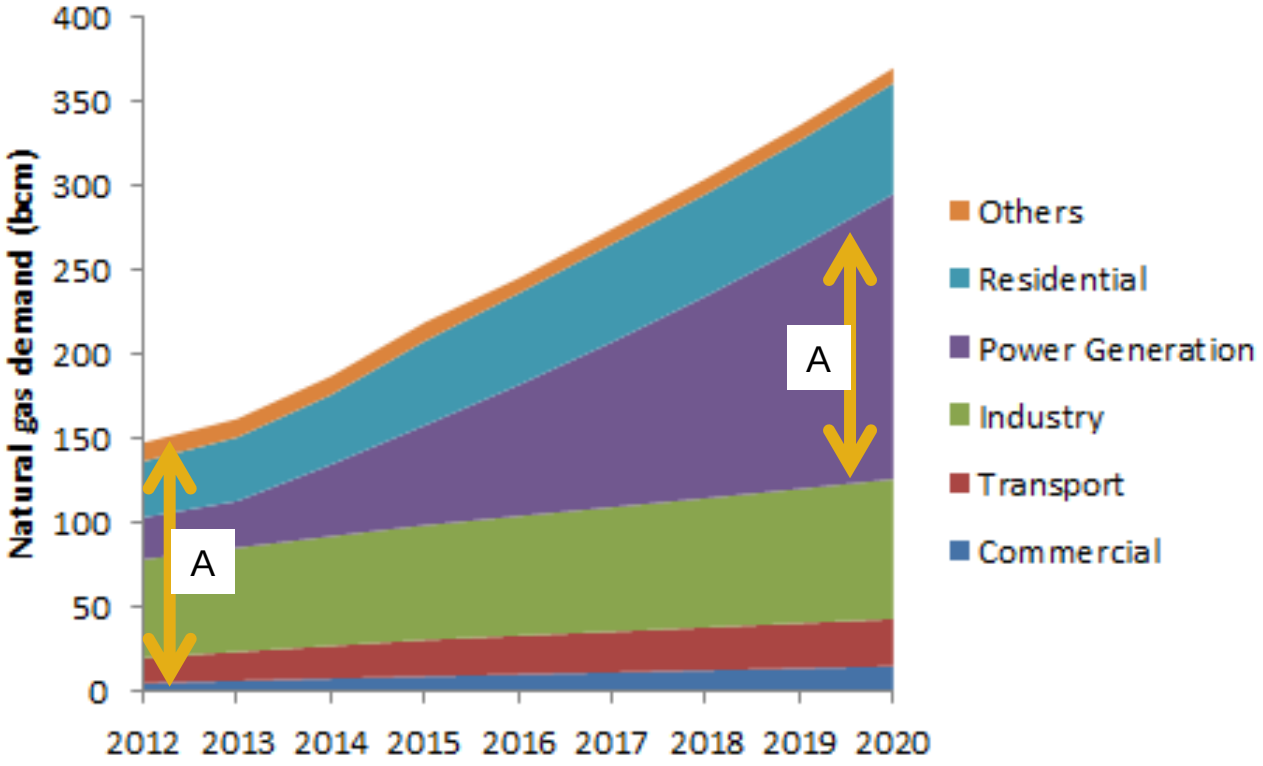
http://www.zjdpc.gov.cn/art/2013/2/21/art_398_501551.html

Source: TLG Analysis for installed capacities

- Many gas fired plants rely on the financial subsidies from local governments, except those with gas supply from earlier LNG contracts or West-East Gas Pipeline I
- Recent increases for gas fired generation on-grid prices are not be sufficient to induce more gas penetration in the power sectors
- Given high gas fired on-grid prices, grid operators do not have financial incentives to dispatch more gas fired generation.
- More stable and robust financial and dispatch mechanisms are required to support gas fired power generation.

China's power sector will need to pay much higher prices before imported gas becomes a more significant fuel for power generation…. Just like in India!

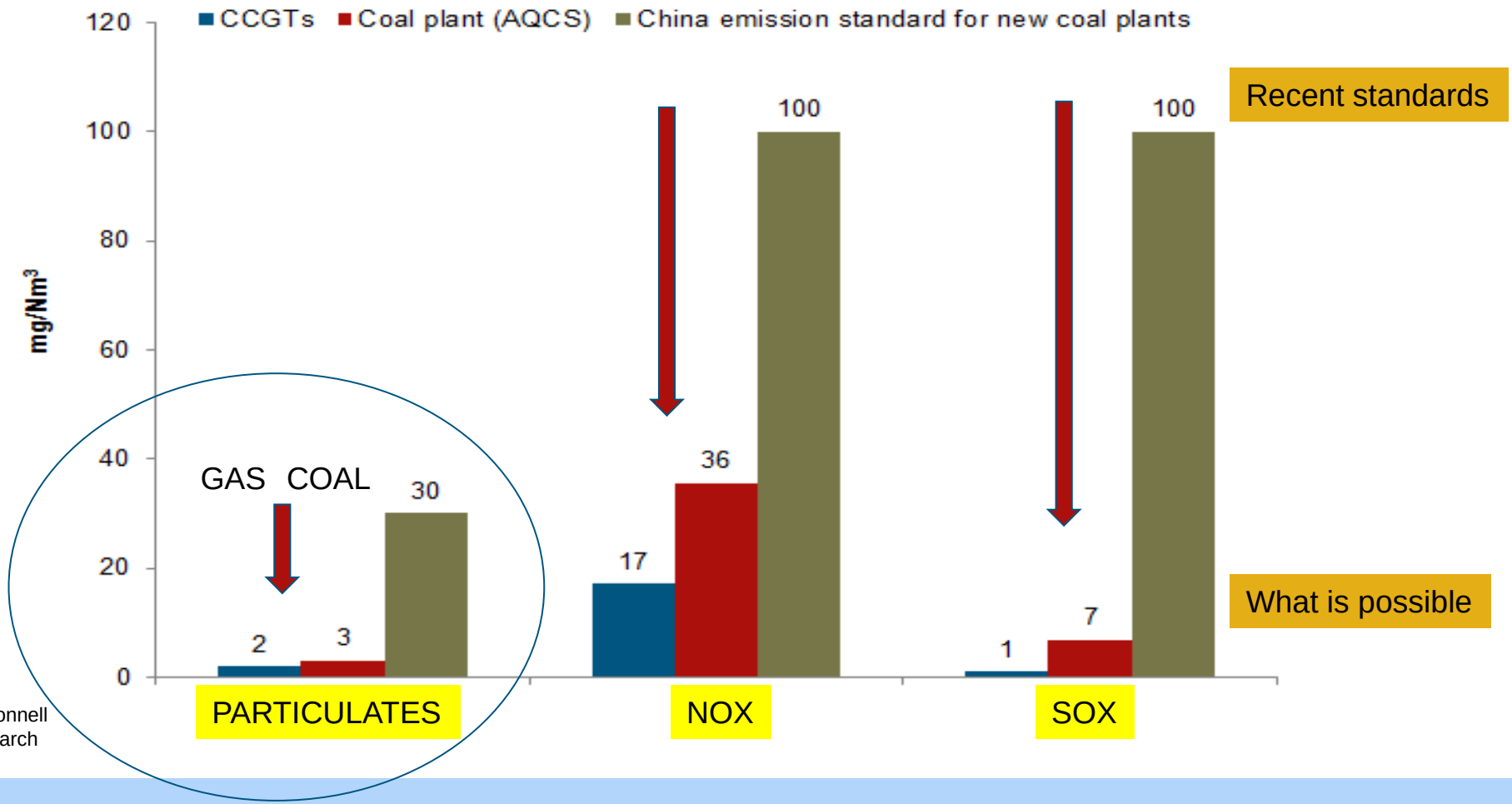
The amount of natural gas needed by the power sector to achieve a merely 10 percent generation share is almost as much what China currently uses



- China's power sector alone would consume more than China's 2013 consumption by 2020, creating huge stresses on the already stressed gas supply sector if gas fired power generation catches 10% of generation share by 2020

The power sector has been the major enabler of gas in other countries, but the economics and infrastructure are not in place in China at this time to support displacement of coal by gas.. Just like in India!

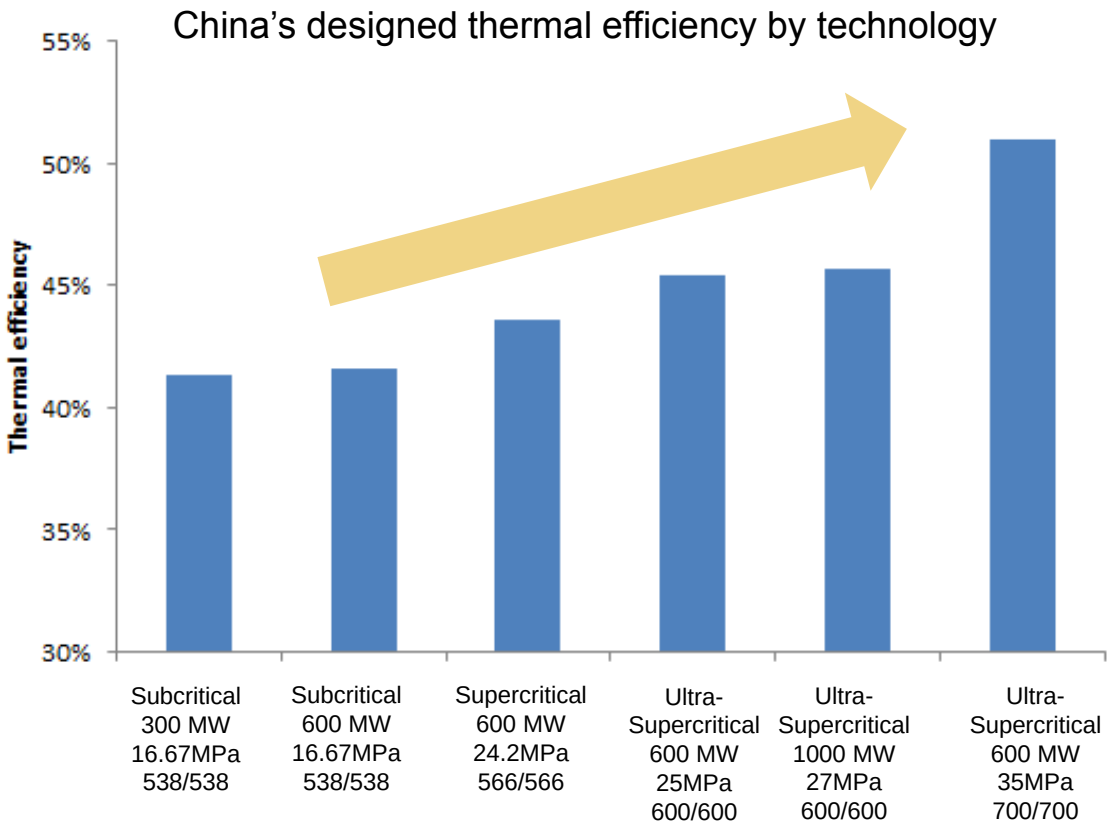
But what does this mean for emissions? Are there other solutions?



Data source:
Burns & McDonnell
and TLG research

Coal-fired boilers *can* achieve almost the same low levels of air non-carbon emissions as natural gas

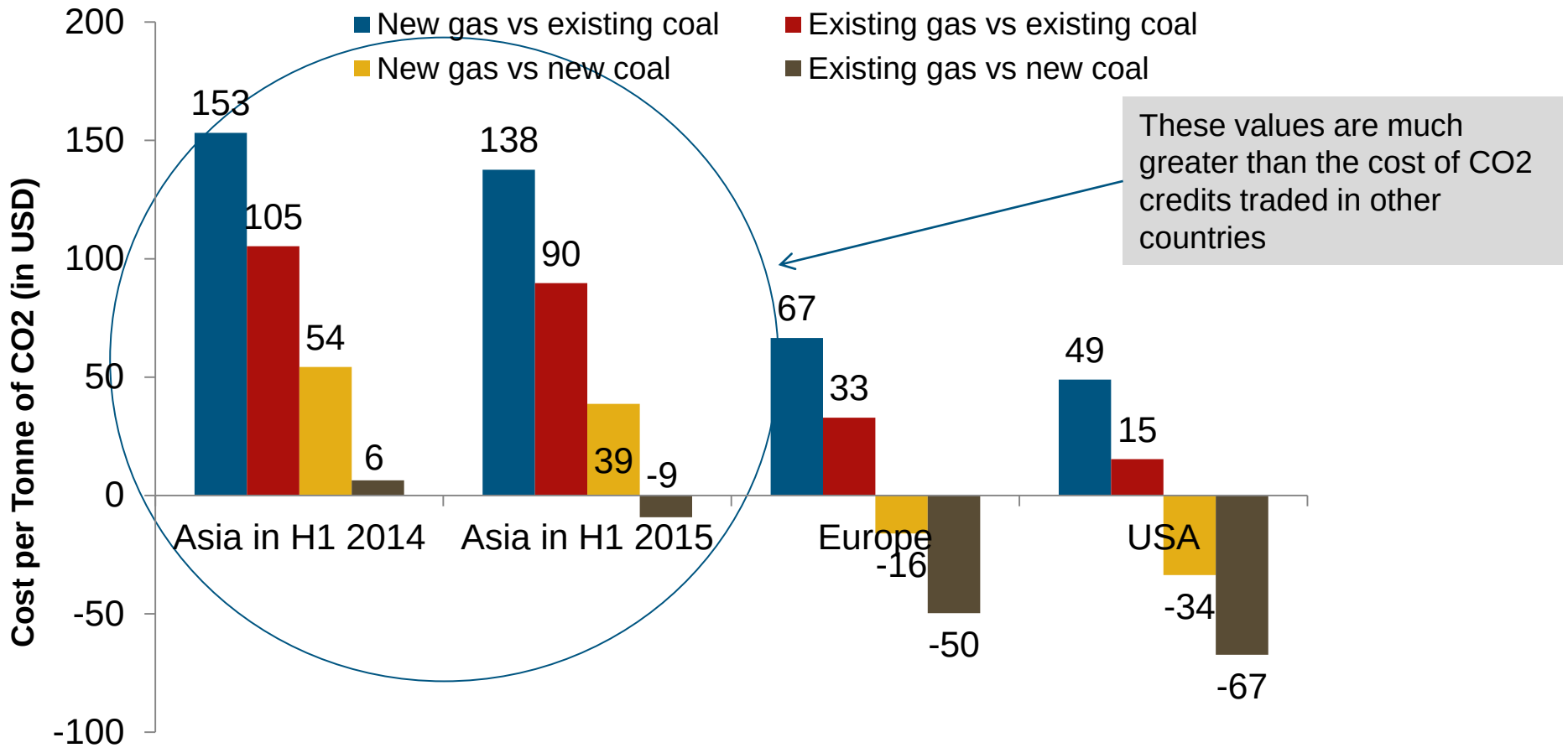
China's use of coal in power generation is emerging as the most efficient in the world – reducing potential emissions per kWh generated



- If 300 MW units are replaced by an advanced USCs, 72 million fewer tonnes of 5500 kcal/kg coal would be used for each 1,000 TWh generated
- With latest AQCS, emissions per MWh would approach the level of a gas fired CCGT
  - For example, dust removal efficiency rates (ESP、BH、ESP+BH)
    - ✓99.84% for 4 ESP
    - ✓99.968% for 5 ESP
    - ✓99.99% for 6 ESP

China is still building more efficient coal-fired generation to meet growth and to displace older less efficient generation (slowing or reducing emissions growth). This could also happens in India.

Switching from coal to natural gas for CO_2 involves exceptional costs in Asia, including India, compared to the rest of the world



Much more cost-effective to stay with coal and participate in global carbon trading arrangements, than for India to switch from coal to natural gas for power generation at this time

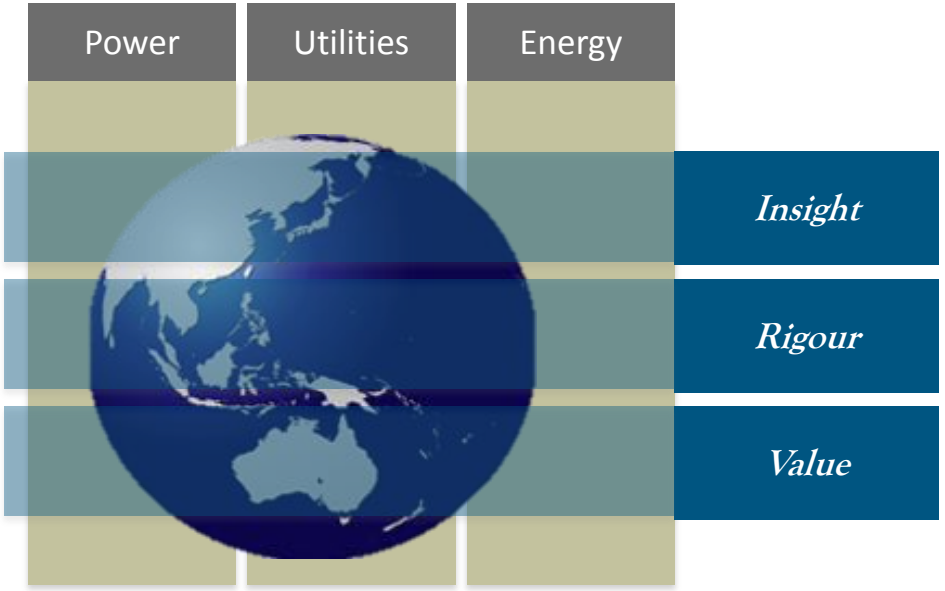
Coal-fired generation with technologically advanced AQCS systems can play a significant role in improving air quality.

- China's coal-fired power generation is cleaner than coal combustion in China's non-power sector and cleaner than coal-fired generation in most developed countries
  - Higher boiler efficiency
  - Lower emissions
  - China can improve even more as it adopts the latest AQCS technology

- A key opportunity involves shifting away from smaller, less efficient, boilers, towards the most efficient larger boiler designs with AQCS emission control systems

- Aggressive switching from coal to natural gas is not cost-effective for China, even when considering CO_2 costs
  - Better options involve participation in global CO_2 trading regimes and development of non-emitting technologies (China's nuclear, hydro, and other renewable energy initiatives)

If they can do it in China, they can do it in India



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