



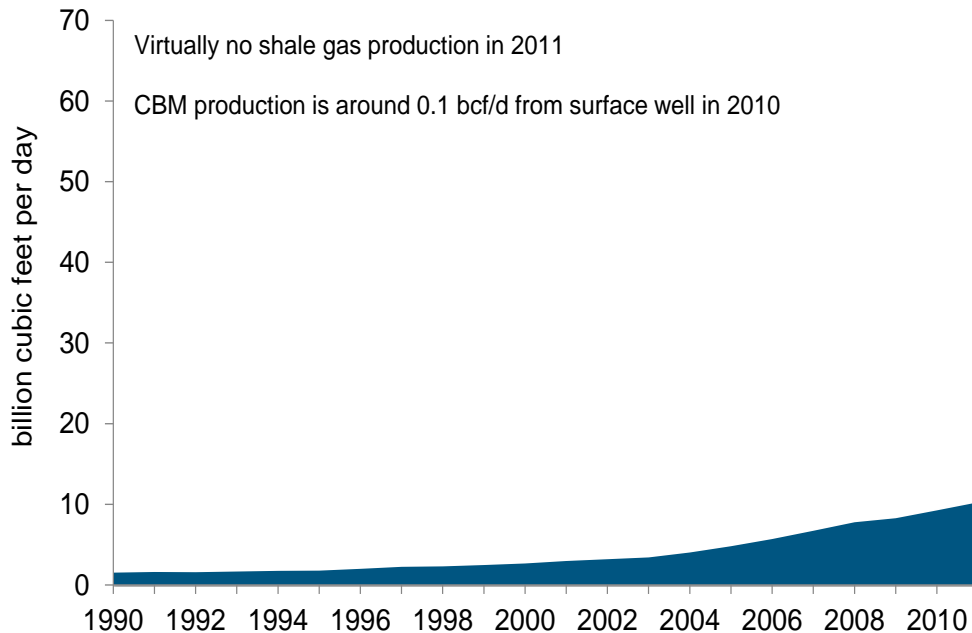
## Creating the Conditions for Growing Unconventional Gas – Midstream Infrastructure Requirement

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# China and US gas supply comparison

## China gas supply, 1980-2011

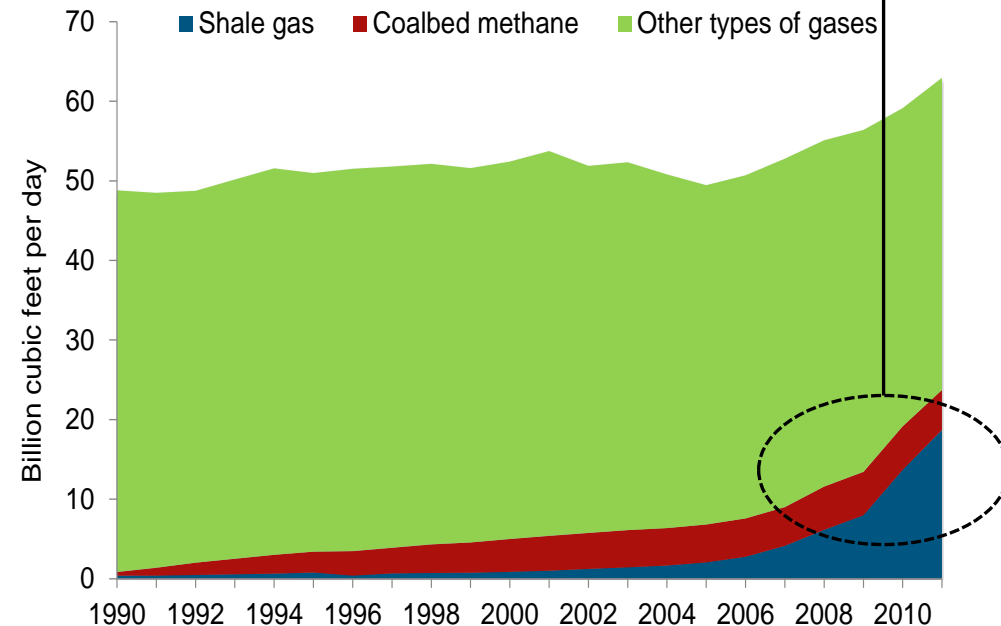
- Production volume is only one sixth of US and conventional gas production will continue to grow fast
- Shale gas E&P is still at early stage



Source: IEA, BP and TLG analysis

## US gas production, 1980-2011

- Shale gas production increased sharply after 2008 and will drive growth in the future
- Conventional gas production is declining

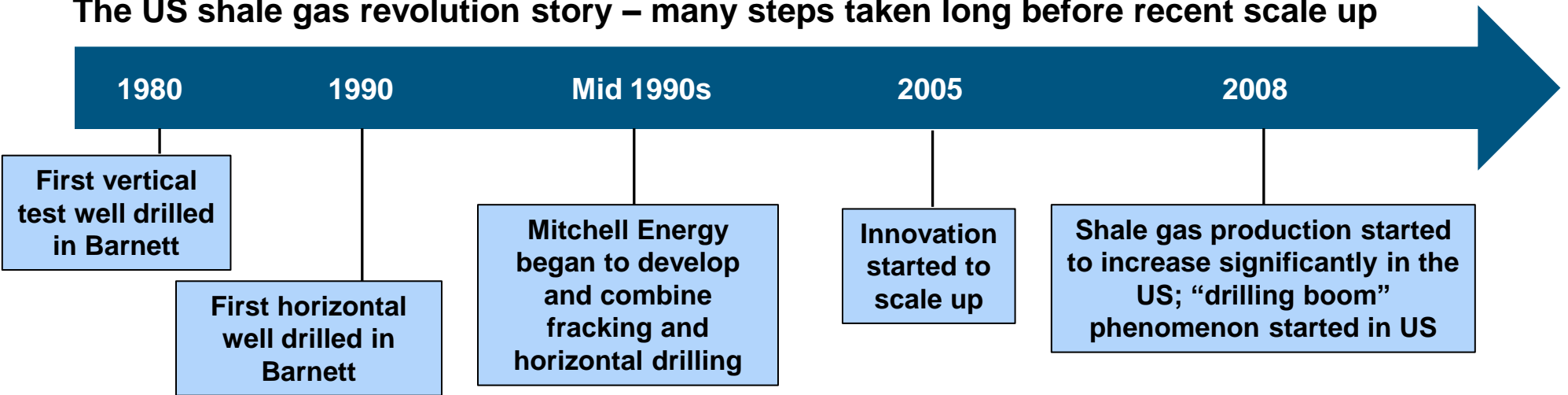


Source: EIA

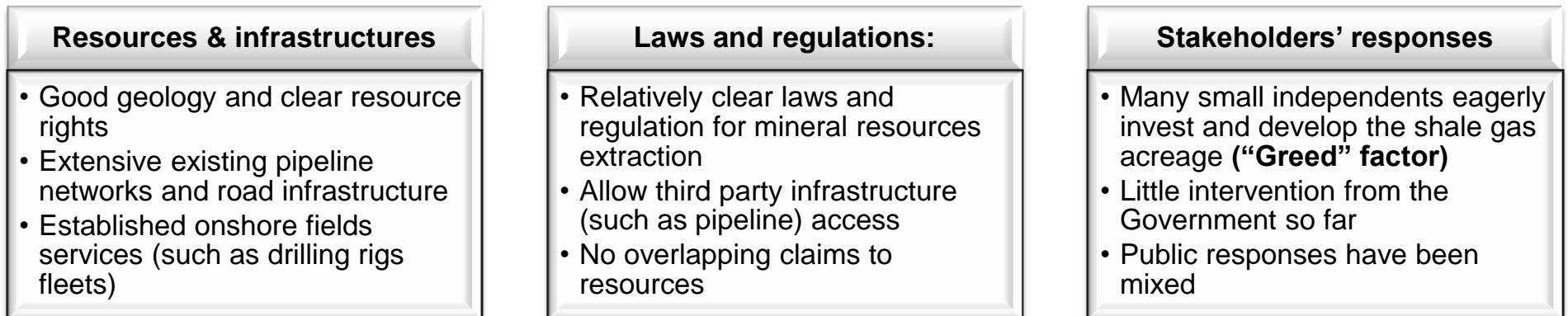
**Chinese gas production is growing and its shale gas development is still at early stage**

# US shale gas “revolution” story – long time to develop

## The US shale gas revolution story – many steps taken long before recent scale up



## What makes the US Shale Gas Story a Success

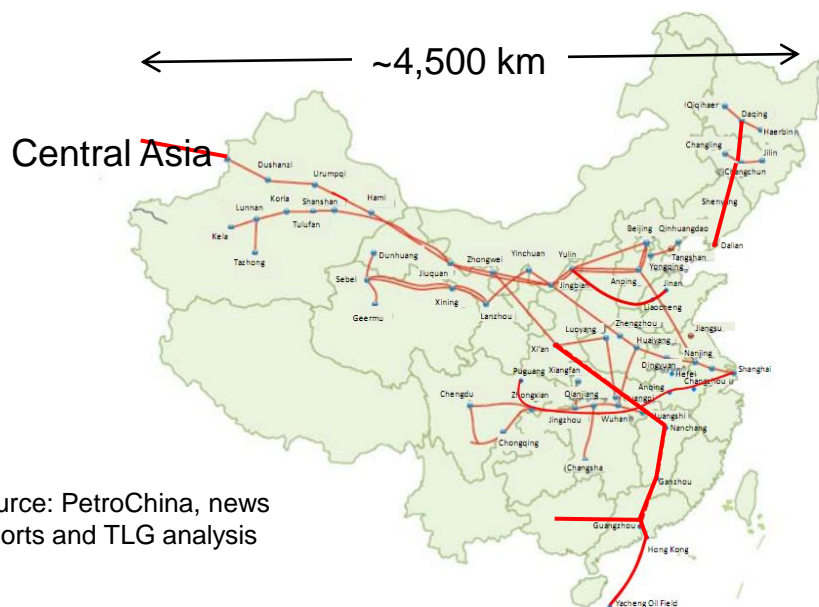


# Chinese gas market is structurally different from the US market

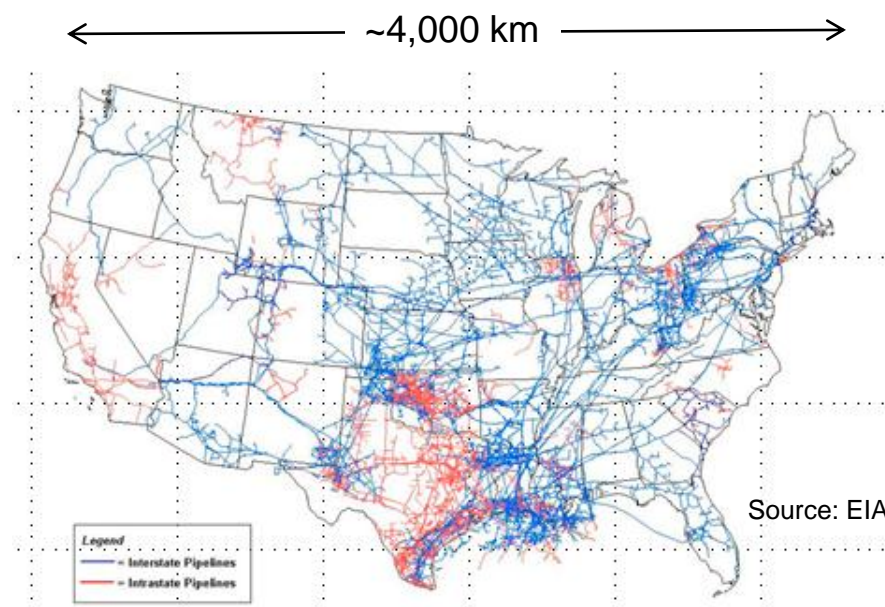
	China	US
Upstream	<ul style="list-style-type: none"><li>• Complex land ownership structure</li><li>• Challenging geology with low permeability (although it may be too early to tell)</li><li>• Onshore field service is still developing</li></ul>	<ul style="list-style-type: none"><li>• Clear mineral rights</li><li>• Good geology: permeable coals, thick shale deposits</li><li>• Established onshore field services (such as drilling rigs)</li></ul>
Midstream	<ul style="list-style-type: none"><li>• Large gas transmission pipeline length: 45,000 km</li><li>• Third party gas infrastructure access is very limited</li><li>• Very limited gas storage sites</li></ul>	<ul style="list-style-type: none"><li>• Inter-state gas transmission pipeline length: 360,000 km</li><li>• Third party gas infrastructure access is common, and many independent pipeline companies exist in US</li><li>• About 400 gas storage sites in US</li></ul>
Regulatory regimes and key players	<ul style="list-style-type: none"><li>• State owned oil and gas companies dominate the upstream and midstream sector with foreign companies participating in challenging basins</li><li>• Regulated market but slowly moving towards more liberalized market</li></ul>	<ul style="list-style-type: none"><li>• A mix of IOCs and small independents companies invest in the sector</li><li>• Competitive gas market, and hub price based with liquid gas future market</li></ul>

# China and US gas pipeline infrastructure comparison

## China gas infrastructure, 2012 45,000 km



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

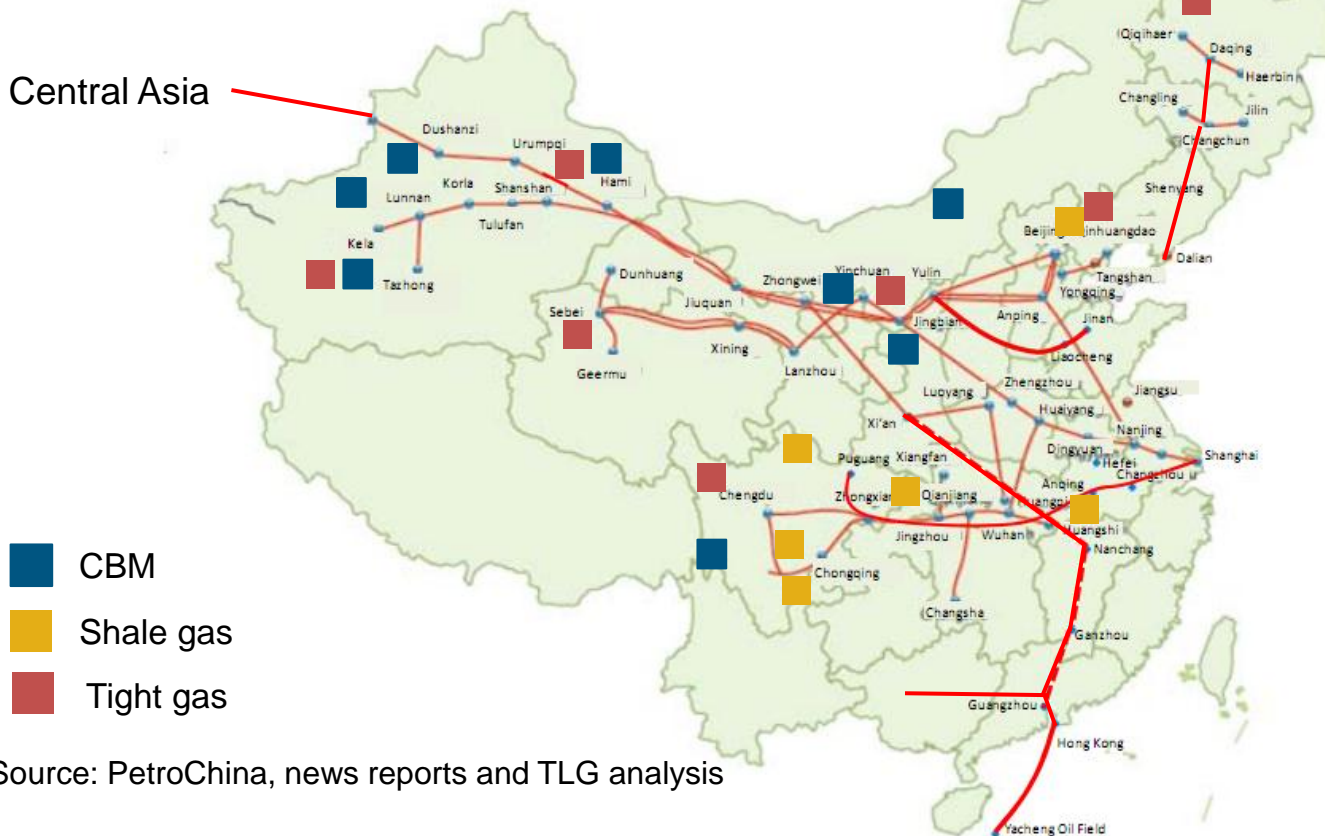


**US gas pipeline infrastructure is much more extensive**

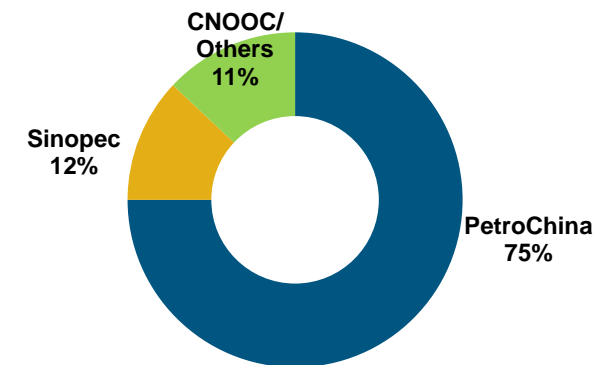


# Pipeline investment is required to transport large amount of unconventional gas to the demand centres

China existing gas pipelines  
~ 45,000 km



China gas pipelines by owners in 2012  
~ 45,000 km



How to create conducive conditions for pipeline infrastructure expansion?

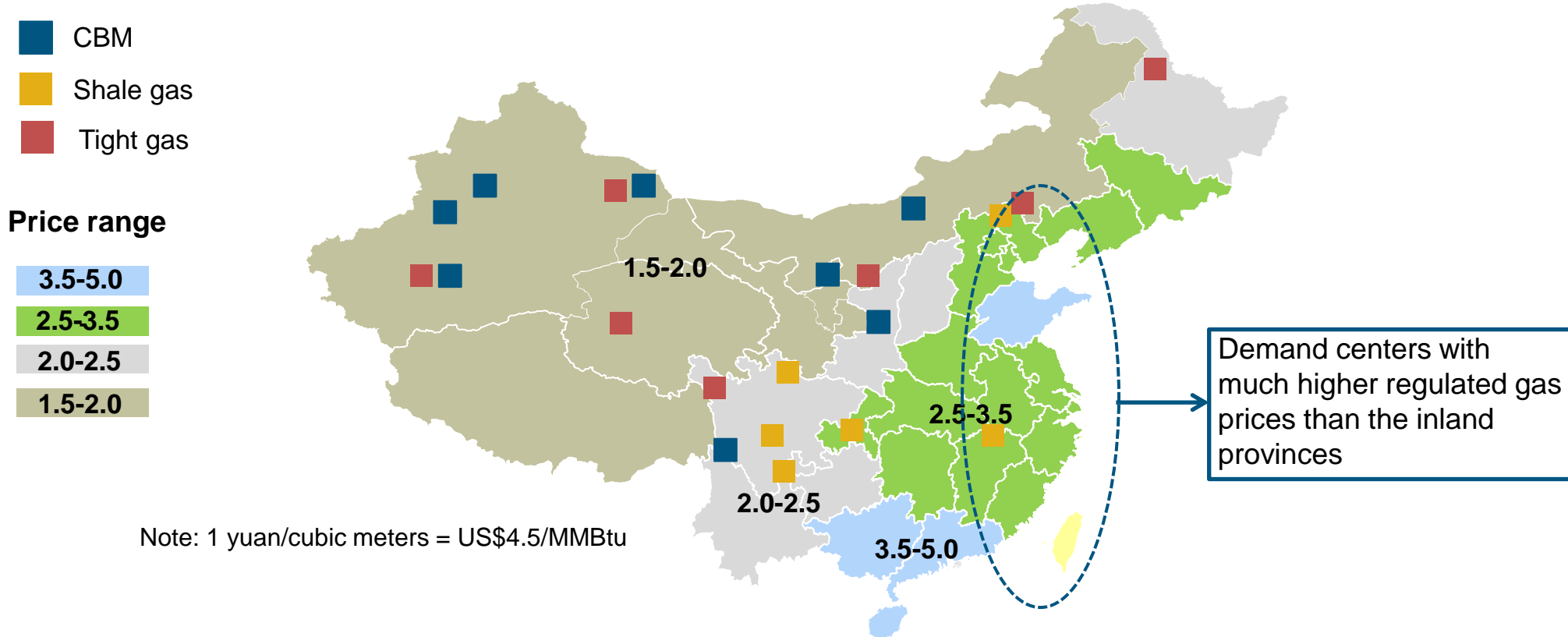
- Top-down government directives?
- Price incentives?
- Others?

Source: PetroChina, news reports and TLG analysis

Significant pipeline infrastructure investments will be required to get the shale gas to the demand centers in the coastal regions

# High regional gas price differential will incentivise gas transportation to the coastal areas

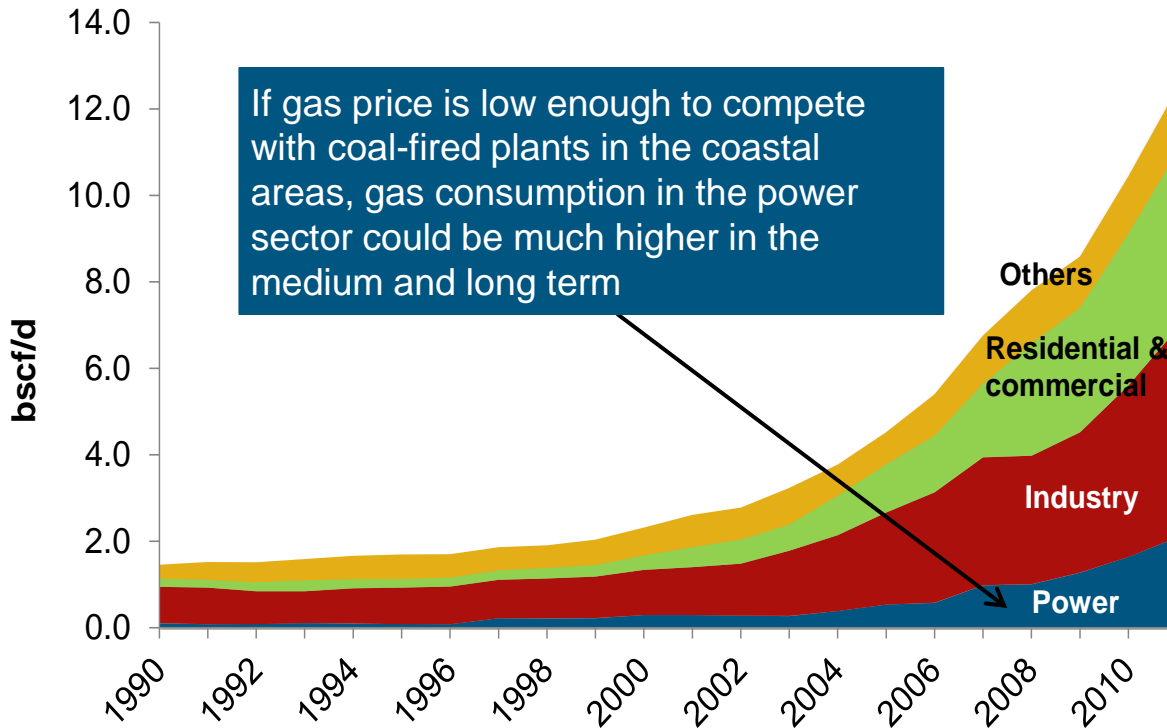
2012 average industrial gas tariff, yuan per cubic meters



The unconventional gas reserve basins are located in the inland provinces that have low gas tariffs and limited consumption growth, so getting the unconventional gas production to the coastal areas in the cheapest way will be critical to make its economics viable

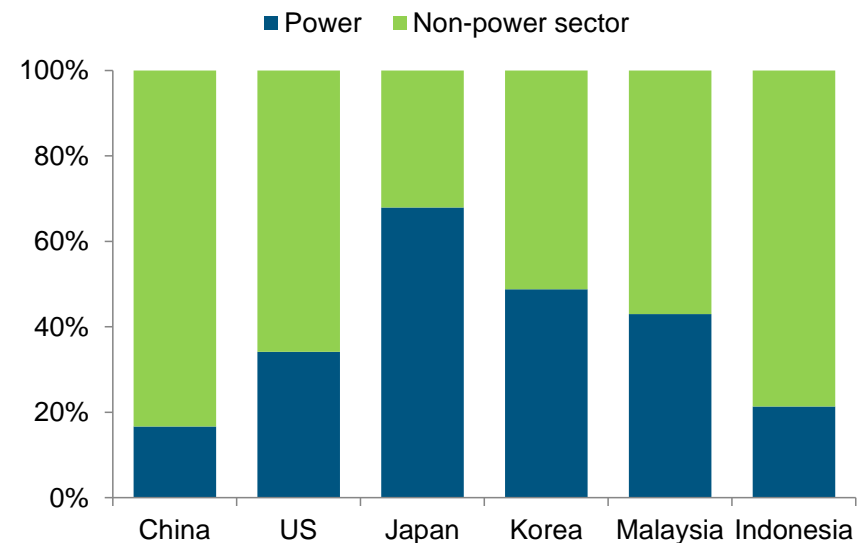
Gas consumption is likely to be driven by industrial and residential & commercial sector, but consumption in the power sector will be a wildcard

China gas consumption by sector



Source: IEA and National Bureau of Statistics of China

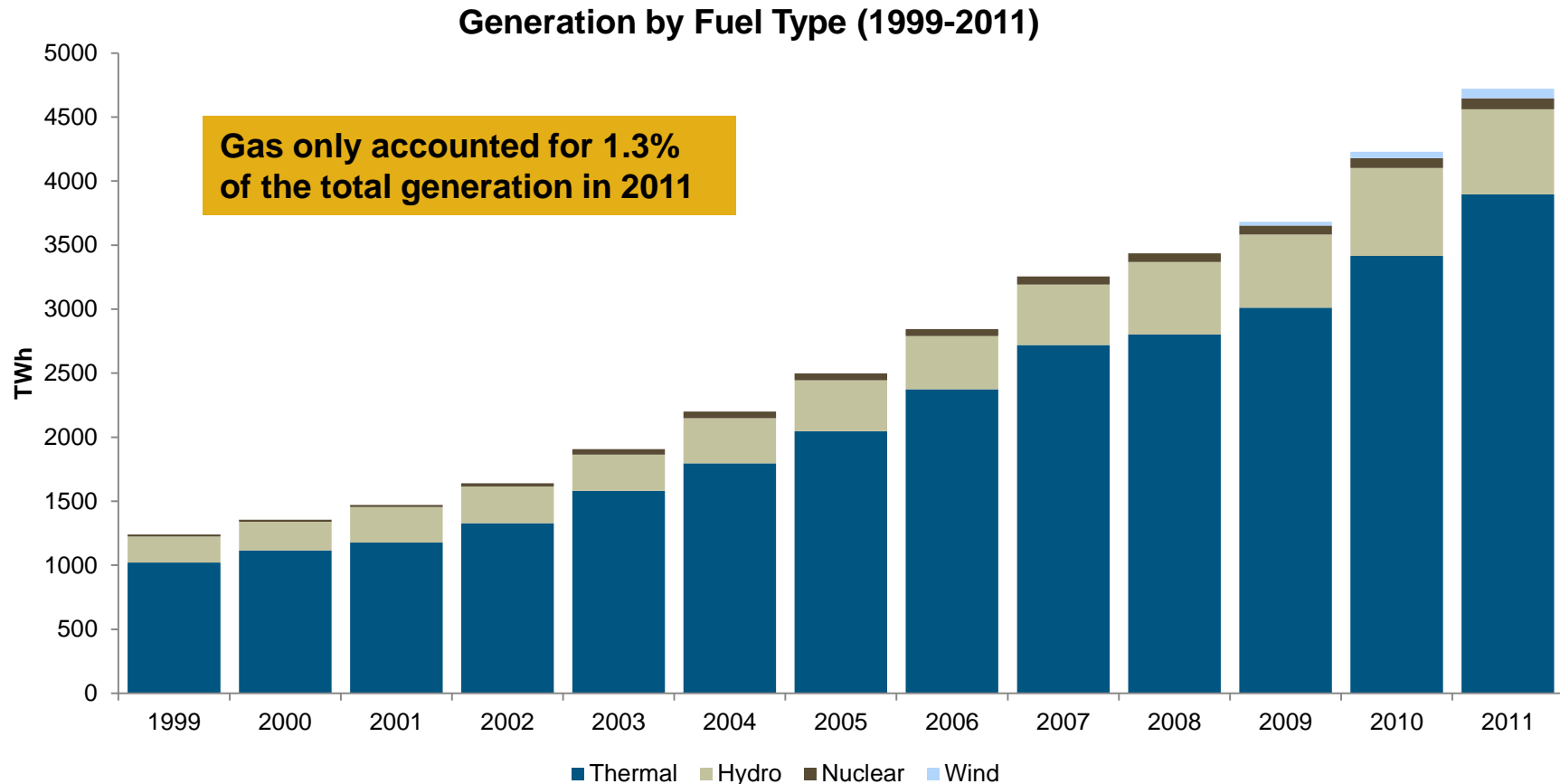
China has low share of gas consumption in the power sector compared to other countries



Gas use in the power sector is a wildcard



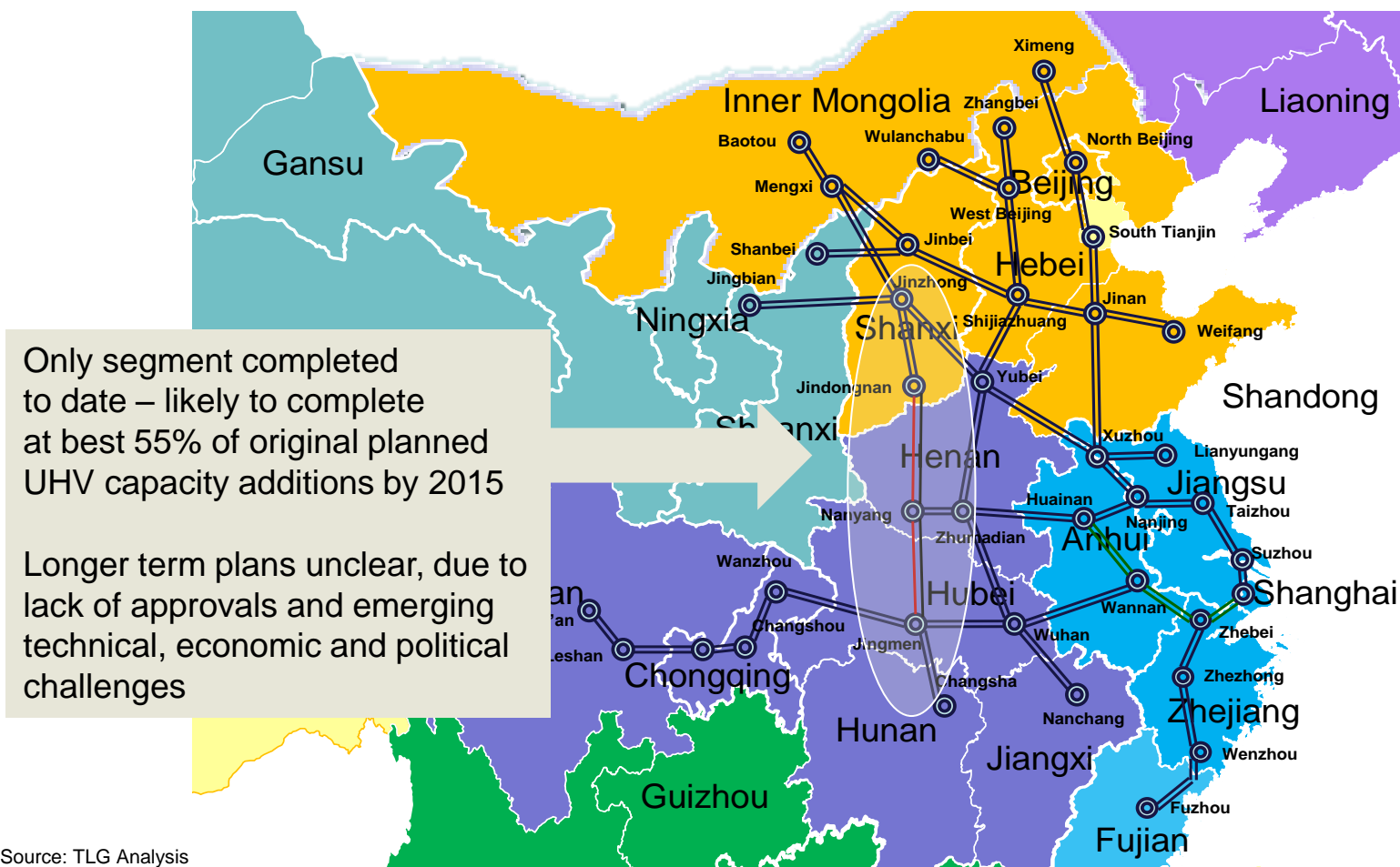
# China's Generation Fuel Mix



Source: TLG Analysis

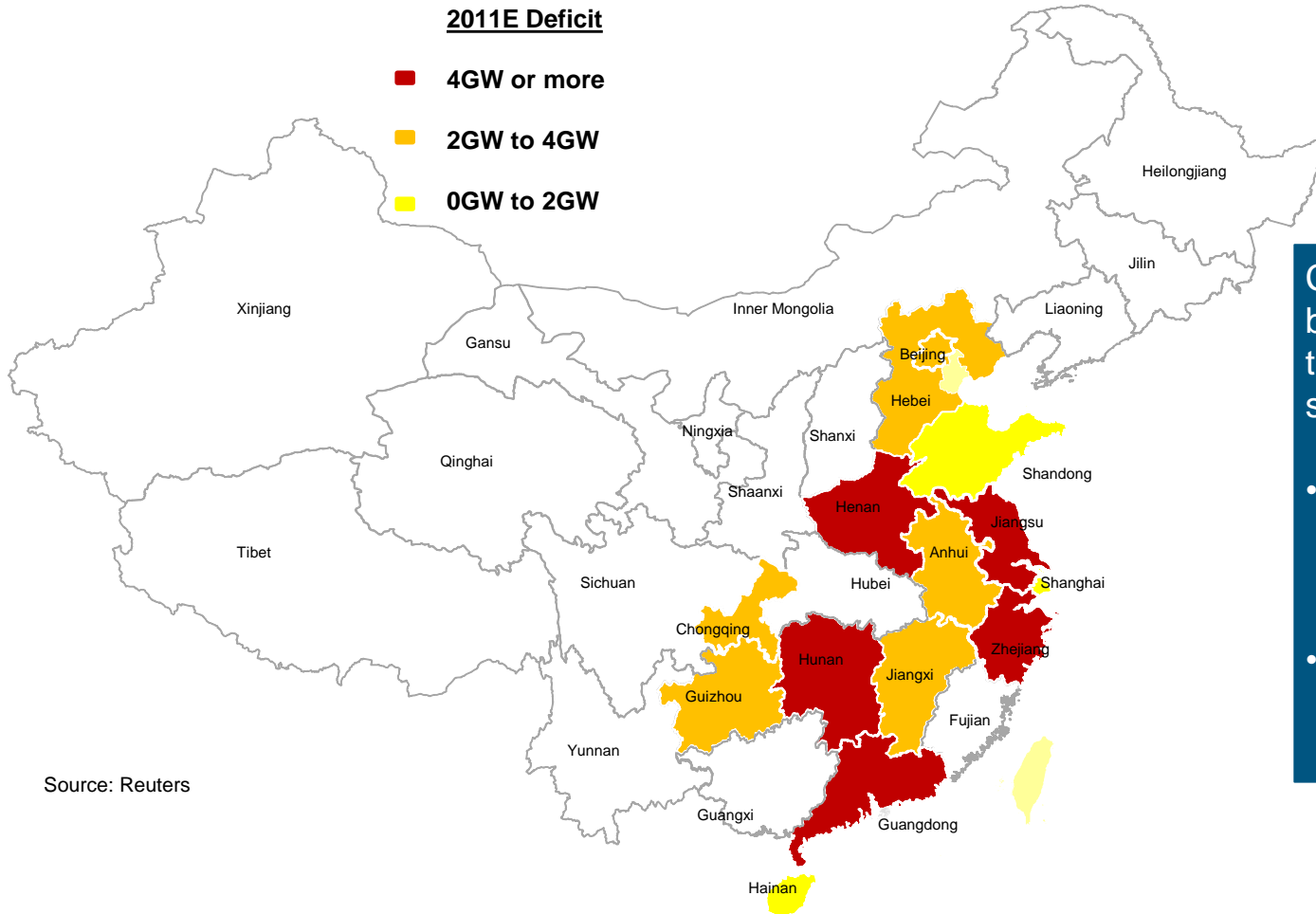
Nearly all of China's generation comes from coal-fired power stations and hydropower stations.  
Wind power is the main form of renewable energy

## Planned Ultra High Voltage (UHV) core grid is behind schedule



In its 12<sup>th</sup> FYP, State Grid had proposed to have virtually completed a backbone of “3 vertical, 3 horizontal and 1 loop” of UHV AC routes connecting the North, Central And East China Grids

# Gas power plants in the coastal cities – one of the solutions for power shortage in China

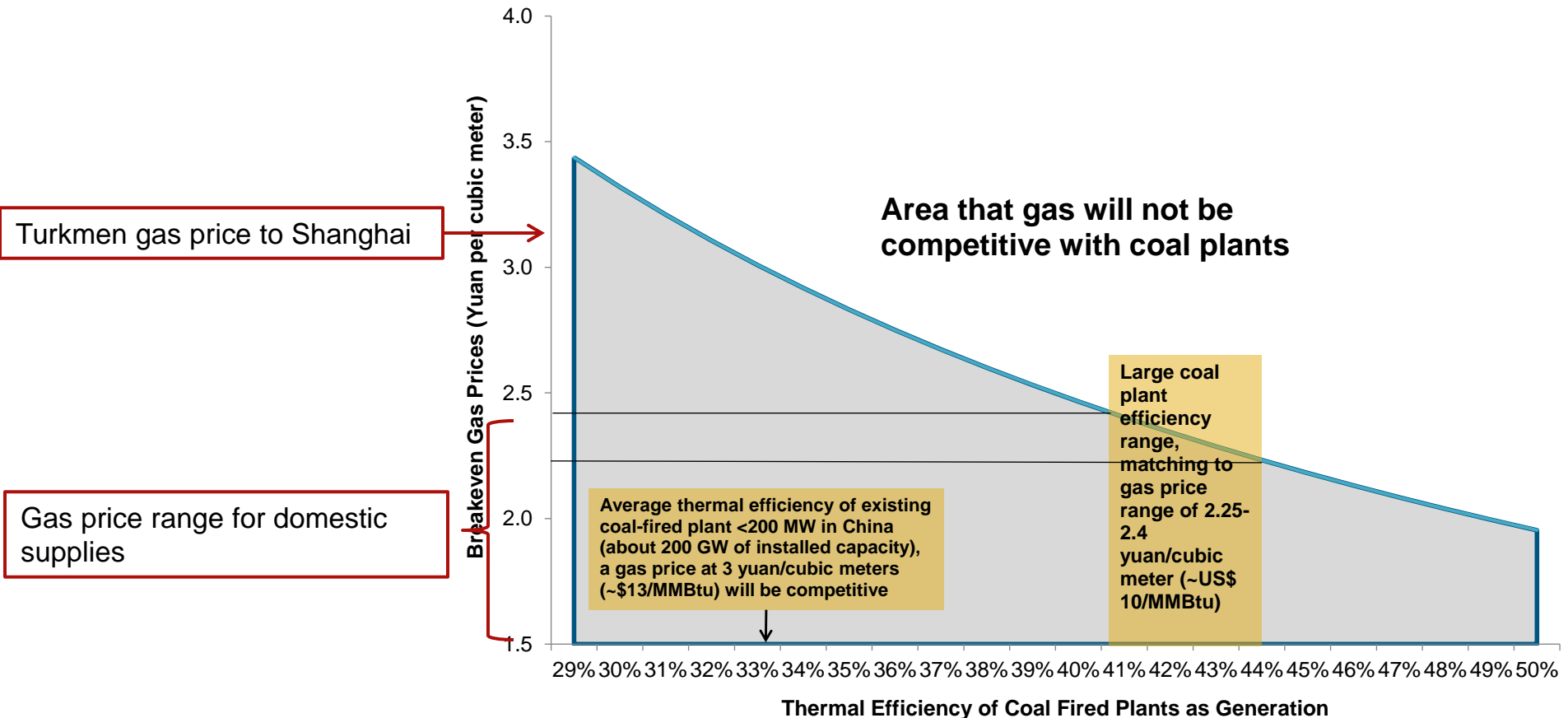


Combine cycle gas plants can be built in the coast cities to mitigate the power shortage situation in summer and winter

- But what is CCGTs economics against coal plants in the coastal areas?
- Infrastructure builds: gas pipelines vs coal railways vs UHV power transmission lines

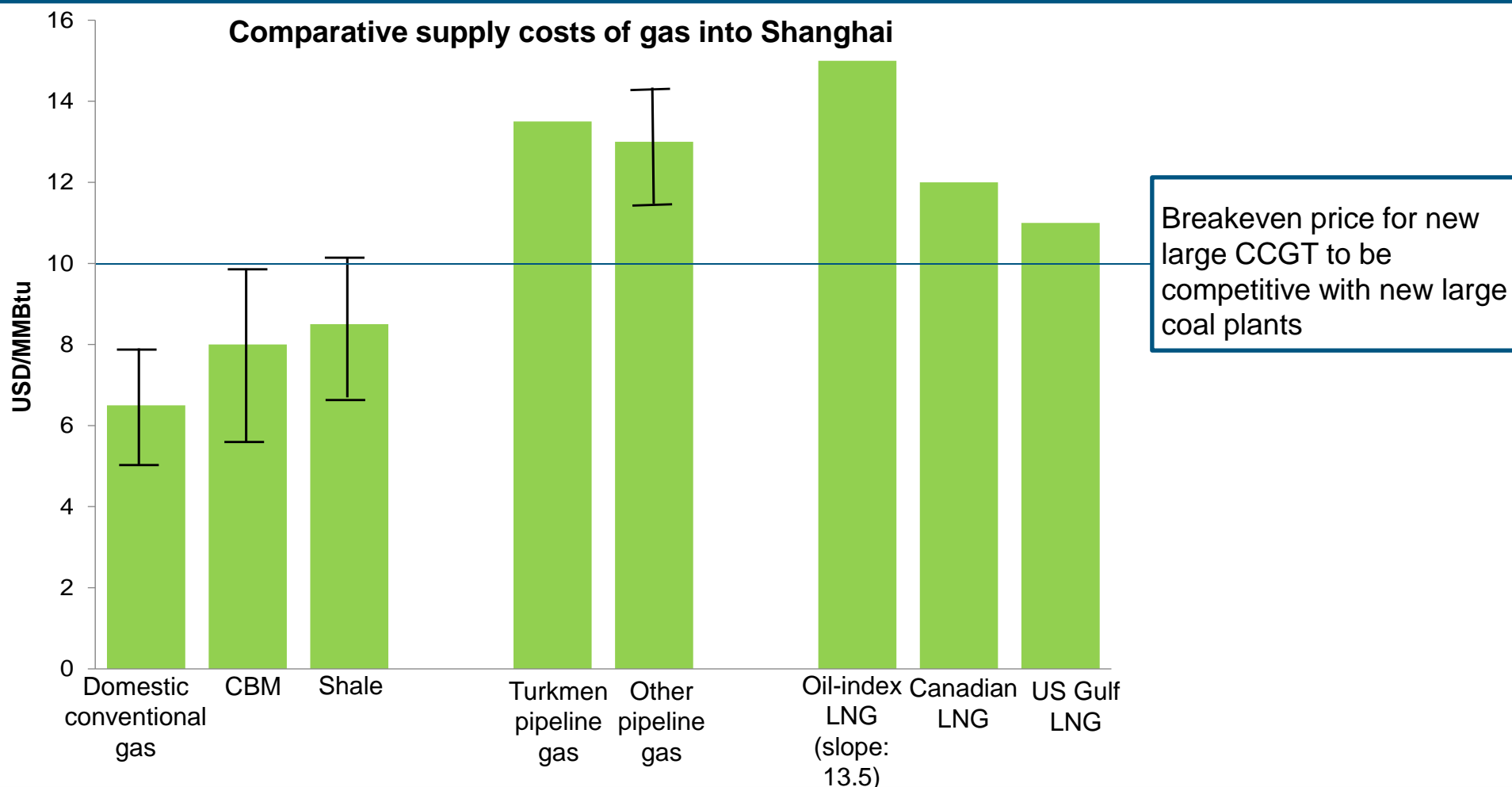
# Coal and gas plants economics comparison in the coastal areas

**Breakeven gas price line competing with coal plants with different efficiencies**



Assumptions: thermal coal price in the coastal area: 700 yuan/ton; efficiency of the CCGTs: 60%; capital cost of coal plant is 4,000 yuan/kW and that of gas plant is 3,267 yuan/kW; utilization rate of coal plant is 63% and that of CCGTs is 51%.

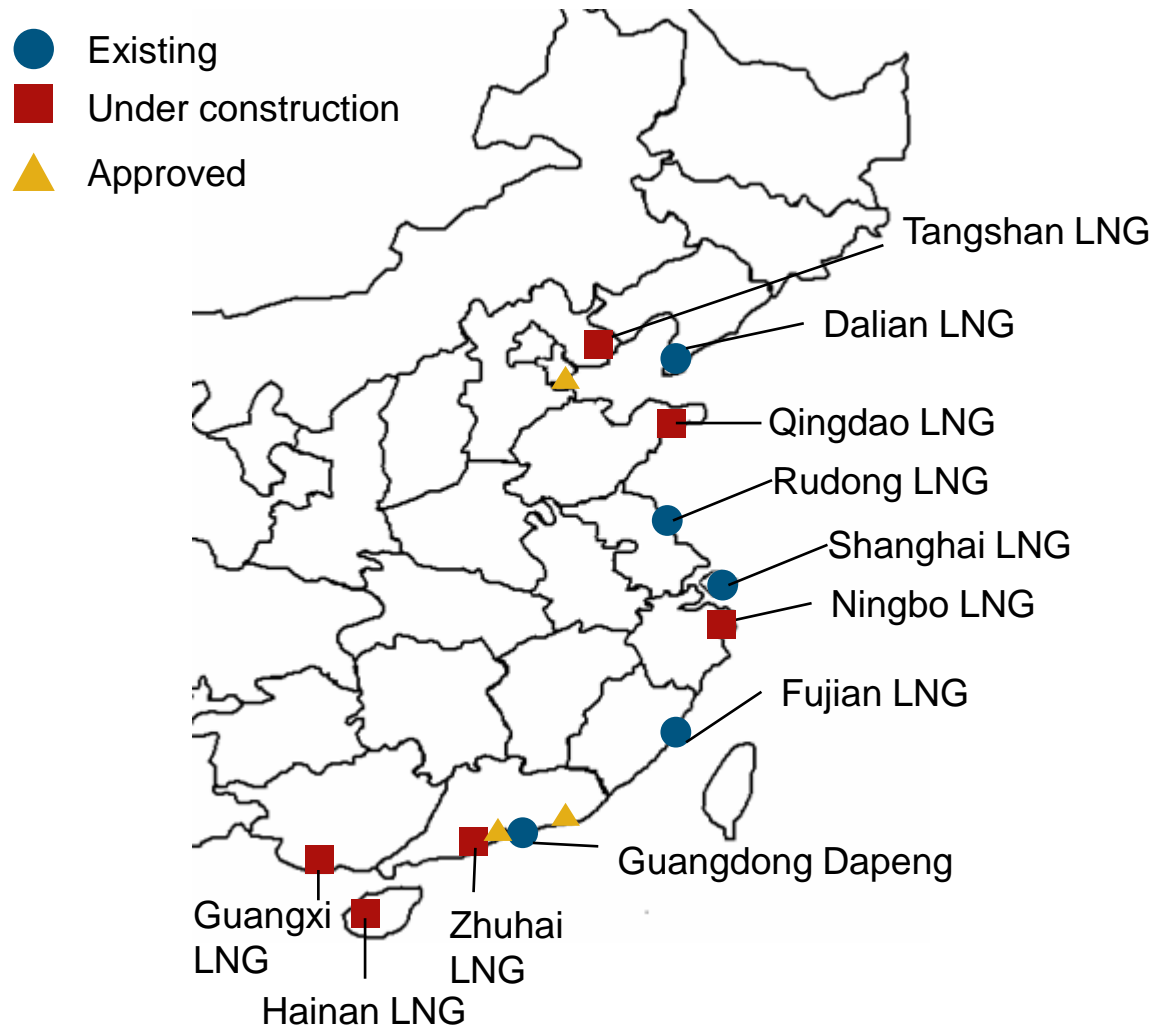
## Difference sources of gas supplies



New LNG and pipeline gas imports are not economical to be used in the power sector to compete with coal in the coastal cities because of their expected high cost of supplies



# LNG Regasification Terminals in China

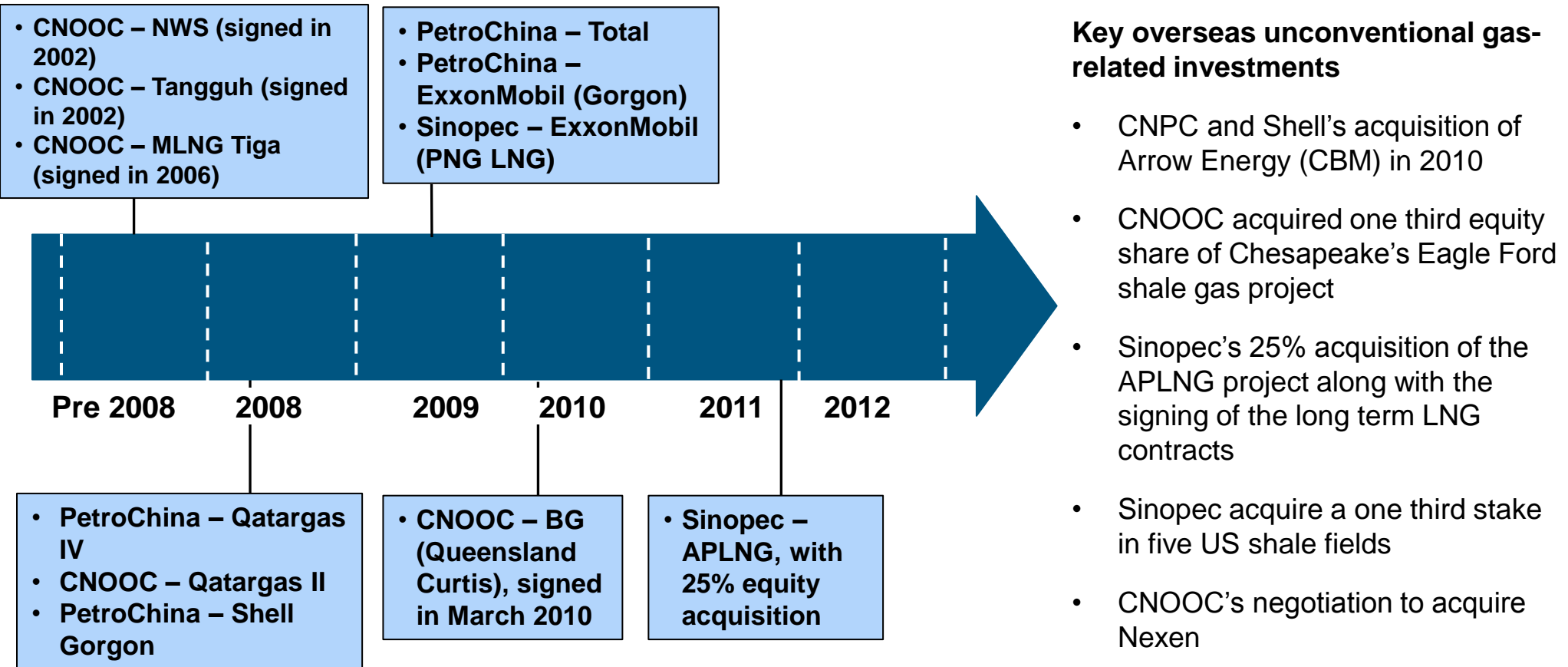


There are many more planned LNG terminals. With the uncertainties of shale gas production in the future, how should the Chinese players increase their flexibilities in LNG procurement and investment in the LNG terminals?

## Lessons from the US:

- Many LNG terminals were proposed and built in the Gulf Coasts in mid 2000s
- After 2008, the LNG terminals' utilization rates are virtually zero and operators are considering to change those import terminals to export facilities

# Recent developments in long term LNG procurements and gas-related overseas investment by Chinese NOCs



In the past two years, China has only signed one new long term LNG contracts, possibly due to the high LNG price and re-focus on the domestic shale gas plays and overseas equity investment of unconventional gas and oil assets

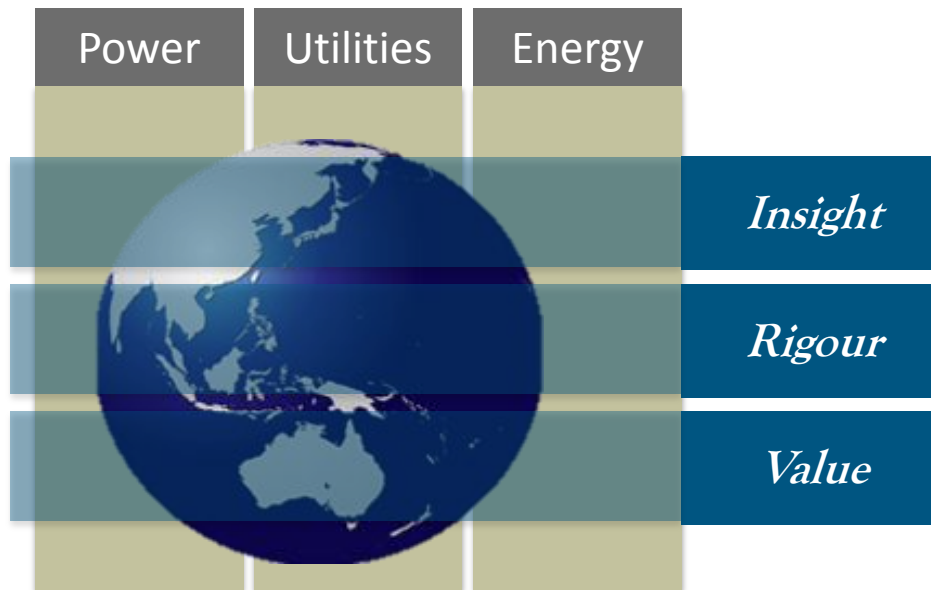
In conclusion, it will take some time before shale gas production to increase substantially..... But it is time to consider the expansion of the infrastructures to accommodate future growth

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- Shale gas exploration and development is still at an early stage in China
- There is not enough existing pipeline infrastructure to ship the unconventional gas to the coastal regions; incentives and responsive regulatory approval processes for pipeline construction might be needed for these high capital investments
- Gas consumption in the power sector will be a wildcard for demand growth
  - In coastal regions, gas price at 2.25-2.4 yuan/cubic meters is just competitive with large coal plants
  - More CCGT plants in the coastal areas could mitigate future power shortage in the coastal area and alleviate the requirement for infrastructure expansion in the power sector
- Domestic unconventional gas production will likely have cost advantage over more pipeline or LNG imports
- Value of flexibility for future LNG contractual arrangement and infrastructure build-up will increase with high uncertainty of future unconventional gas production



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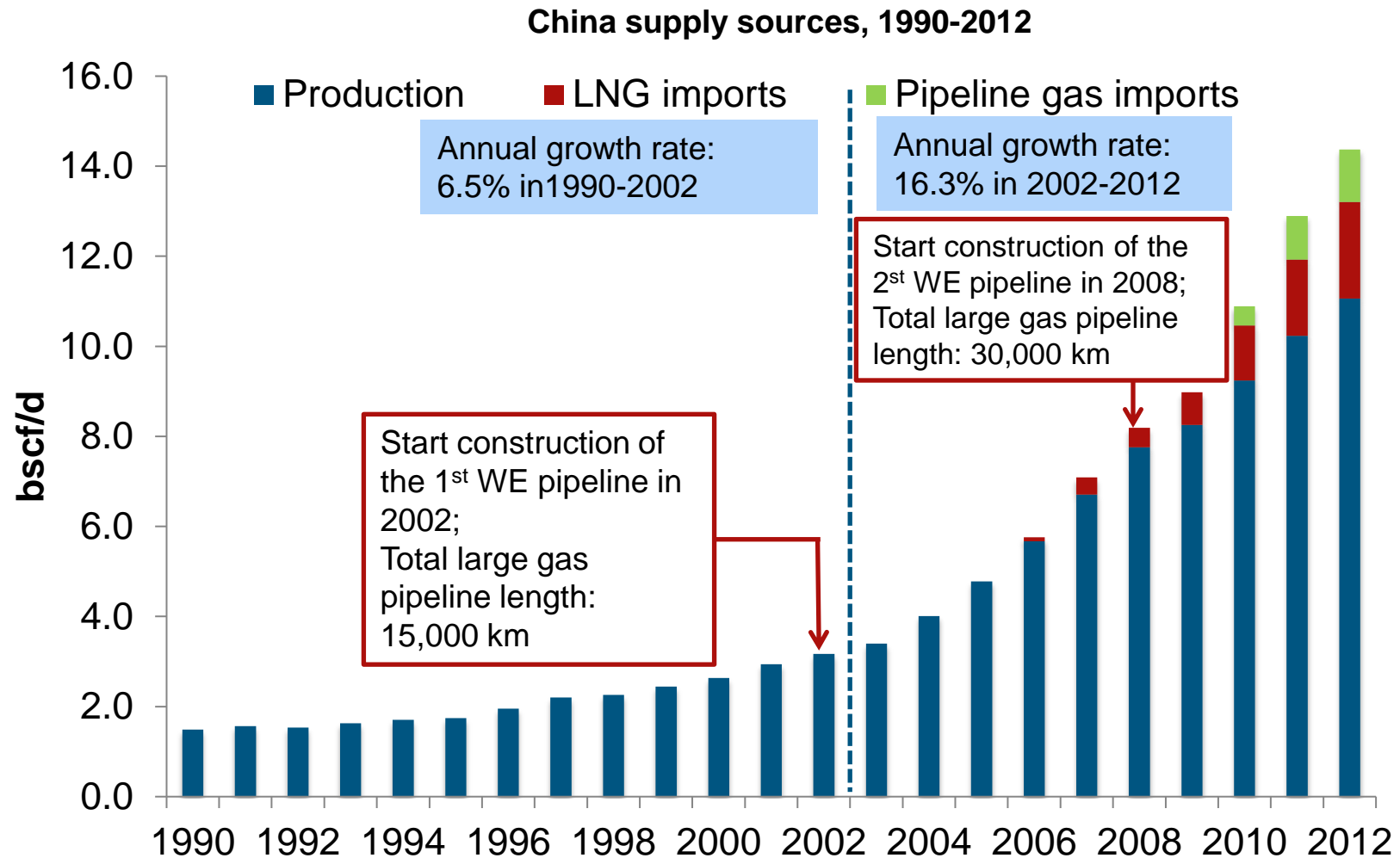
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# Pipeline infrastructure is one of the key building blocks to stimulate gas supply growth



Source: China Yearly Databooks and IEA, 2011 is preliminary data and 2012 is estimated data

Historically, infrastructure is a necessary prerequisite of supply growth



## Background: China is in the process of reforming gas prices

### Existing cost-plus gas price mechanism

NDRC set both these prices, and the combination of them called city gate price

Exploration wellhead price (regulated)



Pipeline transmission tariff (regulated)



Set by local governments

Distribution cost plus margin (regulated)



End-user gas prices

Wellhead prices varied by gas fields and sectors. The industrial sector (excluding fertilizers) in the coastal cities pays the highest prices

### Proposed netback pricing mechanism

Benchmark gas price in Shanghai (unregulated, linked to LPG and fuel oil)



Adjusted by transmission cost

City gate price



Distribution cost plus margin (regulated)



End-user gas prices

Trial run of new netback pricing mechanism started in end 2011 in Guangdong and Guangxi, and it could be extended to other provinces/cities, including Shanghai, Jiangsu, Zhejiang and Anhui.

## Background: details of the new gas pricing mechanism

### New pricing formula for city gate price in Guangdong and Guangxi

$$P_{\text{Natural Gas}} = \text{Discount Factor}^{\#} \times (W_{\text{Fuel Oil}} \times P_{\text{Fuel Oil}} \times \frac{H_{\text{Natural Gas}}^*}{H_{\text{Fuel Oil}}^*} + W_{\text{LPG}} \times P_{\text{LPG}} \times \frac{H_{\text{Natural Gas}}^*}{H_{\text{LPG}}^*}) \times (1 + \text{VAT})$$

#### Notes:

The weight of Fuel Oil and LPG is set at 60% and 40% respectively

<sup>#</sup>Discount factor is now set at 90%

\*Heating Value for Fuel Oil, LPG, Natural Gas are 10,000 kcal/kg, 12,000 kcal/kg and 8,000 kcal/m<sup>3</sup> respectively

H= Heat value

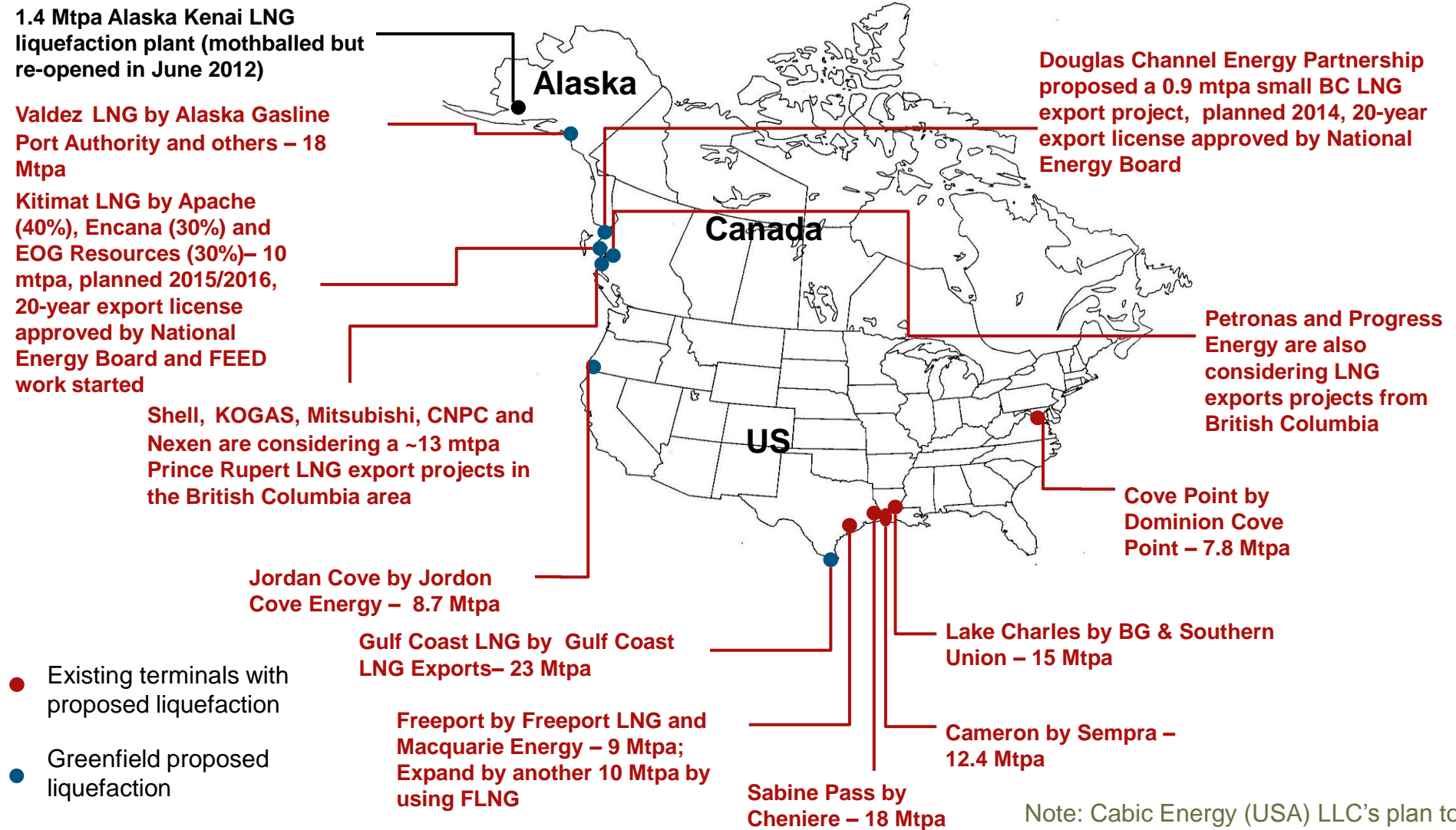
W= Weight

P= Price based on import price of fuel oil and LPG in Shanghai market

Source: NDRC

- Benchmarking to the Shanghai city gate price – (formula above)
- Add in the pipeline distribution tariffs (which will be fixed by the NDRC) based on location and the economic situation of the province.
- There will be only one city gate price in one province and differentiation of prices from different supply sources will be abolished
- The frequency of price adjustment will be annually and gradually increased to semi-annually and quarterly

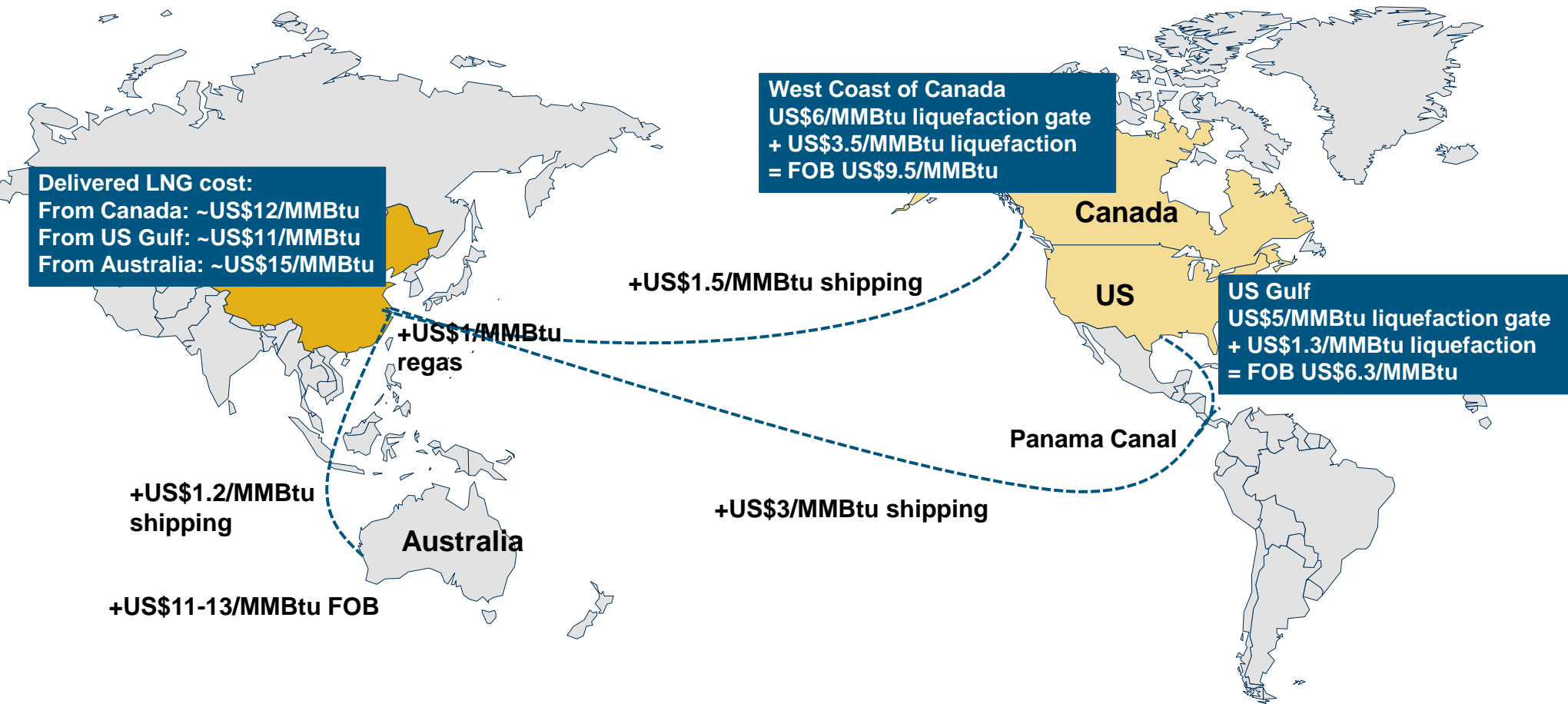
# The many (>120 Mtpa) LNG export projects planned in the US and Canada could further disrupt global LNG pricing, depending on timing and demand



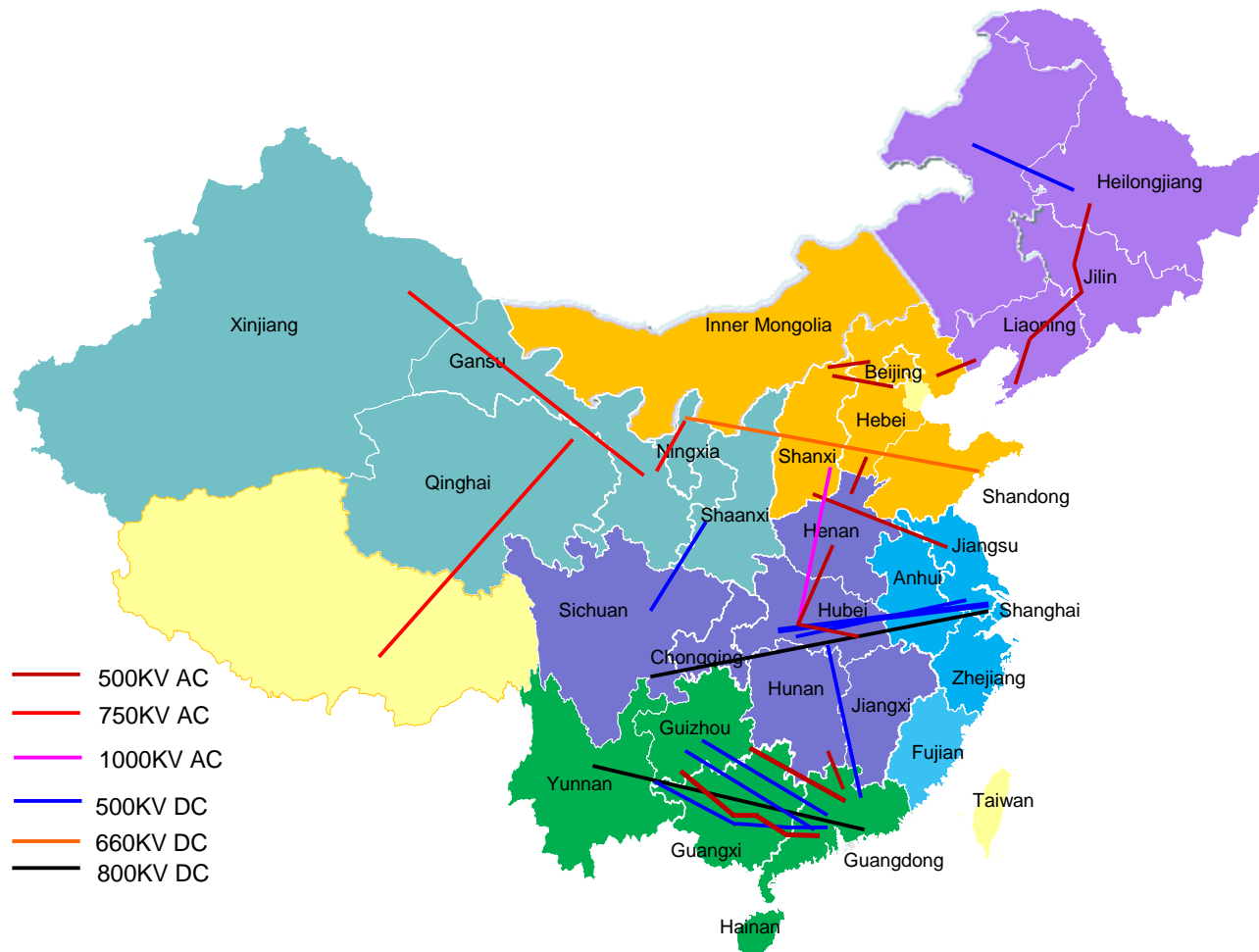
Note: Cabic Energy (USA) LLC's plan to export 0.22 mtpa to FTA and 0.07 mtpa to Non-FTA countries are not included

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# Comparisons of LNG import prices from Australia and the US/West Canada



# Current High-Voltage Transmission System



Source: TLG Analysis

Despite its vast scale as measured in terms of kilometres of transmission circuits, China's high-voltage transmission system has relatively few interconnection points. As a result, it is relatively weak