Coal and Coal Power's Role in China's Energy System

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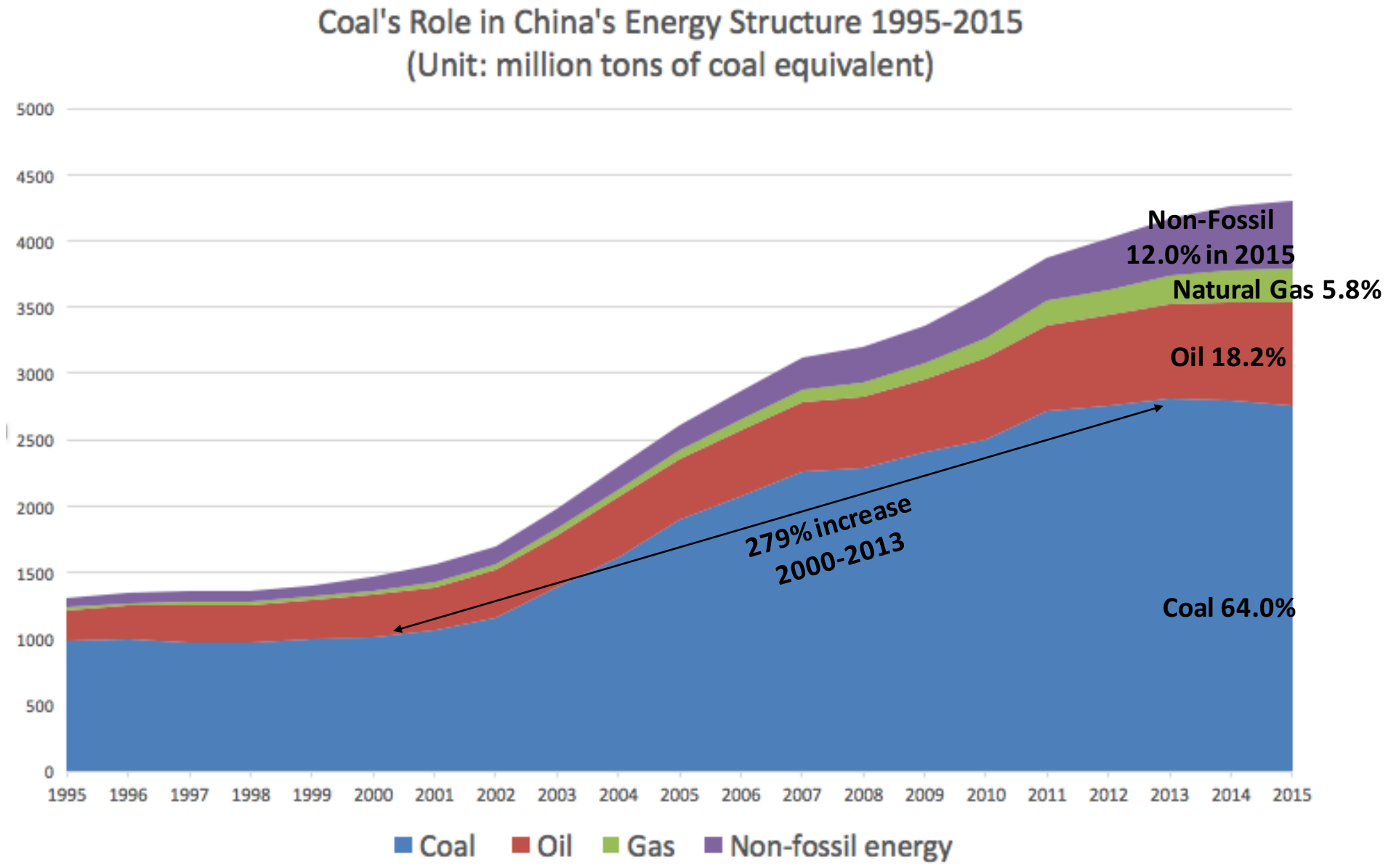
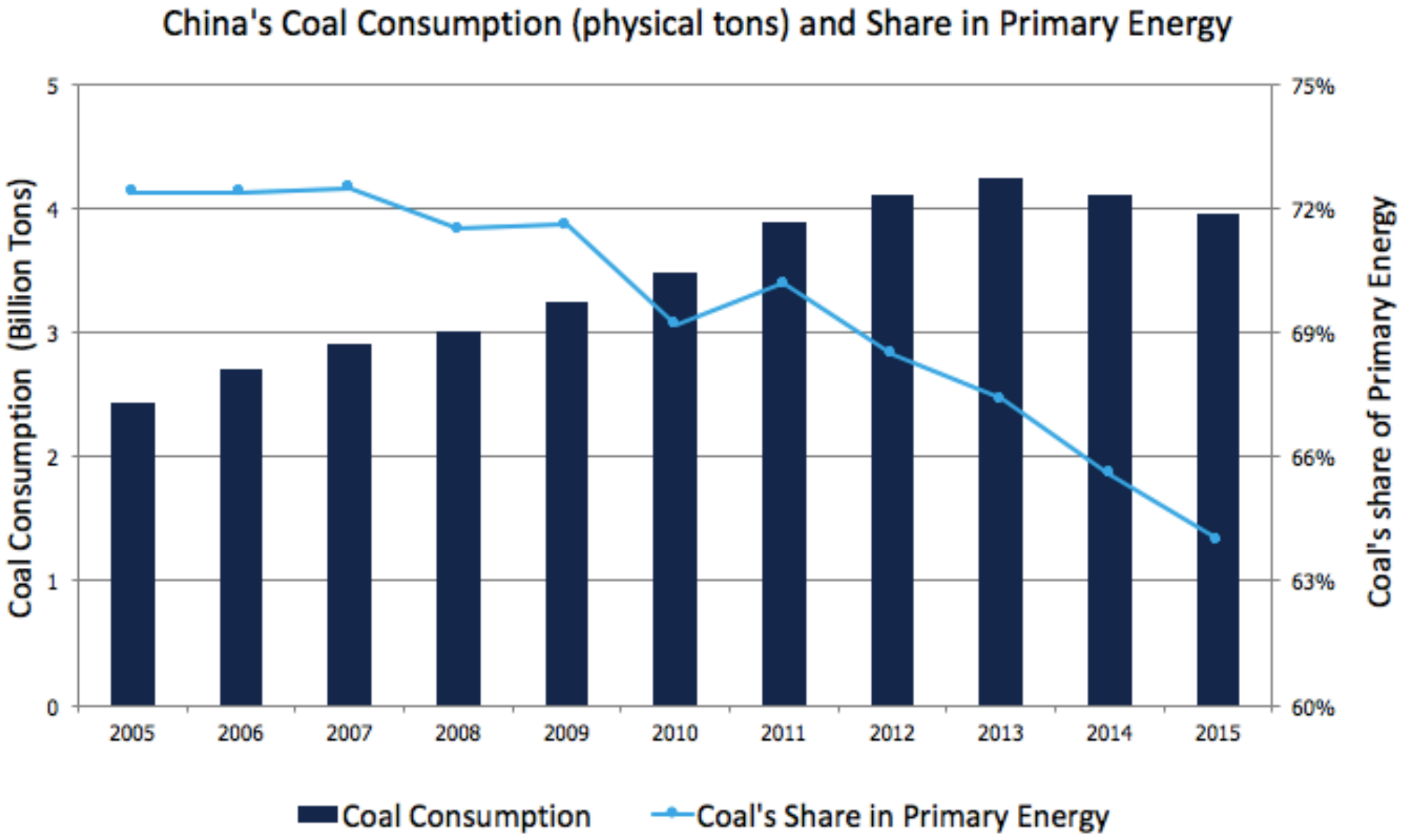
Coal has played a dominant but recently decreasing role in China's energy supply: 75% of primary energy in 1995 to 64% in 2015



China's absolute coal consumption has fallen since 2013; coal's share of primary energy consumption has fallen since 2007



Reasons for China's increase and fall in coal consumption

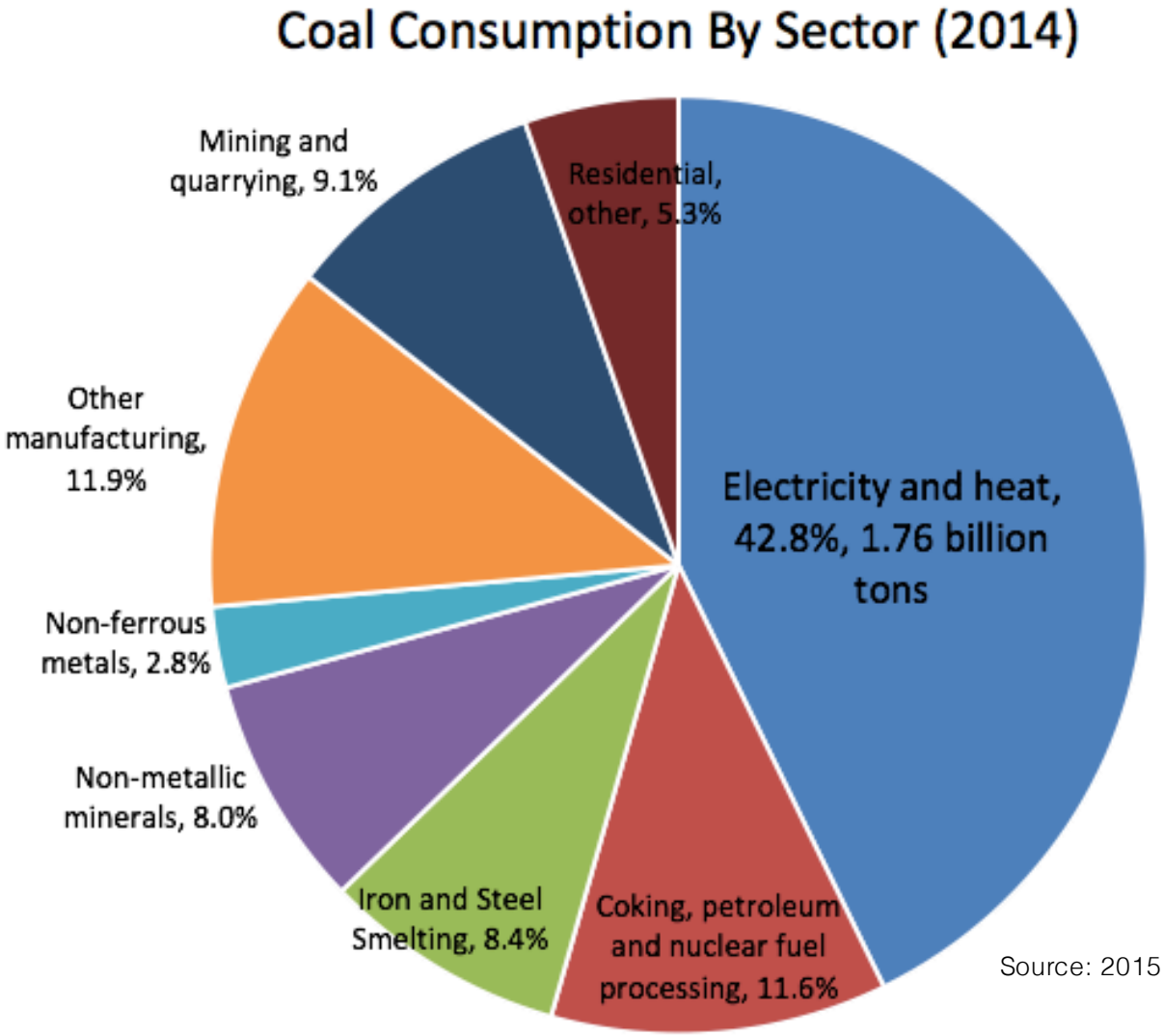
Reasons for rapid increase 2001-13:

- Rapid economic growth (average 10.5% GDP growth 2001-11), focused on heavy industry, exports, infrastructure and real estate.

Reasons for decrease in 2014 and 2015

- *Slowing economic growth (6.9% in 2015)*. Excess capacity in all heavy industry and need to rebalance economy away from heavy industry.
- *Continued development of non-hydro power:* development of world's largest hydro, wind, solar and nuclear markets since mid-2000s.
  - Target to achieve 15% non-fossil energy and reduce coal to 62% by 2020.
- *Severe air pollution and stronger air pollution policies* beginning with September 2013 *Air Pollution Action Plan*: Set coal consumption caps in 3 key air pollution regions, limited new coal power addition
- *Stronger climate and energy efficiency targets and policies:* Coal is responsible for ~80% of China's fossil CO2 emissions. China strengthened energy efficiency, climate and non-fossil targets beginning in Eleventh Five Year Plan (2006-10). Set goal to peak CO2 emissions by 2030, with efforts to peak earlier.

Electricity and heat generation constitutes 43% of China's coal consumption, followed by other heavy industry



Source: 2015 China Energy Statistics Yearbook

Within the power sector, thermal power (mainly coal*) was 65.7% of installed capacity and 73% of generation in 2015

	Installed Capacity (GW)	%	Generation (Twh)	%
Thermal	**990.2**	65.7%	**4242.0**	73.0%
Hydro	319.4	21.2%	1126.4	19.4%
Nuclear	26.1	1.7%	170.8	2.9%
Wind	129.0	8.6%	186.3	3.2%
Solar PV	43.0	2.9%	38.3	0.7%
Other			46.7	0.8%
Total	1506.7		5810.6	

***There were 55 GW of natural gas thermal power in 2014.**

Thermal power generation fell 2.7% in 2015 and was entirely replaced by non-fossil power generation

Thermal power generation fell 2.7% in 2015 (117.7 TwH)

- Average thermal power utilization hours fell to 4,329 hours (49.4%), the lowest level since 1978.

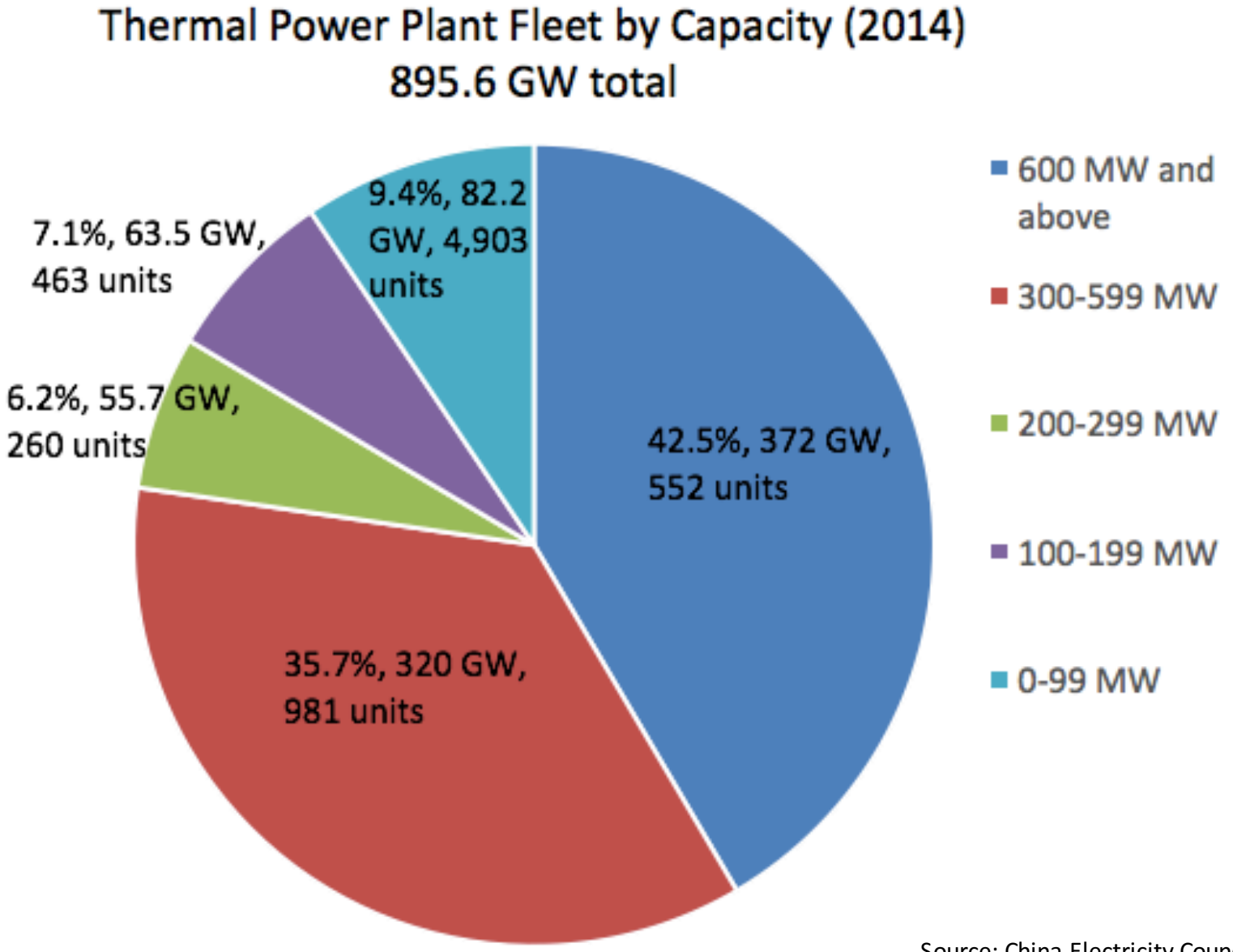
Increase of 133.2 TwH of new non-fossil generation:

- Hydropower generation increased 5% (53.6 TwH)
- Nuclear generation increased 28.9% (38.3 Twh)
- Wind power generation increased 16.6% (26.5 Twh)
- Solar power generation increased 62.9% (14.8 Twh)

Government concern over excess capacity in coal power.

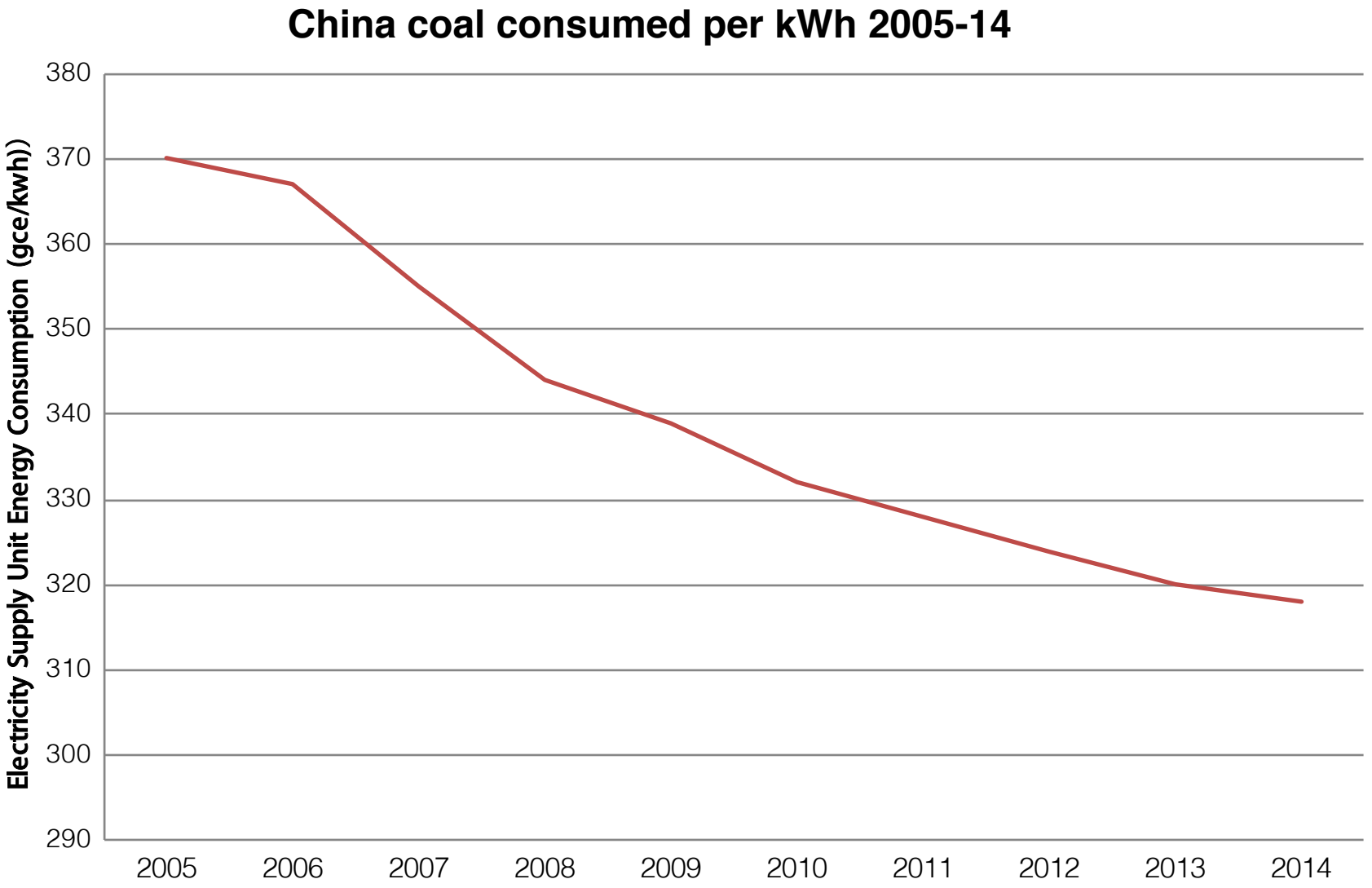
169 GW of coal power projects approved in 2015.

China's Coal Power Plants Have Been Increasing in Size and Efficiency
78.2% of thermal power plants now are 300 MW and above



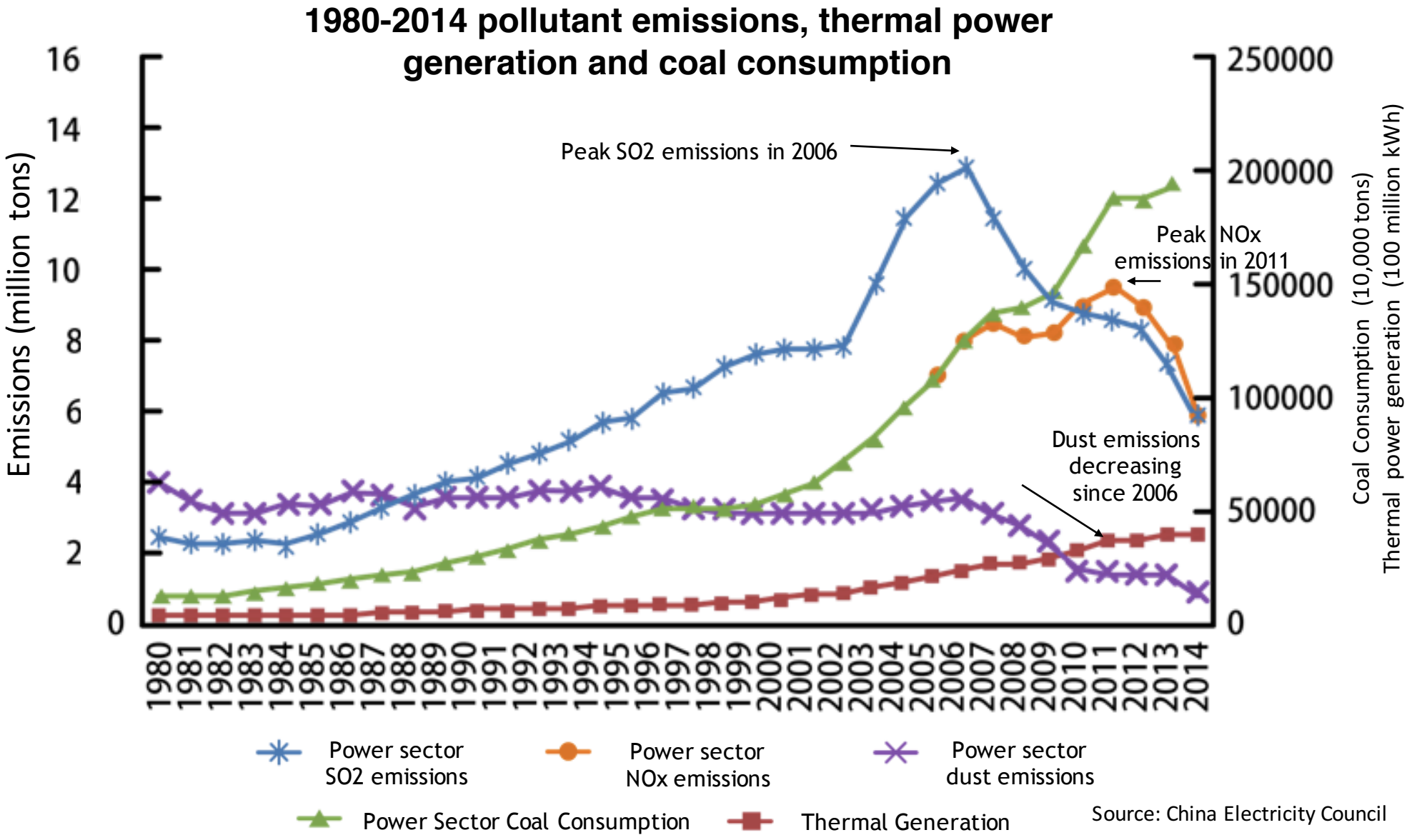
Source: China Electricity Council

Coal consumed per kWh has fallen from 370 g/kWh in 2005 to 319 g/kWh in 2014



Source: China Electricity Council

However, the power sector's total coal consumption increased from ~500,000 tons in 1999 to ~2.0 billion tons in 2013



Thermal power's share of total air pollutant emissions has decreased with improved pollution control but is still large

Coal power plants emit about 30% of national SO2 and NOx emissions.

Emissions have fallen more rapidly with stricter thermal power plant emissions standards implemented in 2012.

- SO2 emissions: 6.2 million tons in 2014 (31.4% of total 19.7 m tons).
  - *20.5% reduction from 2013*
  - Emissions per unit thermal power: 1.47 grams/kWh.
- NOx emissions: 6.2 million tons in 2014 (29.8% of total 20.8 m tons).
  - *25.7% reduction from 2013*
  - Emissions per unit thermal power: 1.47 grams/kWh.
- Dust emissions: 980,000 tons in 2014 (total 17.4 m tons)
  - *31% reduction from 2013*, 72.8% reduction from 2005.
  - Emissions per unit thermal power: 0.23 grams/kWh.

The power sector's air pollutant emissions per ton of coal are lower than some other sectors but still high

Sector	Coal consumption (m tons)	Total emissions (tons)			Kg emissions per ton of coal consumption		
		SO2	NOx	Dust	SO2	NOx	Dust
Electricity and heat	1,760,980,000	6,211,869	7,134,068	2,724,160	3.53	4.05	1.55
Coking, petroleum and nuclear fuel processing	477,740,000	787,451	397,680	421,385	1.65	0.83	0.88
Iron and Steel Smelting	345,270,000	2,150,358	1,008,939	4,271,819	6.23	2.92	12.37
Non-metallic Mineral	330,150,000	2,086,269	2,909,964	2,644,862	6.32	8.81	8.01
Non-ferrous metals	114,830,000	1,229,750	327,538	384,801	10.71	2.85	3.35

Source: 2015 China Energy Statistical Yearbook,
2015 China Statistical Yearbook on Environment

Environmental and Health Impacts of Coal in China

The Coal Cap Project has quantified the impacts of coal for the policymakers and the public:

- **Coal Utilization's Contribution to Air Pollution:** Coal consumption contributes to 62 percent of China's primary PM2.5 emissions, 93 percent of SO2 emissions, and 70 percent of NOx emissions. Reducing coal consumption is key to reaching 2020 and 2030 air quality goals.
- **Coal Cap Policy's Public Health Benefits:** Air pollution from coal led to about 708,000 premature deaths in China in 2012 due to cardiopulmonary disease. Air quality improvements from a coal cap policy would save 49,000 lives per year in 2020, 89,000 in 2030, 80,000 in 2040 and 51,000 in 2050, with aggregate economic benefits of ~1.3 trillion RMB through 2050.
- **The True Cost of Coal:** The environmental and public health costs from coal mining, transportation, combustion and utilization were 303 RMB per ton in 2012, while the loss and damage from CO2 emissions from coal were estimated at 160 yuan/ton, for a total cost of 463 RMB/ton.

Water, Climate and Jobs Impacts of Coal Cap Policy

The Coal Cap Project has quantified the impacts of coal for the policymakers and the public:

- **Water Resources Red Lines and Coal Production and Use Controls (China Institute for Water Resources and Hydropower Research):** Coal mining and use, especially coal power and coal chemicals, threatens water resources, particularly in the large-scale coal bases of Shanxi, Shaanxi, Inner Mongolia, Ningxia, and Gansu. Coal cap policies are needed to meet national and regional water consumption redlines.
- **Coal cap and CO2 emissions (National Center for Climate Strategy):** By strictly controlling coal consumption, China can overachieve its 2020 carbon intensity reduction target and meet its 2030 CO2 peaking target before 2030.
- **The Effect of a Coal Cap Policy on Jobs (Chinese Academy of Social Sciences):** A coal cap policy will accelerate job creation in the wind, solar, energy efficiency and other clean energy industries, which will more than compensate for the jobs lost in coal mining.

Recommendations for National Coal Cap (2016-20)

China Coal Consumption Cap Plan and Research Report: Recommendations for the 13th Five Year Plan

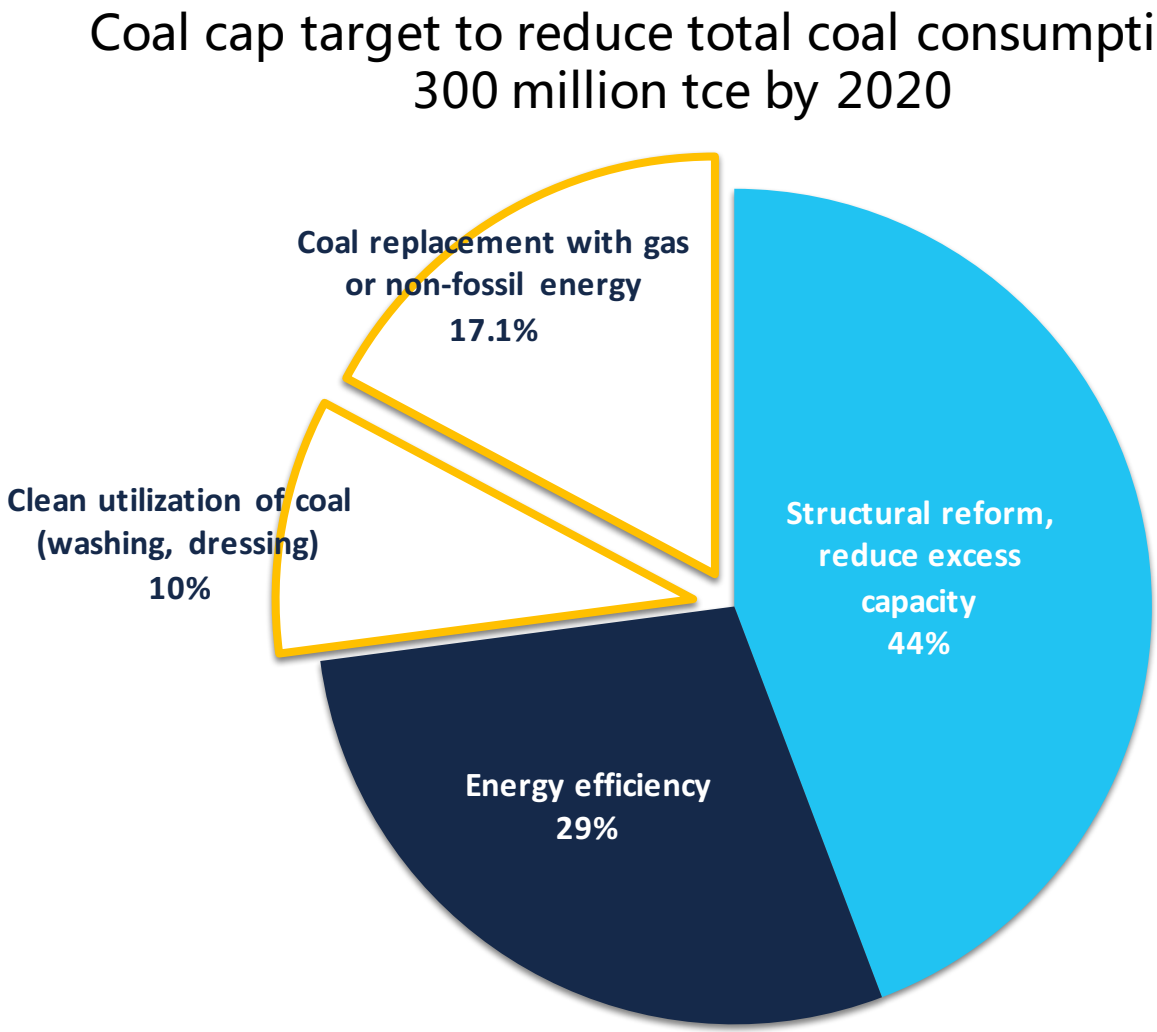
- Recommends national coal cap target of **3.5 billion tons by 2020, 55% of primary energy consumption**, compared to 64% in 2015 based on latest statistics.
- Establishes **redlines for coal consumption** based on CO2, air pollution, water and land resources constraints.
- Sets coal cap targets for each **region of China** and **key coal consuming sectors**.
- Submitted to National Development and Reform Commission, National Energy Administration, State Council Research Office, Ministry of Environmental Protection.

Coal consumption cap allocation by sector for 2020

The Coal Cap Project also set forth targets and plans for capping coal by sector

- Coal Cap Target of 3.5 billion tons of coal in 2020 allocated by sector:
  - **Power:** 1.86 billion tons
  - **Iron and steel:** 476 million tons
  - **Cement:** 196 million tons
  - **Buildings:** 322 million tons
  - **Coal chemicals:** 168 million tons
  - Other: 476 million tons
- Analysis by industry associations of key technologies by sector for capping coal consumption

Coal cap plan reduction



China's Coal Cap Policy Has Been Drive by Air Pollution

Coal cap policies have been evolving, focusing on implementation:

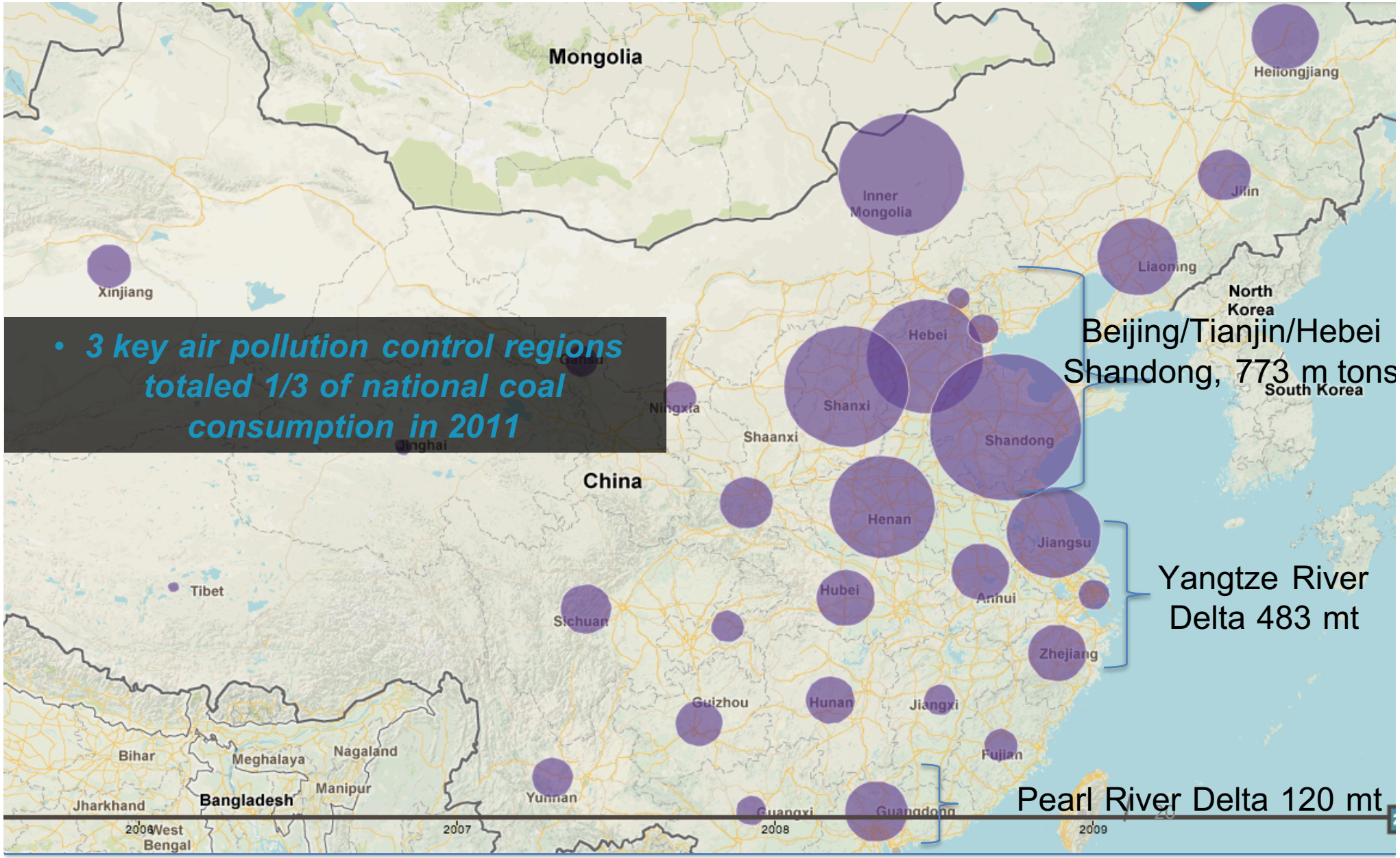
- September 2013: **Air Pollution Action Plan for 2013-17:** Sets PM 2.5 reduction targets for 3 key air pollution regions, requires key air pollution regions to decrease coal consumption, and calls for establishing "medium to long-term coal consumption cap targets." Goal of reducing coal to 65% or below by 2017.
- November 2014: **Energy Development Strategy Action Plan for 2014-2020:** Sets national energy consumption target of 4.8 billion tce and coal consumption target of 4.2 billion tons for 2020. ***Reduce coal to 62% or below by 2020***.
- December 2014: **"Key air pollution region coal consumption reduction and replacement regulation":** Requires coal cap plans and evaluations for provinces in key regions
- May 2015: **"Work plan for strengthening air pollution measures through key city coal consumption control"**, targeting coal caps in 10 most polluted cities
- August 2015, **Amended Air Pollution Law:** Sets goal to gradually reduce the share of coal in primary energy consumption.
- December 2015-February 2016: Policies for reducing excess capacity in coal mining and iron and steel, reviewing coal power plant approvals.

State Council Air Pollution Action Plan (2013-17)

Air quality improvement targets by 2017:

- PM 10 levels in prefecture-level cities to be reduced by 10% or more, number of good quality air days to increase.
- PM 2.5 reduction levels for 3 key regions to be reduced: Beijing-Tianjin-Hebei (25%), Yangtze River Delta (Shanghai-Zhejiang-Jiangsu) 20%, Pearl River Delta (southern Guangdong) 15%.
- Beijing to reach 60 ug/m3, from ~100 ug/m3 in 2012

Regional Coal Consumption Caps to Address Air Pollution



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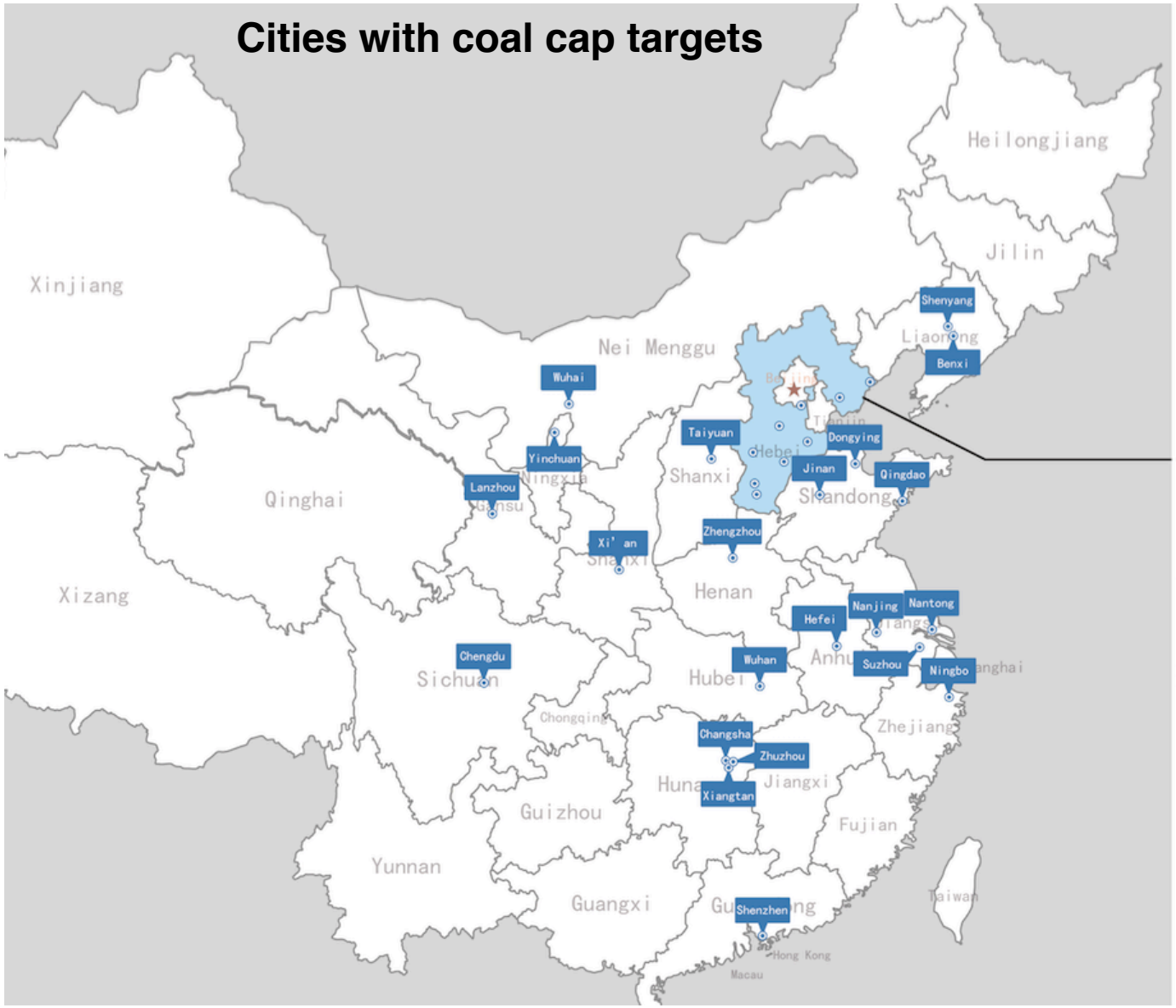
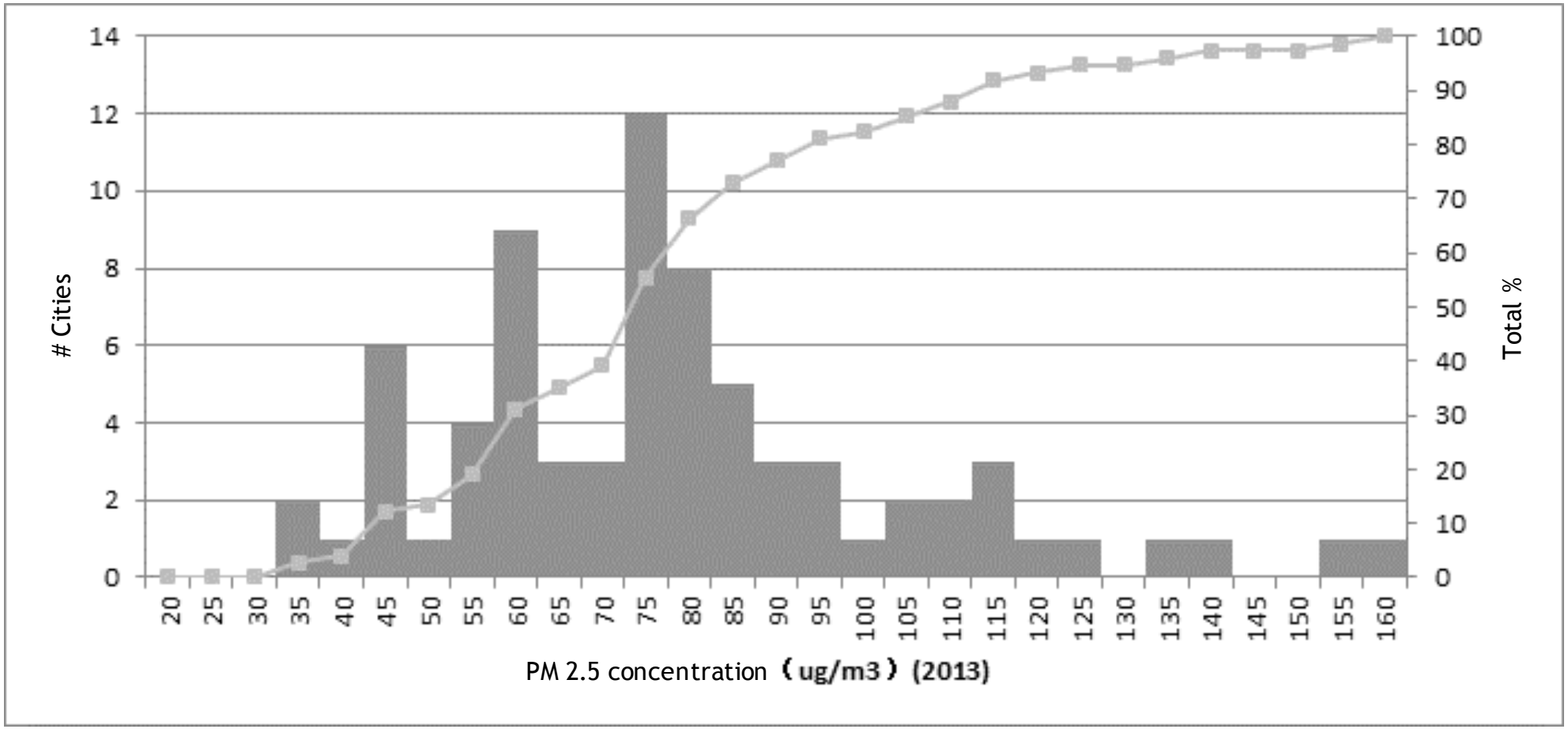


Some improvement in city air quality from 2013 to 2015, due in large part to coal reduction, but still far above 35 ug/m3 national standard

Average annual PM 2.5 concentration in 74 key cities (2013)



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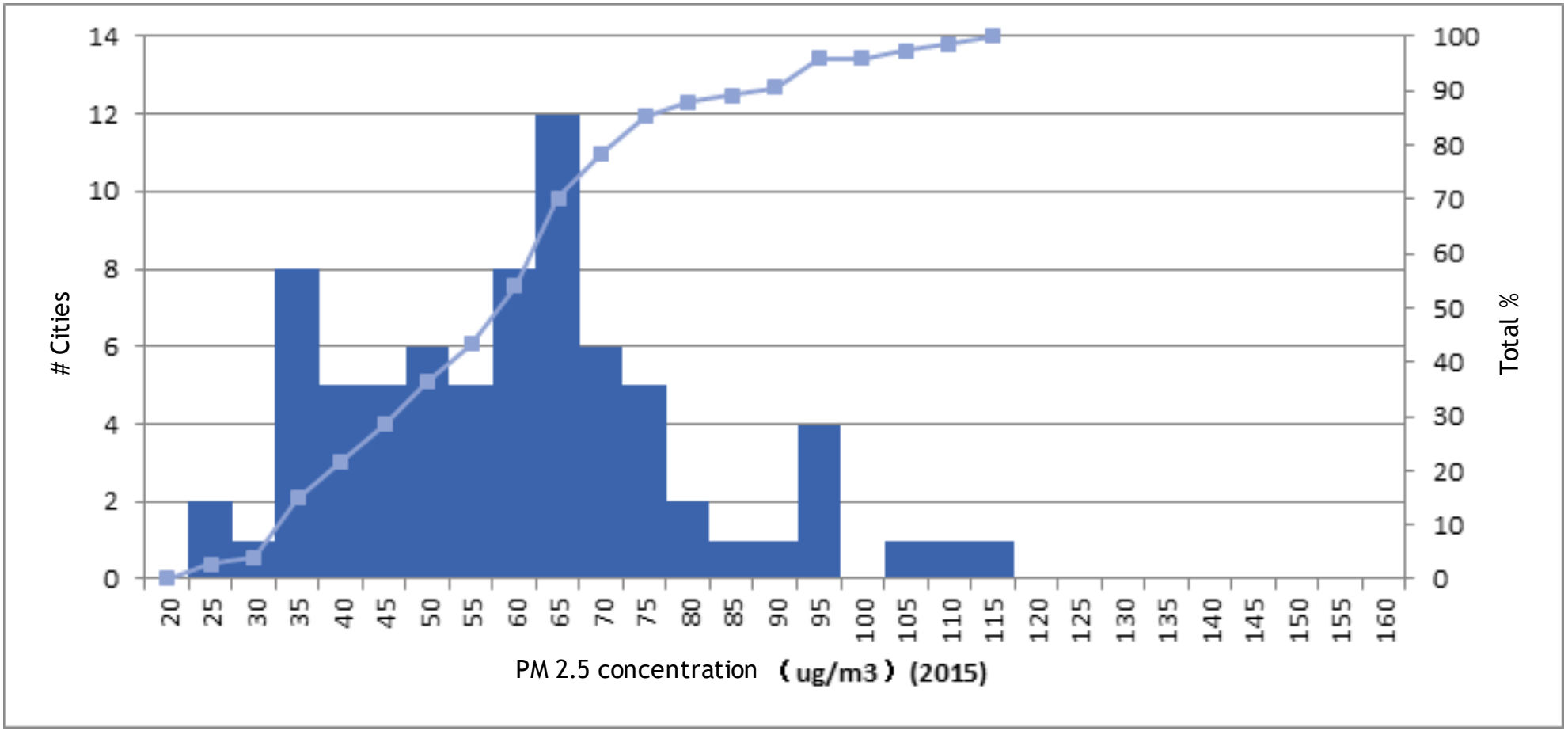


Targets for China's 13th Five Year Plan

	12th FYP Targets (2011-15)	12th FYP Result (2011-15)	*13th FYP Targets (2016-20)*
Energy Intensity (Energy Consumption per Unit GDP)	-16%	-18.20%	*-15%*
Carbon Intensity (CO2 per Unit GDP)	-17%	-20%	*-18%*
Non-Fossil Energy Share	11.40%	12%	*15%*
SO2	-8%	-18%	*-15%*
NOX	-8%	-18.60%	*-15%*
Ammonia Nitrogen	-10%	-13%	*-10%*
Chemical Oxygen Demand	-10%	-12.90%	*-10%*
Forest Coverage	21.70%	21.63%	*23.04%*

Targets for China's 13th Five Year Plan

Additional air quality and energy targets:

- 293 prefecture and above level cities to increase number of "good" or "excellent" air quality days from 76.7% to 80%
- Cities not meeting average annual PM 2.5 standard of 35 ug/m3 must reduce annual average PM 2.5 levels by 18%.
- Total energy cap target of 5.0 billion tons of coal equivalent by 2020, compared to 4.3 billion tce in 2015.

Efforts to reduce excess capacity by 2020

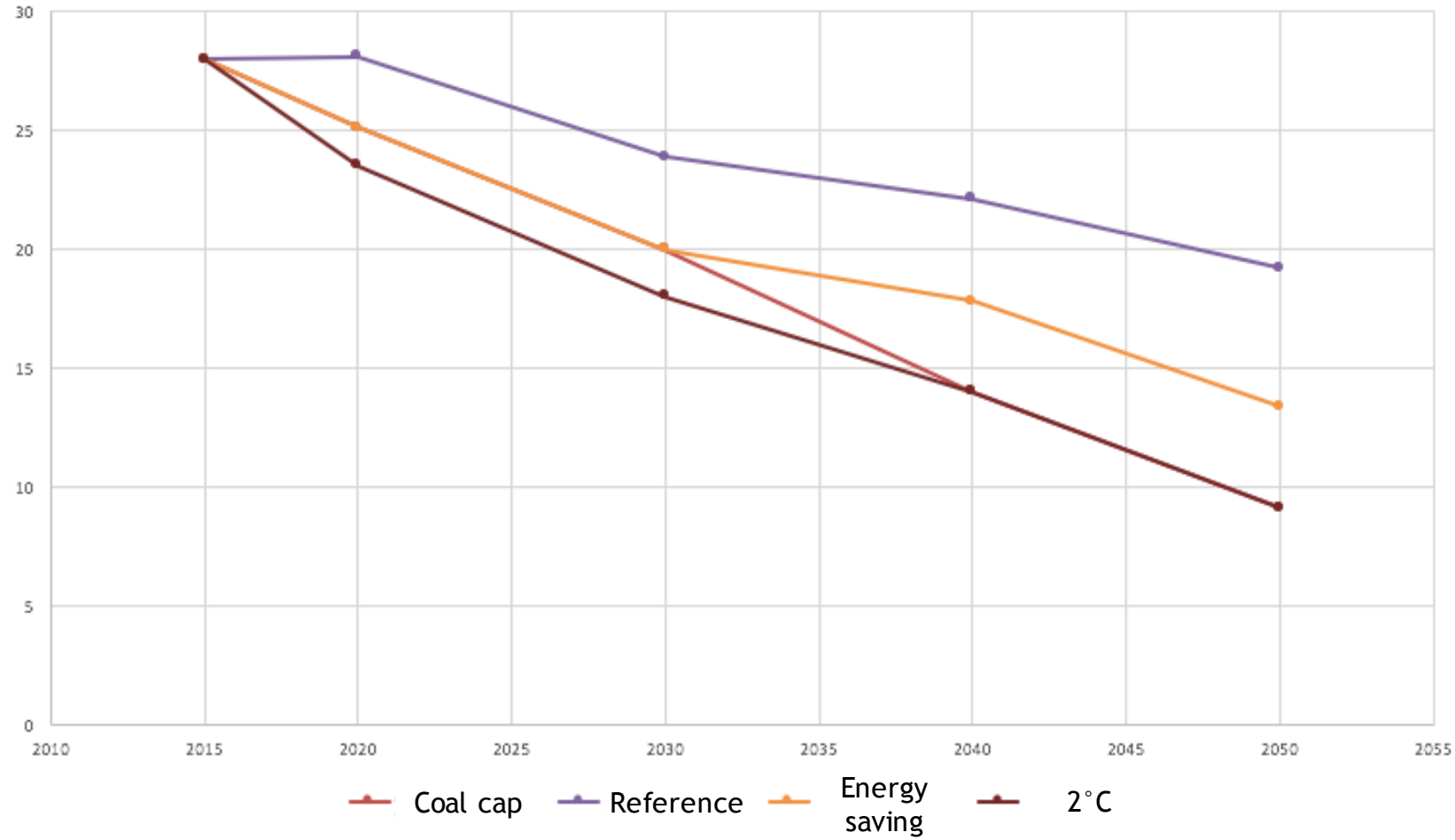
- Government has set targets to reduce excess production capacity:
  - coal mining (reduce 1.0 billion tons capacity by 2020, no new approvals)
  - iron and steel (reduce 100-150 m tons capacity by 2020)
  - coal power (decreasing utilization, excess capacity risk; reviewing approvals and slowing construction)
  - cement (reduce 300 m tons capacity)
- Focus on shift to services, consumption, high technology
- Continued increase in non-fossil energy.
  - 2020 targets: wind 200 GW, solar 150 GW, hydro 380 GW, nuclear 58 GW with 30 GW under construction

Energy Efficiency and Power Sector Reform Policies in China

- Power sector reform underway in China, with goal to increase competition and further green the power sector
- "Green dispatch policy" aimed at prioritizing non-fossil energy
- Efforts to improve wind and solar curtailment
- Top 10,000 enterprises program
  - Began as Top 1,000 enterprises program in 11th Five Year Plan (2006-10)
  - Now over 16,000 enterprises and public institutions included in the program
  - Establish targets and plans, incentives for improving energy efficiency
- Demand side management and demand response pilots and policies

Coal Consumption Cap Scenario

Coal cap scenario now focused on 2013 as peak coal consumption and continued decrease through 2050



Long-Term Outlook For Coal in China (2000-50)