Air Pollution Control in China: Progress and Perspectives

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Sep. 18, 2014

Outline

- *Review*
- *Measures since 2010*
- *Recent progress in air quality management*
- *Outlook*

Phase 1: 1970～1990

- Main source: Point sources (industry)
- Major pollutants: TSP
- Scale of air pollution: Local
- Air quality management: Emission concentration, smoke and dust control, point sources, local management
- Milestones：
  - ✓ 1973, 1st national comprehensive emission standard—The three wastes emission standard of industry
  - ✓ 1987, Air Pollution law, targeting industry and coal-burning pollution

Phase 2: 1990～2000

- Main source: Coal burning, industry
- Major pollutants: SO_2,TSP
- Air pollution problems: Smoke, acid rain
- Scale of air pollution: local + regional
- Air quality management: Emission concentration, coal burning control, point sources, local management
- Milestones：
  - ✓ 1998, SO_2 and acid rain control zone approved by State Council ;
  - ✓ 2000, total emission amount control of SO_2 in the SO_2 and acid rain control zone

Start to be anxious about air quality in cities

Prof. Jiming Hao write a published article “ Chinese people could hardly wait for the blue sky”, in May 1997.

- The monitor data served as a wake-up call, that the air pollution plagued Chinese cities.
- The blue sky need clean energy.
- Healthy development of the automotive industry is necessary to the blue sky.
- The government should protect the blue sky according to the law.


绿色视野 LUSEGUANCHA

郝吉明

中国人翘首待蓝天

Beijing started to combat air pollution in 1998

- On Dec. 17,1998, Beijing held a mobilization conference for implementing the emergency measures to control the air pollution.
- The “China Environment News” published an article “Beijing started to combat air pollution”

采取紧急措施 进行全民动员

北京治理大气出重拳

本报讯（记者 潘洪涛 班健）12月17日，北京市委、市政府召开贯彻落实控制大气污染紧急措施动员大会。会上传达了朱镕基总理、李岚清副总理对控制北京大气污染紧急措施所做的批示。北京市委书记、市长贾庆林和国家环保总局局长解振华出席会议并讲话。

北京市的环境保护工作历来得到党中央、国务院领导的高度重视。江泽民总书记对北京市的环境保护问题多次做过重要指示。最近，朱镕基总理、李岚清副总理针对北京市政府上报的《关于采取果断措施控制北京大气污染的紧急请示》分别作了批示。

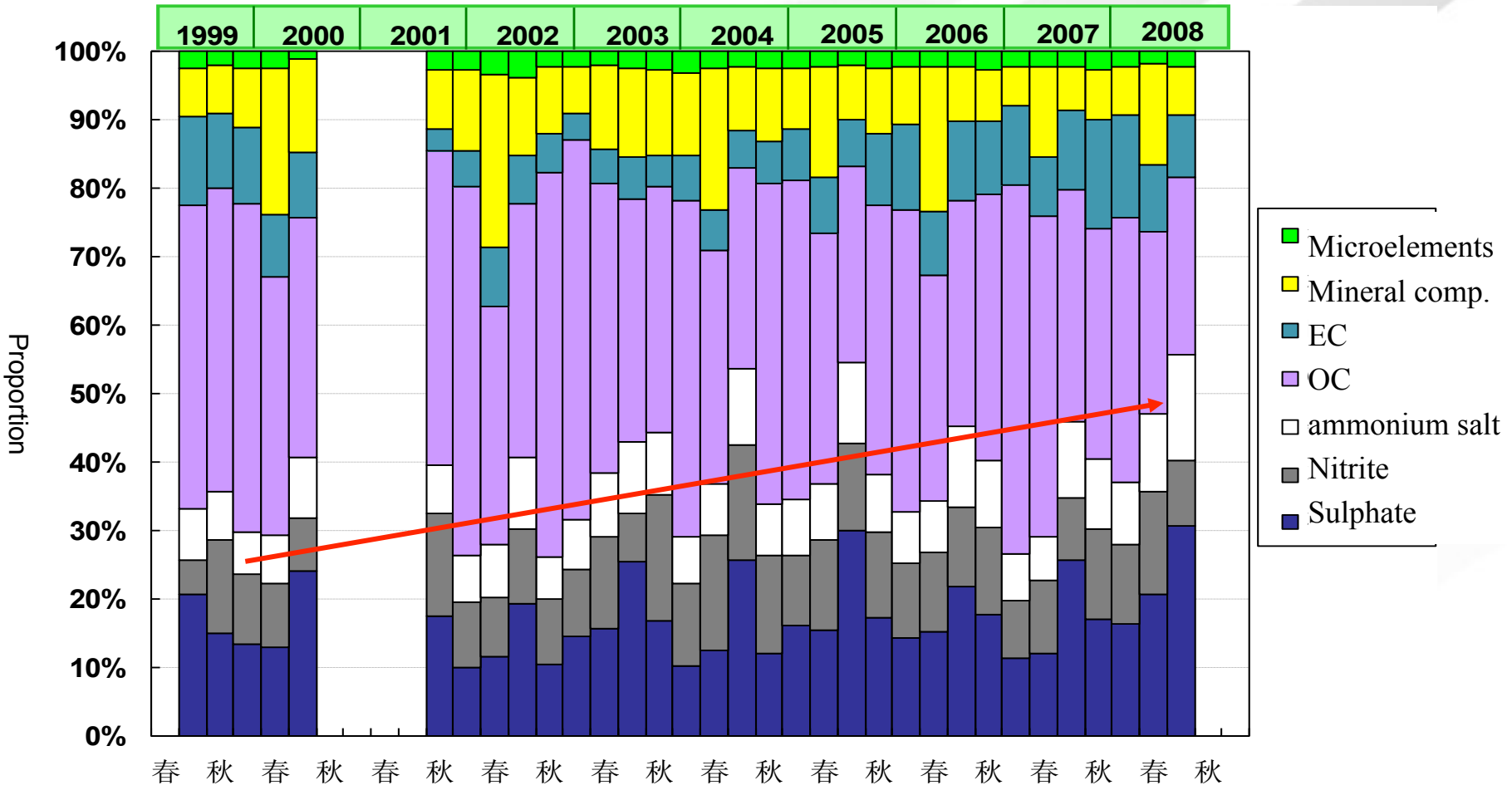
朱镕基总理12月8日所作的批示是：国务院完全支持北京市为控制大气污染所采取的紧急措施，国务院各部门和中央在京单位必须全力支持和严格遵守。希望北京市加大执法力度，切实监督执行，造福北京人民。

李岚清副总理12月6日所作的批示是：赞成北京市提出的控制北京大气污染的意见。大家对此都很关心。关键是要切实认真实施，对不认真实施的要有严格的惩治措施，要追究有关责任者的责任。我们许多政策、条例、办法、措施不能得到实施或不能得到很好实施，往往主要是由于缺乏认真的精神，严格的责任制度和可行的法制保证，希望注意一下这一问题。

北京市委书记、市长贾庆林指出，北京将严格执法，加强管理，动员广大群众参与。市政府决定与各区县政府和有关部门签订责任书，各部门、各单位要根据紧急通知要求，制定详细实施方案，把每一项目标、每一件工作、每一个细节都要搞得十分明确，指定责任单位、负责人和经办人，规定完成时限和奖罚办法，一丝不苟地抓好落实。市监察局要加大行政监察力度，对不认真贯彻《通知》要求、推诿扯皮的单位和领导，要严肃查处，追究责任，绝不姑息迁就。

国家环保总局局长解振华在大会发言中指出，北京是首都，北京市的环境质量如何，国内外都很关注。因此，北京市在环境保护工作上应在全国起到表率作用。北京环境污染治理工作是国务院确定的“三河、三湖、两区、一市”污染治理重点之一。国家环保总局将认真贯彻国务院的要求，把治理北京市的污染作为重要工作，在政策和管理上，给予全力支持。中央各部委和驻京

THU started to monitor the chemical composition of $PM_{2.5}$ since 1999.



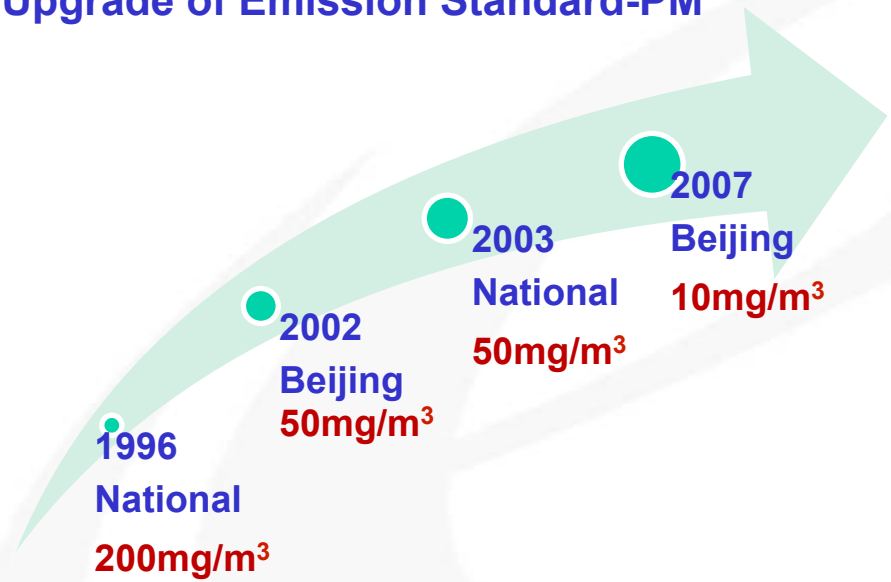
➢ The SNA and EC proportion to $PM_{2.5}$ in Beijing has been increasing.

Phase 3: 2000～2010

- Main source: Coal burning, industry, dust, vehicles
- Major pollutants: SO_2、TSP、NO_x、PM_{10}
- Air pollution problems: Smoke (coal burning), acid rain, haze/PM2.5, photochemical pollution, regional complex air pollution
- Scale of air pollution: Regional + global
- Air quality management: Single pollutant total amount control, coal burning emission control, point sources, local management with start of multi-pollutants management, trial of regional control in some key regions.
- Milestones：
  - ✓ 2000, amendment of air pollution law: total amount control in SO_2 and acid rain control zone, vehicle emission control, dust control
  - ✓ Total emission amount control of SO_2 was expanded to whole country
  - ✓ Regional corporation for Beijing Olympics, Guangzhou Asian Games and Shanghai Expo

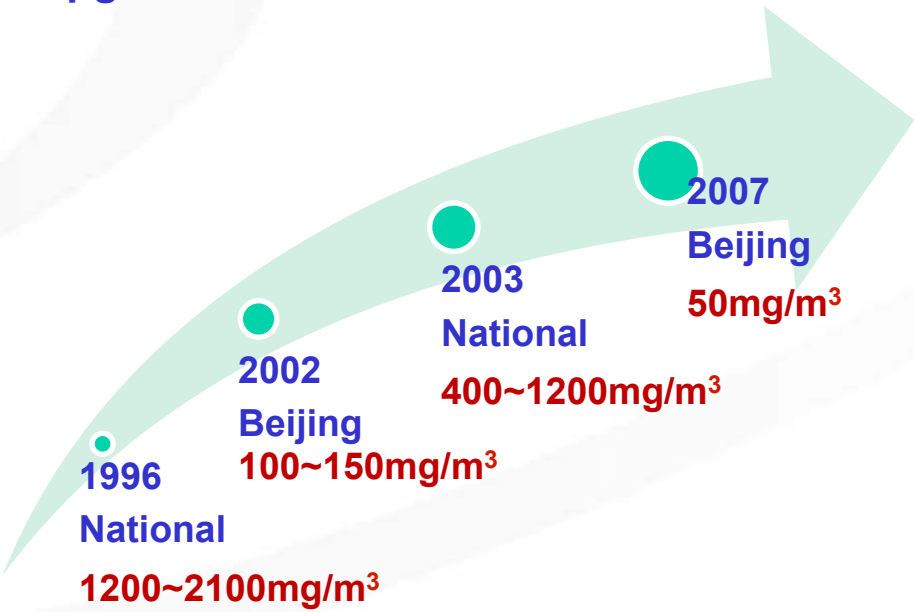
Emission Standards—Stationary Sources

Upgrade of Emission Standard-PM



Emission Standard of Air Pollutants for Thermal Power Plants
Dust emission limit of newly built, expanded and transformed boilers in China

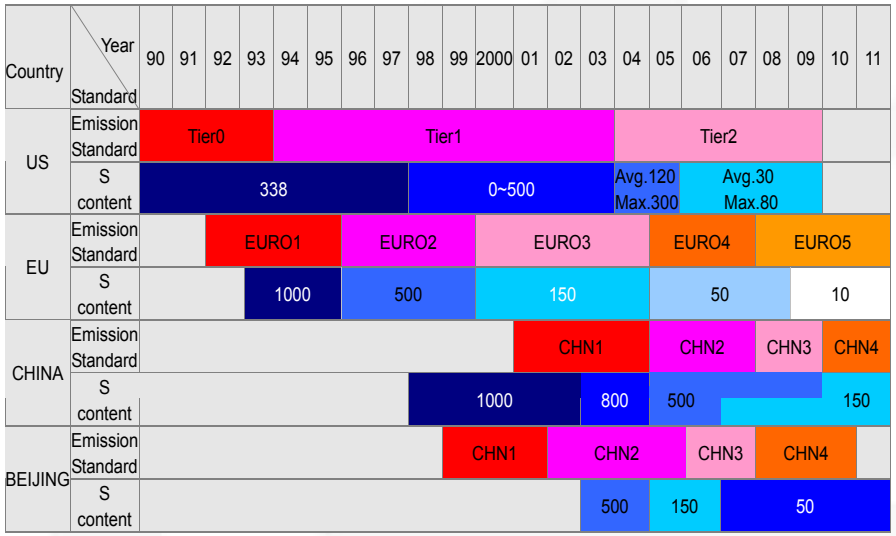
Upgrade of Emission Standard-SO2



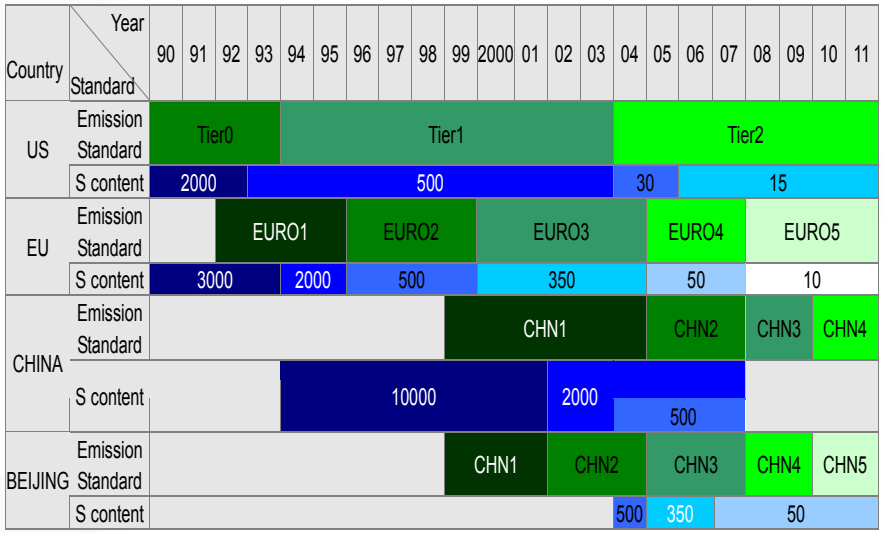
Emission Standard of Air Pollutants for Coal--Burning Oil-Burning Gas -Fired Boilers
Dust emission limit of newly built, expanded and transformed boilers in Beijing

Emission Standards—Vehicle Sources

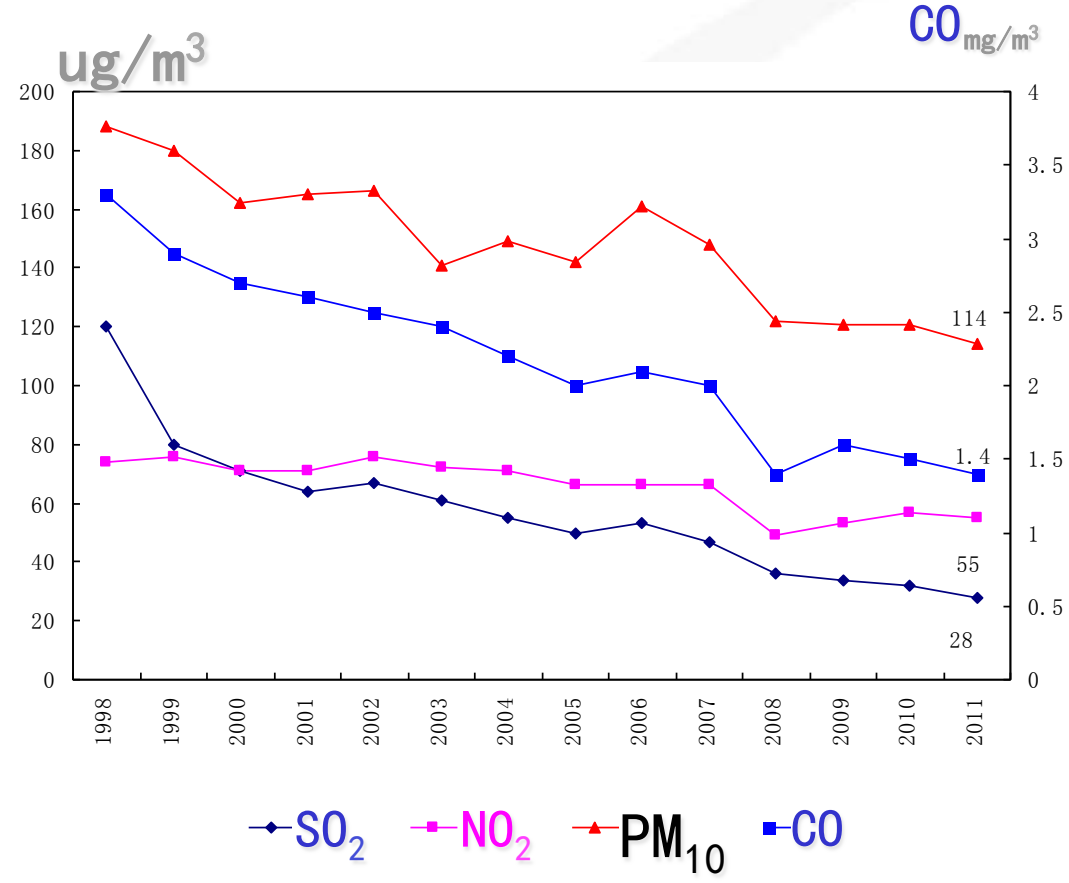
Emission standards for gasoline vehicles



Emission standards for diesel vehicles



Air quality Improved with Socio-economic Development in Beijing

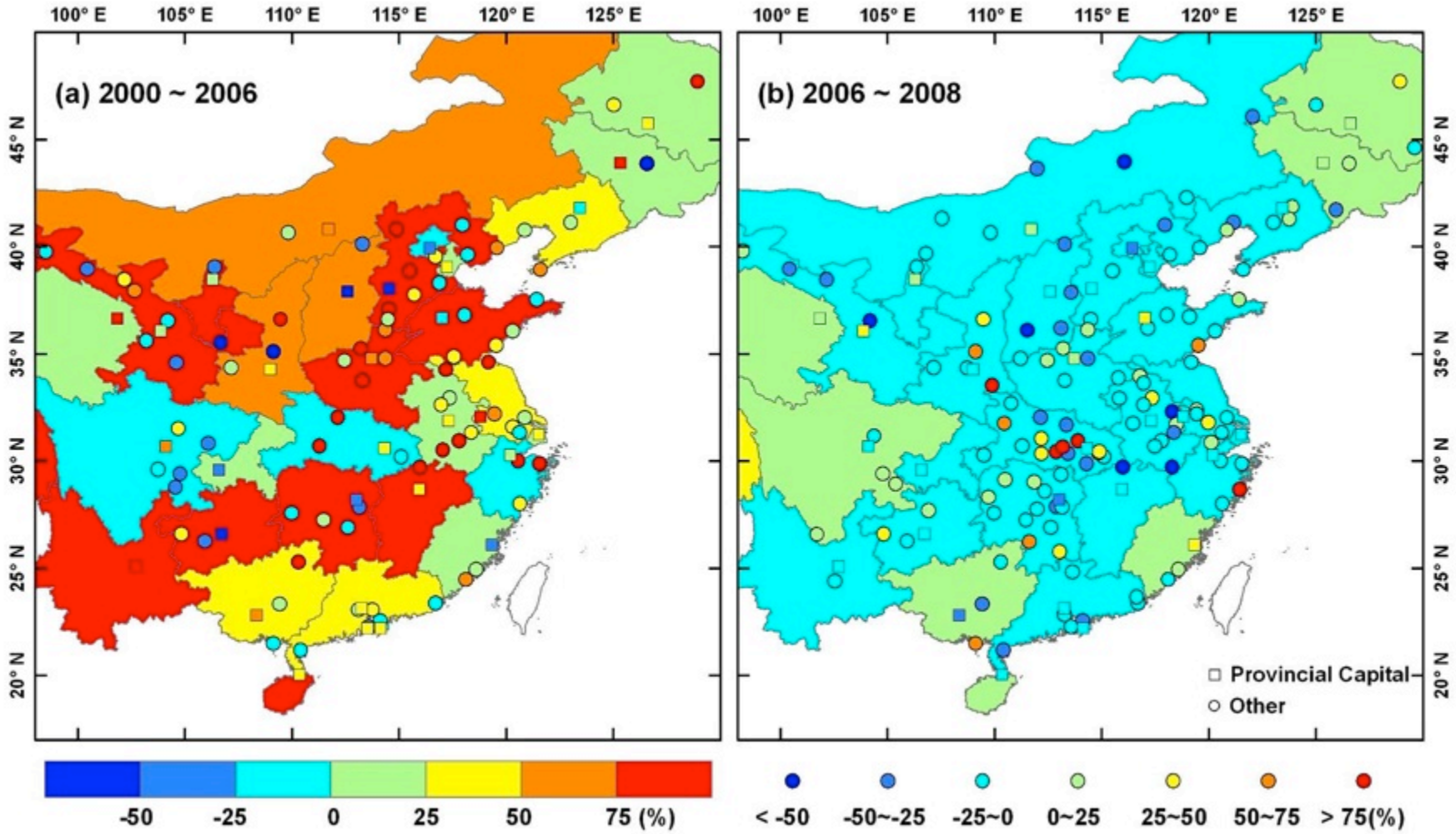


With the efforts of air pollution treatment in past years, concentrations of main pollutants are declining:

- ✓ SO_2:↓77%
- ✓ NO_2: ↓26%
- ✓ PM_{10}: ↓39%
- ✓ CO: ↓58%

However, there is still a gap between air quality and public expectation.

SO_2 Emission and Concentration in China

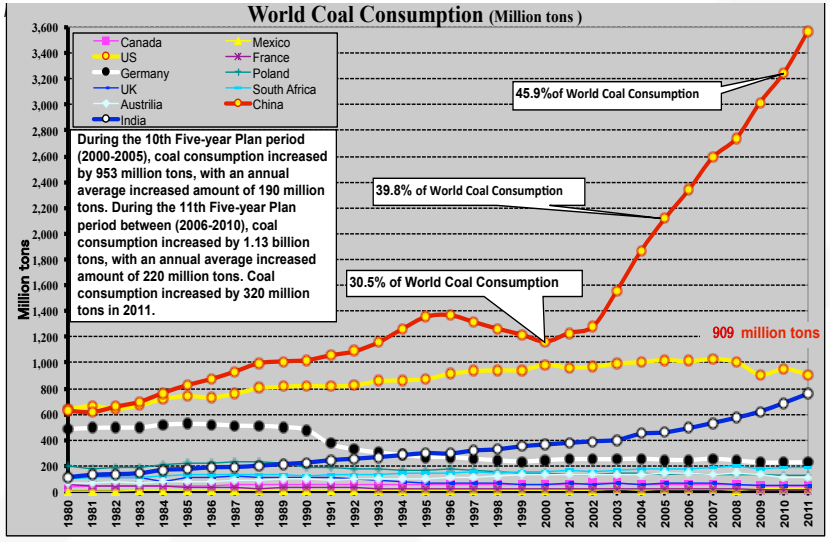


The percentage change of SO_2 emission (provinces) and SO_2 concentrations (cities) in China.

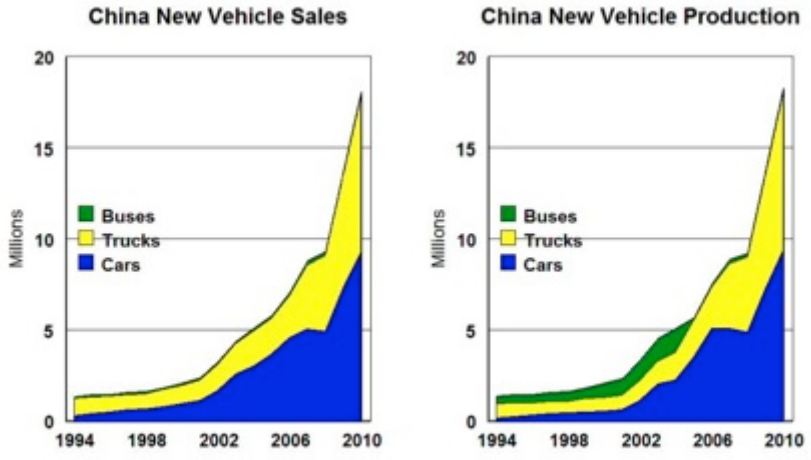
Lu et al., ACP, 2010

Rapid Industrialization in China

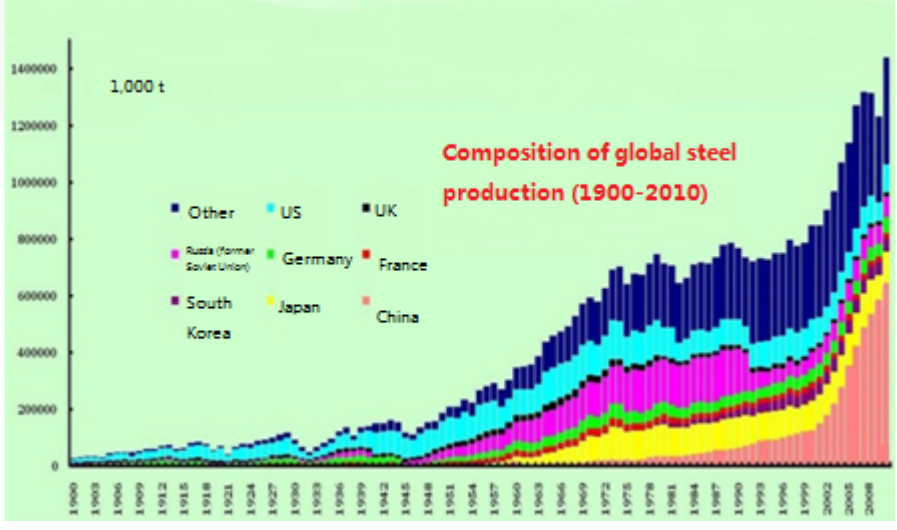
Energy Consumption



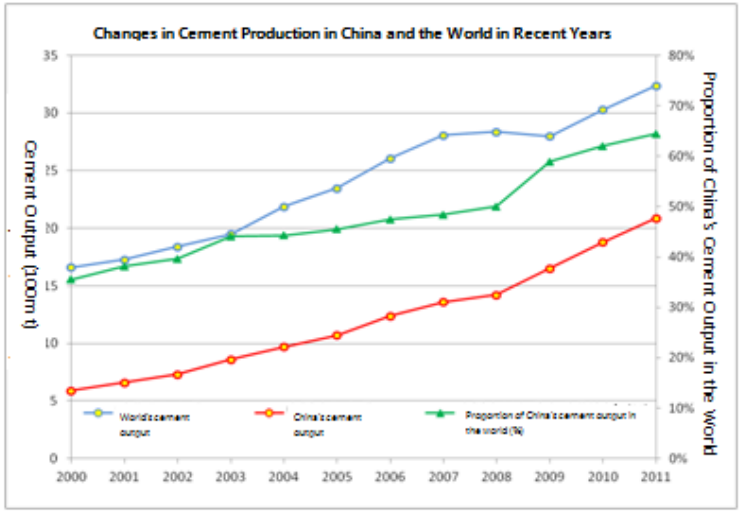
Vehicle Population



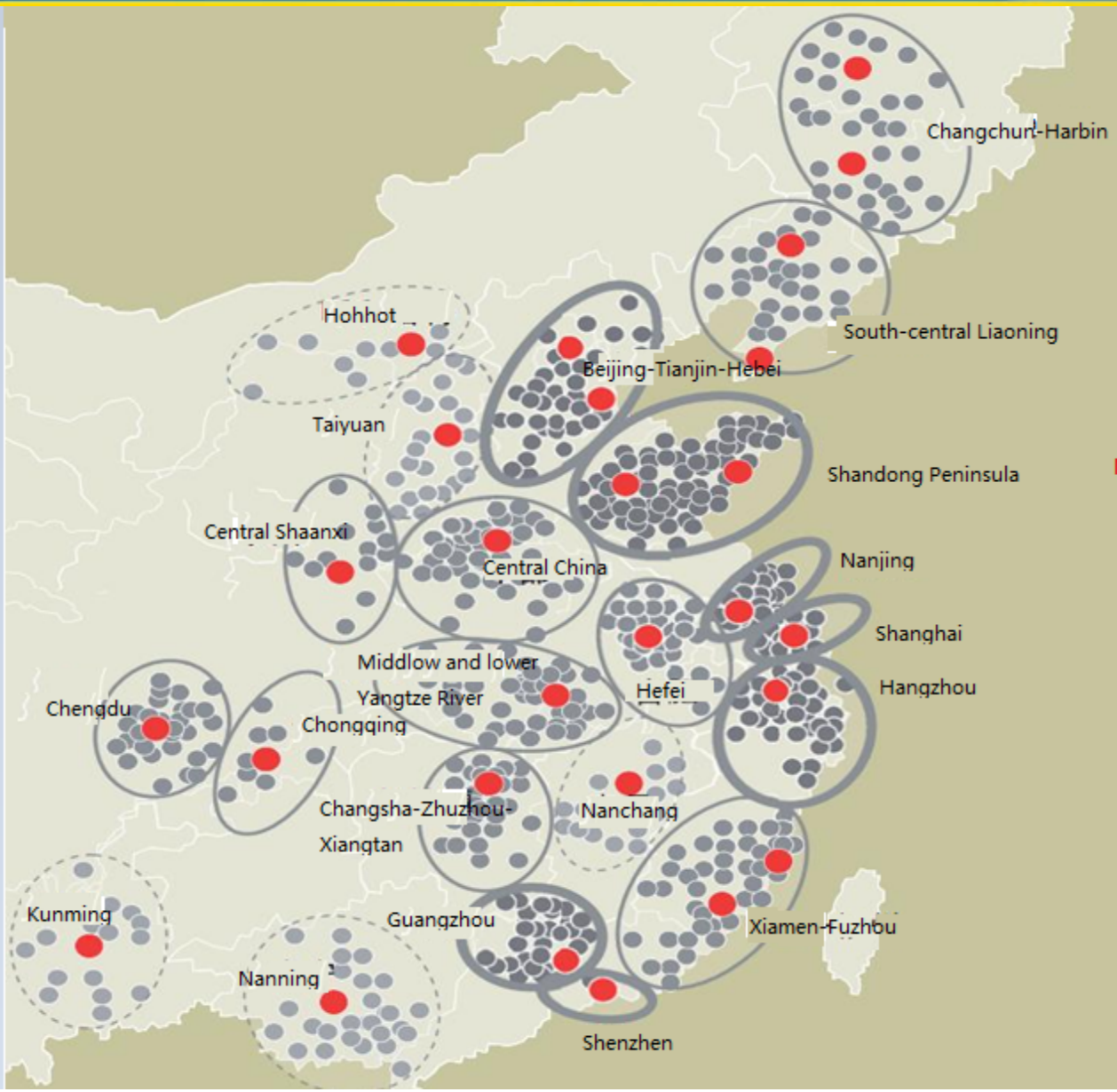
Steel Production



Cement Production

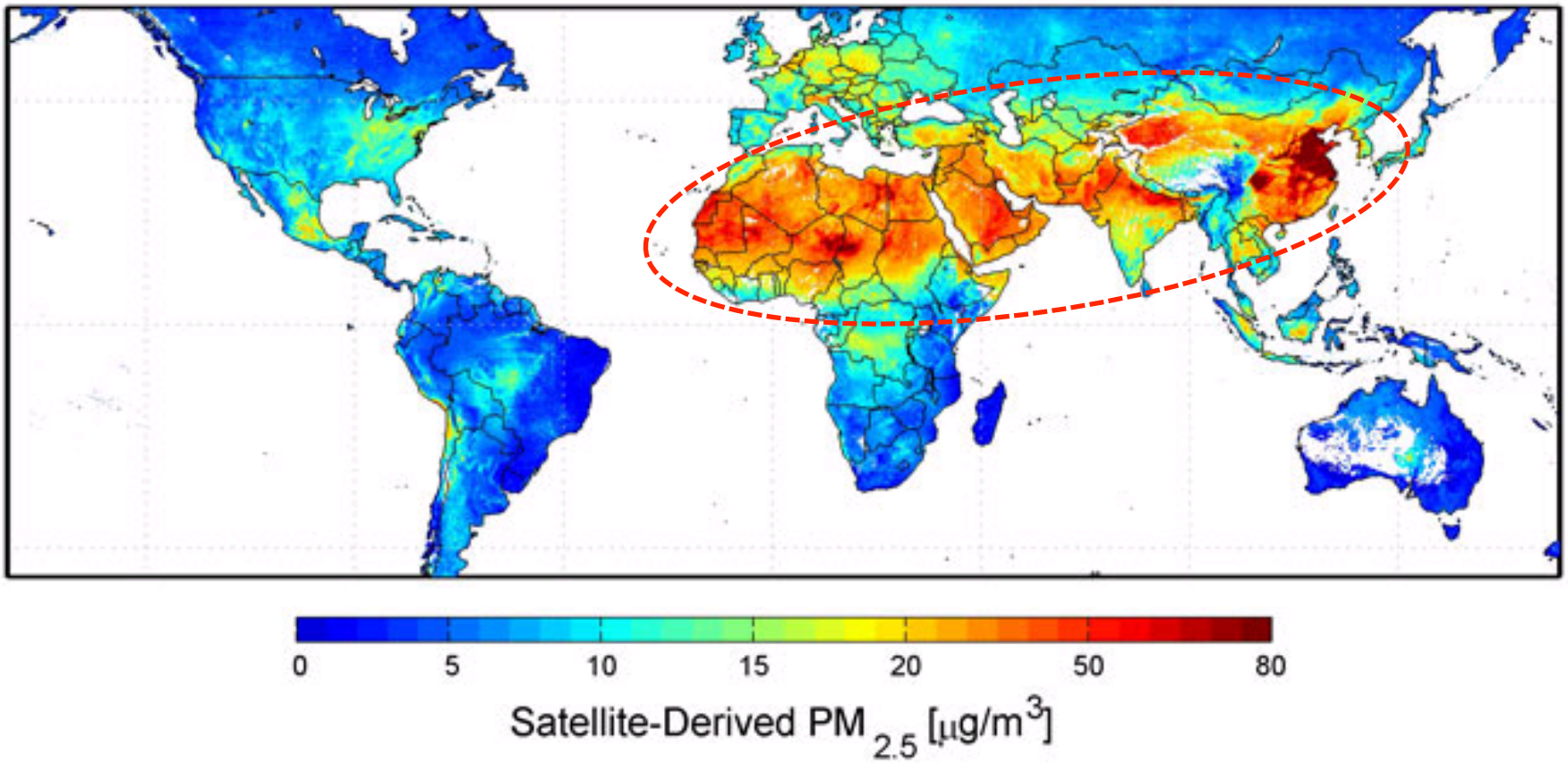


Rapid Urbanization in China



Name of city group Number of cities	City group GDP	Hub city GDP
Large city group		
Beijing-Tianjin-Hebei (37)	10.8%	7.9%
Shanghai (19)	10.8%	6.2%
Shandong Peninsula (67)	9.0%	2.1%
Hangzhou (38)	6.7%	1.6%
Guangzhou (24)	6.6%	2.6%
Nanjing (27)	4.8%	1.8%
	4.3%	2.9%
Medium city group		
South-central Liaoning (30)	4.3%	2.4%
Xiamen-Fuzhou (42)	4.2%	1.4%
Middle and lower Yangtze River (42)	4.0%	1.8%
Central China (40)	3.8%	0.7%
Changchun-Harbin (36)	3.6%	1.6%
Chengdu (29)	3.2%	1.6%
Hefei (29)	2.8%	0.8%
Changsha-Zhuzhu-Xiangtan (28)	2.2%	0.8%
Central Shaanxi (15)	1.9%	1.2%
Chongqing (6)	1.8%	1.5%
Small city group		
Nanning (28)	1.8%	0.3%
Nanchang (22)	1.7%	0.6%
Taiyuan (19)	1.4%	0.5%
Hohhot (10)	1.3%	0.4%
Kunming (16)	1.1%	0.5%

$PM_{2.5}$: 2001-2006



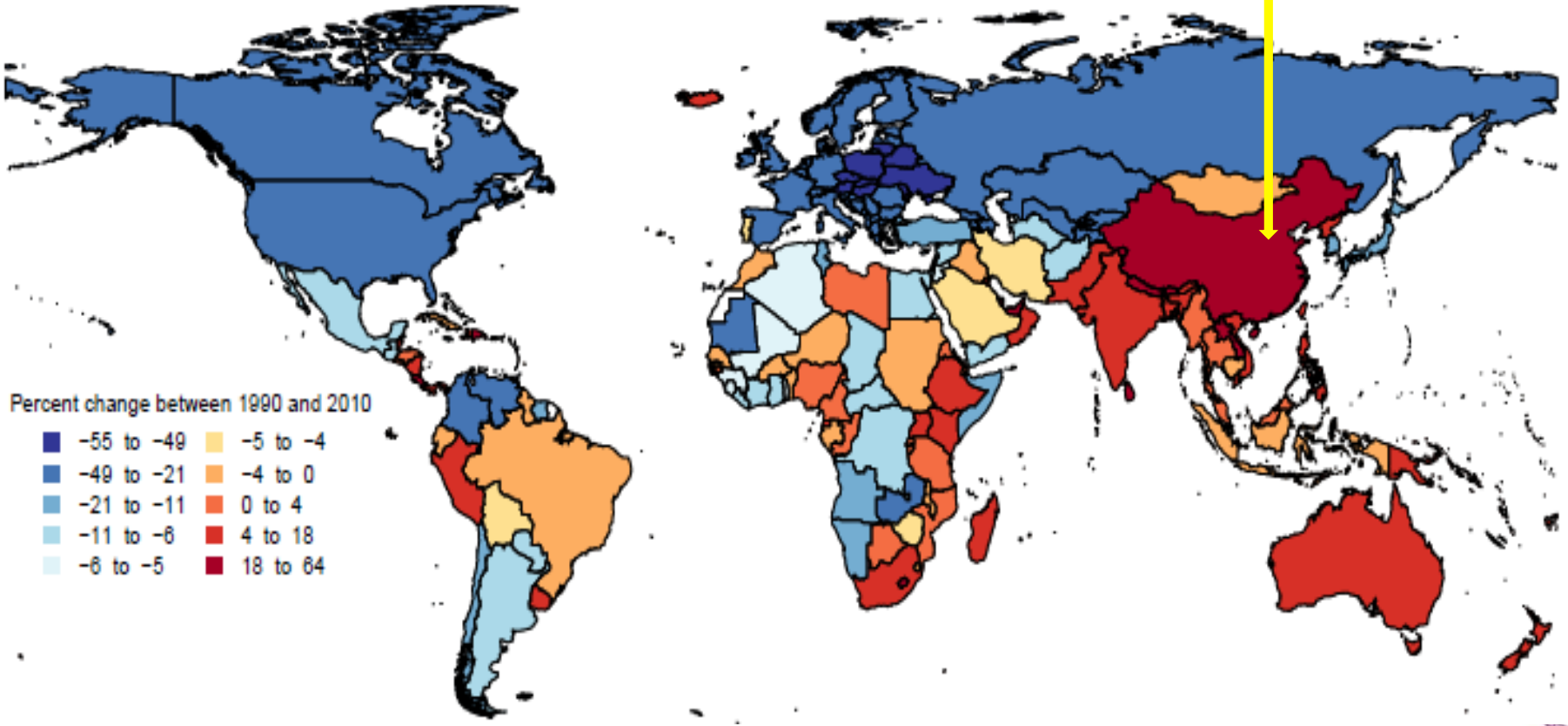
van Donkelaar et al., *Environmental Health Perspectives* 2010

http://www.nasa.gov/topics/earth/features/health-sapping.html

$PM_{2.5}$ concentration trends in ambient air: 1990-2010

1990 to 2010:$PM_{2.5}$ increased 10% globally by population -weighted estimation

1990 to 2010: $PM_{2.5}$ increased 50% by population-weighted estimation in China



Air quality in Chinese cities in the global prospective

- According to the report released by the World Bank in 2012, the health losses of diseases and pre-mature death of the public triggered by PM_{10} pollution in 2009 accounted for 2.8% of GDP.

- In 2011, the WHO released the air quality report of world cities with PM_{10} as the major factor which showed that Beijing ranked 1,035th among 1,082 cities and Haikou, a city with sound air quality in China, ranked behind the 800th position.

- In May 2014, WHO released “Ambient (outdoor) air pollution in cities database 2014” containing results of ambient (outdoor) air pollution monitoring from almost 1600 cities in 91 countries. Among the 100 cities with the highest $PM_{2.5}$ concentration, 9 cities are from China: Lanzhou, with worst air quality in China , ranked the 36th; while the capital city Beijing ranked the 77th. Haihou, with the best air quality in China, came in 674 on the list.

Air Pollution Control in China: Efforts since 2010

China's Strategic Targets

The Ministry of Environment Protection of China and the Chinese Academy of Engineering jointly completed the Studies on China's Macro Environment Strategy from 2007 to 2009, a critical project that summarizes the past, guides the present work, and plans the future.

Overall atmospheric environment protection target by 2050:

Through comprehensive air pollution control, China works to greatly reduce the concentration of various pollutants in the air, significantly improve air quality in cities and major regions, fully reach national air quality standards, basically realizes the concentration standard for ambient air quality of the World Health Organization (WHO) , and meet the requirement for public health and ecological safety. (China hopes to integrate with the standard system of the WHO.)

Integrate SO_2 and NO_X Emission into the Obligatory Targets in the 12th FYP

	SO_2 (million tons)	NOx (million tons)
Emission in 2010	22.08	21.57
Projected increment emission (2010-2015)	4.17	5.34
Increased emission reduction capacity (2010-2015)	5.97	7.6
Proportion of emission reduction (2010-2015)	8%	10%

Environment Standards Optimized, Industries Upgraded and Emission Limits

Evolution of emission standards of China's coal-fired power plants

1996
China
SO_2:1200-2100mg/m^3
NOx:650-1000mg/m^3
PM: 200mg/m^3

2003
China
SO_2: 400-1200mg/m^3
NOx:450-1000mg/m^3
PM: 50mg/m^3

2011
China
SO_2:200mg/m^3
NOx:100-200mg/m^3
PM: 30mg/m^3

2014
Key Regions
SO_2:50 mg/m^3
NOx:100 mg/m^3
PM: 20 mg/m^3

Ambient Air Quality Standards (GB3095-2012)

Attachment

ICS 13.040.20
Z 50

National Standard of the People's Republic of China

GB 3095—2012
Replace GB 3095—1996 GB 9137—88

Ambient air quality standards

This electronic edition is a release version. Please subject to the formal standard text published by China Environmental Science Press.

Released on Feb. 29, 2012 Effective as of Jan. 1, 2016

Ministry of Environment Protection
The State Administration of Quality Supervision,
Inspection and Quarantine

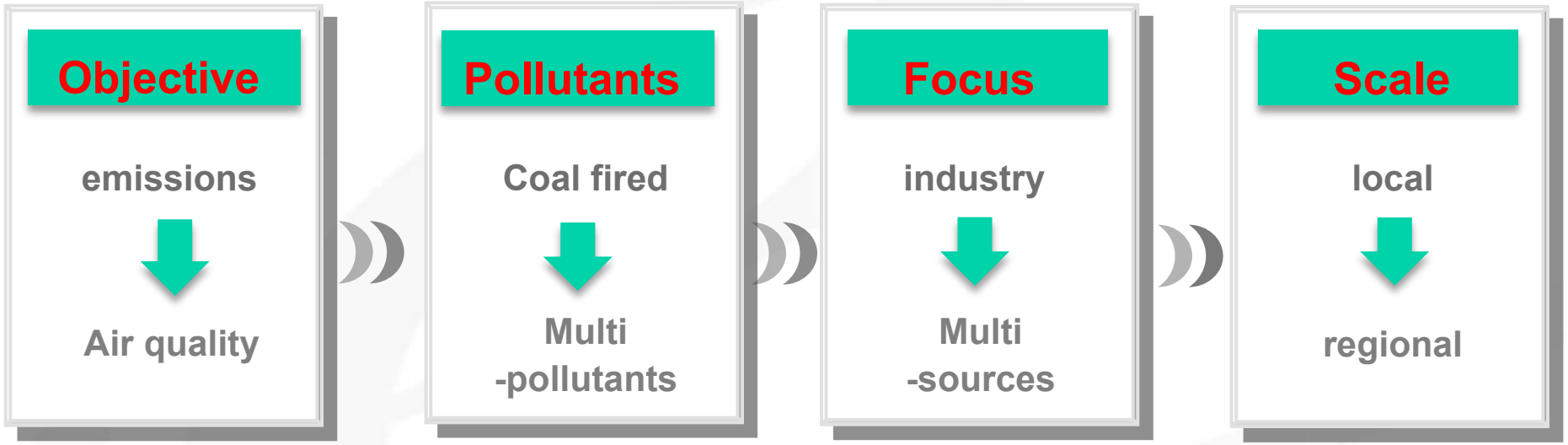
Table 1 Concentration Limits of Basic Ambient Air Pollutants

SN	Pollutants	Average time	Concentration Limit		Unit
			Level 1	Level 2	
1	Sulfur dioxide (SO_2)	Yearly Average	20	60	μg/m³
		Daily average	50	150	
		Hourly average	150	500	
2	Nitrogen dioxide (NO_2)	Yearly Average	40	40	
		Daily average	80	80	
		Hourly average	200	200	
3	Carbon monoxide (CO)	Daily average	4	4	μg/m³
		Hourly average	10	10	
4	Ozone (O_3)	Average maximum in 8 hrs per day	100	160	μg/m³
		Hourly average	160	200	
5	Particulate matter (grain size less than	Yearly Average	40	70	
	or equal to 10 um)	Daily average	0	150	
6	Particulate matter (grain size less than or equal to 2.5 um)	Yearly Average	15	35	
		Daily average	35	75	

Table 2 Concentration Limits of Other Ambient Air Pollutants

SN	Pollutants	Average time	Concentration Limit		Unit
			Level 1	Level 2	
1	Total suspended particulates (TSP)	Yearly average	80	200	μg/m³
		Daily average	120	300	
2	Nitrogen oxide (NO_x)	Yearly average	50	50	
		Daily average	100	100	
		Hourly average	250	250	
3	Lead (Pb)	Yearly Average	0.5	0.5	
		Quarterly average	1	1	
4	Benzo-a-pyrene (BaP)	Yearly Average	0.001	0.001	
		Daily average	0.002 5	0.002 5	

Four Strategic Turning Points for Implementation of Air Pollution Control

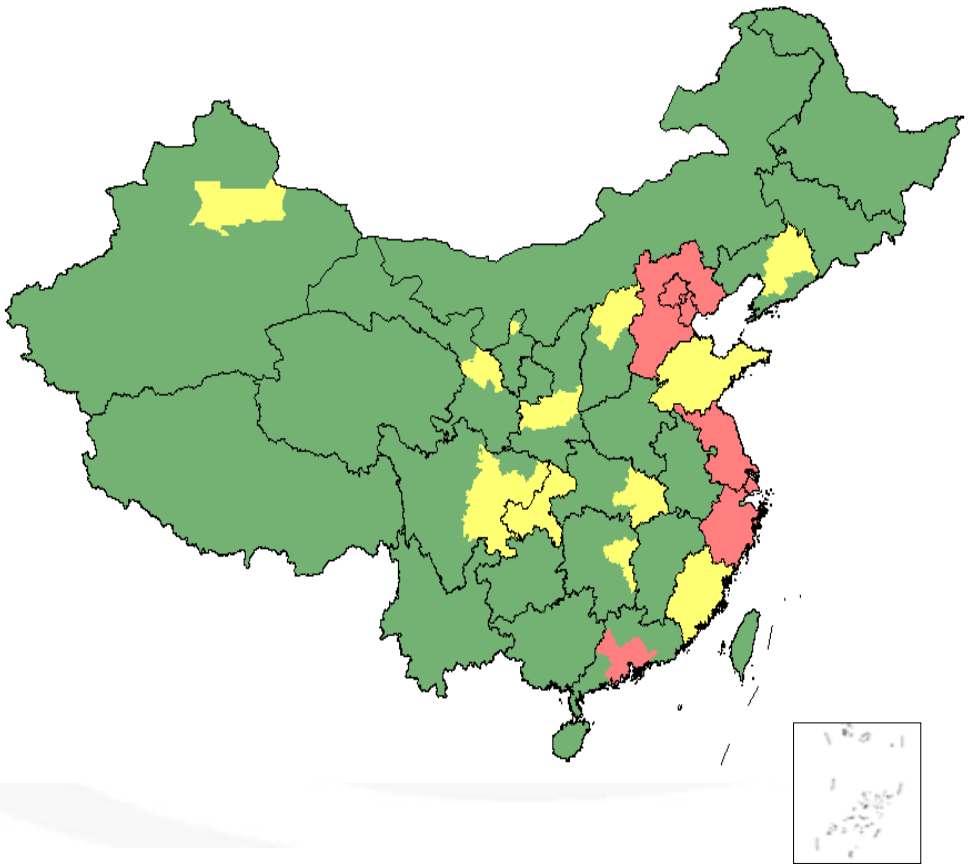


- Milestones：

  two critical documents issued by State Council

  - ✓ 2012, the *12th FYP on air pollution control for key regions* heralds the four turning points for the first time.
  - ✓ 2013, the *action plan of air pollution control* indicates a new air quality management after the four turning points.

The 12th FYP on Air Pollution Control for Key Regions



3 regions and 10 city clusters

1.Beijing-Tianjin-Hebei
2.Yangzi river delta
3.Pearl river delta
4.Middle Liaoning
5.Shandong
6.Wuhan region
7.Changsha-Zhuzhou-Xiangtan
8.Chengdu-Chongqing
9.The west coast of the Taiwan Straits
10.North Shanxi
11.South Shaanxi
12.Gansu-Ningxia
13.Urumuqi

- **Totally 13 regions, including 19 provinces, 117 cities, 1.3256 km^2**
- **Emission intensity is 2.9-3.6 times higher than national average**
- **82% cities are non-attainment, according to the new air quality standard**
- **Complex air pollution, including $PM_{2.5}$、O_3**

Planning Targets of Key Regions

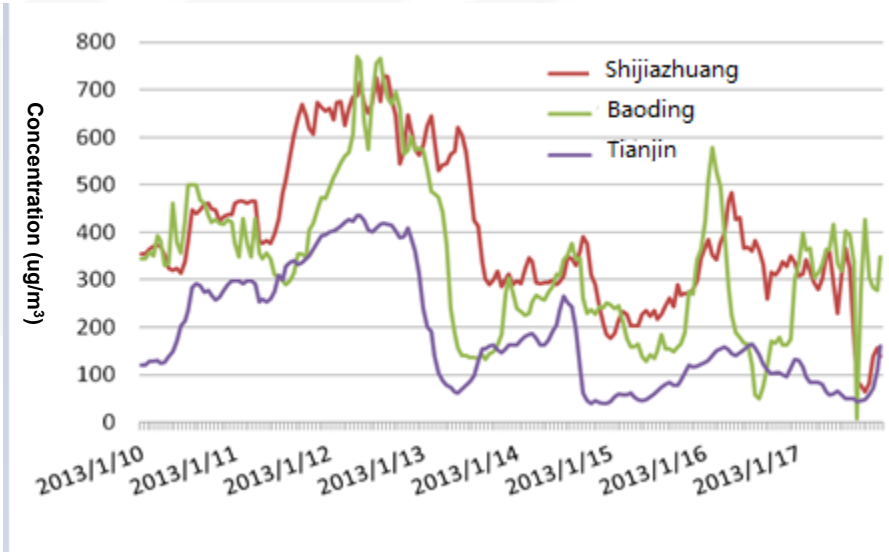
Focus on both emission reduction and air quality

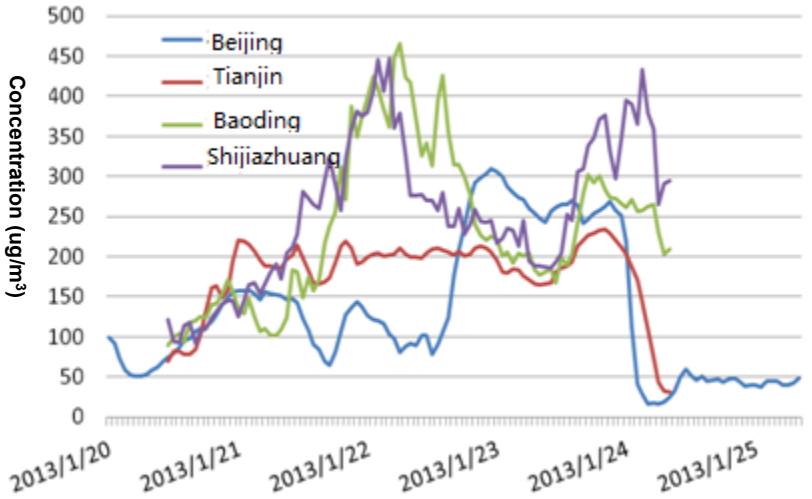
Category		Index	Value
Air quality	1	Annual SO_2 reduction	10%
	2	Annual NO_2 reduction	8%
	3	Annual PM_{10} reduction	10%
	4	Annual $PM_{2.5}$ reduction	5%
	5	O_3 non-attainment days reduction	5%
Emission control	6	SO_2 emission reduction	12%
	7	NO_x emission reduction	13%
	8	Dust emission reduction	10%
	9	VOCs emission reduction (key sectors)	14%

China Regional Haze Pollution Episodes January

Jan. 2013: features

1300 thousands km^2	In some region, it lasts 3 weeks	$PM_{2.5}$ concentration is higher than the instrument max	850 million people exposed





Action Plan on Prevention and Control of Air Pollution or Ten Measures from the State Council : Breakthrough in AQ management

A milestone: Air Pollution Prevention and Control Action Plan

The first air pollution prevention and control action plan at state-level

The first action plan aiming at improving $PM_{2.5}$ concentration in ambient air

The first action plan aiming at improving ambient air quality (on the basis of risk analysis)

Objectives and principals

1. Accelerate AQ improvement: An enhanced plan based on current 12th FYP to make greater change

2. Highlight the key regions: Higher target for key regions (Beijing-Tianjin-Hebei, YRD , PRD)

3. Differentiate the priorities: $PM_{2.5}$ for the key regions, and PM_{10} for the other

Top-level Design at the Height of National Strategy

Objectives:

After 5 years of commitment, the number of days under heavy pollution would be significantly reduced, nationwide air quality would be improved, air quality in Beijing-Tianjin-Hebei, YRD, PRD and other regions would be evidently improved.

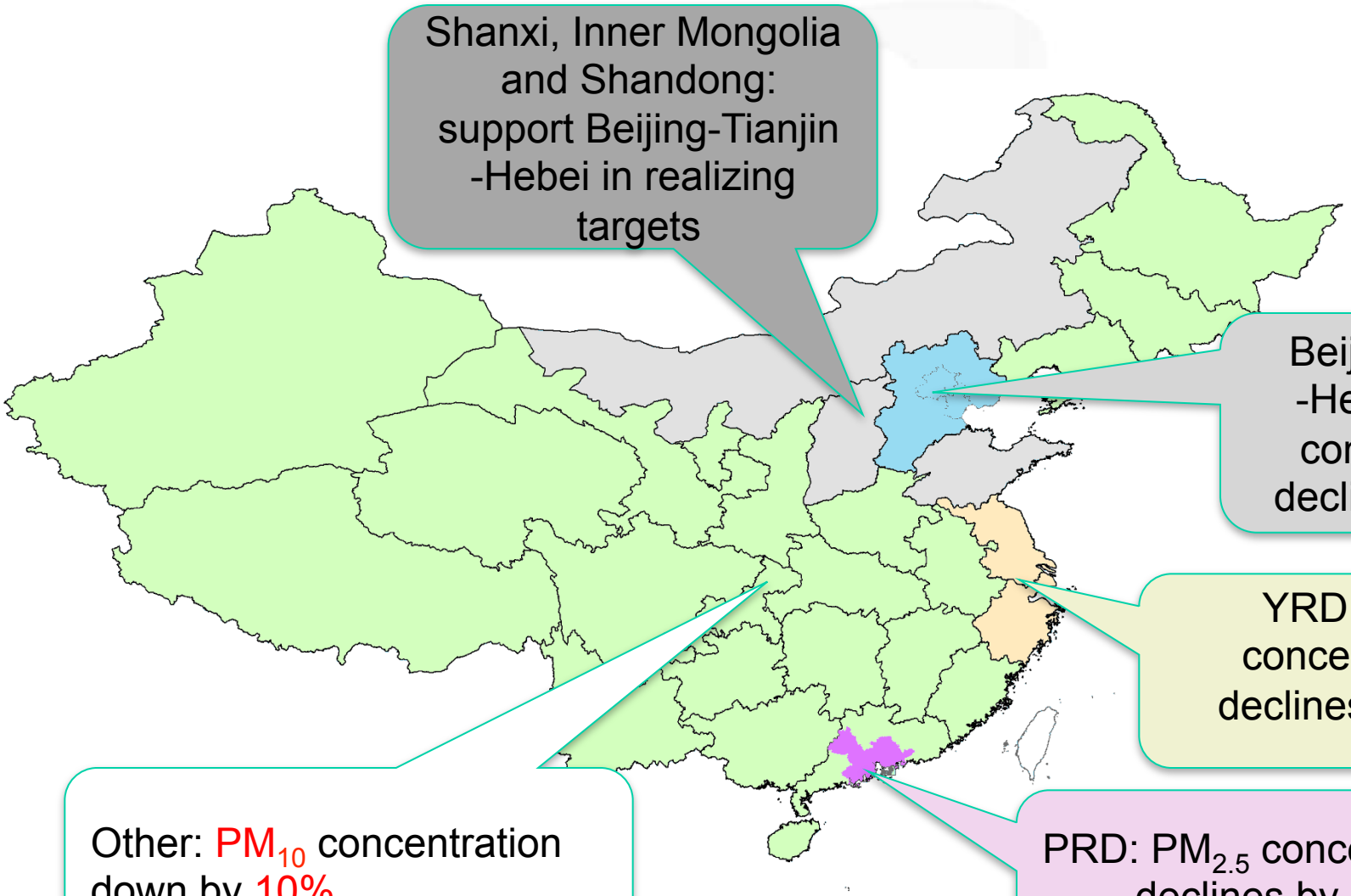
Heavy pollution weather would be basically eliminated and nationwide air quality evidently improved in another 5 years.

Indicators:

by 2017, PM_{10} concentration in prefecture cities and above across the country would be down by more than 10% based on the 2012 level and the number of fine days would be increased year by year.

Concentration of PM in Beijing-Tianjin-Hebei, YRD, PRD and other regions would decrease by more than 25%, 20%, and 15% respectively based on the 2012 level, and average annual concentration of PM would be controlled at about 60μg/m3 in Beijing.

Region-Cased Control



Shanxi, Inner Mongolia and Shandong: support Beijing-Tianjin -Hebei in realizing targets

Beijing-Tianjin -Hebei: $PM_{2.5}$ concentration declines by 25%

YRD: $PM_{2.5}$ concentration declines by 20%

PRD: $PM_{2.5}$ concentration declines by 15%

Other: PM_{10} concentration down by 10%

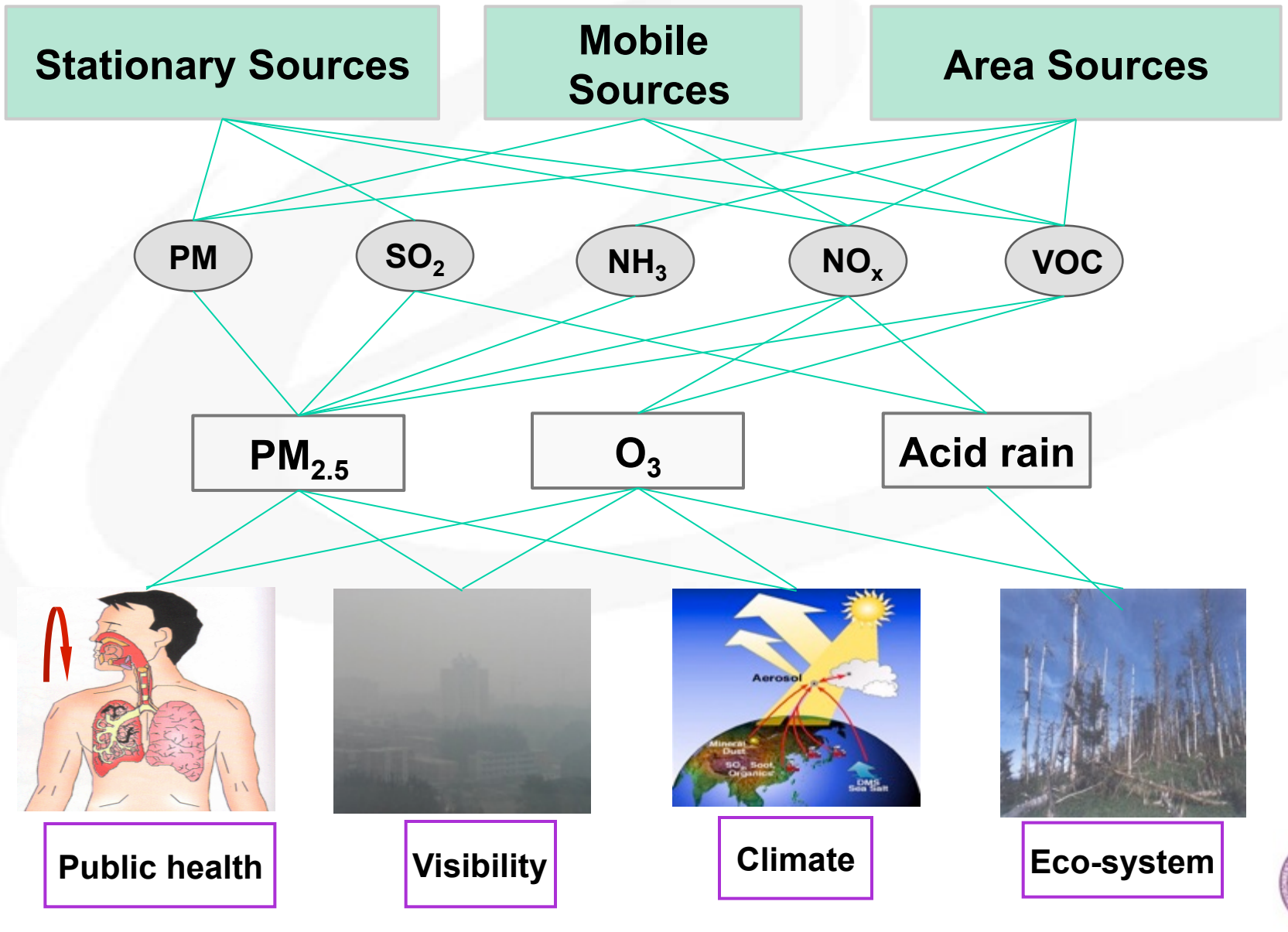
Important Factors of Air Pollution

Accelerate industrial restructuring

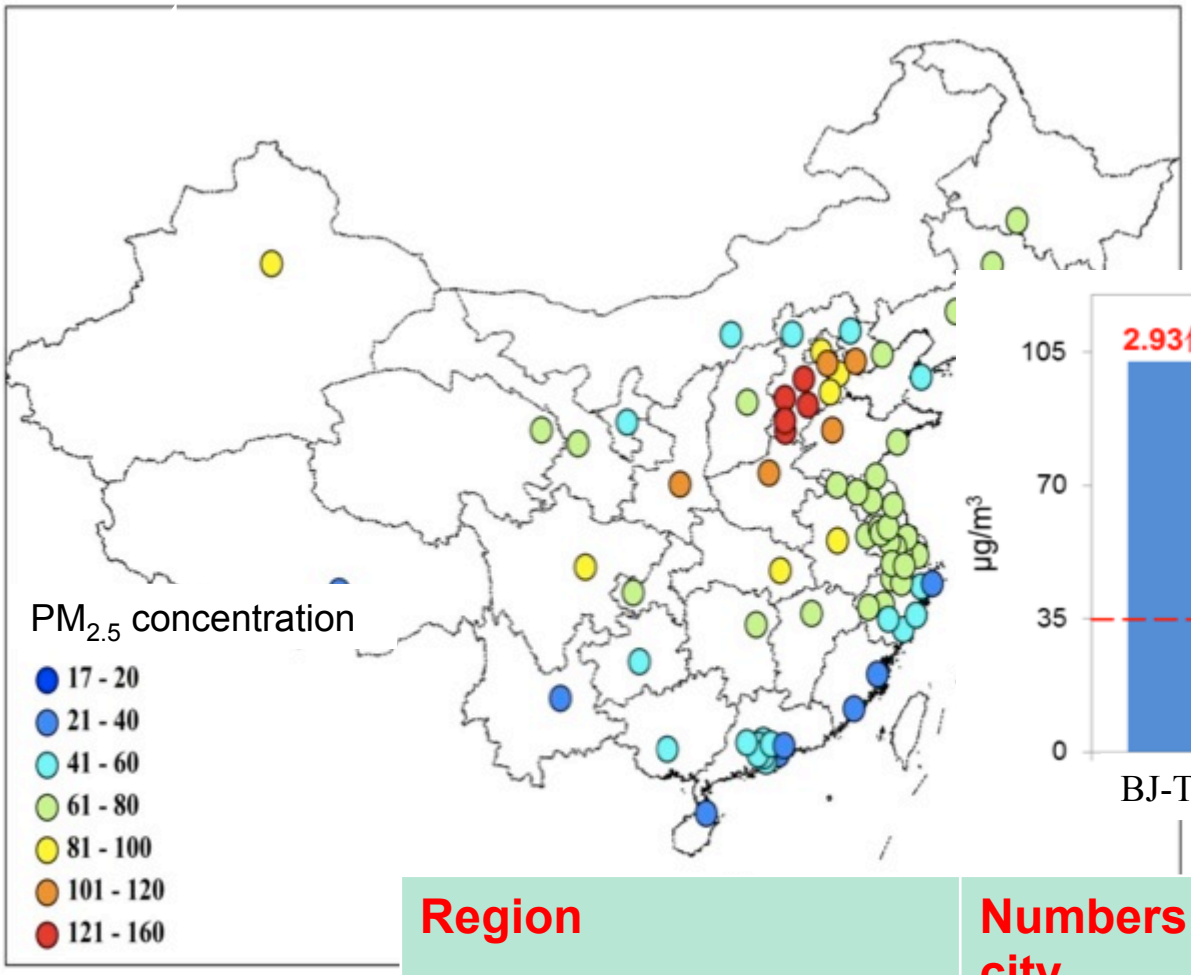
Speed up clean energy utilization

Tighten vehicle emission control

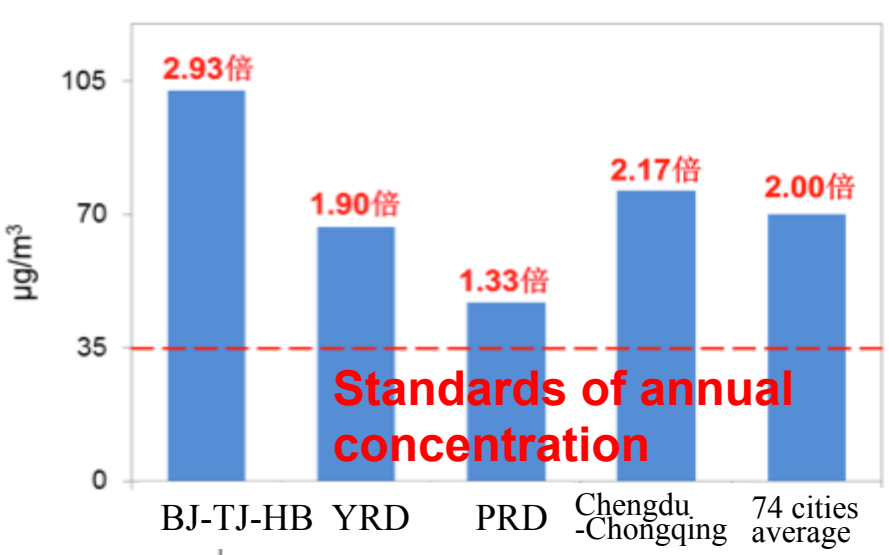
Co-control of Multi-pollutants



Accelerate the construction of $PM_{2.5}$ concentration monitoring



Monitoring results of 74 key cities in 2013



Region	Numbers of city	Average blue sky days
Beijing-Tianjin-Hebei	13	37.5%
YRD	25	64.2%
PRD	9	76.3%

Regional Coordination Mechanism in Beijing-Tianjin-Hebei and YRD

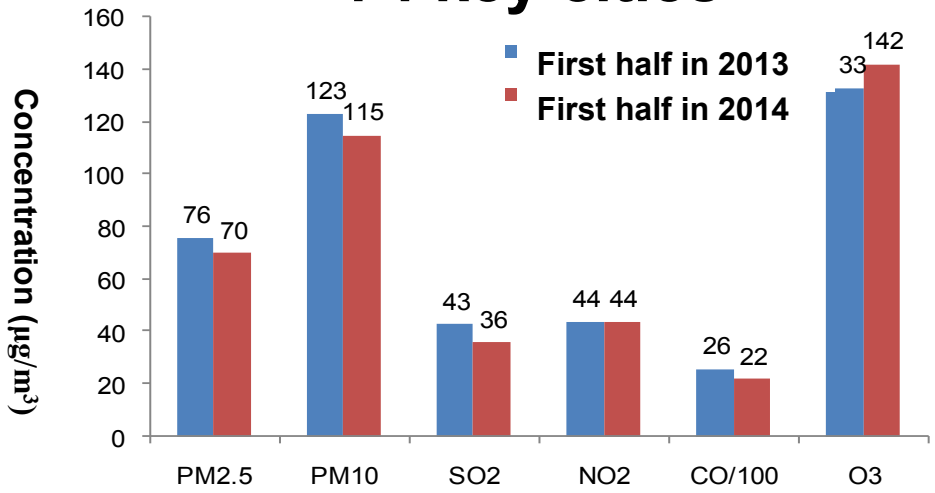
Departments of the State Council

Provincial governments

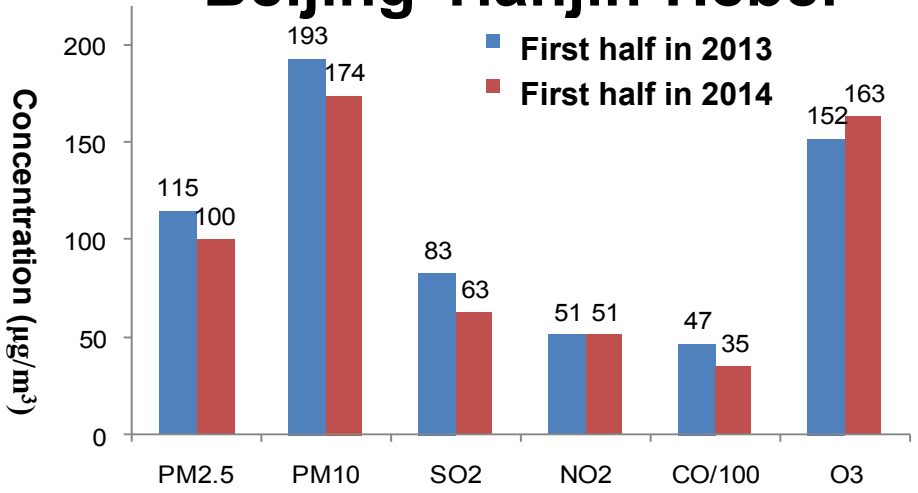
- Address evident regional environmental issues in a coordinated manner
- Organize environmental assessment conference, joint law enforcement by environmental and other departments , information sharing, early warning and emergency treatment, among other works
- Report on work progress
- Clearly define periodical work requirements, priorities and major tasks.

The control effect has been shown: Air quality in first half in key cities

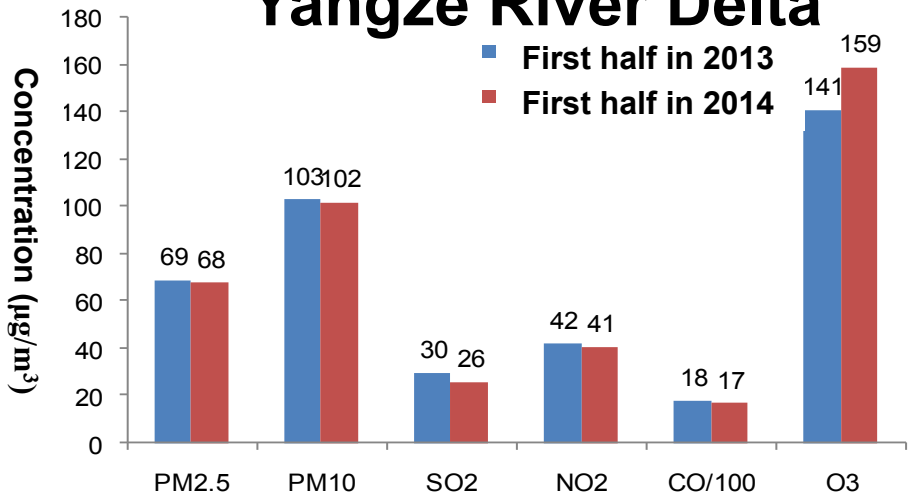
74 key cities



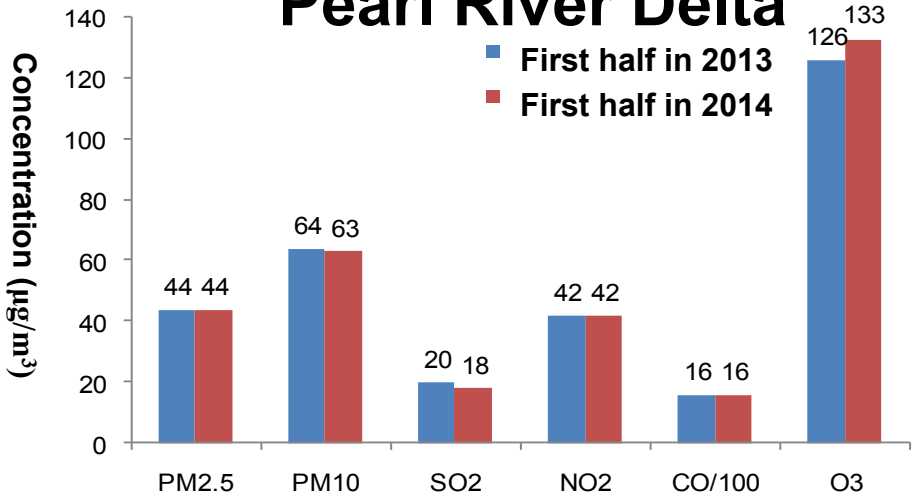
Beijing-Tianjin-Hebei



Yangze River Delta



Pearl River Delta



➢Note: PM_{10}、$PM_{2.5}$、SO_2、NO_2 concentrations are averaged data by six months; CO concentration is the 95th percentile of 大daily average; O_3 concentration is the 90th of daily max 8-hour average.

Air pollution control in China:

Perspectives

Requiring Great Efforts to Achieve Goals

- **In order to achieve targets, the degree of emission reduction of multiple pollutants is much larger than ever.**

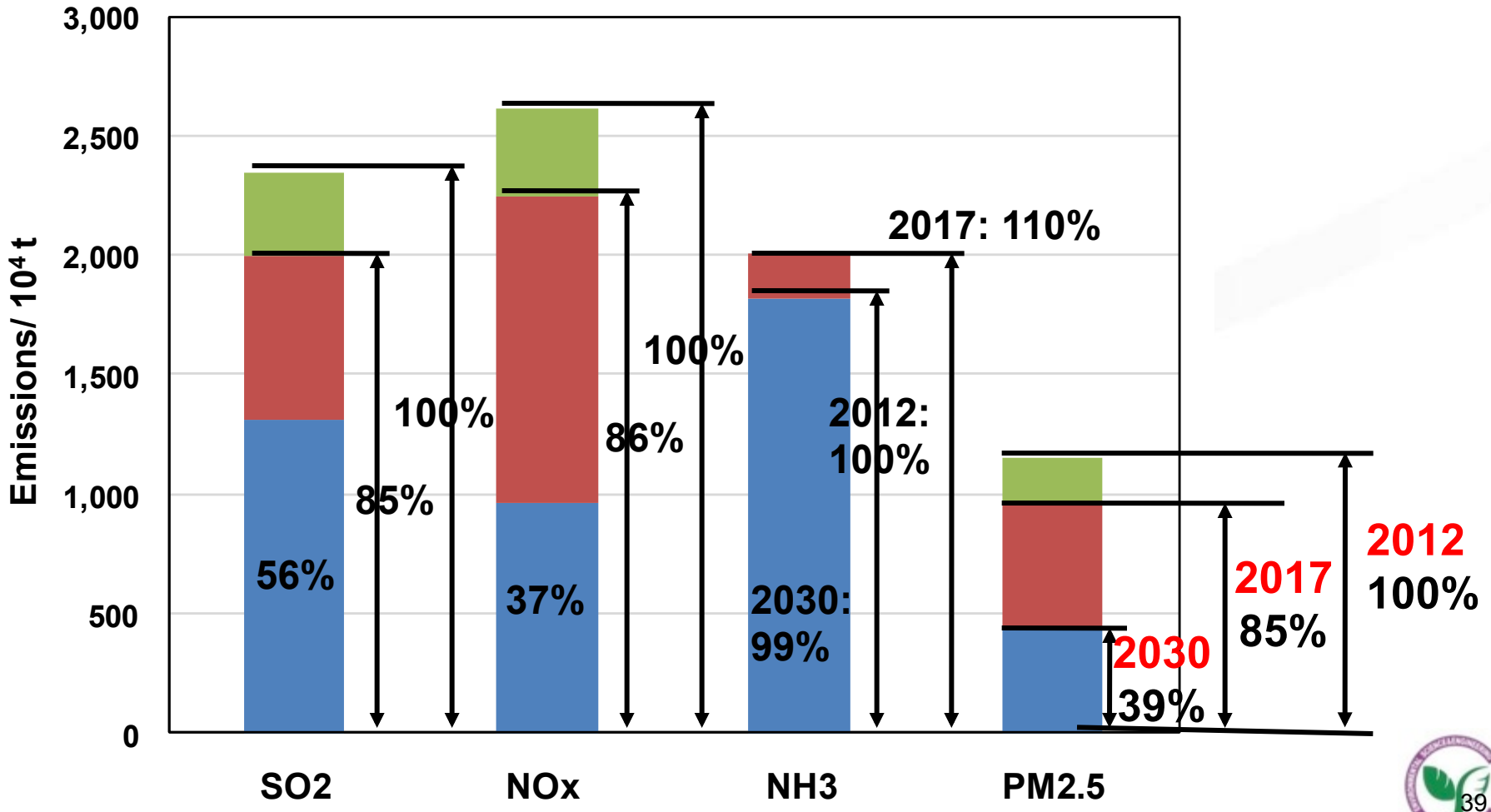
Comparison of percentage of pollutants emission reduction targets

	SO_2	NO_X	PM	VOCs
(To guarantee) action plan	>15%	>20%	>20%	>7%
12th FYP	>8%	>10%	N/A	N/A
11th FYP	>10%	N/A	N/A	N/A

- **The proportion of emission reduction is higher for three major regions.**

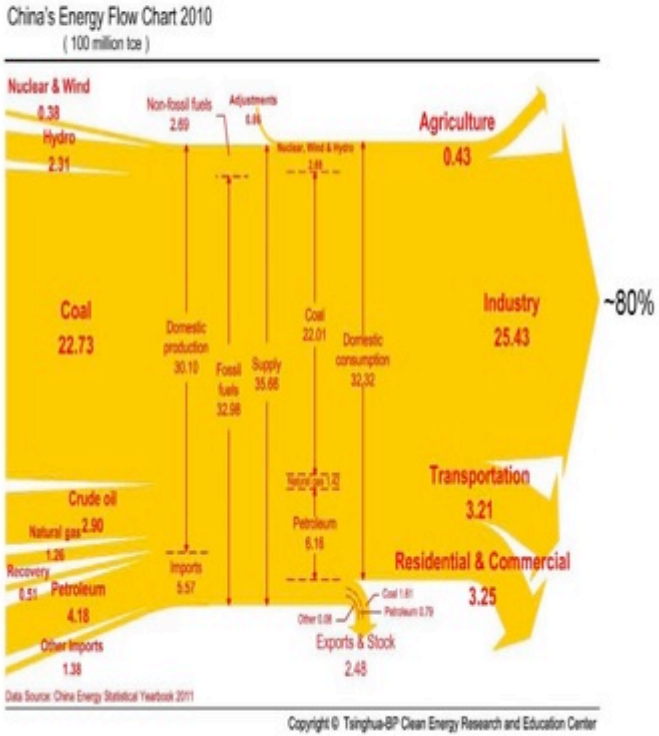
Deep cuts in emission are needed to reach the air quality standard

- Air quality target：$PM_{2.5}$ concentration will meet the standards by 2030
- Reduction needed in country level



Co-benefit of Energy Saving to Air Pollution Control

China: more than 2/3 are for industry

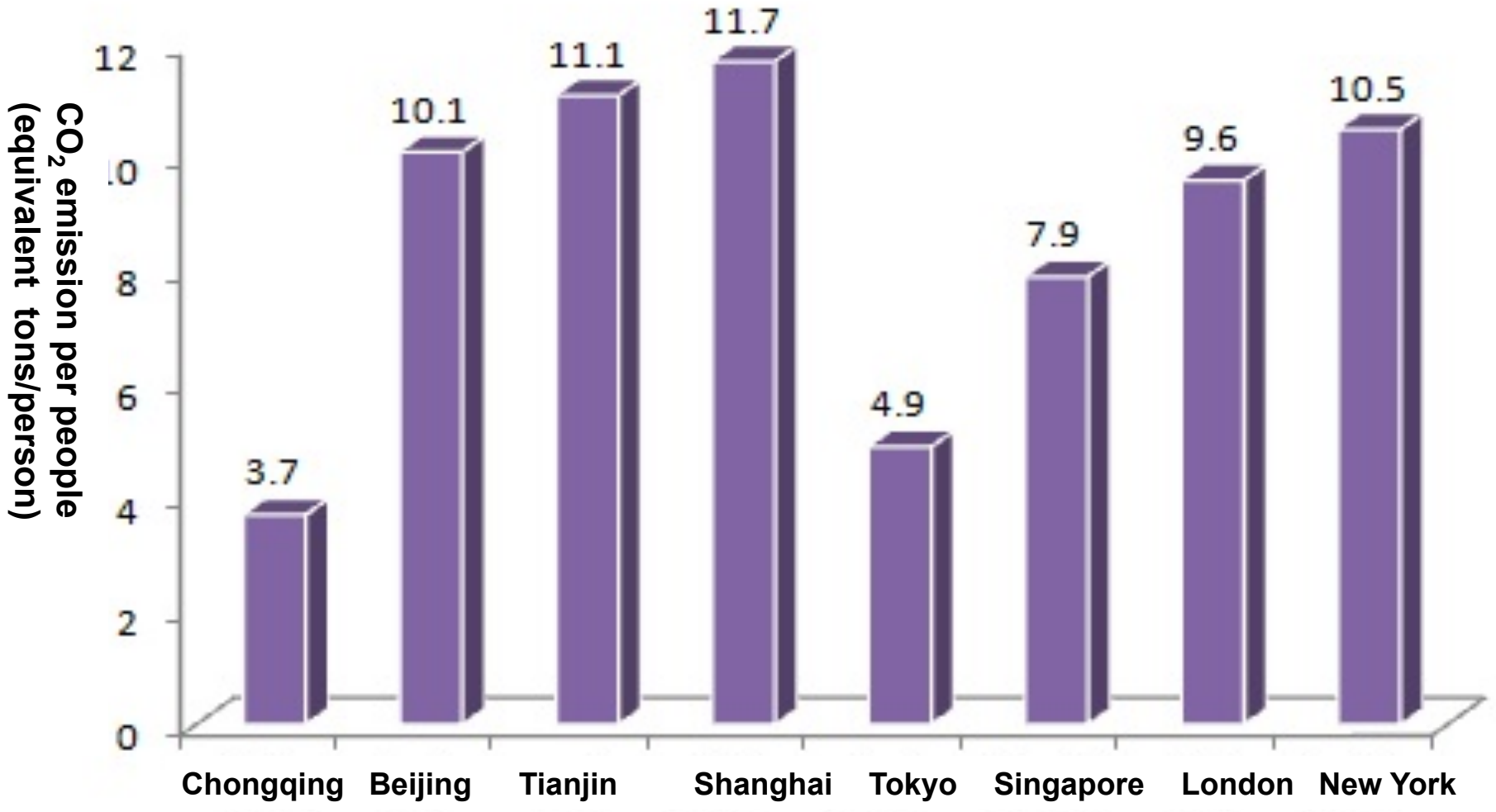


Gap between energy consumption of China's industrial products and international advanced level

Unit energy consumption (kgce/t)	China	International advanced level	Gap (%)
Iron & steel	625	550	13.6
Cement	151	118	28.0
Ethylene	1003	629	59.5

- Improve energy efficiency in **industrial** production
- Enhance materials R&D and management， and reinforce energy efficiency in **building sector**
- Decrease oil consumption in **transportation**

Attach more importance to the relevance, cooperativity, and consistency between improving air quality and climate change



Data source: World Bank, Sustainable Low-Carbon City Development in China

Scientific Planning and Promoting Urbanization in an Orderly Manner

- Integrate industrial and energy adjustment requirements into urbanization: Tighten industrial threshold, control expansion of backward productivity; reinforce infrastructure construction, ensure clean energy supply.

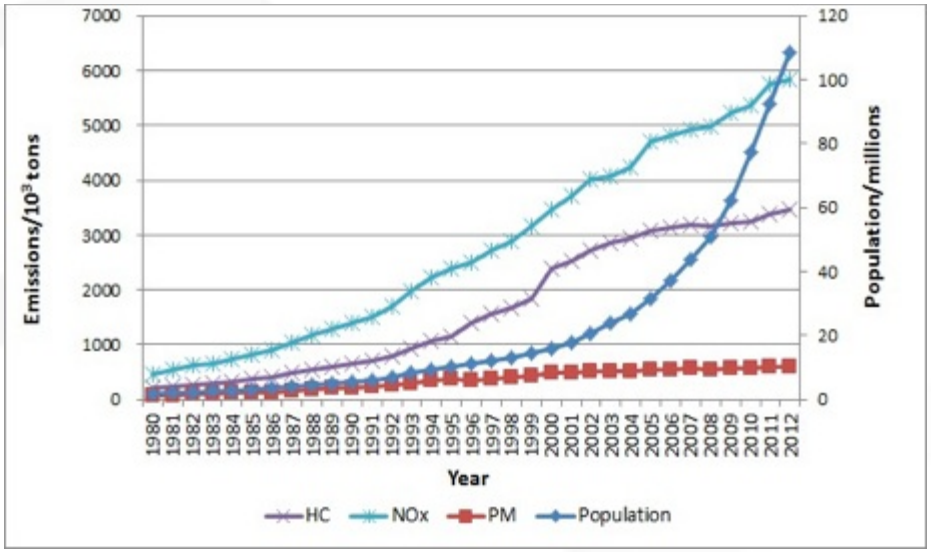
- Make scientific urban planning: Reasonably plan the size of cities, remain prudent in developing cities with 10 million population; control urban coal consumption to reduce coal burning pollution.

- Urban space design: Optimize transportation system to reduce vehicle pollution.

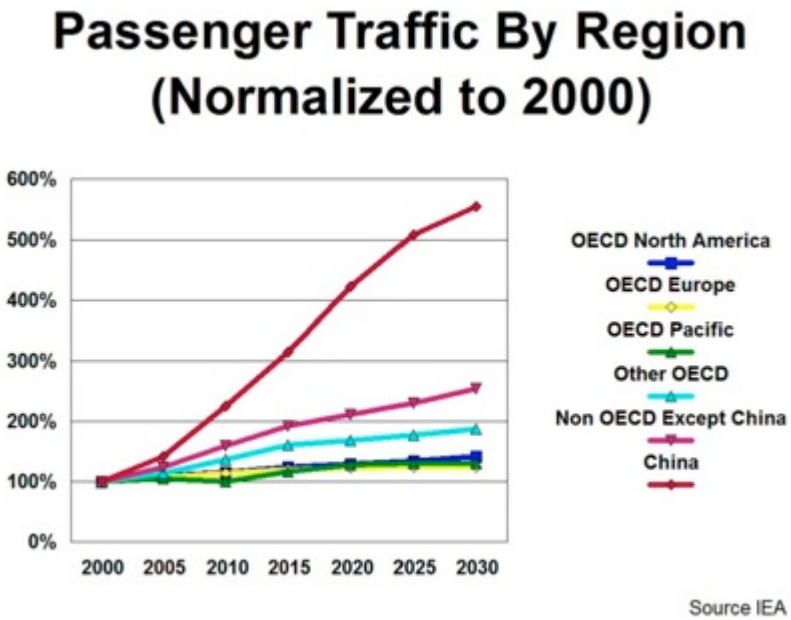
- O_3 pollution： Improve O_3 control in key regions along with in-depth PM pollution control.

Mobile Source Pollution Control

- Properly deal with pressure of vehicle population and frequent vehicle utilization
- Actively promote off-road mobile source pollution control



Rapid vehicle increase largely offsets the emission reduction outcome



Traffic demand will greatly increase

Conduct research on effects of air pollution on human health actively

- The research results about effects of air pollution on human health are important driving force to put forward the progress of the air quality standards and air pollution prevention and control.

  WHO has revised the air quality guidelines for three times since 1987. Every revision is based on the research progress and achievement on human health.

  China has used the international experiences and achievements during the progress of formulating and revising the air quality standards and air pollution prevention and control law, since 1979.

- The methods and new achievements on the health effect of air pollution from the international academic community will provide valuable support to environmental health research and policy-making in China.

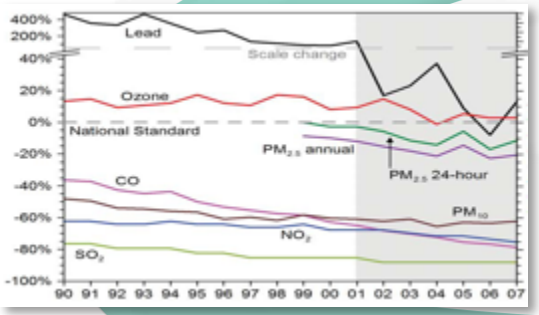
Long-term, Constant and Prudent Progressive Commitment

Environment Quality Target

Emission Reduction Target

Control Measures

Scientific Research



Track and Evaluation

Project Implementation

Conclusion: A Long-term Task for Air Control

1. Air pollution is local, regional and global;
2. Improving ambient air quality calls for focusing on primary pollutants and secondary pollutants formed in the air environment;
3. Total emission reduction is more important than concentration control by standards for air pollution control. The emission reduction by 30-50% could help evident air quality improvement;
4. Air quality management needs long-term efforts on sustainable development and improvement. It requires regional coordination and cooperation among governments, enterprises and the public . To get real blue skies, resolve and patience are needed.

Thanks