Promoting Energy Conservation in China:
Findings from an Input-Output Analysis of China's Energy Consumption

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Outline

- **Challenge** of China's current energy conservation policies
- **Key clue** to understand the challenge
- **A Case** to demonstrate how to explore energy-saving potentials
- **Summary**

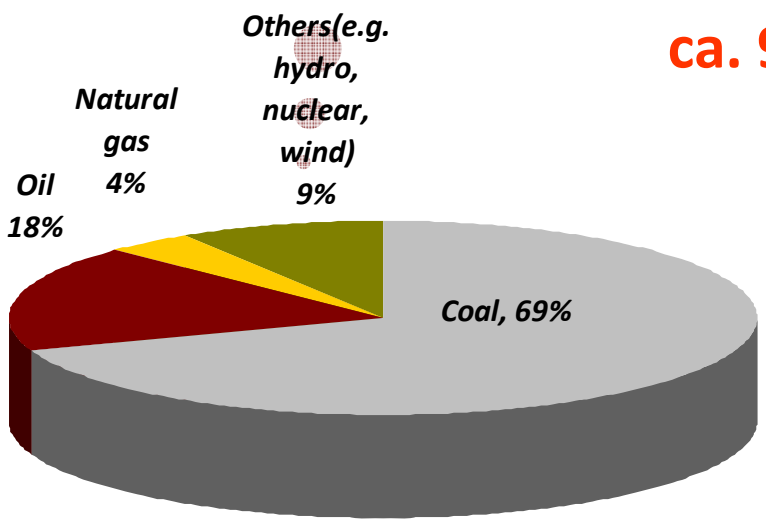
Why energy conservation in China? (1)

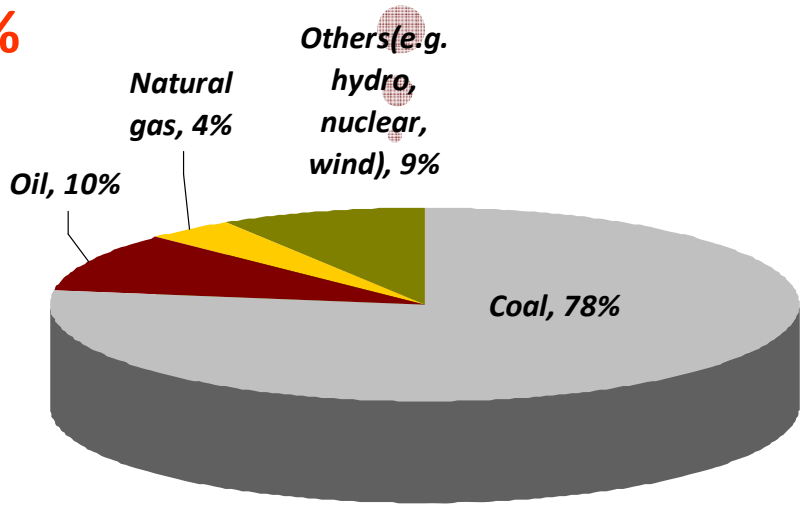
- China is now the world's second largest energy consumer/producer

In 2009, China's total primary energy **Consumption** reached **2.2** billion tons of oil equivalent (toe)

In 2009, China's total primary energy **Production** ca. **2.0** billion toe

Self-Sufficiency ca. 90%

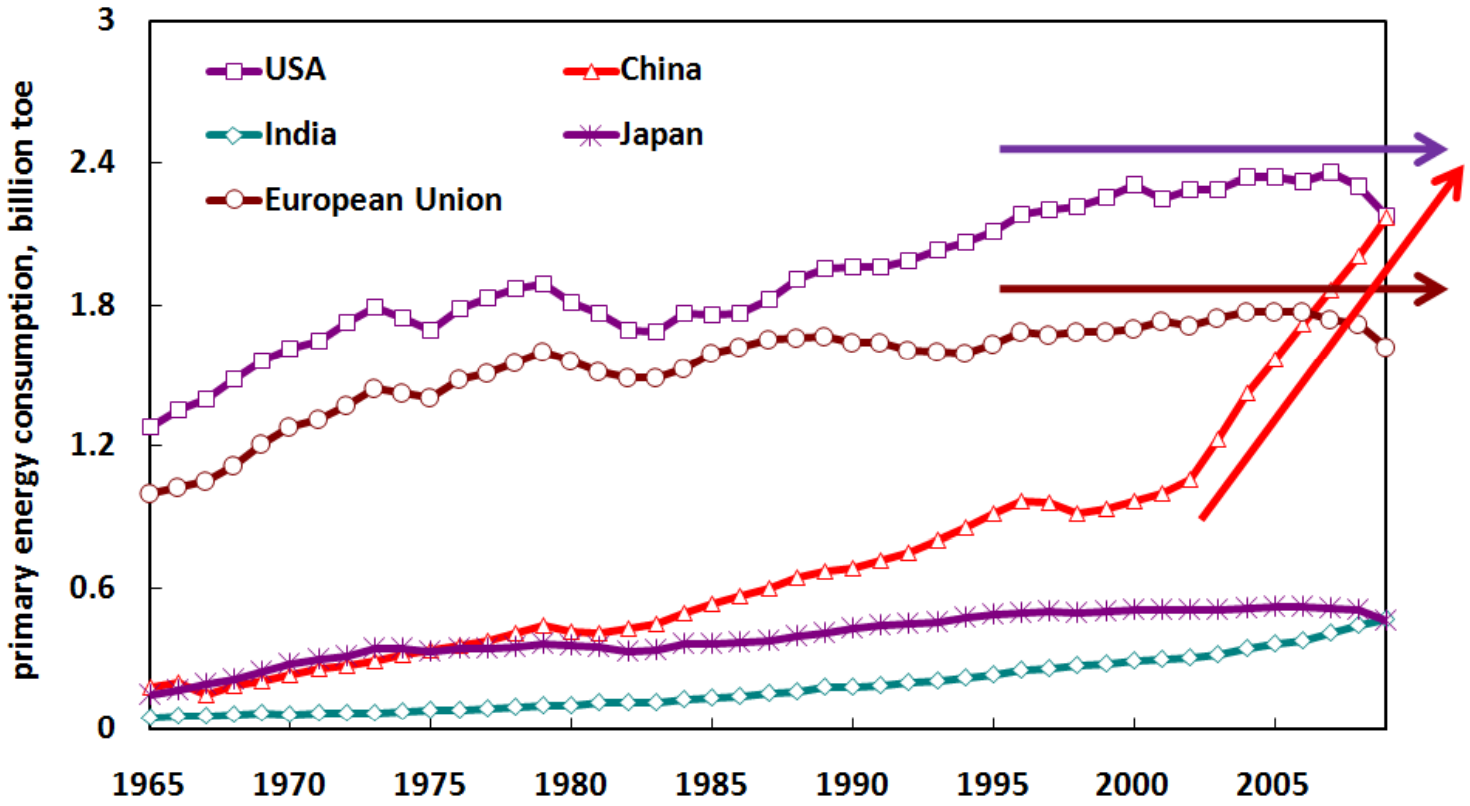




Source: National Bureau of Statistics of China (NBSC). Statistical Communiqué 2009.

Why energy conservation in China? (2)

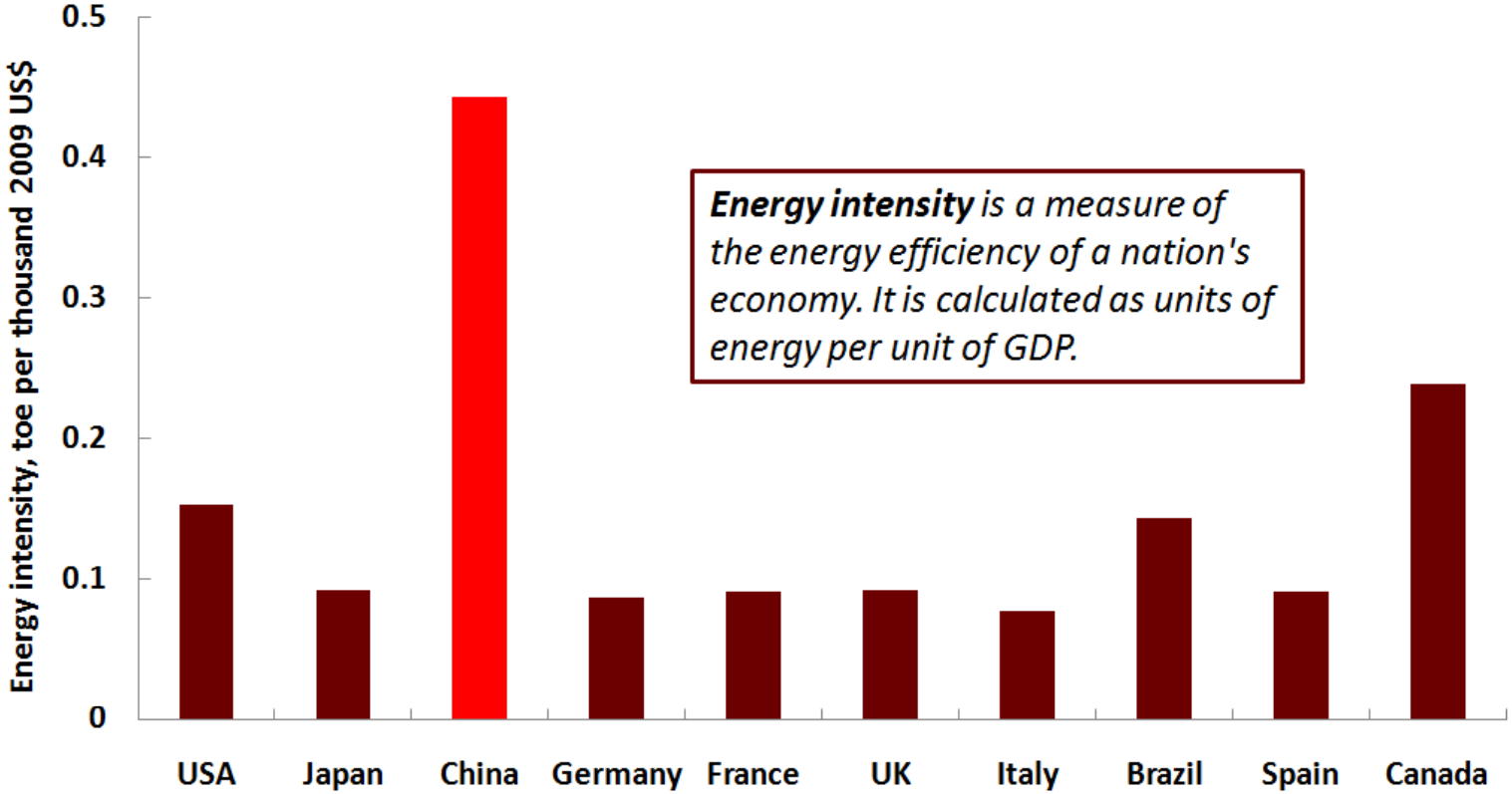
- Dynamic growth is one of the essential characters of China's total energy consumption.



Source: BP Statistical review of world energy 2010. Note: toe means tone of oil equivalent.

Why energy conservation in China? (3)

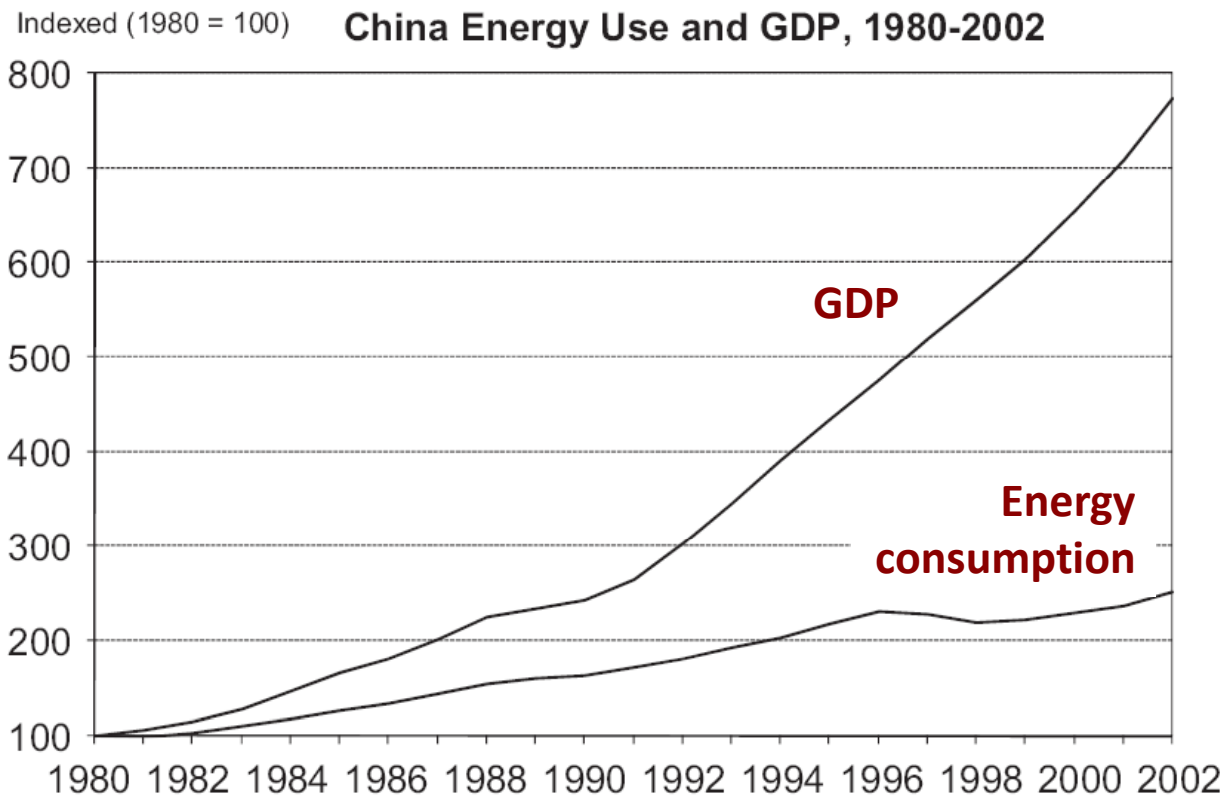
- China's energy intensity is still significantly higher than that in other developed countries



Source: World Bank Database and BP Statistical review of world energy 2010. Note: toe means tone of oil equivalent.

China achieved aggressive energy-efficiency programs in its history

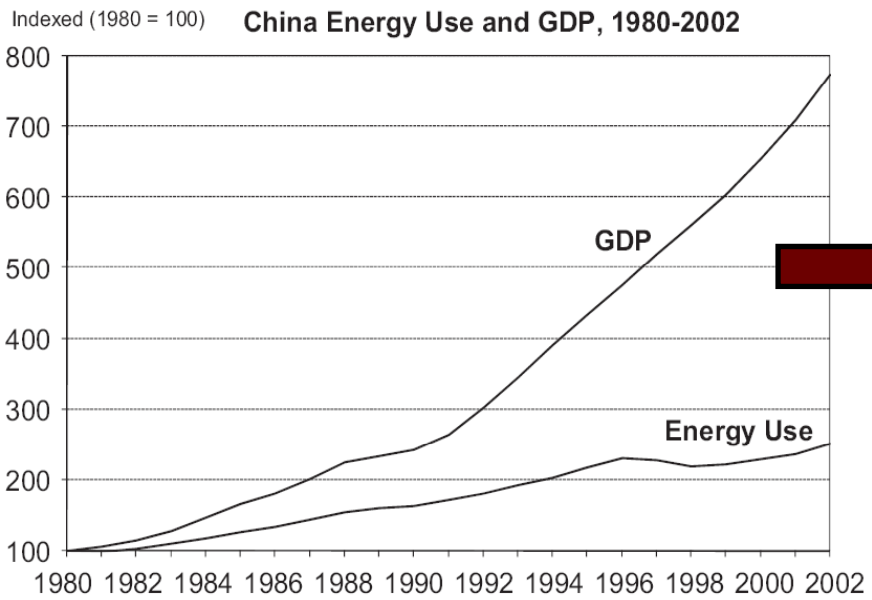
- From 1980 to 2001, China was able to limit energy consumption growth to less than half of GDP growth

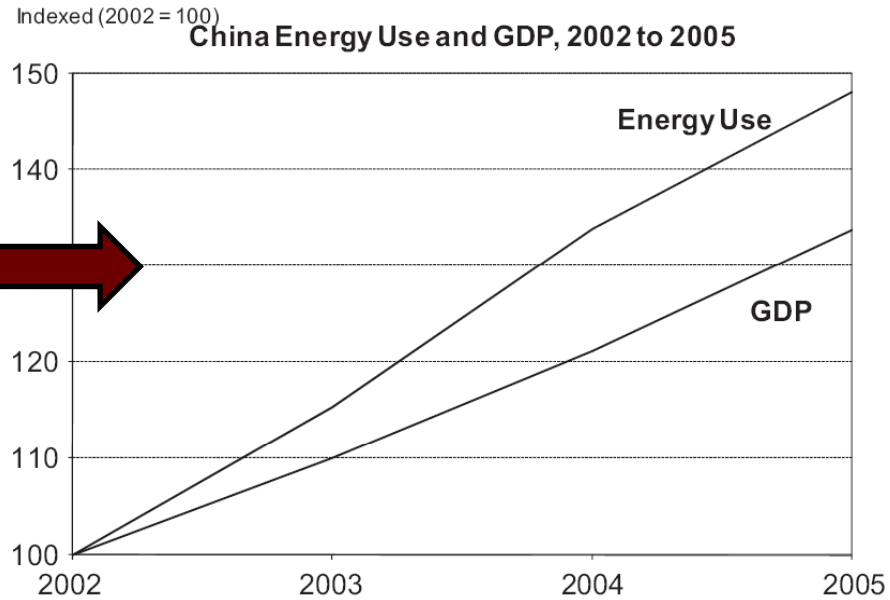


Source: Zhou, N., Levine, M. D., Price, L., 2010. Overview of current energy-efficiency policies in China. Energy Policy 38(11), 6439-6452

Dramatic reversal period

- The period 2002-2005 saw a dramatic reversal of the historic relationship between energy consumption and GDP growth





Source: Zhou, N., Levine, M. D., Price, L., 2010. Overview of current energy-efficiency policies in China. Energy Policy 38(11), 6439-6452

Key policies implemented since 2004

Type of policies	Energy policies	Date effective	Responsible agency
Laws	Revision of the energy conservation law	October 2007	National People's Congress and National Development and Reform Commission (NDRC)
Comprehensive policies	Medium and long-term plan for energy conservation	2005	NDRC
	11th Five-Year Plan	March 2006	NDRC
	The state council decision on strengthening energy conservation	August 2006	State Council
	Implementation measures of 10 key projects in 11th FYP	October 2006	NDRC
Fiscal policies	Reduced export tax rebates for many low-value-added but high energy-consuming products	September 2006	NDRC and Ministry of Finance (MOF)
	Interim management measures for incentives to EC technology reforms and phase out program	2007-December 2010	MOF
	Regulations on implementation of corporate income law (a: Taxtax	January 2008	State administration of taxation
Sectoral policies			
Industry			DRC
Buildings			inistry of Housing and ban--Rural Development HURD)
			OF
Appliances			eneral Administration of uality Supervision, Inspection and Quarantine (AQSIQ)
	Government procurement program	2005 2007	NDRC and MOF
Transportation	Fuel consumption limits for passenger cars	2004	AQSIQ
	Revised consumption tax for larger, energy-inefficient vehicles	April 2006	MOF state administration of taxation
	National phase III vehicle emission standards	July 2007	Ministry of Environmental Protection (MEP)

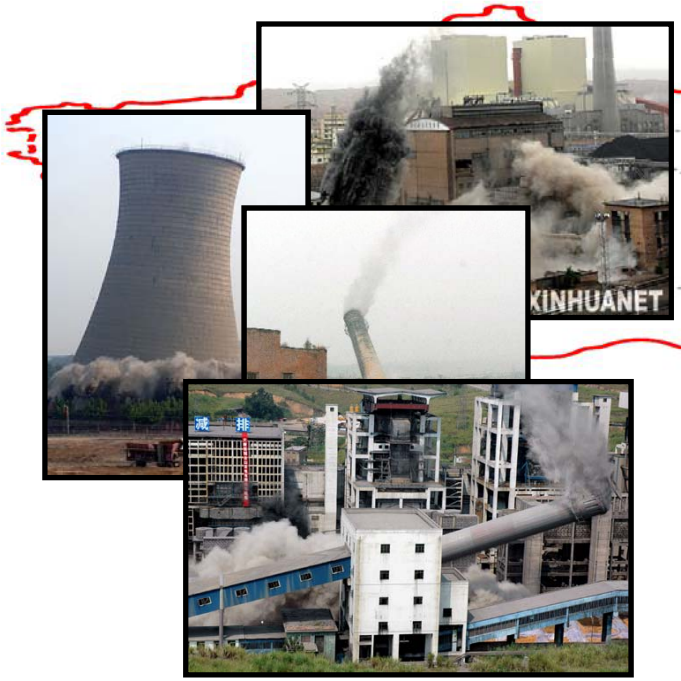
*In the **11th Five Year Plan (FYP)**, the Chinese central government set a target of reducing energy intensity by 20% between 2006 and 2010*

Source: Zhou, N., Levine, M. D., Price, L., 2010. Overview of current energy-efficiency policies in China. Energy Policy 38(11), 6439-6452

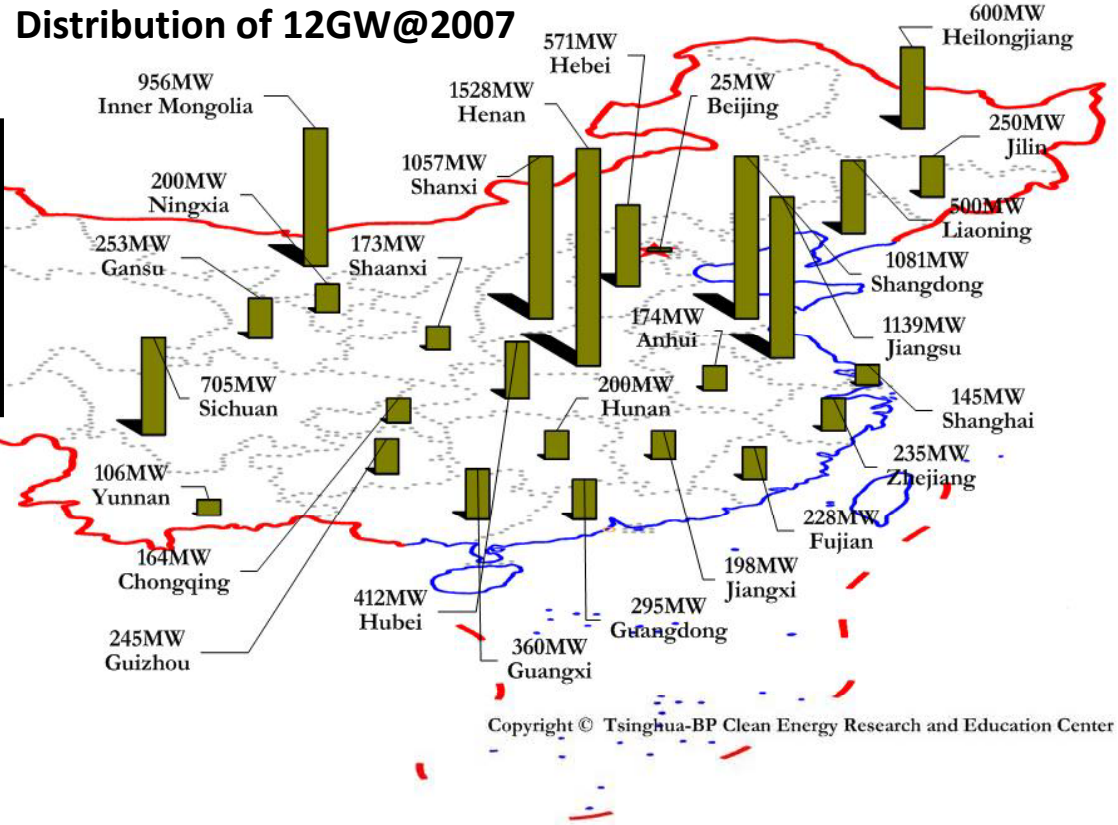
Significant measures on promoting efficiency: A glance at electricity sector

- More than **55GW** of small and low-efficient units was shut down during 2006-2009, another **10GW** will be shut down in 2010.

REF: UK@2005's total power capacity = 80GW



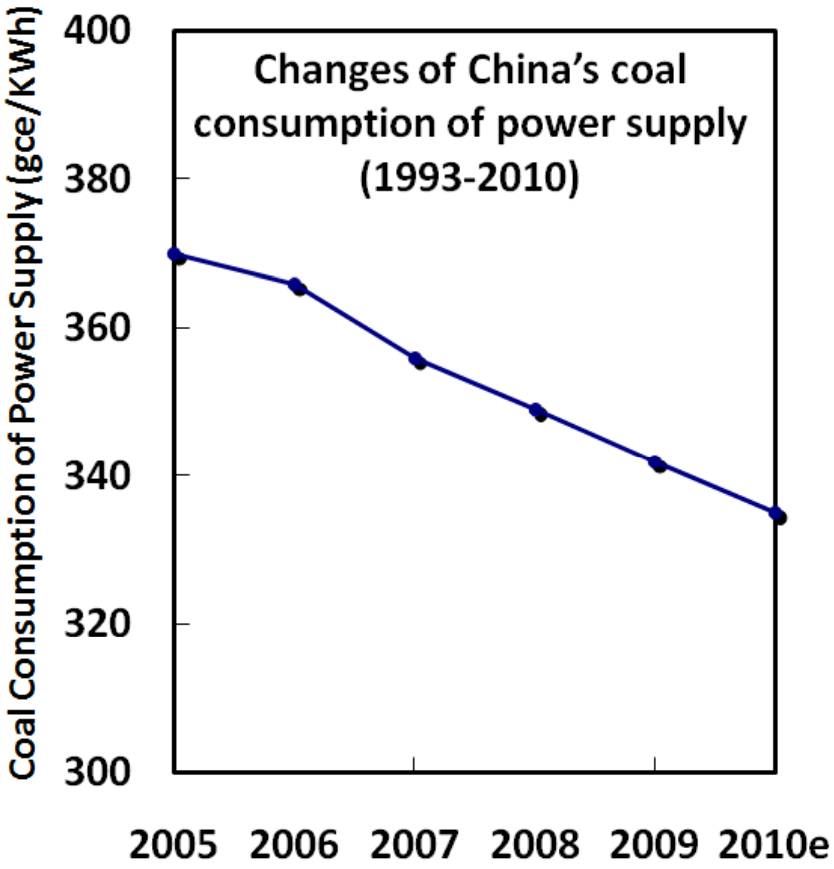
Distribution of 12GW@2007

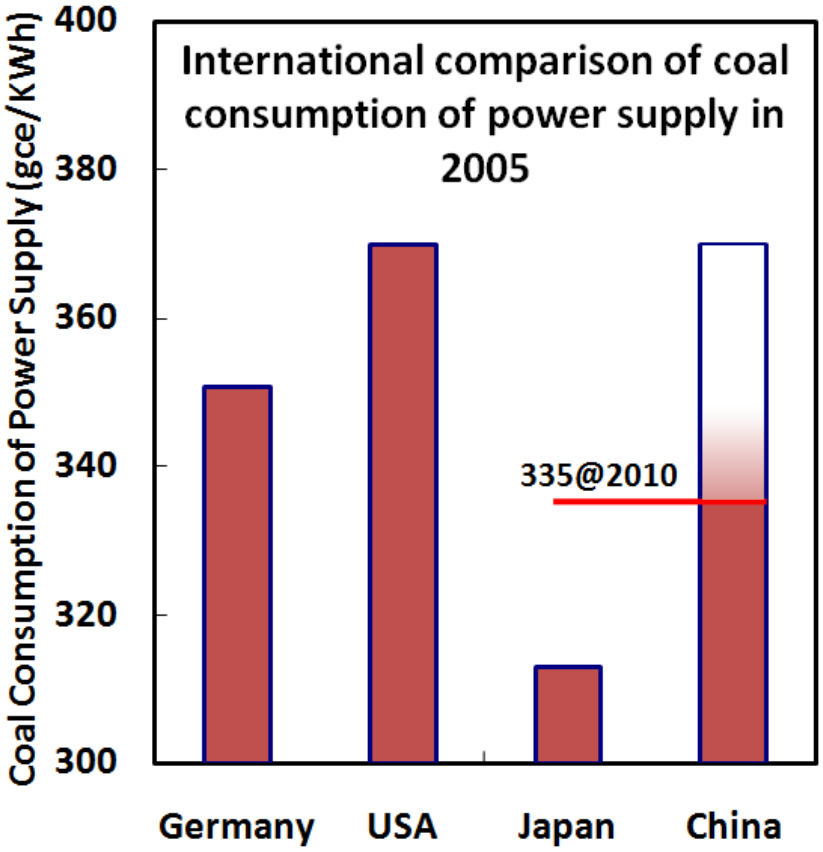


Source: China Electricity Council

Radical improvements on efficiency: A glance at electricity sector

$$\text{Coal consumption of power supply} = \frac{1}{\text{Power supply efficiency}}$$

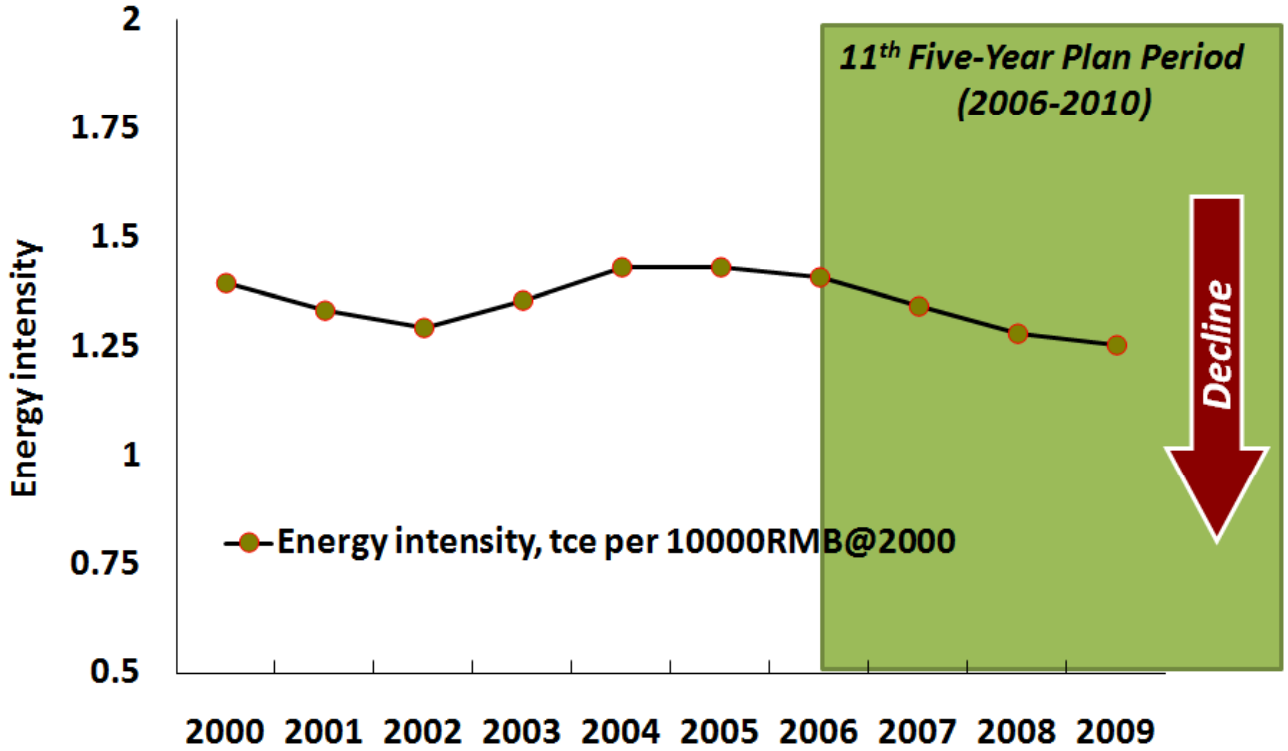




Source: China Electricity Council , NBSC, DOE/NETL, and MIT

Macro-indicator: Energy intensity declines continuously in the 11th FYP period

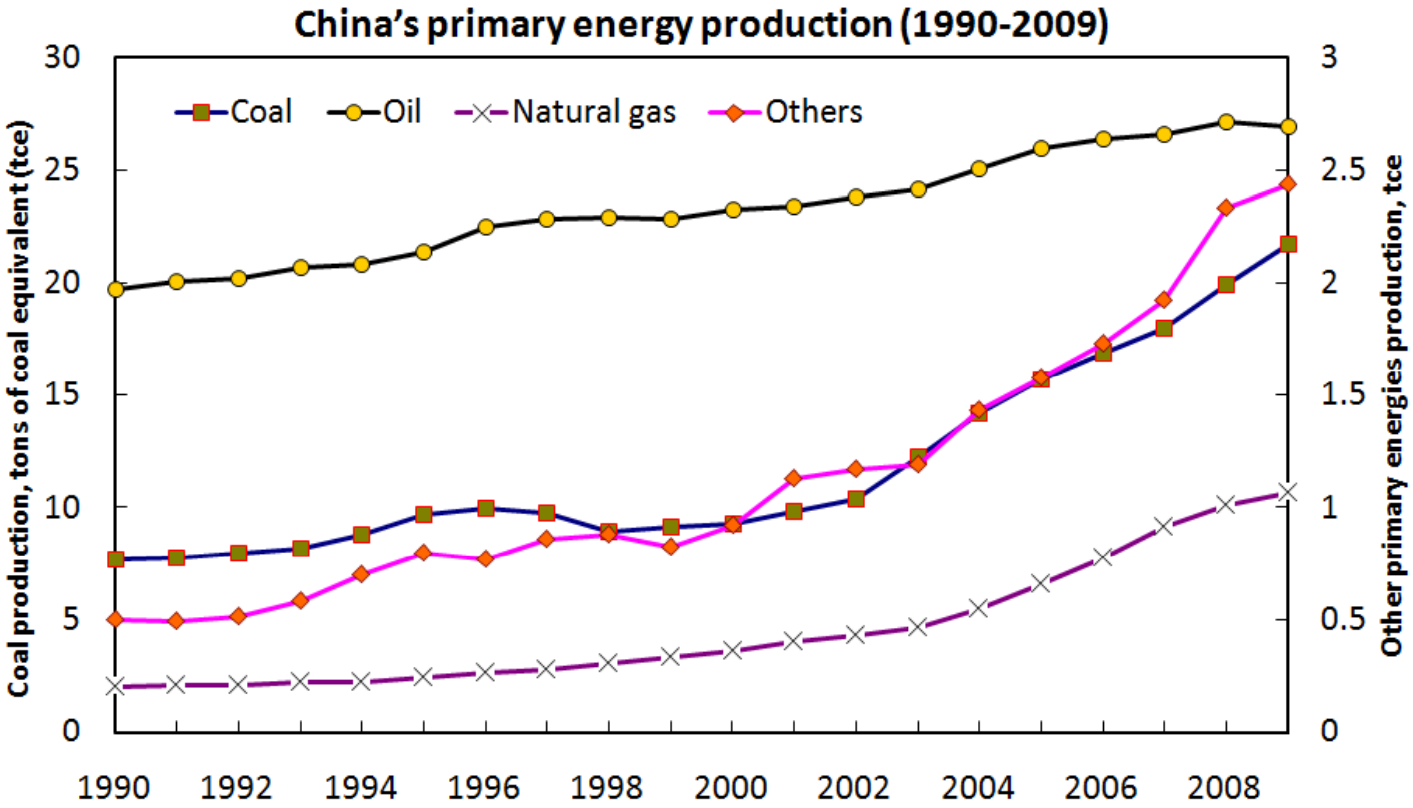
- China has brought its energy intensity down by ca. 15% up to 2009 compared with that in 2005



Source: NBSC. China Statistical Yearbook 2009 and Communiqué on National Energy Consumption for Unit GDP 2009 .

Energy intensity vs. Energy supply

- To release the huge and fast-increasing pressure on energy supply requires more comprehensive energy conservation policies



Source: NBSC. China Statistical Yearbook 2009 and Statistical Communiqué 2009.

Where China is headed under BAU by 2030?
Energy demand = ca. 4 billion toe?

GDP growth rates ***by region in the Reference Scenario***

	1980-1990	1990-2007	2007-2015	2015-2030	2007-2030
OECD	3.0%	2.5%	1.4%	1.9%	1.8%
China	*8.9%*	*10.0%*	*8.8%*	*4.4%*	*5.9%*
World	2.7%	3.3%	3.3%	3.0%	3.1%

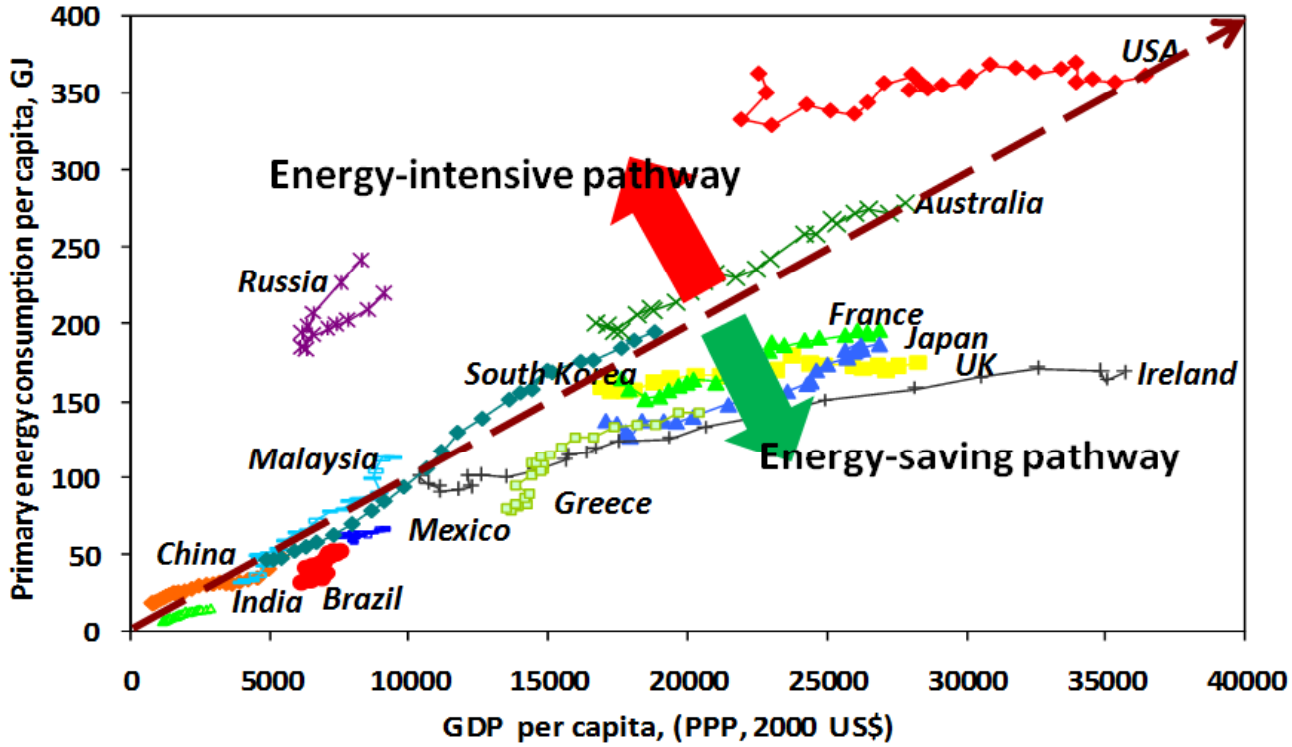
Primary energy demand ***by region in the Reference Scenario (unit: Mtoe)***

	1980	2000	2007	2015	2030	2007-2030*
OECD	4 050	5 249	5 496	5 458	5 811	0.2%
China	*603*	*1 105*	*1 970*	*2 783*	*3 827*	*2.9%*
World	7 228	10 018	12 013	13 488	16 790	1.5%

Source: IEA. World energy outlook 2009. Paris: OECD/IEA, 2009.

Challenge of China's current energy conservation policies

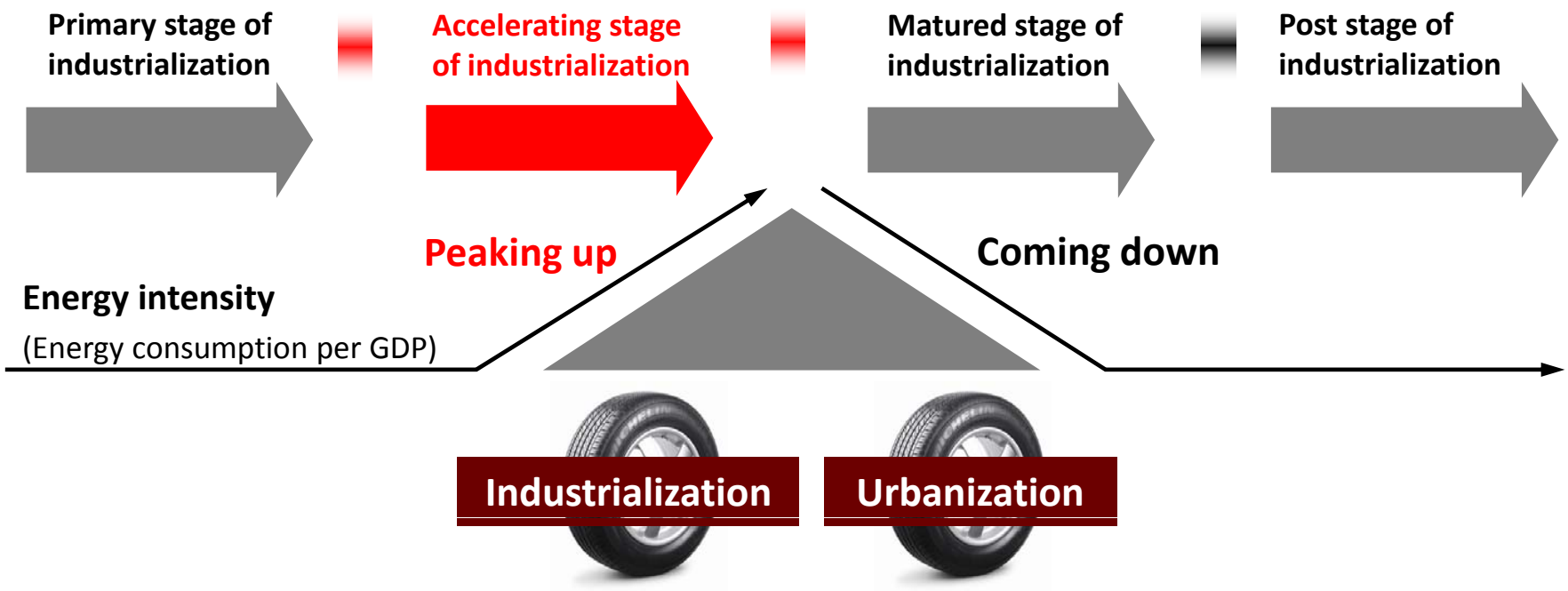
- Policies should deal with the problem of how to minimize China's energy consumption during its process to catch up with developed countries.
- Current decisions will result in pathway-locking of the basic load of energy demand, as well as greenhouse gas emission.



Source: U.S. Energy Information Administration (EIA) and World Bank World Development Indicators (WDI) Database

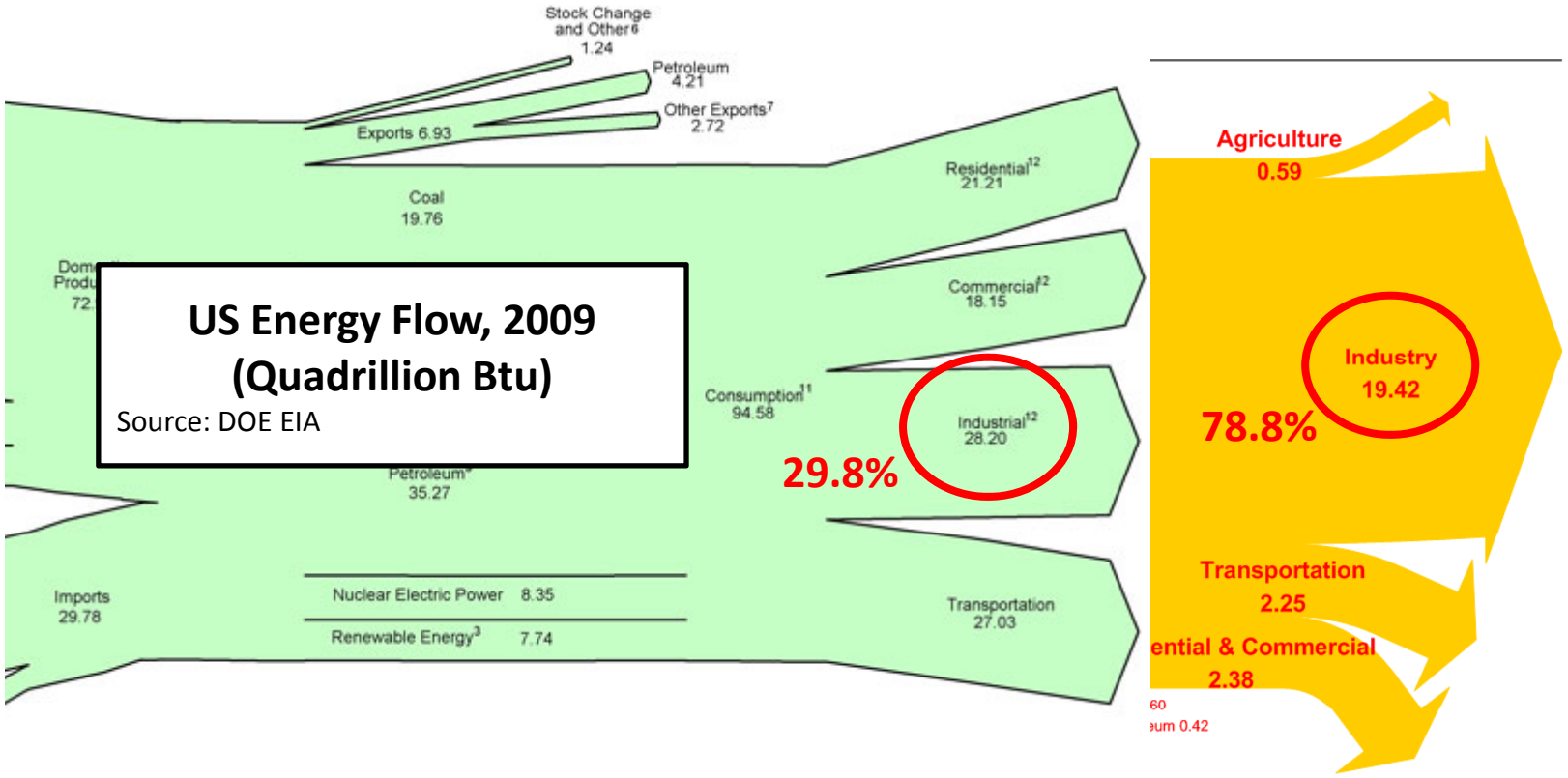
Key clues to understand the challenge

- Dynamic growth of energy consumption in China is mainly driven by economic development factors, such as industrialization and urbanization



Industrialization process: Industries keep on as a major energy absorber

- China's industrial sector consumes ca. 2/3 of its total final energy consumption



Data Source: China Energy Statistical Yearbook 2007

Author: Fu, Feng

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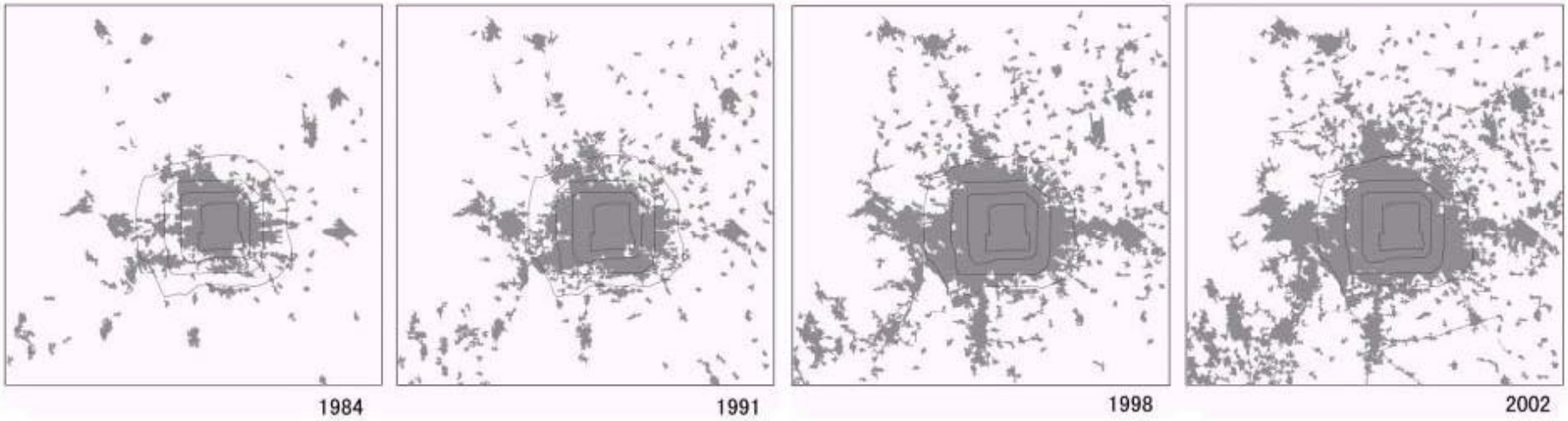
Urbanization process: Large scale construction accumulation of buildings and infrastructures

- Urbanization process of Beijing during 1984-2002 as A typical example of China



北京城市“摊大饼”——根据 1984—2002 年卫星遥感图像制作的北京城市中心区蔓延示意图

Source: TSMPT (Tsinghua-BP Sustainable Mobility Project Team). Sustainable Mobility in rapid urbanization: Theory and practice in China. Beijing: China Railway Publishing House, 2008

Regional imbalance: China's economic growth is far from saturated

- Investment is continuously needed to expand the existing facilities (e.g. buildings and infrastructures, etc.) meeting those emerging demands

What's difference of GDP components between China and other developed countries

- The proportion of GDP components varies in different stages of economic development
- The proportion of capital formation of GDP in China is significantly higher than that in developed countries

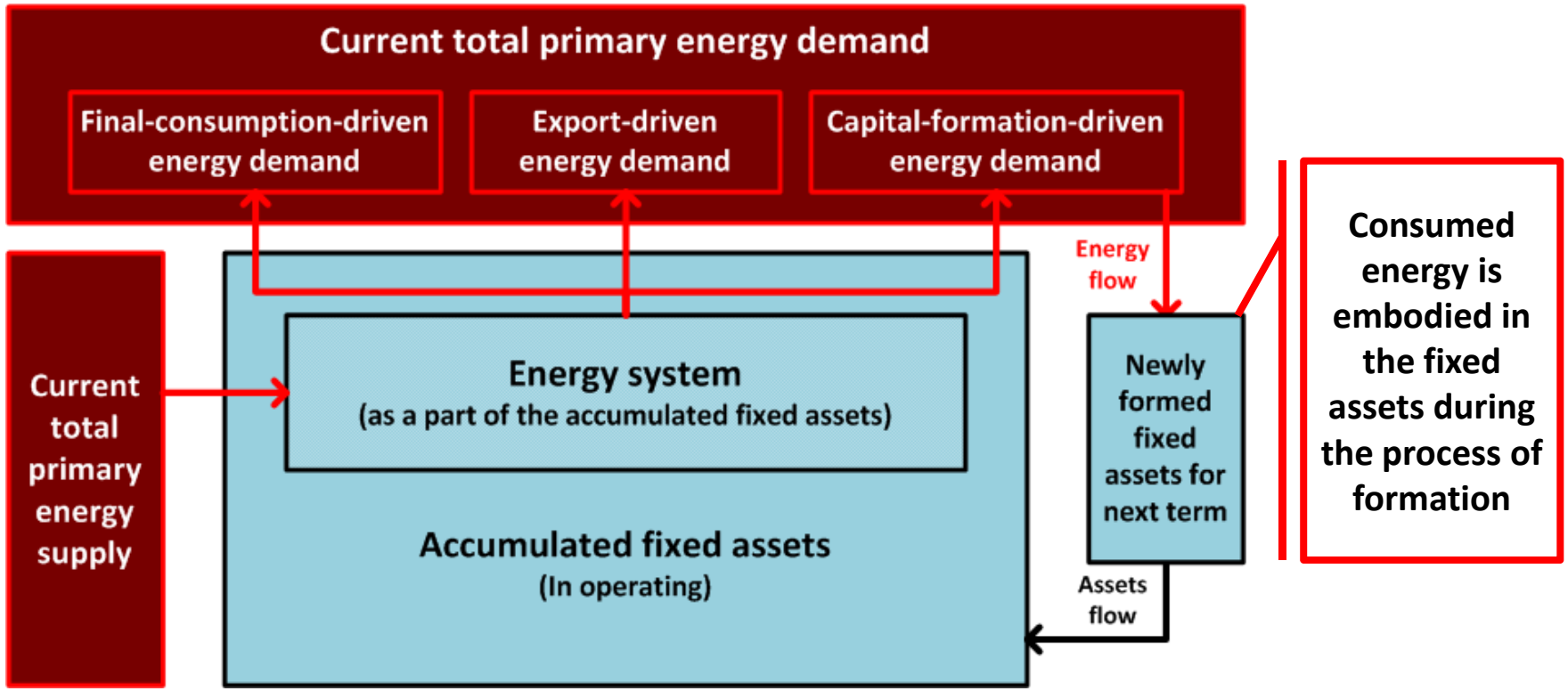
Components of GDP by Expenditure Approach (Unit: %)

	China (2008)	Japan (2004)	South Korea (2006)	Canada (2004)	USA (2004)	UK (2005)
Final consumption	**48.6**	75.4	68.9	74.9	**86.1**	87.1
Capital formation	**43.5**	22.7	30.0	21.0	**19.2**	16.8
Net export	**7.9**	1.9	1.1	4.2	**-5.3**	-3.9
Total	100.0	100.0	100.0	100.0	100.0	100.0

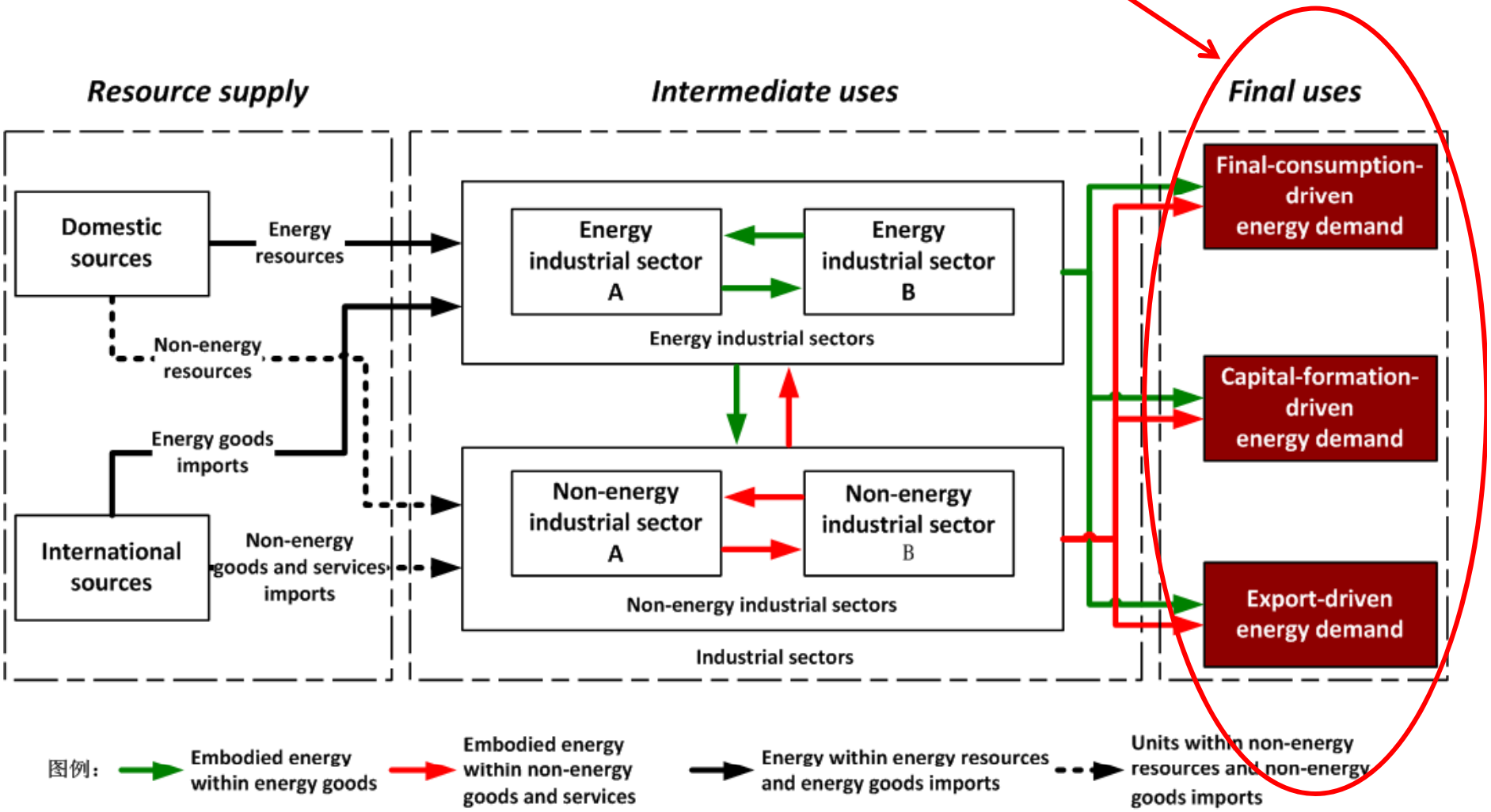
Source: NBSC. China Statistical Yearbook 2009, and International Statistical Yearbook 2008

A framework to decode the relationship between GDP and energy demand

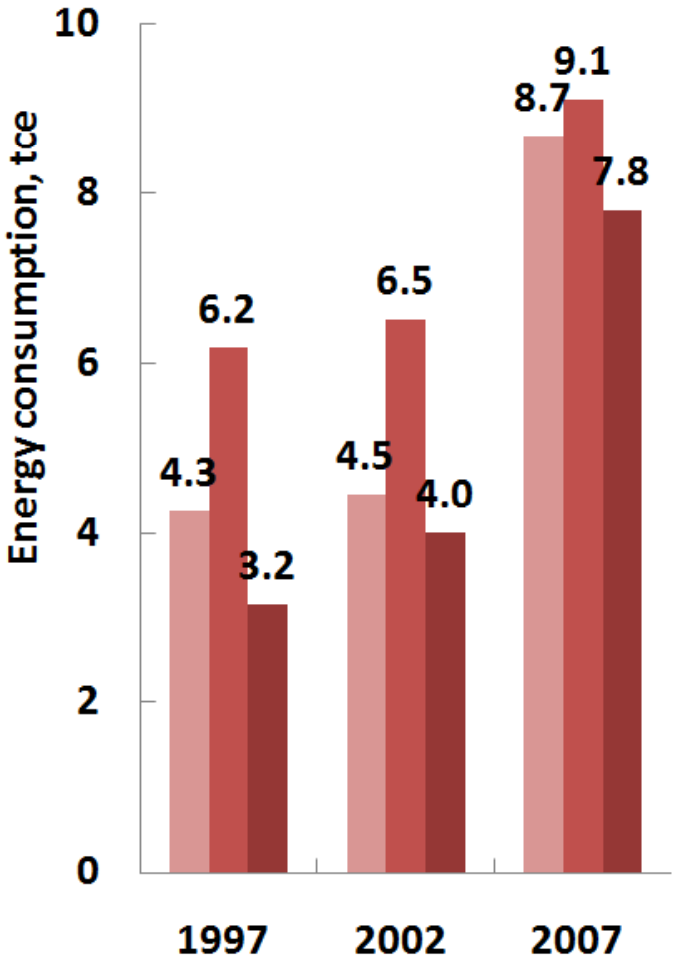
- The total primary energy demand within a certain term can be decomposed into there categories in accordance with the purposes to meet the final uses, i.e. ***Final-consumption-driven***, ***Export-driven***, and ***Capital-formation-driven*** energy demand.
- Although current ***Capital-formation-driven*** energy demand is statistically considered as a part of the current total energy demand, it will take effect in the future terms.

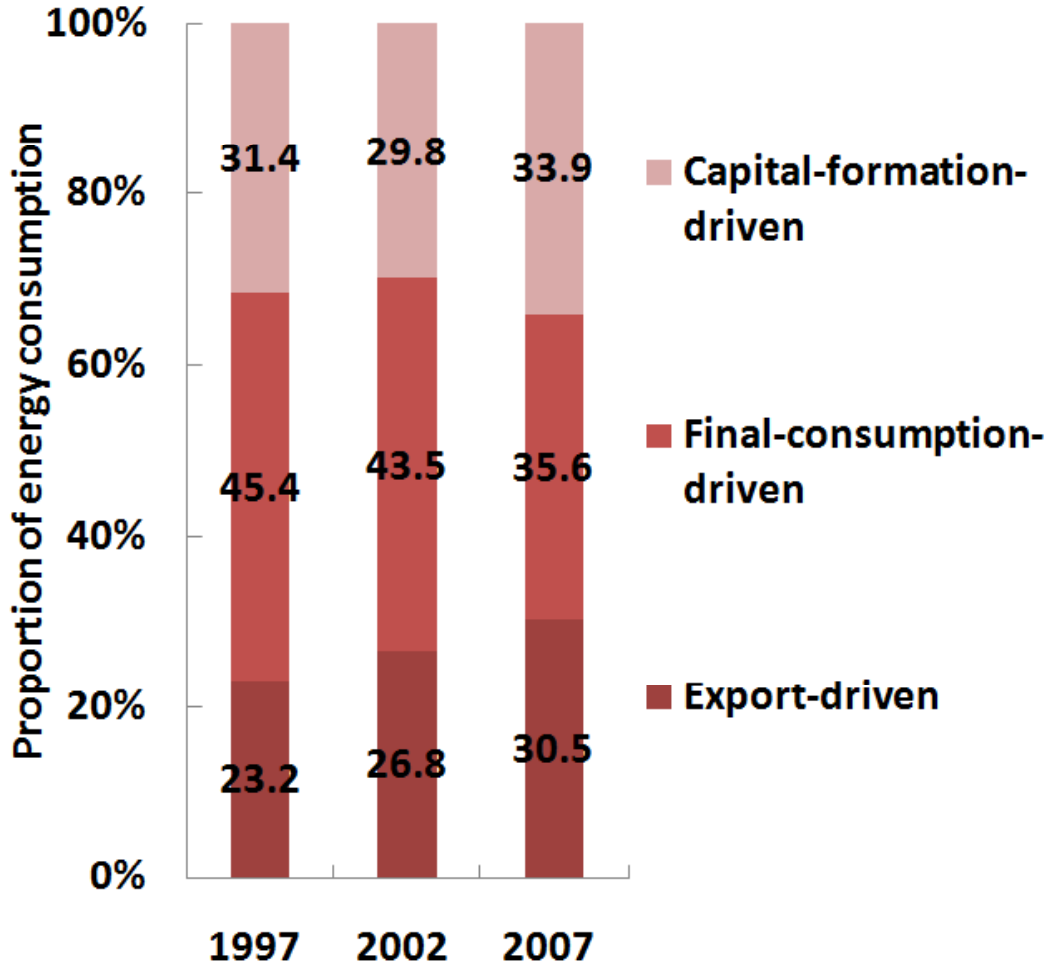


An input-output model to track the energy flows and distribute them into three categories

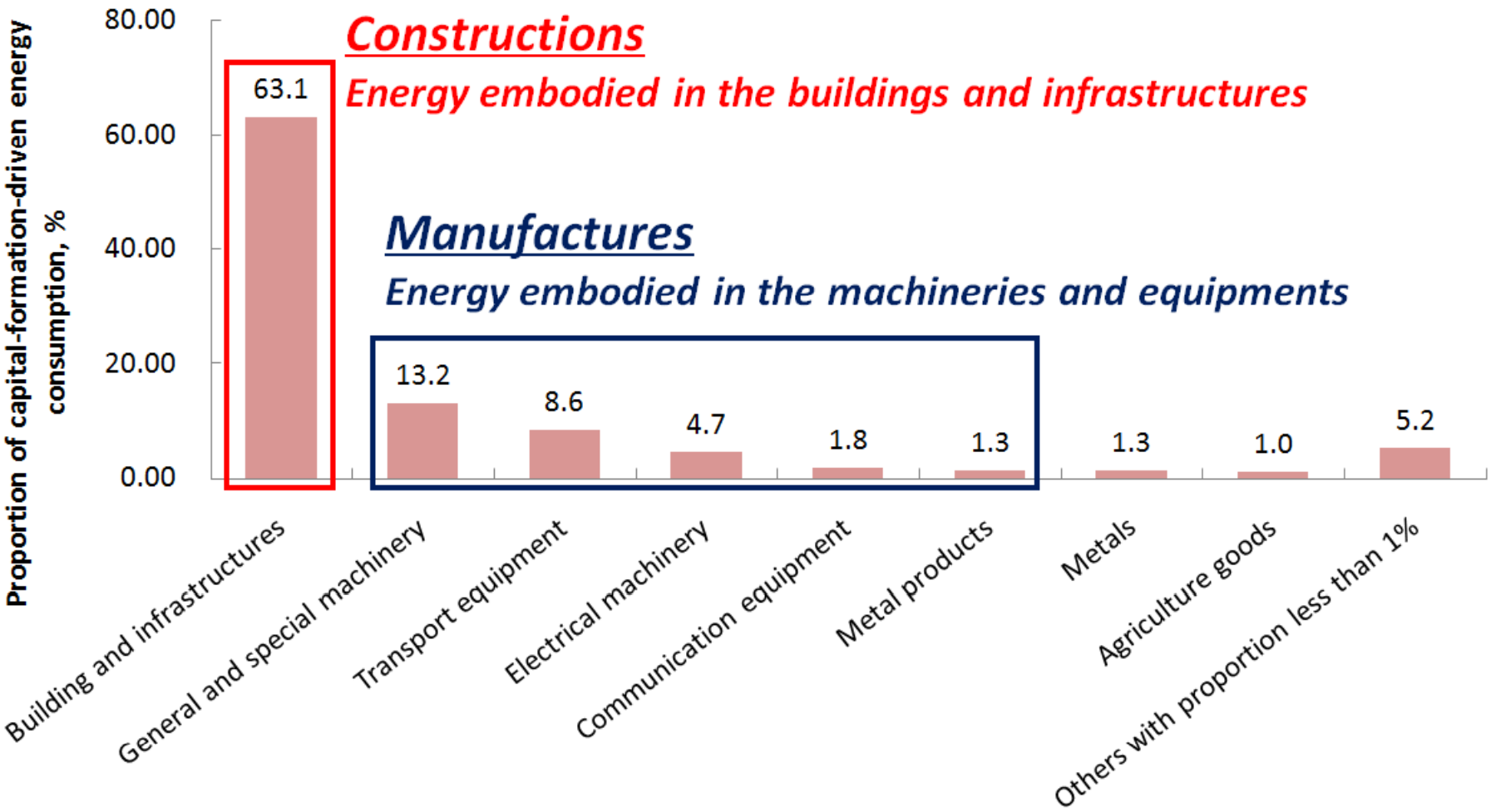


Decomposition results of China's total energy consumption (1997, 2002, and 2007)



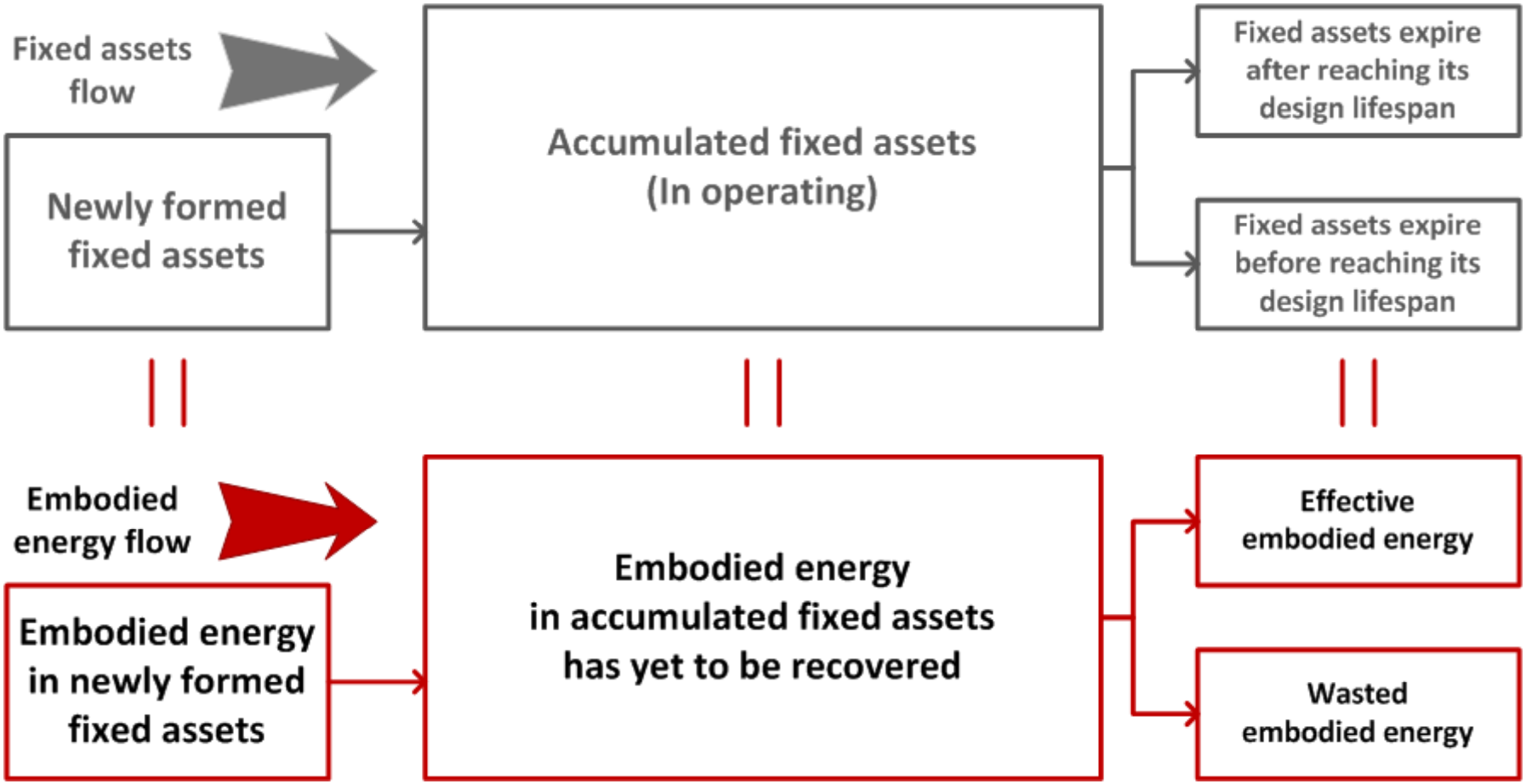


Focusing on the Capital-formation-driven energy consumption: Decomposition results of 2007



How to explore energy-saving potentials of Capital-formation-driven energy consumption?

- To guarantee the effectiveness of every unit of energy



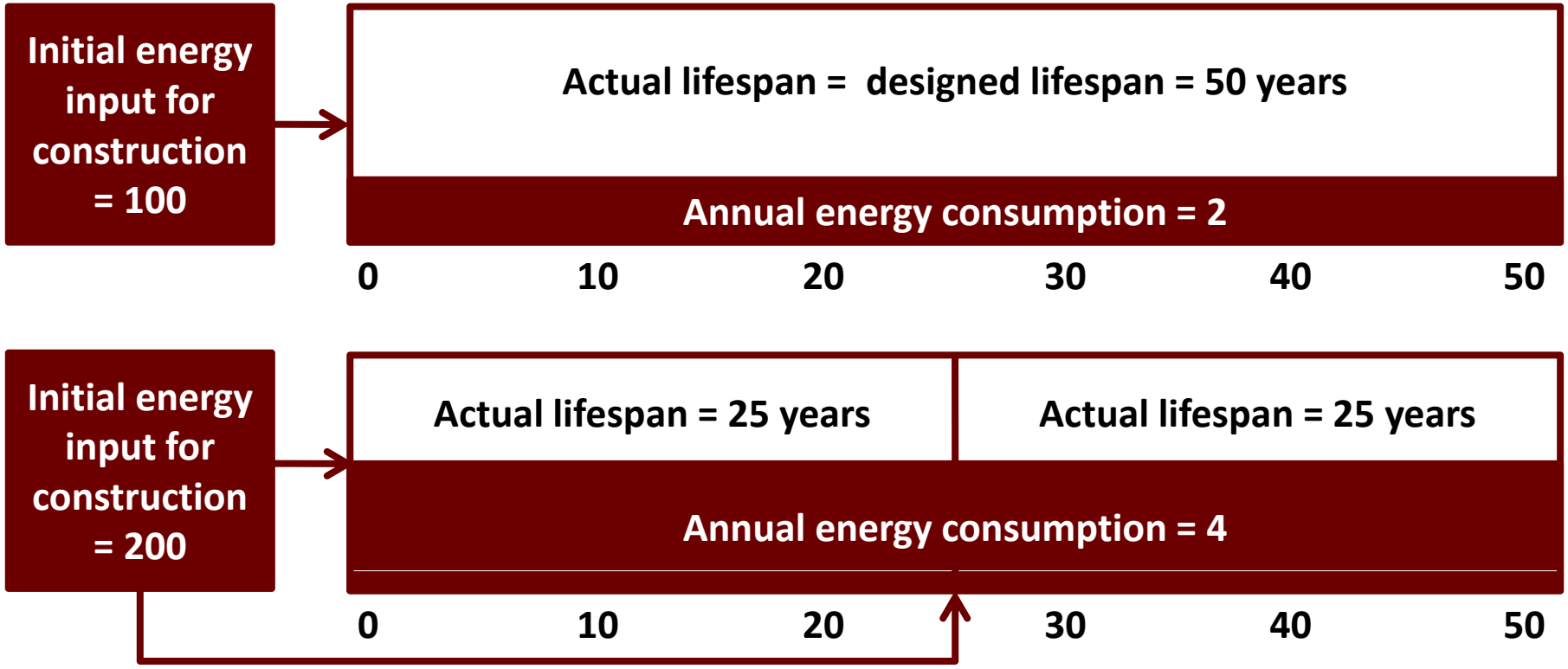
Case of buildings: Short lifespan may lead overlapping construction activities

- The actual lifespan is much less than the designed one
  - The designed lifespan of general civil buildings is **50** years in China. However, the actual lifespan is only **25-30** years on average.
- China's demand of floor area shows the trend of sustained and fast growth
  - China's annual growth of new buildings is up to **2** billion m^2 in recent years.
  - Given current growth rate, China's floor area will double, from ca. **40** billion m^2 in 2010 to ca. **80** billion m^2 in 2030.

Source: Ministry of Construction (now Ministry of Housing and Urban-Rural Development). Code for design of civil buildings (GB50352-2005). 2005. Qian Wang. Short-lived buildings create huge waste. China Daily. (04-06-2010). http://www.chinadaily.com.cn/china/2010-04/06/content_9687545.htm. NBSC. China Statistical Yearbook 2009. Chinese Academy of Engineering (CAE). Research report of China's Long-term Energy Development Strategy up to 2030 and 2050.

Case of buildings: The shorter actual lifespan is, the more annual energy is consumed

- Initial energy input for construction doubles with the same amount of utility



Scenario settings under different combination of policy goals

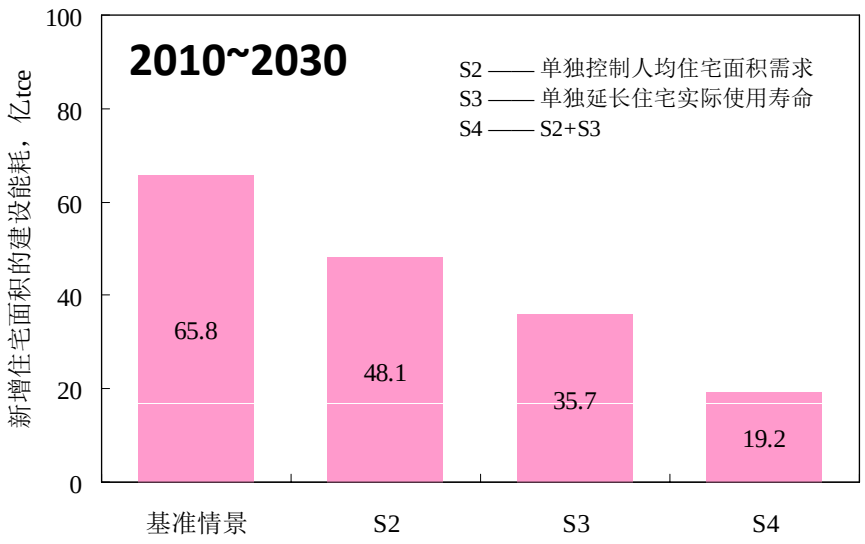
- ***Goal 1***: Extending the actual lifespan of civil buildings
- ***Goal 2***: Mitigating the growth of floor area demand per capita

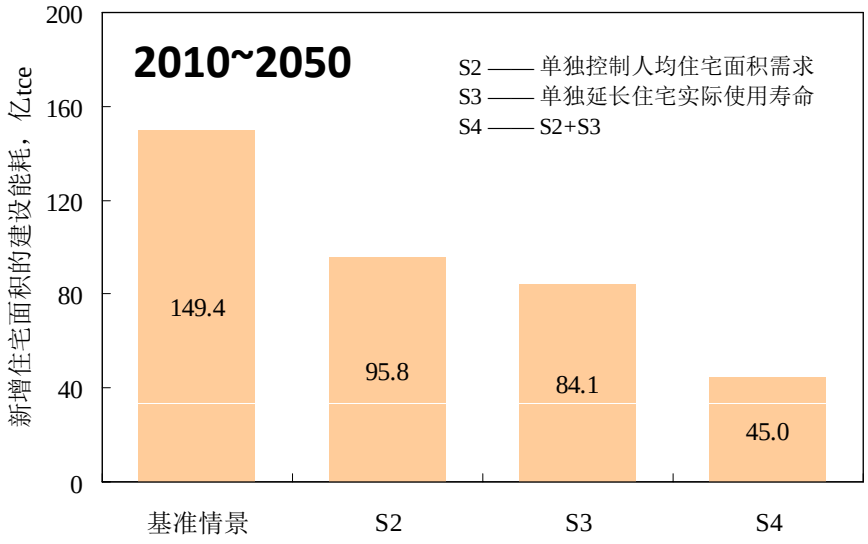
Scenario settings	BAU Scenario	Alternative scenarios		
		S2	S3	S4
To mitigate the growth of floor area demand per capita	No	Yes	No	Yes
	$60m^2/p$ in 2050	$40m^2/p$ in 2050	$60m^2/p$ in 2050	$40m^2/p$ in 2050
To extend the actual lifespan of civil buildings	No	No	Yes	Yes
	25years	25years	50years	50years

Scenario results: Energy-saving potentials compared to BAU

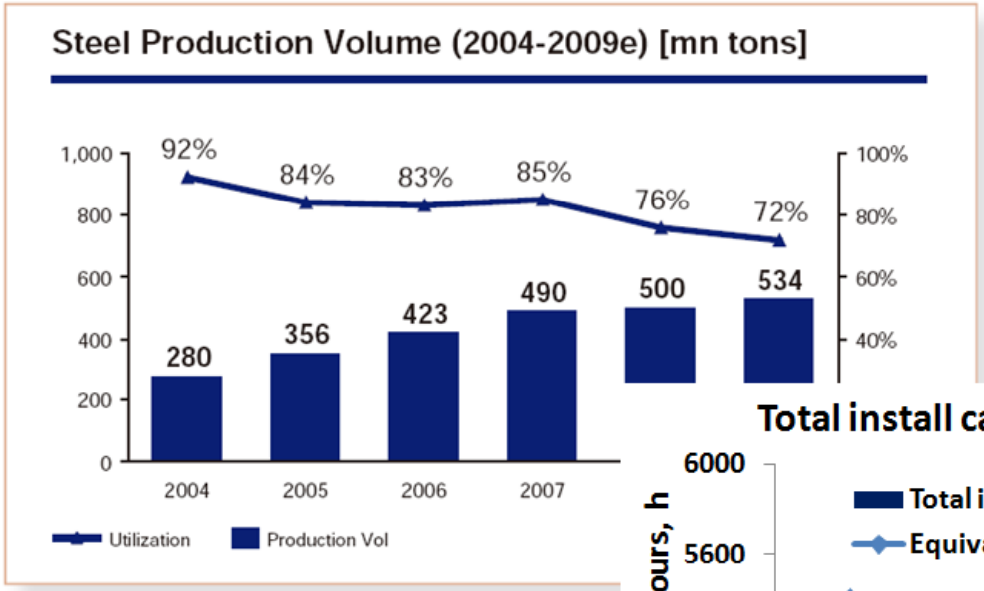
Energy-saving potentials compared to BAU Unit: Mtce		Observation period			
		2010-2030		2010-2050	
		Accumulated	Annual average	Accumulated	Annual average
Alternative scenarios	S2	1760	90	5370	130
	S3	3000	150	6530	160
	S4	4660	230	10450	260

REF: China's total energy consumption in 2009 = 3100 Mtce



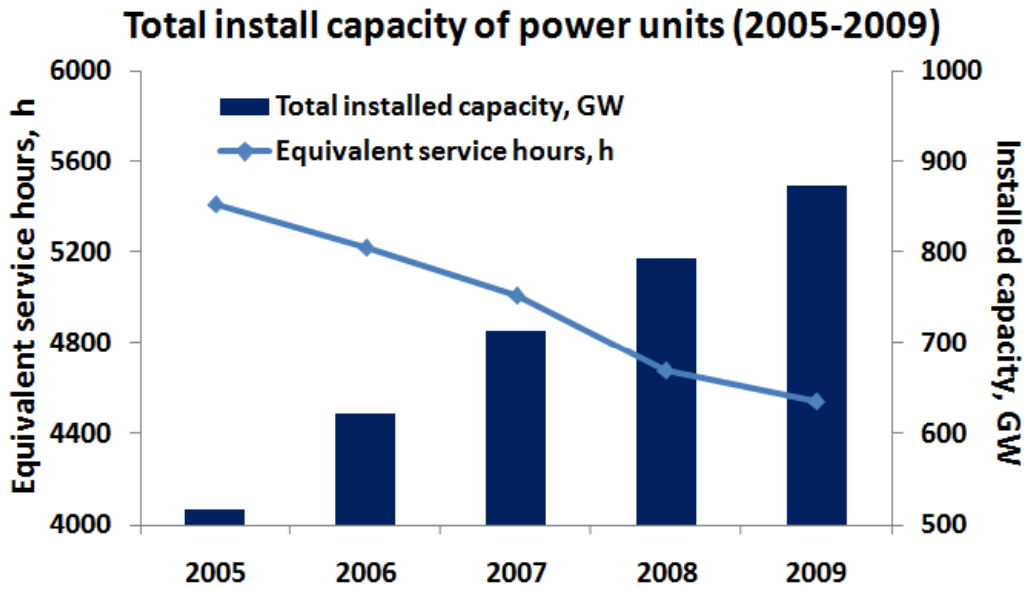


Another case: Overcapacity in China's industrial sectors which is under-studied



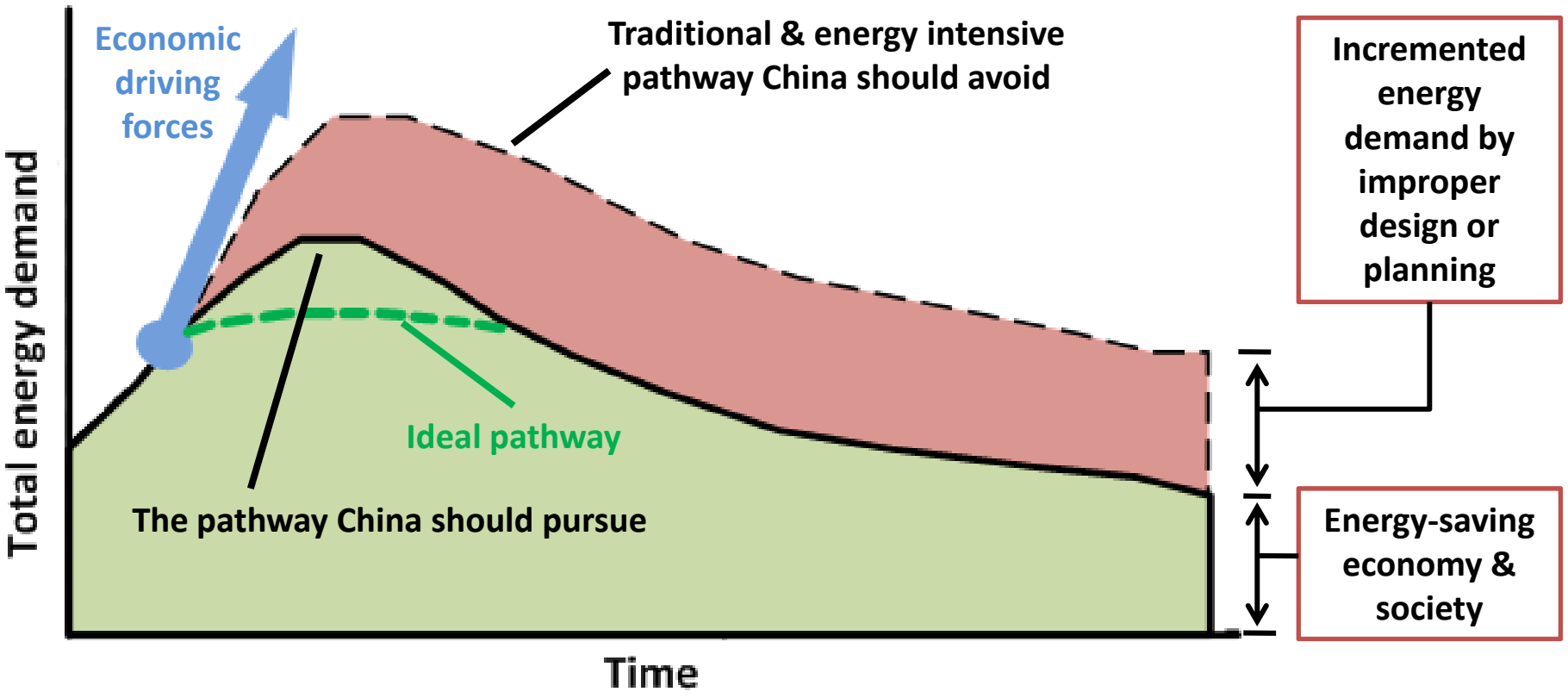
Source: European Chamber and Roland Berger Strategy Consultants. Overcapacity in China: Causes, impacts and recommendations. 2009.

Although excess capacities contribute China's GDP growth, it actually result in huge waste of energy.



Source: China Electricity Council

To think about China's energy conservation in a long run has strategic significances



Summary

- China's dynamic growth of energy consumption and high energy intensity are mainly caused by its economic development factors, such as industrialization and urbanization.
- The goal of China's energy conservation is to minimize the energy consumption during its whole development process. Therefore, it requires not only to establish strict energy-efficiency policies, but more important to develop comprehensive energy conservation strategies.
- Given the evidence that Capital-formation-driven energy demand accounts for large share of China's total energy demand, China should avoid its problems, such as overlapping construction and overcapacity, due to any improper design or planning, and pursue a less energy-consuming pathway.
- Systems analysis is urgently needed to reveal the correlation between China's economy and energy demand based on its dynamic domestic situation.

Acknowledgements

- **Chen, Wenying.** *Professor, Institute of Nuclear and New Energy Technology, Tsinghua University*
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