



China: Regional Industrial Structure and Energy Intensity

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Note: The views expressed in the ppt are that of the author and should not be attributed to her affiliated institution.

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Outline

- China's energy supply & demand situation
- Causes for the high growth of energy demand
- Energy development strategy and policies
- Regional Development and Energy Intensity
- Option of Economic Development Mode

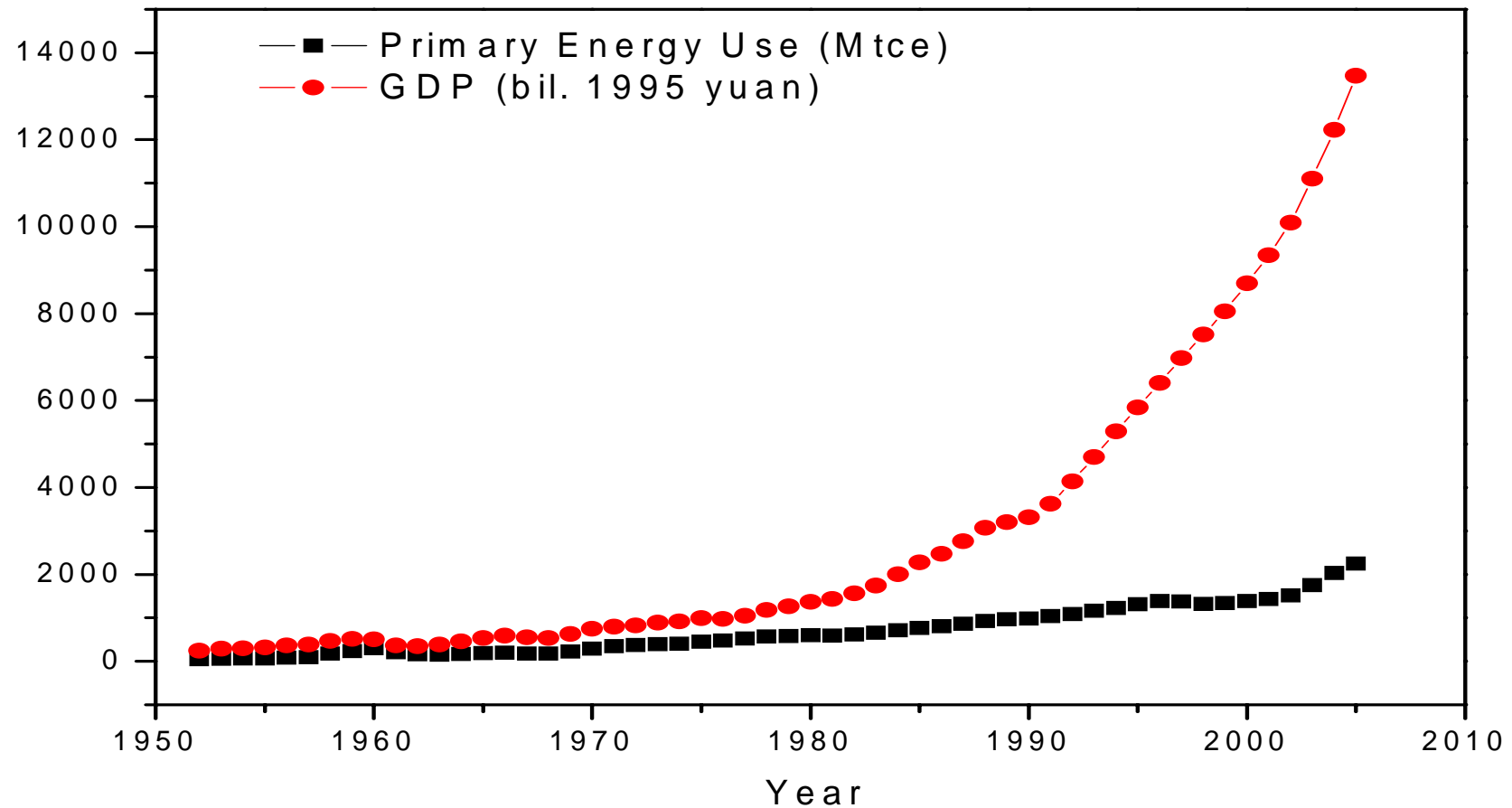


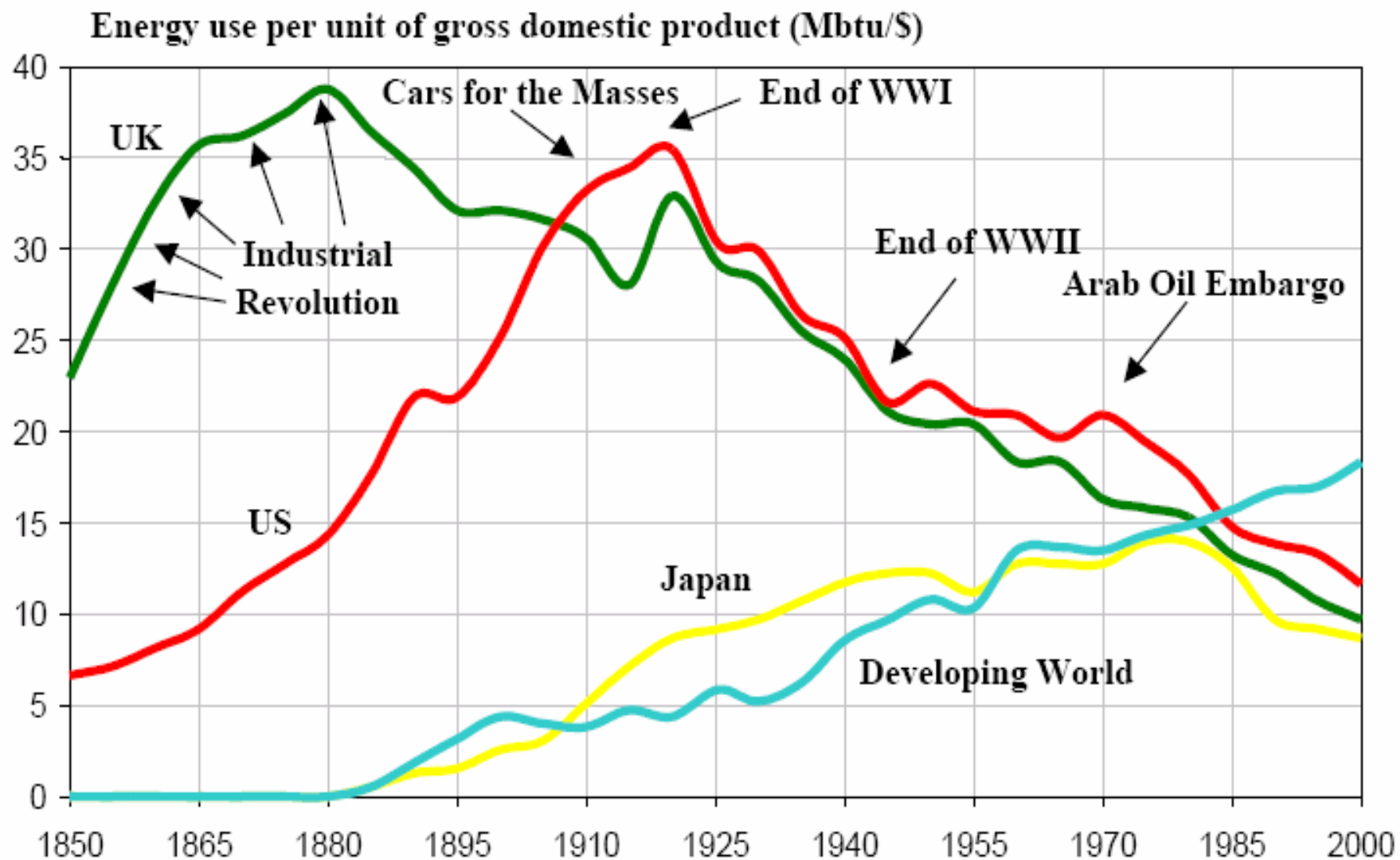
Energy Supply & Demand Situation

Since 2001, China's energy supply & demand situation has been significantly changed and the energy demand has been growing at unheard-of high speed



China's rapid economic growth is accompanied by rapid increase in energy use

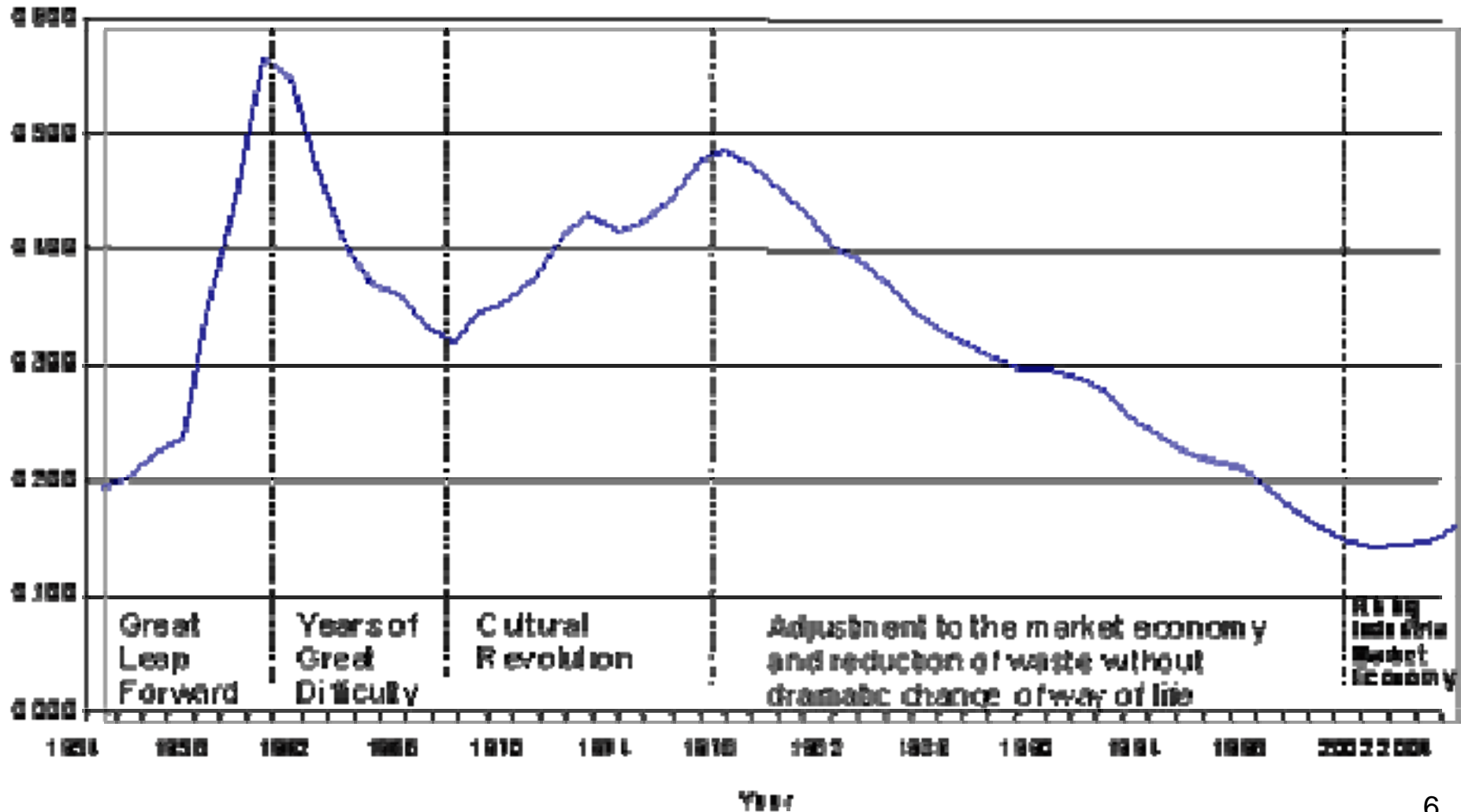




Source: DOE/EIA, 2000, Skov, 2000, DOC/BEA 2001, National Academy of Engineering, 1990



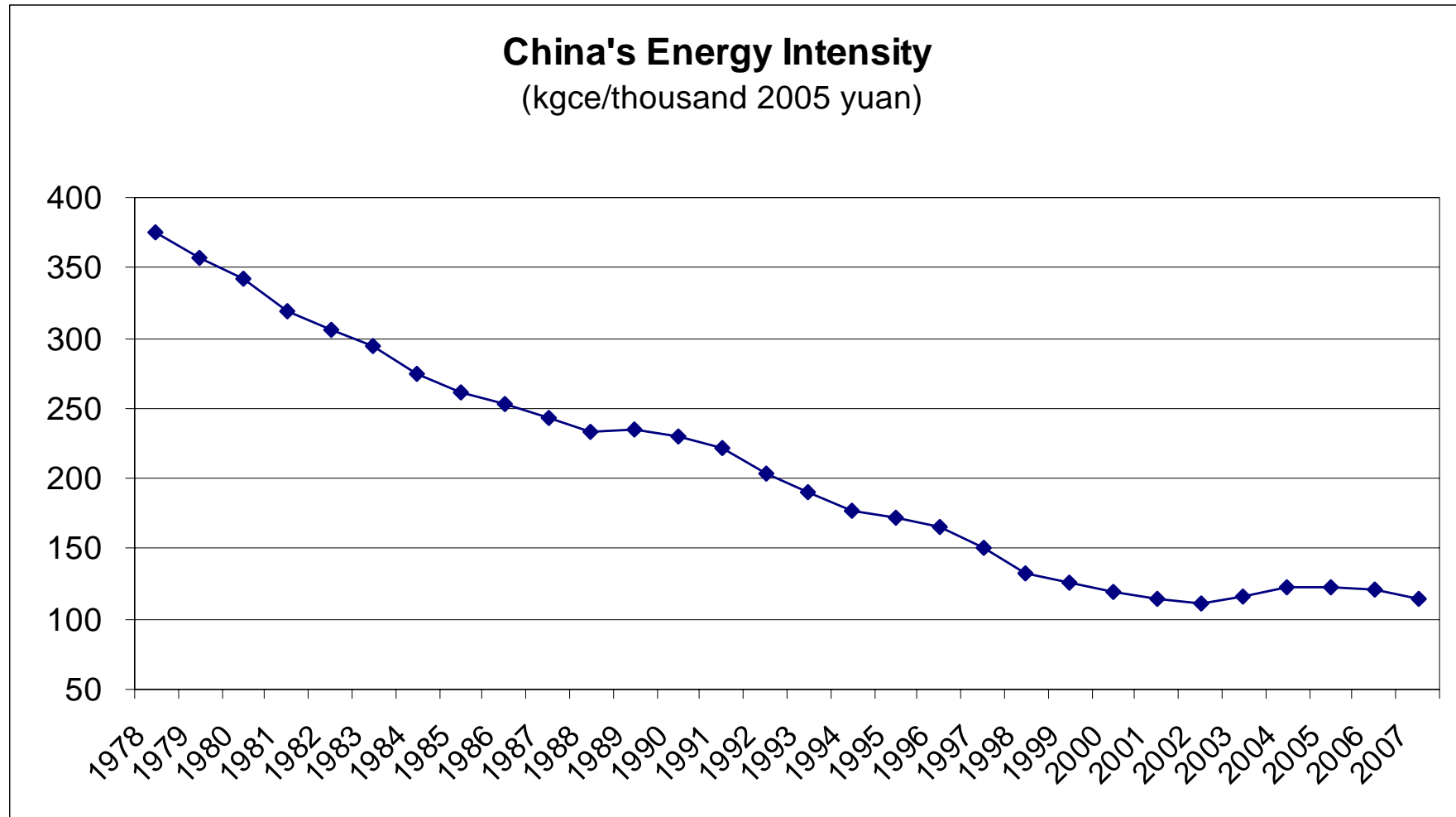
The Energy Intensity is High





China's Energy Intensity (1978-2007)

Kgce/thousand 2005 yuan





Since 2001 the annual average growth rate of the energy consumption is close to 10%, 2 times as the average growth rate of the first 20 years since 1978, and energy consumption elasticity is closed to 1

| | 1980-2000 | 2000-2006 | 1980-2006 |
|---------------------------------------|-------------|--------------|-------------|
| Economic Growth Rate | 9.62 | 9.76 | 9.65 |
| Energy Consumption Growth Rate | 4.41 | 9.8 | 5.63 |
| Energy Consumption Elasticity | 0.45 | 1.003 | 0.58 |



Growth Rate

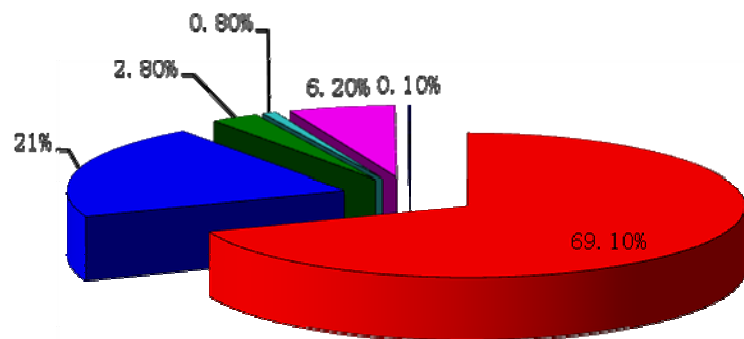
| | GDP | Energy consumption | Industrial COD | Industrial SO ₂ |
|---|------|--------------------|----------------|----------------------------|
| 6th Five-year (1981-1985) | 10.7 | 4.9 | | |
| 7th Five-year (1986-1990) | 7.9 | 5.2 | | |
| 8th Five-year(1991-1995) | 12.3 | 5.9 | 1.7 | -1.4 |
| 9th Five-year(1996-2000) | 8.6 | 1.1 | -1.7 | 2.9 |
| 10th Five-year(2001-2005) | 9.5 | 10.0 | -4.7 | 6.1 |

Data source: China's Statistical Yearbook 2006, China environmental statistic bulletin



Primary energy structure- Coal is dominant energy resource

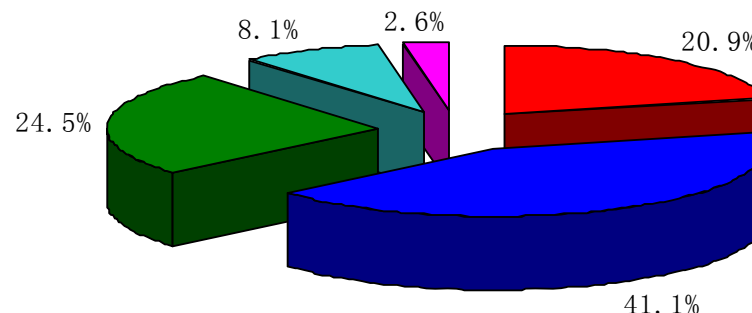
China in 2006



■煤炭 ■石油 ■天然气 ■核电 ■水电 ■其他可再生能源

Coal petroleum Natural gas Nuclear electricity hydropower
Other renewable energy resources

World average in 1998



■煤炭 ■石油 ■天然气 ■核电 ■水力

Coal petroleum Natural gas Nuclear power hydro power

source: Japanese Energy Economic Almanac, China Statistical Yearbook



Energy consumption of main energy intensive products and its comparison with the advanced levels in the World

| | China | | | Advanced level in the world | Gap from the advanced level in the world |
|---|--------|--------|---------|-----------------------------|--|
| | 1990 | 2000 | 2004 | | |
| Coal consumption by thermal power plants/gce/kWh | 427 | 392 | 379 | 312 | +21.5% |
| Comparable energy consumption per ton of steel production/kgce/t (in medium/large- sized enterprises) | 997 | 784 | 705 | 610 | +15.6% |
| Overall energy consumption by cement production/kgce/t | 201.1 | 181.0 | 157.0 | 127.3 | +23.3% |
| Alternating current power consumption by electrolytic aluminum production/kWh/t | 16,223 | 15,480 | 15,080* | 14,100 | +7.0% |
| Overall energy consumption by crude oil processing/kgce/t | 102.5 | 118.4 | 112.0 | 73.0 | +53.4% |



Causes for the high growth of energy demand



High economic growth rate

- **The economy grows continuously with high speed, the growth rate of GDP has been exceeded by 10% in recent four years continuously.**
- **The speed of growth of the secondary industry has exceeded that of GDP by 2 percentage points**
- **The secondary industry accelerates, while high energy intensive goods' growth rate is egregious**
 - ❖ The output of **crude steel** has been grown for more than one time from 0.1285 billion tons in 2000 to 0.423 billion tons in 2006
 - ❖ The output of **cement** has grown for more than one time to 1.24 billion tons in 2006
 - ❖ The annual average growth rate of the output of the ten species of **nonferrous metals** such as copper, aluminum, lead, zinc, etc has exceeded 10%
 - ❖ The annual average growth rate of main **chemical products** of sulfuric acid, soda ash, caustic soda, ethylene, etc is between 7% and 13%
 - ❖ The output of **automobile** has been grown nearly tripled, from 2500 thousand in 2000 to 7279 thousand in 2006
 - ❖ The **building area** grows 1.8-2.0 billion square meters annually



High energy intensive goods grow very fast since 2001

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | Average growth rate |
|--|--------|--------|--------|--------|--------|---------|---------|---------------------|
| Crude steel (粗钢) (10,000 tons) | 12,850 | 15,163 | 18,237 | 22,234 | 28,291 | 35,324 | 42,266 | 21.95% |
| Automobile (汽车) (10,000 cars) | 207 | 234 | 325 | 444 | 509 | 570 | 727 | 23.29% |
| Ethylene (乙烯) (10,000 tons) | 470 | 481 | 543 | 612 | 630 | 756 | 940 | 12.25% |
| Fertilizer (化肥) (10,000 tons) | 3,186 | 3,383 | 3,791 | 3,881 | 4,805 | 5,178 | 5,593 | 9.83% |
| Cement (水泥) (10,000 tons) | 59,700 | 66,104 | 72,500 | 86,208 | 96,682 | 106,885 | 123,500 | 12.88% |
| Plate glasses (玻璃) (10,000 weight boxes) | 18,352 | 20,964 | 23,446 | 27,703 | 37,026 | 40,210 | 40,499 | 14.10% |
| Electrolyzed Aluminum (电解铝) (10,000 tons) | 279 | 337 | 432 | 554 | 669 | 779 | 935 | 22.33% |



Low efficiency and waste

- Electric power installed capacity with small unit capacity around 70 million kilowatts.
- Concerning steel production capacity, blast furnace below 400 cubic meters amounts to 0.1 billion tons
- The wasted energy of the nation amounts to 0.4 billion tons standard coal equivalent



insufficient Energy resource, National resource is difficult to support social economic development

Output of fossil energy of 2005 and proved workable reserves at the end of the year

| | Consumption | | Output | | Reserve | | |
|---|-------------|------|--------|------|---------------------------------|------|---------------------|
| | Consumption | Rank | Output | Rank | Workable Reserve at end of year | Rank | Reserve/pro duction |
| Coal (0.1billion tons) | 21.4 | 1 | 21.9 | 1 | 1145 | 3 | 52.2 |
| Petroleum (0.1billion tons) | 3.0 | 2 | 1.8 | 5 | 23 | 11 | 12.8 |
| Natural Gas (0.1billion m ³) | 450 | 18 | 450 | 16 | 22300 | 21 | 49.5 |

■ Fossil resource reserve per capita

- ❖ Coal-- 60% of world's average per capita;
- ❖ Petroleum--10% of world's average per capita; natural
- ❖ Gas--only 10% of world's average per capita

■ Renewable energies,

- ❖ Hydropower energy resource technical development capacity is 378.5GW, economic development capacity is 294GW.
- ❖ Wind energy resource: ashore and offshore technical development capacity are respectively 250GW and 750GW



External dependence of petroleum is increasingly higher, energy safety issue becomes outstanding

- **Crude oil consumption for 1990 was 0.118 billion tons and that grew to 0.3 billion tons in 2005**
- **The scope of output growth is small, maintained at about 0.18 billion tons and imports grows swiftly**
- **In 1996, China has become the crude oil net importer country; during the 10 years, external dependence had increased to 50%**



Environmental pollution caused by energy consumption has brought heavy burden to the environment

- **SO₂ and dust discharge caused by energy consumption has exceeded 80% of the gross discharge amount**
- **SO₂ discharge of 2005 exceeded 25 million tons**
- **Acid rain area occupies above one third of the country area**
- **More than 90% of the coal burning plant are not equipped with desulphurization facility.**
- **Coal exploitation has caused add up to 0.4 million hectare land collapse**
- **Annual sewage discharge of coal exploitation amounts to 3 billion cubic meters**
- **Mine exhaust emission amount (main basis is CH₄) is 9-12 billion cubic meters**

Major indicators of economic and social development in the 11th five-year plan period

| Category | Indicators | Yr. 2005 | Yr. 2010 | Annual growth rate (%) | Attribute |
|---------------------------------------|---|----------|----------|------------------------|-------------|
| Economic Growth | GDP (Trillion Yuan) | 18.2 | 26.1 | 7.5 | Anticipated |
| | Per Capita GDP (Yuan) | 13985 | 19270 | 6.6 | Anticipated |
| Economic Structure | Ratio of Added Value of Service Industry (%) | 40.3 | 43.3 | [3] | Anticipated |
| | Employment Ratio of Service Industry (%) | 31.3 | 35.3 | [4] | Anticipated |
| | Ratio of Expenditures on R & D to GDP (%) | 1.3 | 2 | [0.7] | Anticipated |
| | Urbanization Rate (%) | 43 | 47 | [4] | Anticipated |
| Population, Resources and Environment | Total Population (10,000 people) | 130756 | 136000 | < 8‰ | Obligatory |
| | Reduction of Energy Consumption per Unit GDP (%) | | | [20] | Obligatory |
| | Reduction of Water Consumption per Unit Industrial Added Value (%) | | | [30] | Obligatory |
| | Efficient Utilization Coefficient of Agricultural Irrigation Water | 0.45 | 0.5 | [0.05] | Anticipated |
| | Comprehensive Utilization Rate of Industrial Solid Wastes (%) | 55.8 | 60 | [4.2] | Anticipated |
| | Total Cultivated Land (100 million ha.) | 1.22 | 1.2 | -0.3 | Obligatory |
| | Reduction of Total Major Pollutants Emission Volume (%) | | | [10] | Obligatory |
| Forest Coverage (%) | 18.2 | 20 | [1.8] | Obligatory | |
| Public Services and Life Quality | Average Schooling Years of Citizens (Yr.) | 8.5 | 9 | [0.5] | Anticipated |
| | Population Covered by Basic Pension in Urban Areas (billion people) | 1.74 | 2.23 | 5.1 | Obligatory |
| | Coverage of the New Rural Cooperative Healthcare System (%) | 23.5 | > 80 | > [56.5] | Obligatory |
| | Newly Increased Urban Employment in Five Years (10,000 people) | | | [4500] | Anticipated |
| | Rural Labor Force Transferred in Five Years (10,000 people) | | | [4500] | Anticipated |
| | Registered Urban Unemployment Rate (%) | 4.2 | 5 | | Anticipated |
| | Per Capita Disposable Income of Urban Households (Yuan) | 10493 | 13390 | 5 | Anticipated |
| | Per Capita Net Income of Rural Households (Yuan) | 3255 | 4150 | 5 | Anticipated |

Note: Figures of GDP and urban resident income are of 2005 price; those in [] are accumulative figures in five years; major pollutants refers to sulfur dioxide and COD.



Object of Development

Total amount of consumption and its structure

- By the year 2010, the target of control of total amount of consumption of primary energy is around 2.7 billion tons standard coal Equivalent (SCE), with average annual growth rate of 4%. Coal, petroleum, natural gas, nuclear electricity, hydro-electricity and other renewable energy resources will have a share of 66.1%, 20.5%, 5.3%, 0.9%, 6.8% and 0.4% respectively of total amount of consumption of energy. Compared with the year of 2005, the share of coal and petroleum is declined 3.0 and 0.5 percentage points, while the share of natural gas, nuclear electricity, hydro-electricity and other renewable energy resources have been increased by 2.5, 0.1, 0.6 and 0.3 percentage points respectively



31 Provinces: Population (million)

| | | | | | |
|------------------|-------|---------------------|-------|-----------------------|-------|
| Henan | 93.71 | Yunnan | 44.42 | Inner Mongolia | 23.86 |
| Shandong | 92.39 | Jiangxi | 43.07 | Xinjiang | 20.08 |
| Guangdong | 91.85 | Liaoning | 42.20 | Shanghai | 17.78 |
| Sichuan | 82.08 | Heilongjiang | 38.18 | Beijing | 15.36 |
| Jiangsu | 74.68 | Guizhou | 37.25 | Tianjin | 10.43 |
| Hebei | 68.44 | Shaanxi | 37.18 | Hainan | 8.26 |
| Hunan | 63.20 | Fujian | 35.32 | Ningxia | 5.95 |
| Anhui | 61.14 | Shanxi | 33.52 | Qinghai | 5.43 |
| Hubei | 57.07 | Chongqing | 27.97 | Tibet | 2.76 |
| Zhejiang | 48.94 | Jilin | 27.15 | | |
| Guangxi | 46.55 | Gansu | 25.92 | | |

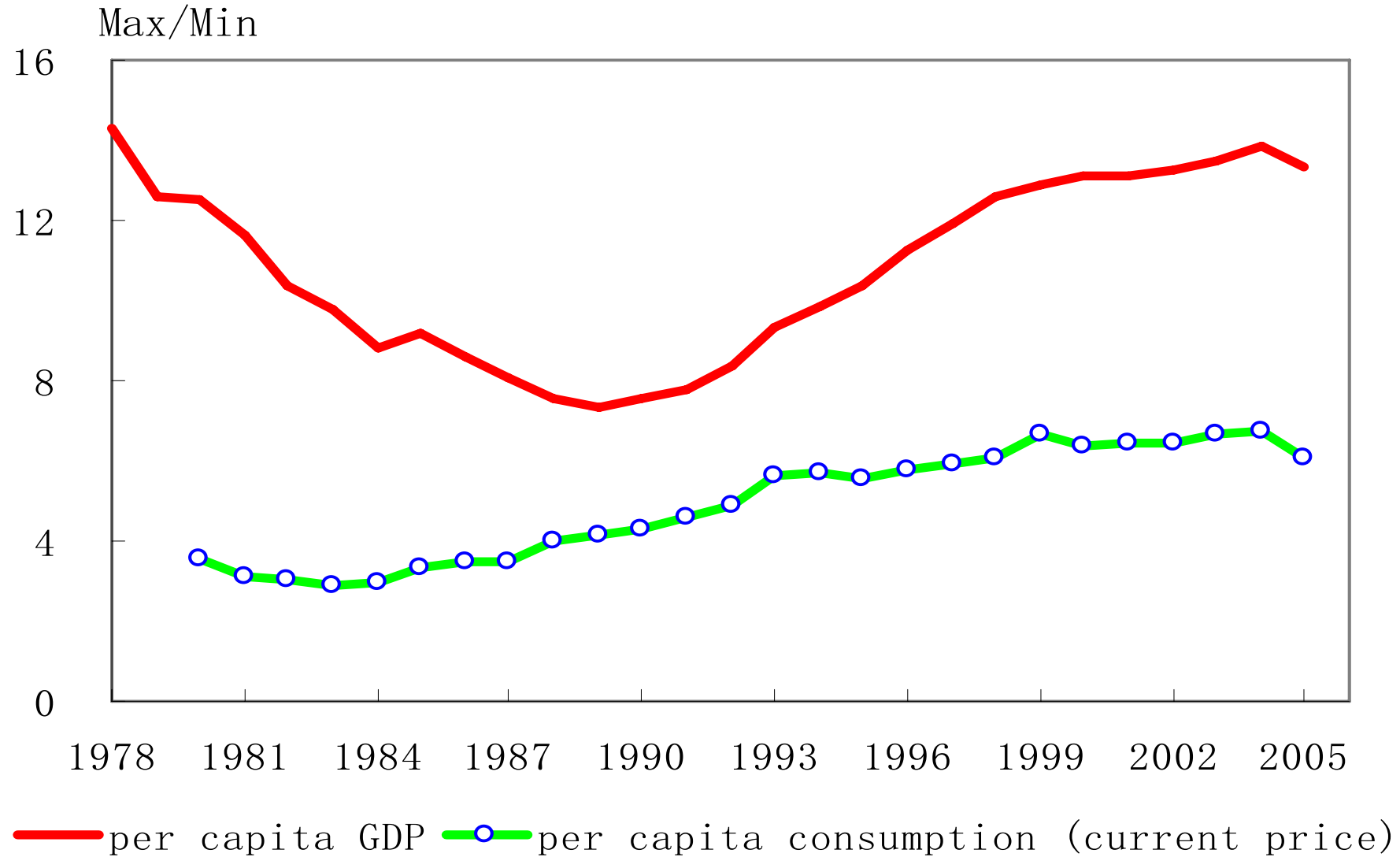


31 Provinces: Area (km²)

| | | | | | |
|-----------------------|-----------|------------------|---------|------------------|---------|
| Xinjiang | 1,660,000 | Hebei | 190,000 | Fujian | 121,400 |
| Tibet | 1,228,400 | Jilin | 187,400 | Jiangsu | 102,600 |
| Inner Mongolia | 1,183,000 | Hubei | 185,900 | Zhejiang | 101,800 |
| Qinghai | 722,000 | Guangdong | 179,800 | Chongqing | 82,400 |
| Sichuan | 485,000 | Guizhou | 176,100 | Ningxia | 66,400 |
| Gansu | 455,000 | Henan | 167,000 | Hainan | 35,000 |
| Heilongjiang | 454,000 | Jiangxi | 166,947 | Beijing | 16,807 |
| Yunnan | 394,000 | Shandong | 157,100 | Tianjin | 11,305 |
| Guangxi | 236,300 | Shanxi | 156,000 | Shanghai | 6,341 |
| Hunan | 211,875 | Liaoning | 145,700 | | |
| Shaanxi | 205,600 | Anhui | 139,600 | | |

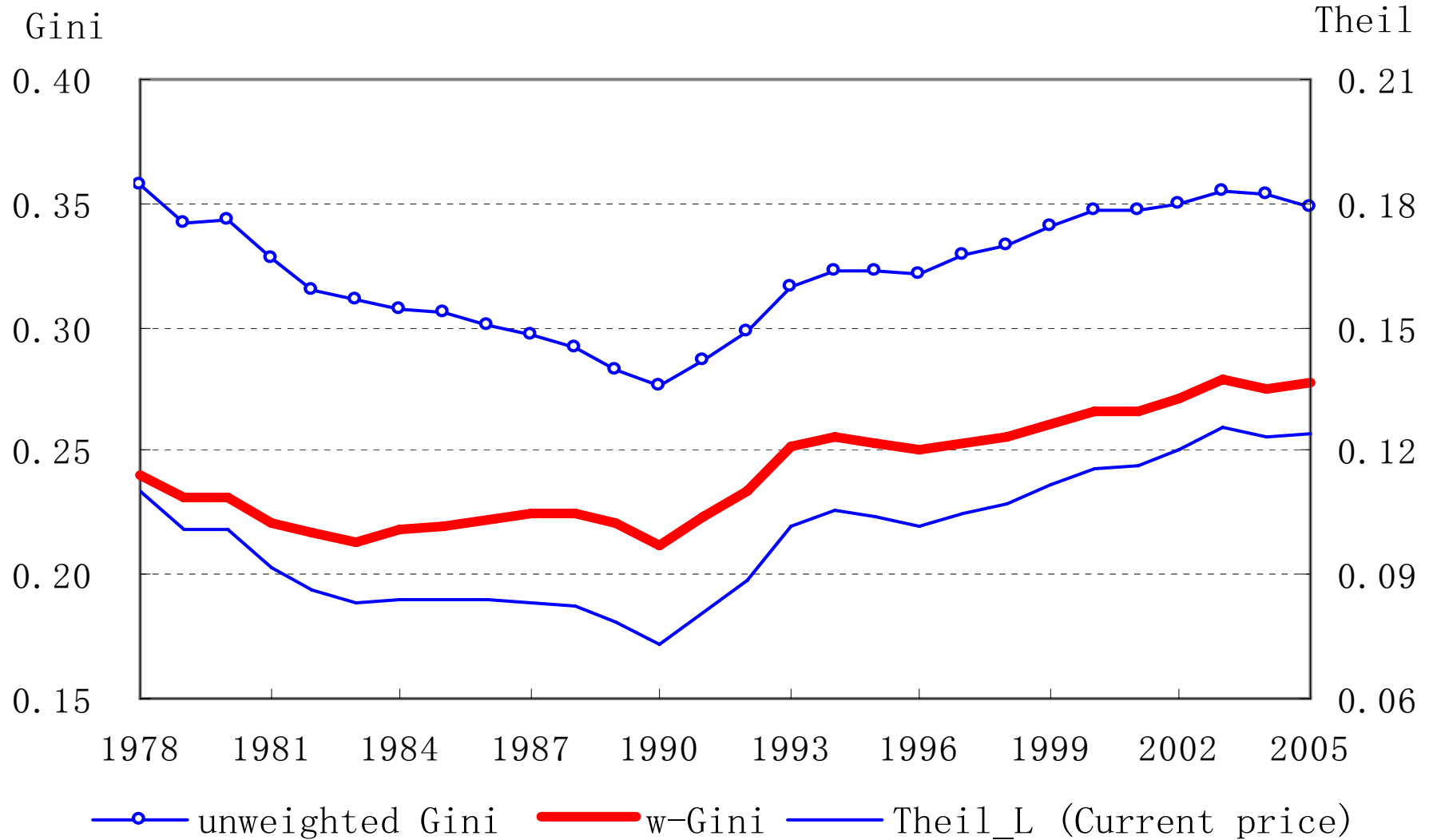


Inter-Provinces– Max/Min



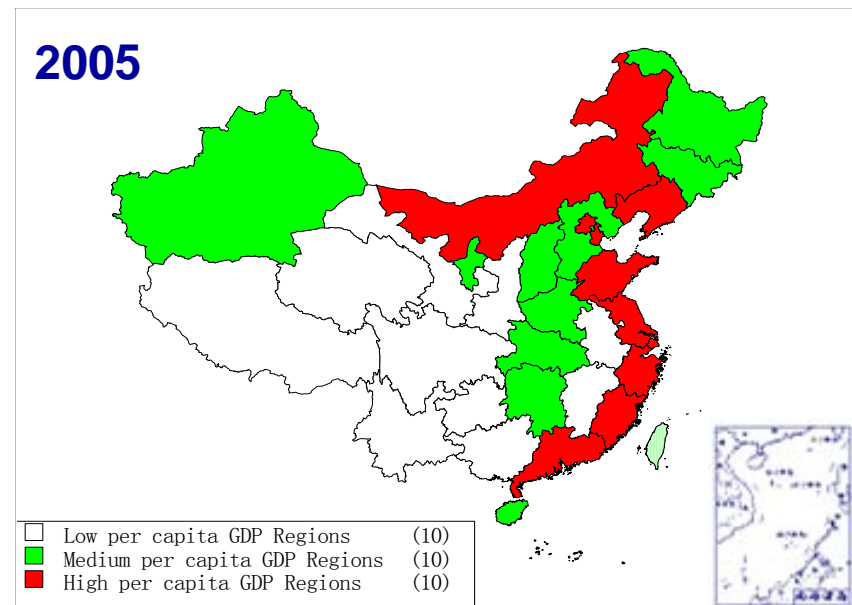
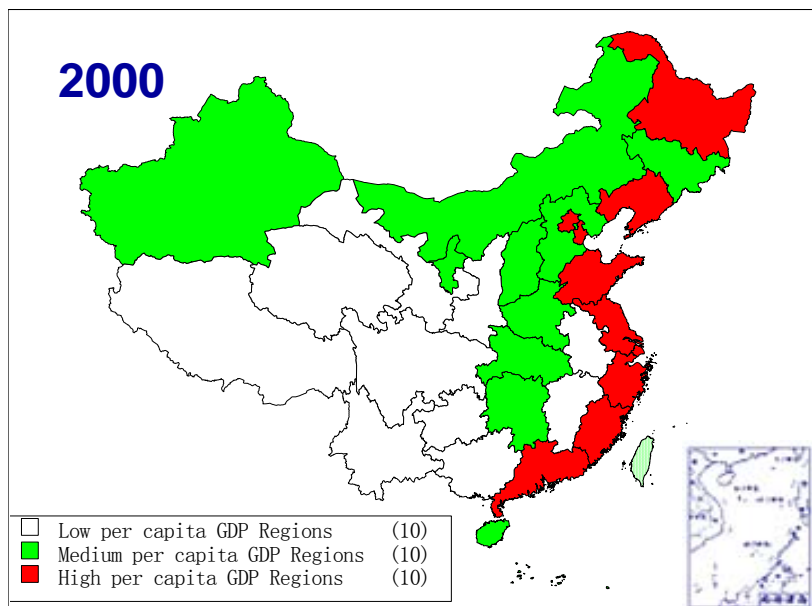
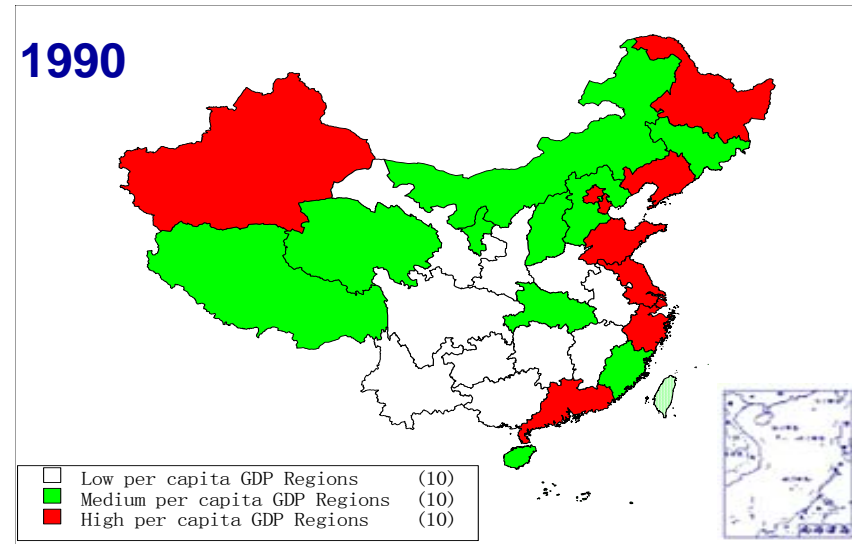
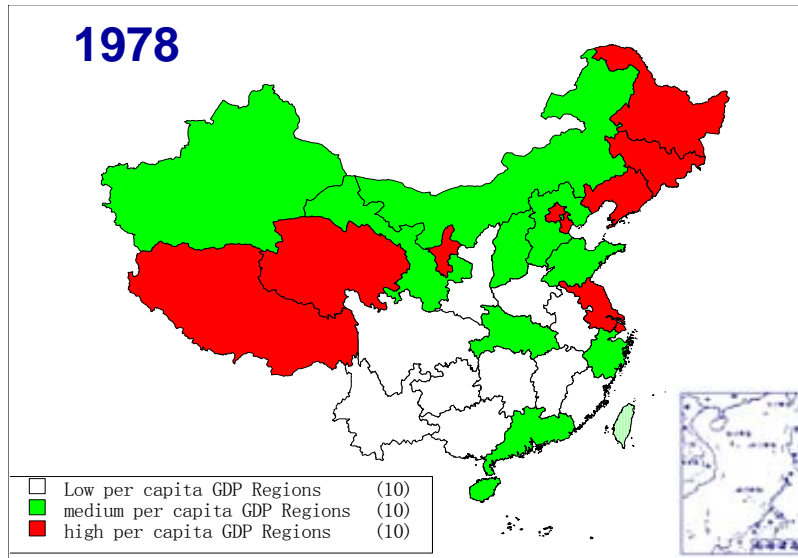


Inter-Provinces— Gini and Theil index (at current price)



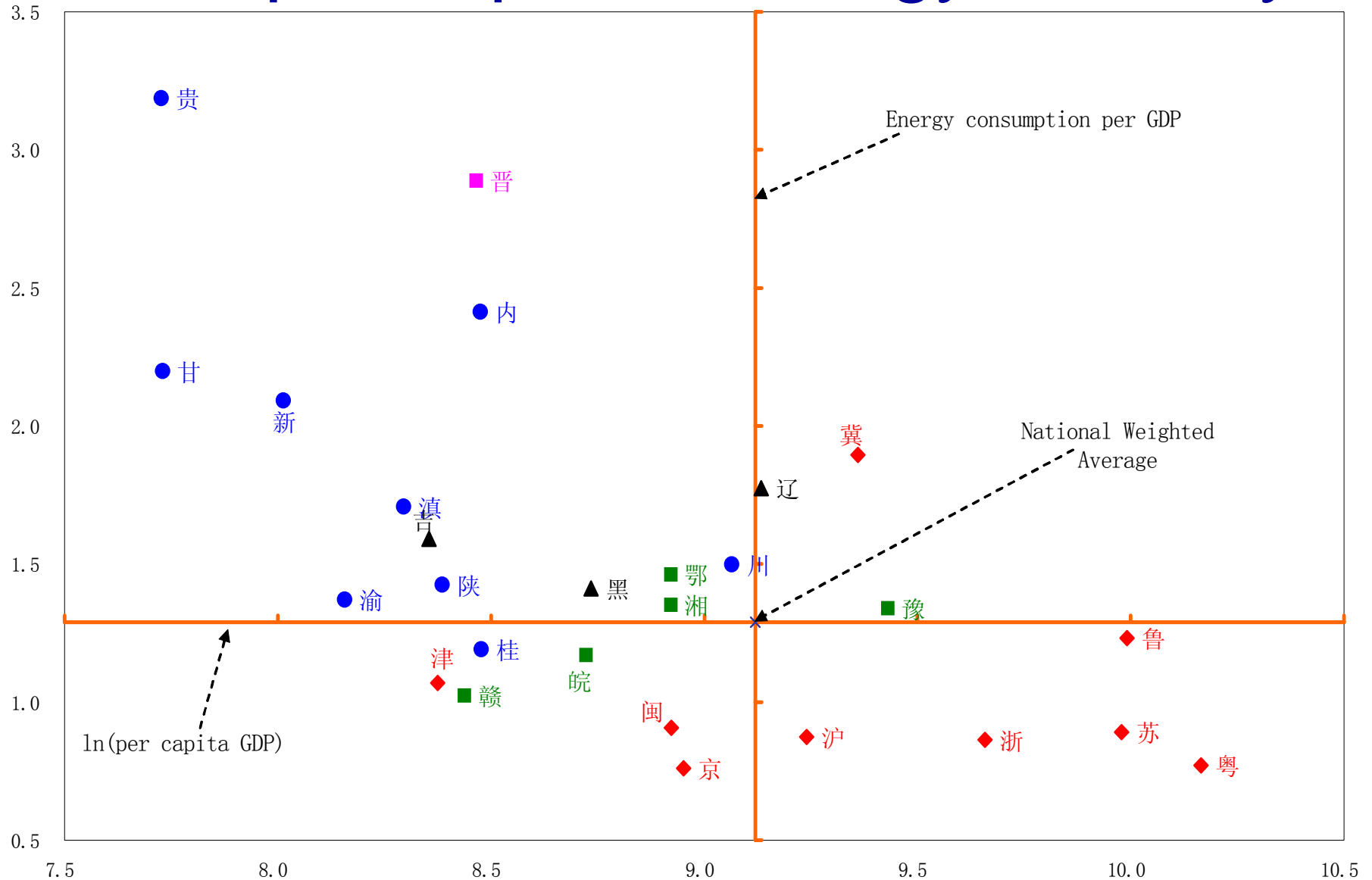


Provincial per capita GDP



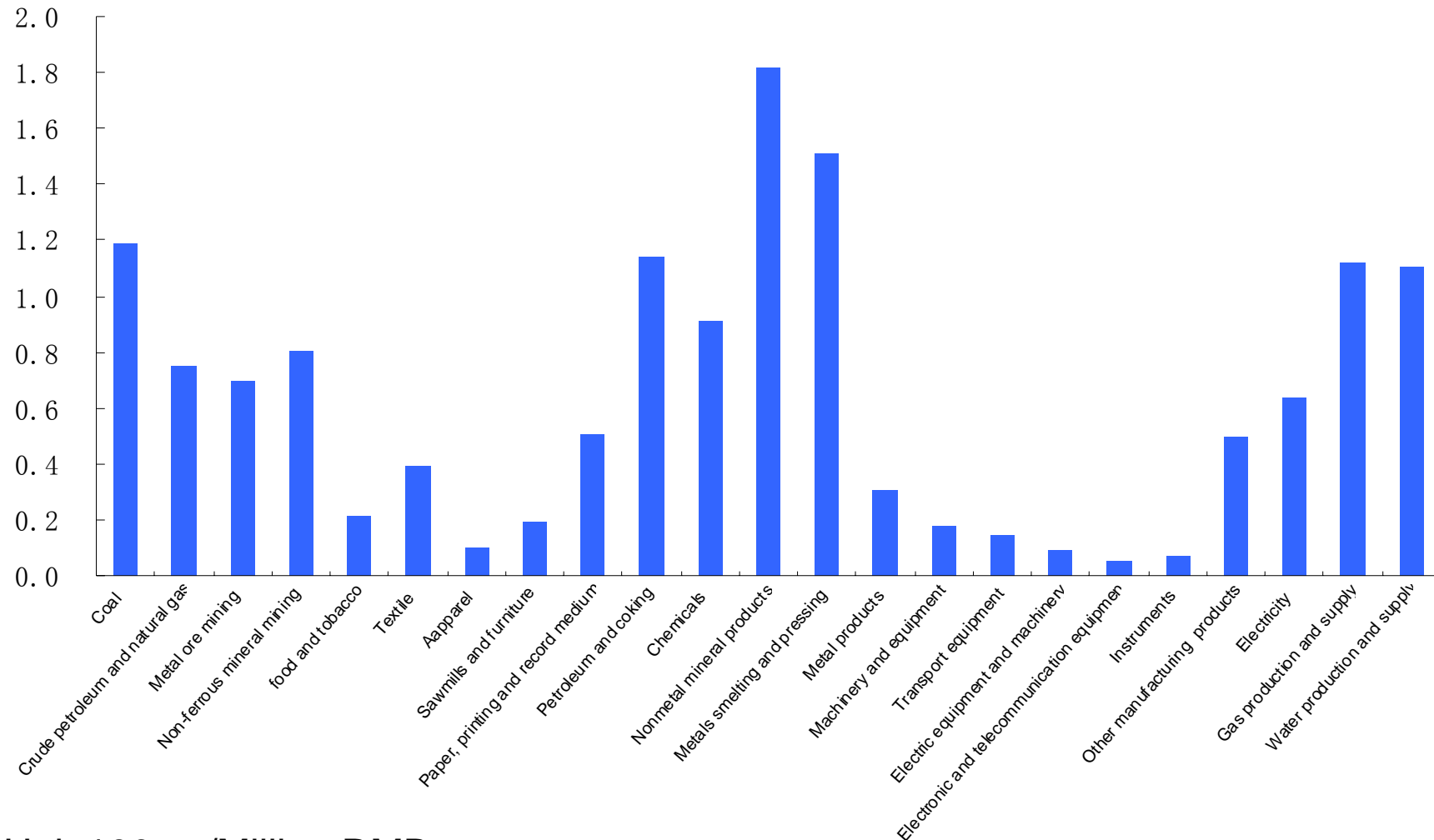


GDP per capita & Energy Intensity





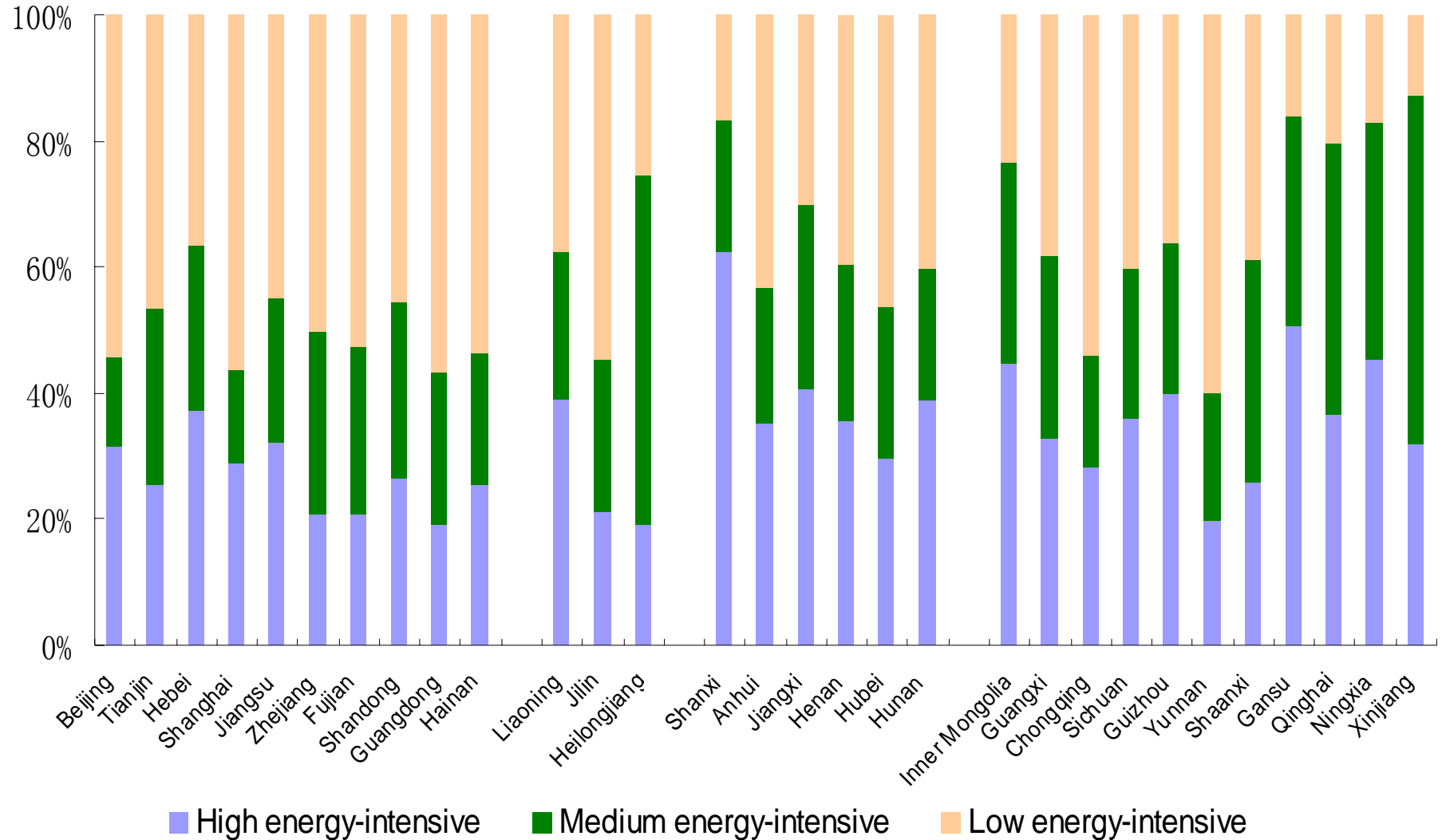
Energy intensity by sectors, 2004



Unit: 100tce/Million RMB



Composition of Industrial Output by energy intensity





Decomposition of Energy intensity

$$\frac{E_2}{GDP_2} - \frac{E_1}{GDP_1} = \frac{A'_2 X_2}{GDP_2} - \frac{A'_1 X_1}{GDP_1}$$

$$= \underbrace{(A'_2 - A'_1) S_1}_{\text{Sectoral Efficiency}} + \underbrace{A'_1 (S_2 - S_1)}_{\text{Structural effect}} + \underbrace{(A'_2 - A'_1)(S_2 - S_1)}_{\text{Residua}}$$

Sectoral Efficiency

Structural effect

Residua

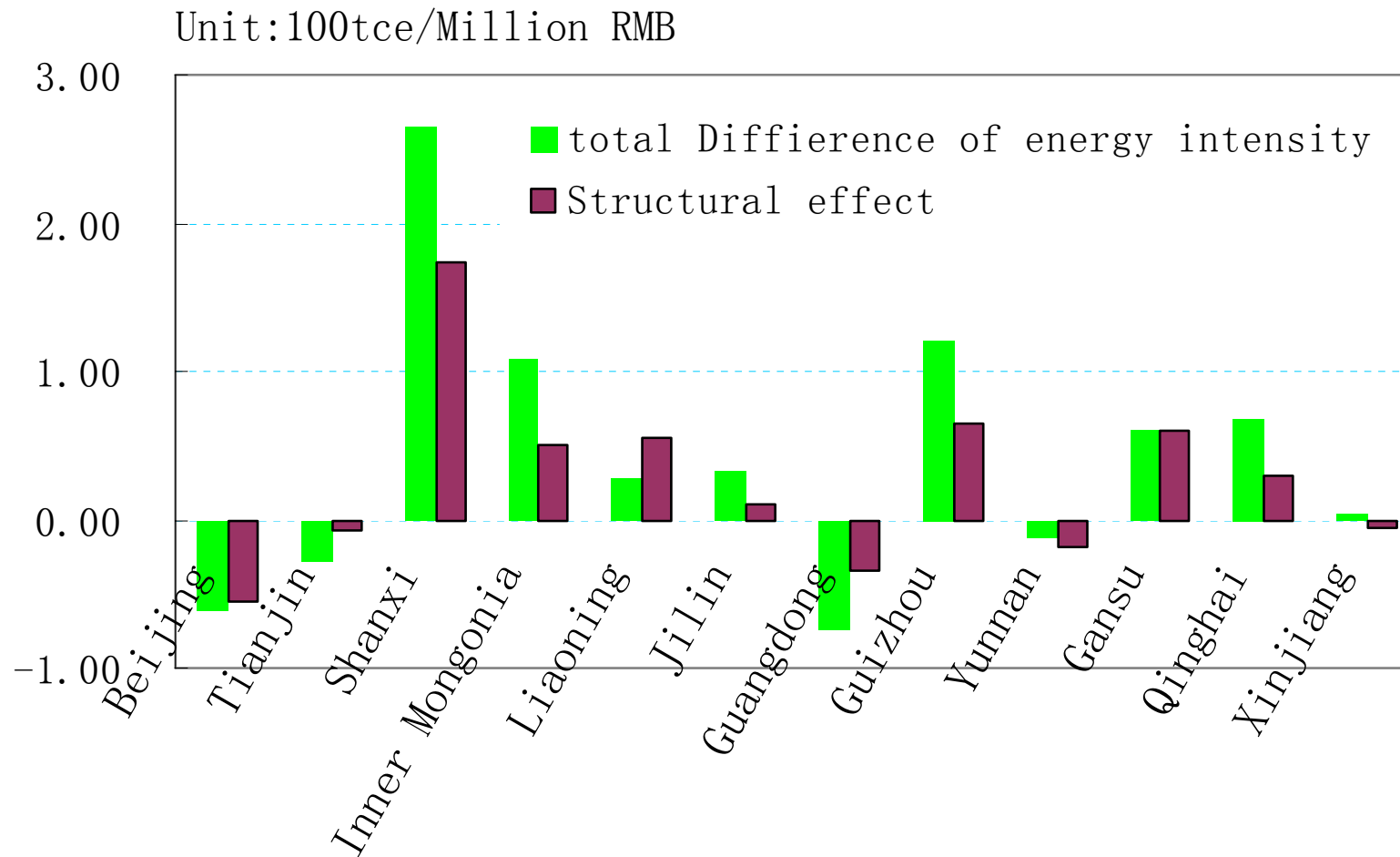
$$A_i = \left(\frac{E_{i1}}{TVA_{i1}}, \frac{E_{i2}}{TVA_{i2}}, \dots, \frac{E_{i24}}{TVA_{i24}} \right)$$

$$S_i = \begin{pmatrix} \frac{TVA_{i1}}{GDP_i} \\ \frac{TVA_{i2}}{GDP_i} \\ \dots \\ \frac{TVA_{i24}}{GDP_i} \end{pmatrix}$$

$$E_i = \sum_{j=1}^{24} E_{ij}$$



Contributions to the difference of regional energy intensity





Option of Mode of Economic Development



Sustainable Production, Consumption, and Trade energy saving can be achieved through three aspects:

- Structural saving
- Technical saving
- Institutional saving



Structural saving

- **Structure of primary, secondary and tertiary industries,**
- **Structure of industry**
- **Division of Labor structure of industries among countries**
- **Structure of urban Development**
 - ❖ The admixture of and relations among small-sized, medium-sized and large-sized cities
 - ❖ To optimize the functions and layout of cities, advocating “compact cities” and “expansion in a smart way”
 - ❖ To establish a transportation system conducive to energy saving.
- **Structure of transportation modes**
- **Consumption structure**



Institutional saving

- **Law**
 - ❖ Conservation Law
- **Standards**
- **Governance**
- **Public participation**
- **Tax**
- **Incentive System**



Thank you very much!