China’s energy challenges

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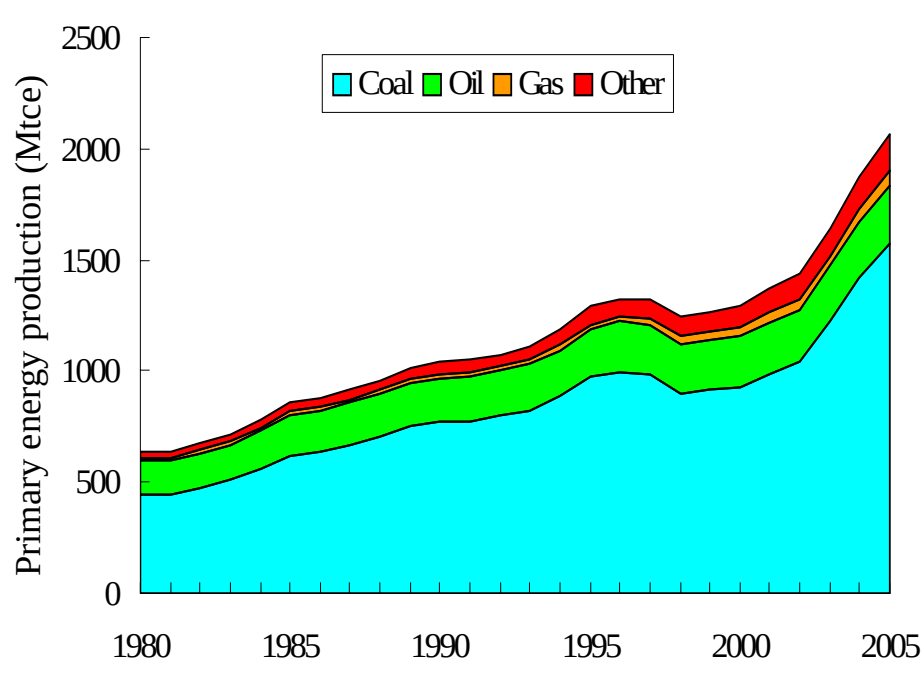
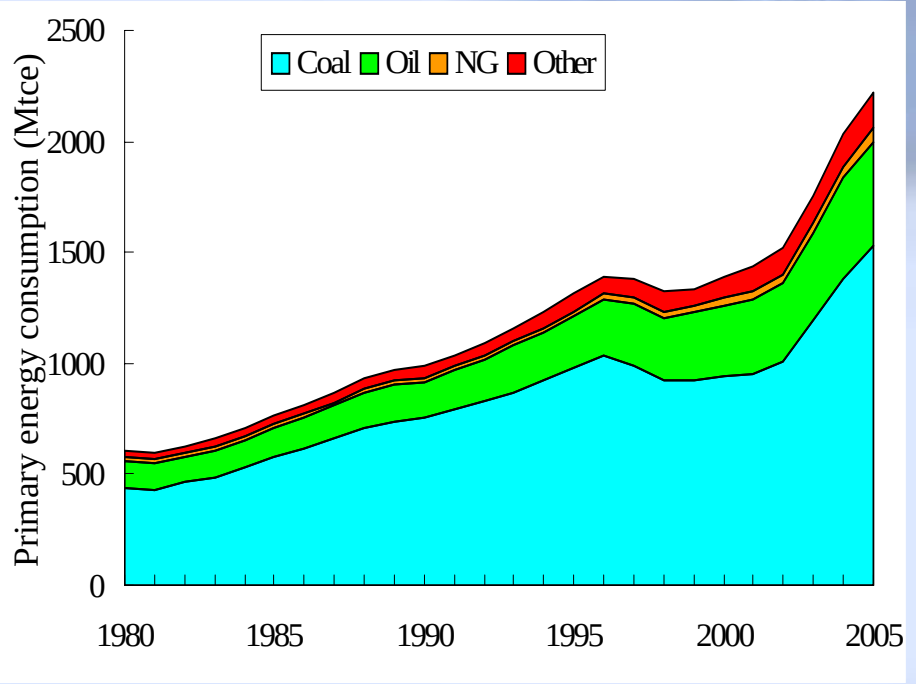
Outline of the presentation

- China's current energy situation
- Challenges facing China energy
  - Energy mix optimization
  - Energy efficiency improvement
  - Energy security
  - Local environment protection
  - Global climate change
- Energy development perspective and policies addressing energy challenges
- Long-term energy development scenario

China’s current energy situation

Primary energy production and consumption





1980 – 1984: low increasing of energy consumption due to decreasing proportion of secondary industry

1985 – 1996: accelerating increasing of energy consumption due to the light industry expansion

1996 – 2000: energy consumption increasing fluctuation

2000– 2005: accelerating increasing of energy consumption

Factors causing fast increase of energy consumption in recent years

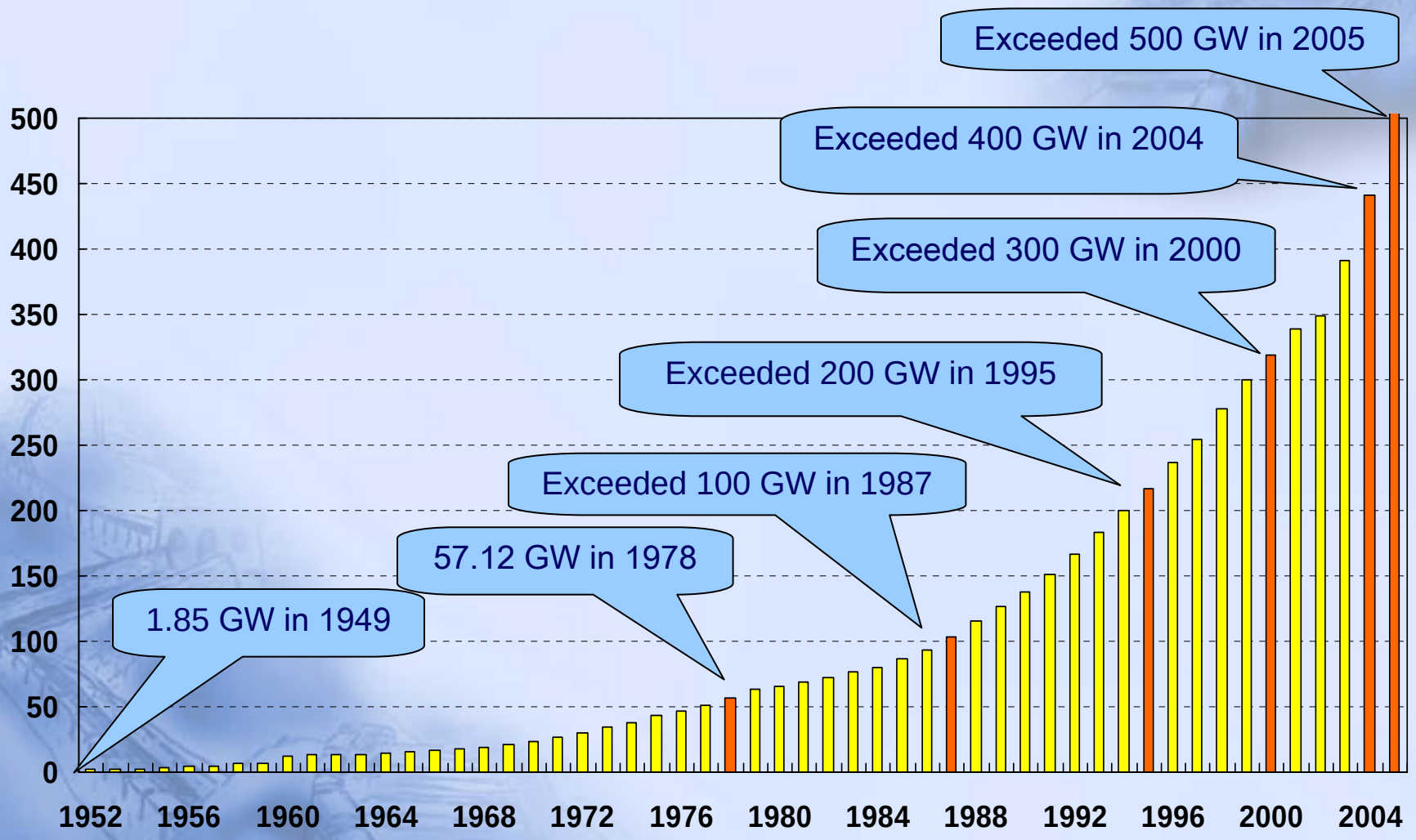
- **Upgrade of consumption structure- - shift to car and housing**
  - **Private passenger vehicle ownership**

    2000 0.28 vehicles/100people 2005 1 vehicles/100people
  - **Per capita living floor area in urban**

    2000 20.3 sq. m 2005 ~26 sq. m
- **Average 1% annual increase of urbanization rate**

  2000 36% 2005 43%
- **Over growth of chemical and heavy industries**
  - **Steel: 131Mton(2000), 397Mton(2005), AGR 25%**
  - **Cement: 597Mton (2000), 1064Mton(2005), AGR 12%**

China's Power Sector Development



Power mix

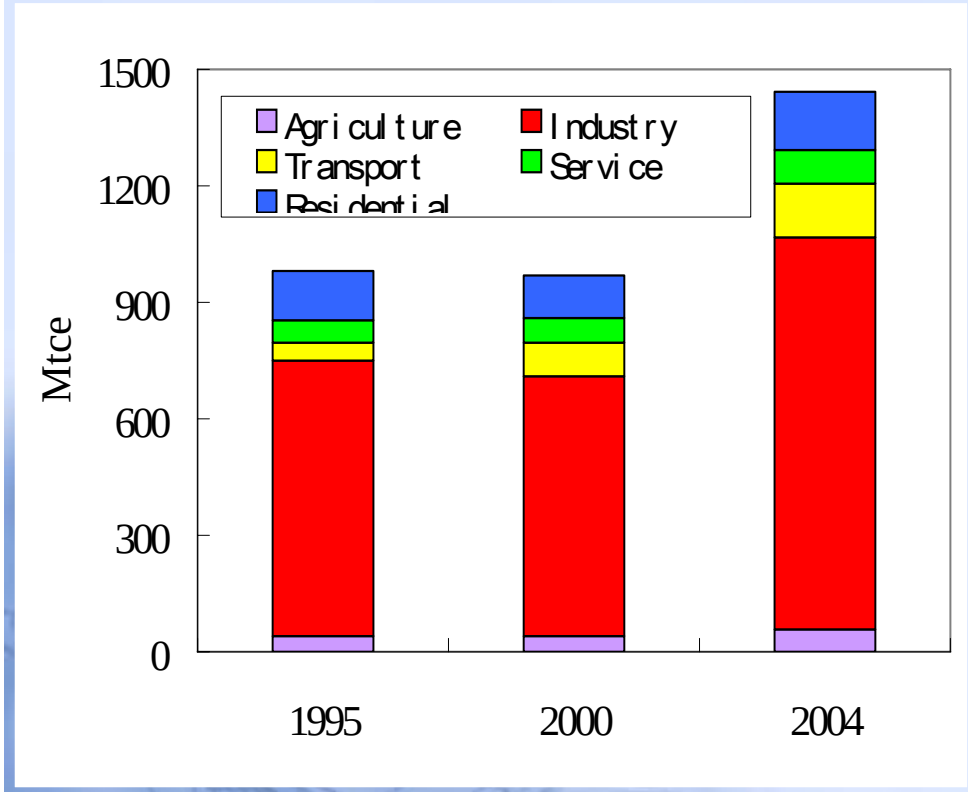
	Capacity/GW				Output/TWh			
	Total	Thermal	Hydro	Nuclear	Total	Thermal	Hydro	Nuclear
1980	65.9	45.6	20.3		301	243	58	
1985	87	60.6	26.4		411	318	92	
1990	137.9	101.8	36		621	495	126	
1995	217.2	162.9	52.2	2.1	1007	807	187	13
2000	319.3	237.5	79.4	2.1	1369	1108	243	17
2001	338.5	253	83	2.1	1484	1205	261	18
2002	356.6	265.6	86	4.5	1654	1352	275	27
2003	391.4	289.6	94.7	7.0	1905	1579	282	44
2004	442.4	329.6	105.3	7.5	2194	1810	331	53
2005	508.4	384.4	116.4	7.6	2500	2048	398	55

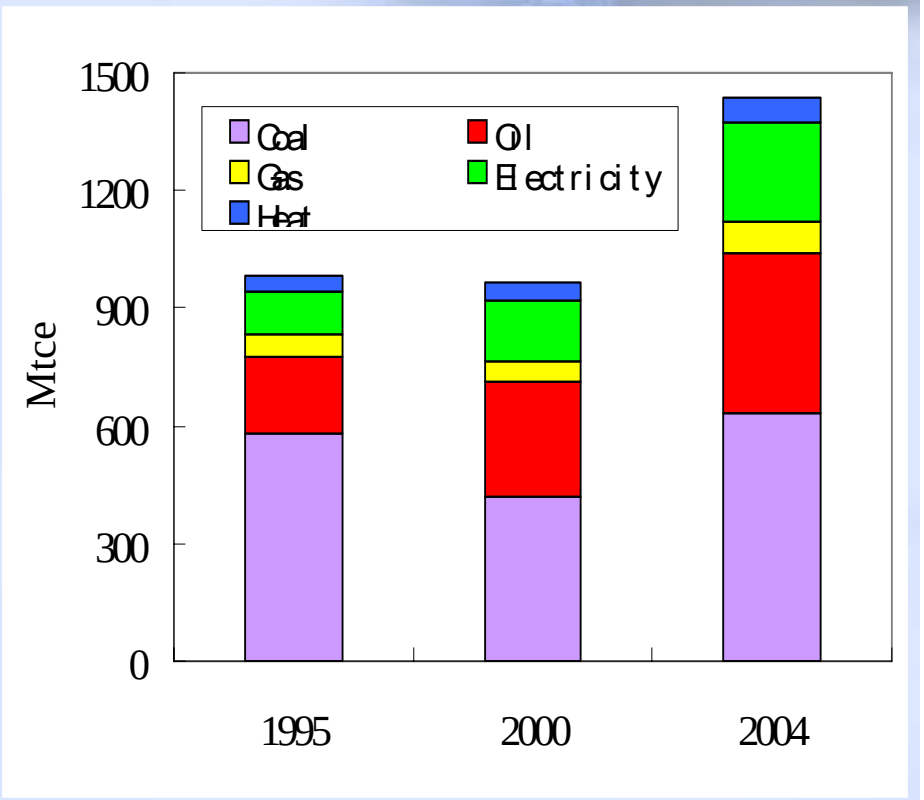
1995:28.4% 2005:38.4%; 1995:9.77% 2005: 14.38%

Energy elasticity

	1981-1990	1991-2000	2001-2005
GDP AGGR(%)	9.28	10.43	9.54
Energy production AGGR(%)	5.01	2.18	9.82
Energy consumption AGGR(%)	5.06	3.45	10.02
Electricity output AGGR (%)	7.53	8.12	13.02
Energy prodution elasticity	0.54	0.209	1.03
Energy consumption elasticity	0.545	0.331	1.05
Electricity elasticity	0.811	0.778	1.366

Final energy consumption

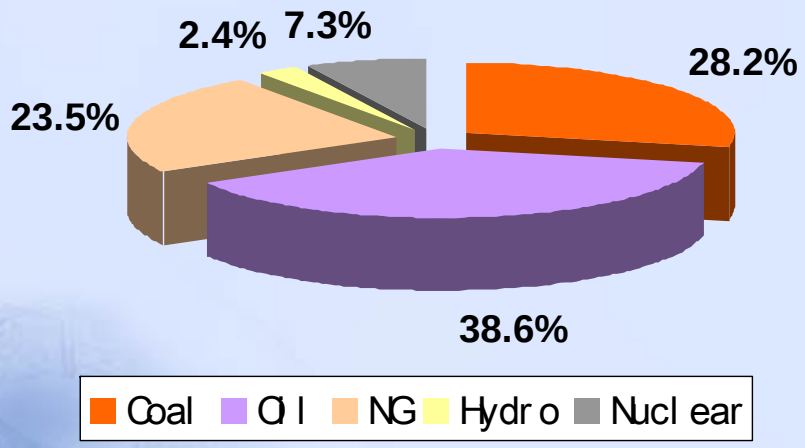




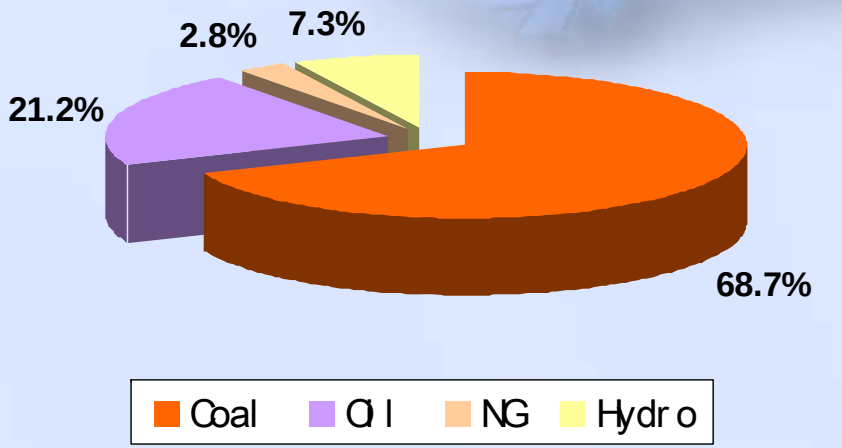
Challenges Facing China Energy

1. Energy mix optimization

Comparison of primary energy consumption mix



World 2004

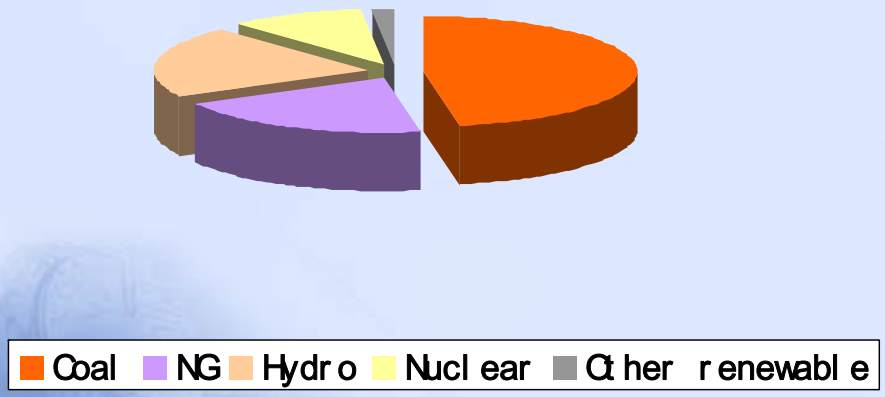


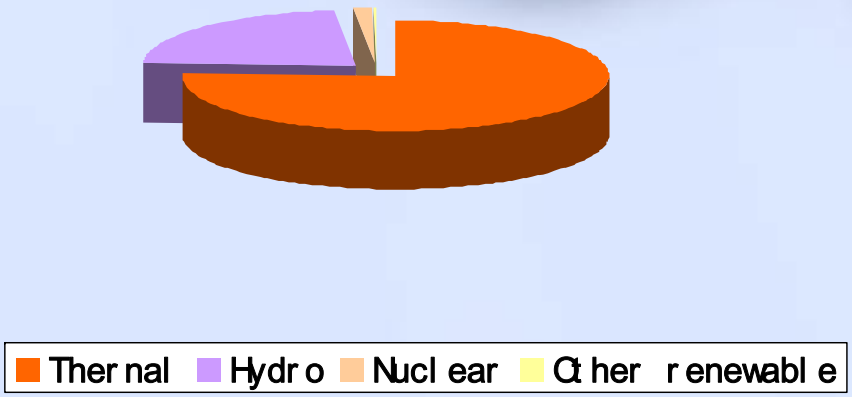
China 2005

Coal (China) --- Oil + NG (World)

Oil + NG (China) -- Coal (World)

Comparison of power mix





2001

Coal – 1636GW , 47%
NG – 690GW , 20%
Hydro – 723GW , 21%
Nuclear – 361GW , 10%
Other renewable – 55GW, 2%

2005

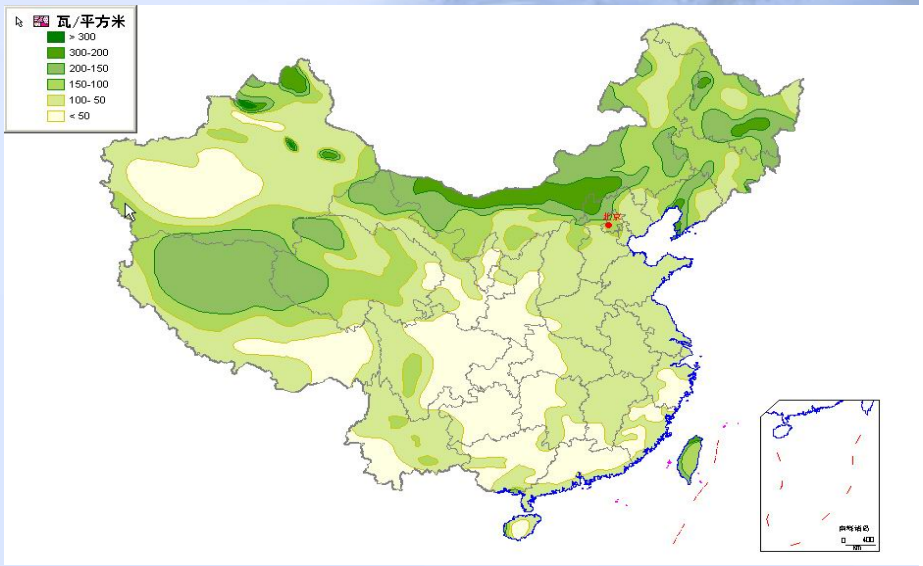
Thermal– 384 GW , 75%
Hydro – 117 GW , 23%
Nuclear – 7.6 GW, 1.5%
Other renewable – 1GW, 0.2%

Hydro power

- Hydro power resource
  - Total
    - 400GW with annual output of 1700TWh
  - Small hydro (50MW and less)
    - 128GW
- Hydro power development
  - Total capacity: 117GW
  - Small hydro: 43.8GW
  - Three Gorge (completed in 2009)
    - 18.2GW (26×700MW)

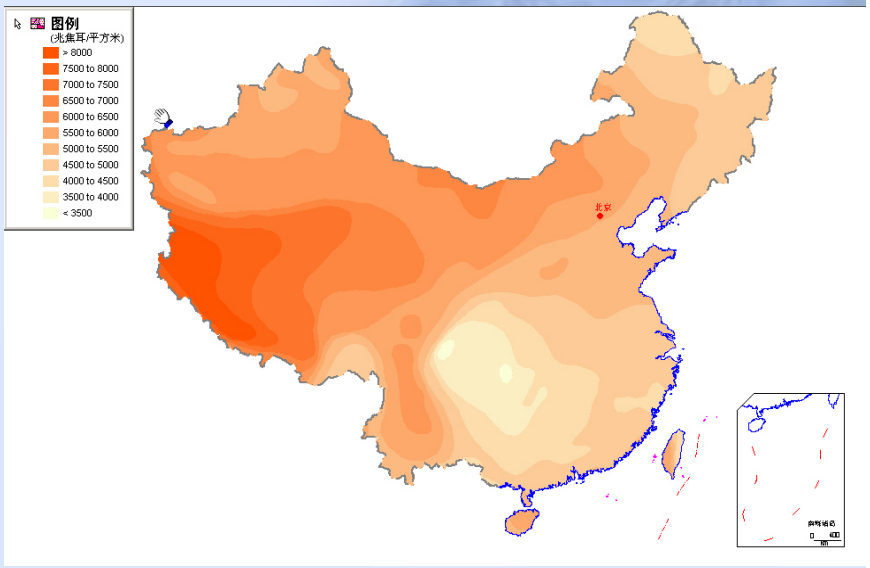
Wind power

- **Wind resource**
  - **Onshore 250GW**
  - **Offshore 750GW**
- **Wind power development**
  - **In grid**
    - **43 wind farms**
    - **1.26GW**
  - **Off grid**
    - **Over 200K units (40MW) with output of 0.04TWh**



Solar energy

- **Solar energy resource**
  - **Theoretical: 1700 billion tce/a**
  - **2/3 land area is over 2200 sunshine hours, 5000MJ/sq.m**
  - **PV: 520GW**
- **Solar energy development**
  - **PV: 70MW**
  - **Solar water heater**
    - **80 million sq.m , about half of the world**



Biomass energy

- **Biomass energy resources : 500 Mtce**
  - **Crop residues: 150 Mtce**
  - **Fuel wood, forestry and wood waste: 200 Mtce**
  - **Factory and livestock waste: 60 Mtce**
  - **Municipal waste: 15 Mtce**
  - **Energy crops**
- **Biomass energy utilization: about 6Mtce**
  - **Biogas: 7.5 billion cu.m/a**
  - **Biomass power generation: 2 GW**
    - **Bagasse: 1700 MW**
    - **Rice husk: 60 MW**
    - **Biogas: 20 MW**
    - **Municipal waste incineration: 200 MW**
    - **Municipal waste landfill gas: 20MW**
- **Bio-fuel: 1Mton**

Renewable energy technology phase

	Technology phase			
Technology	R & D	Demonstration	Commercializing	Commercialized
Small hydro				×
Solar water heater				×
Passive Solar building				×
Solar cooker				×
Solar PV			×	
Large in-grid wind power			×	
Small and micro wind power			×	
Geothermal power			×	
Geothermal heating			×	
Biogas digester (large and middle scale)			×	
Municipal waster power generation		×		
Biomass gasification		×		
Biomass power generation		×		
Biomass liquefaction	×			

Power generation cost of renewable energy technologies

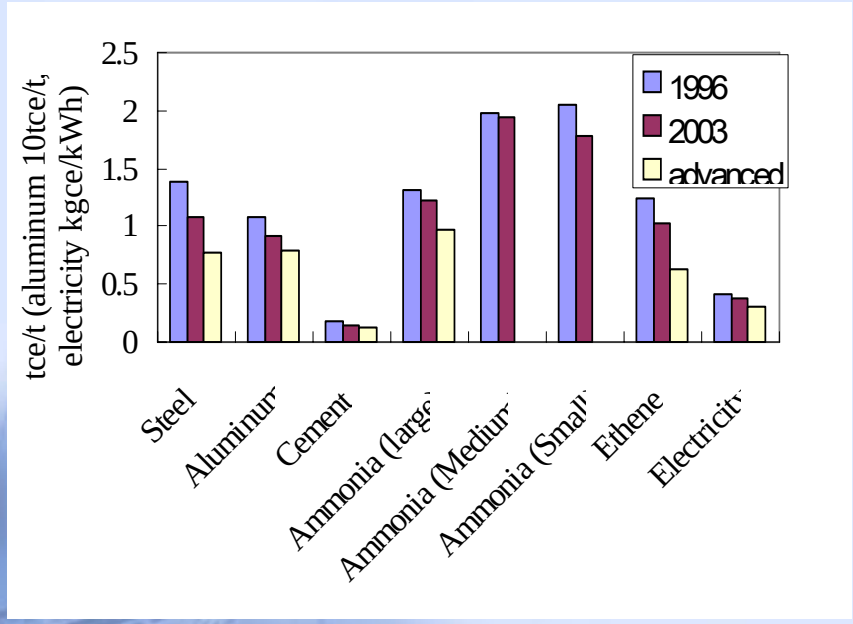
Technology	Generation cost (RMB/KWh)	Cost ratio of renewable and coal-fired
Small hydro	0.31-0.33	1.3-1.4
Micro hydro	0.44	1.9
Wind farm	0.55-0.64	2.4-2.8
Small PV/wind hybrid system	2.01	8.7
PV	2.98	13
Biomass gasification	0.34-0.47	1.5-2
Municipal waster incinerating	0.55	2.4
Landfill gas	0.3-0.44	1.3-1.9
Livestock farms biogas	0.43-0.73	1.9-3.2

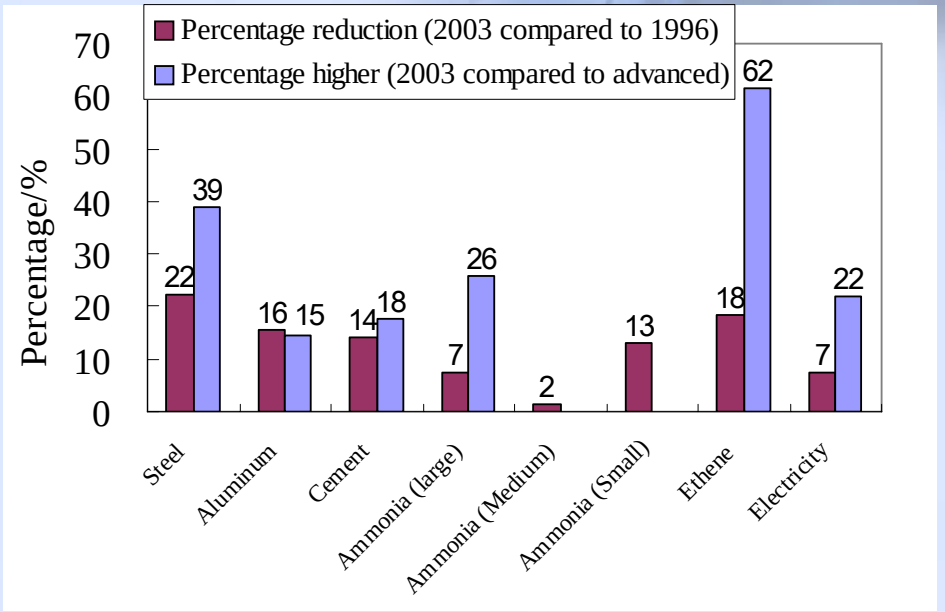
2. Energy Efficiency Improvement

Energy Efficiency Improvement

- **The specific energy consumption for high energy intensive products are about 40% higher than that of the industrialized countries.**
- **Average energy utilization efficiency about 10 percentile lower than world average level**
- **Energy intensity per GDP of China was about 2.9 times of world average level and 4 times of OECD average attributed to as high as 47.3% of industrial proportion in GDP and low value added for most products, and low energy efficiency.**

Main products' energy efficiency





In 2003, industry sector shared 48% of total energy consumption, and 69% of total final energy consumption.
While steel, building material, and chemical industry shared 29%, 32%, and 22% of industrial energy consumption, respectively.

General equipments' energy efficiency

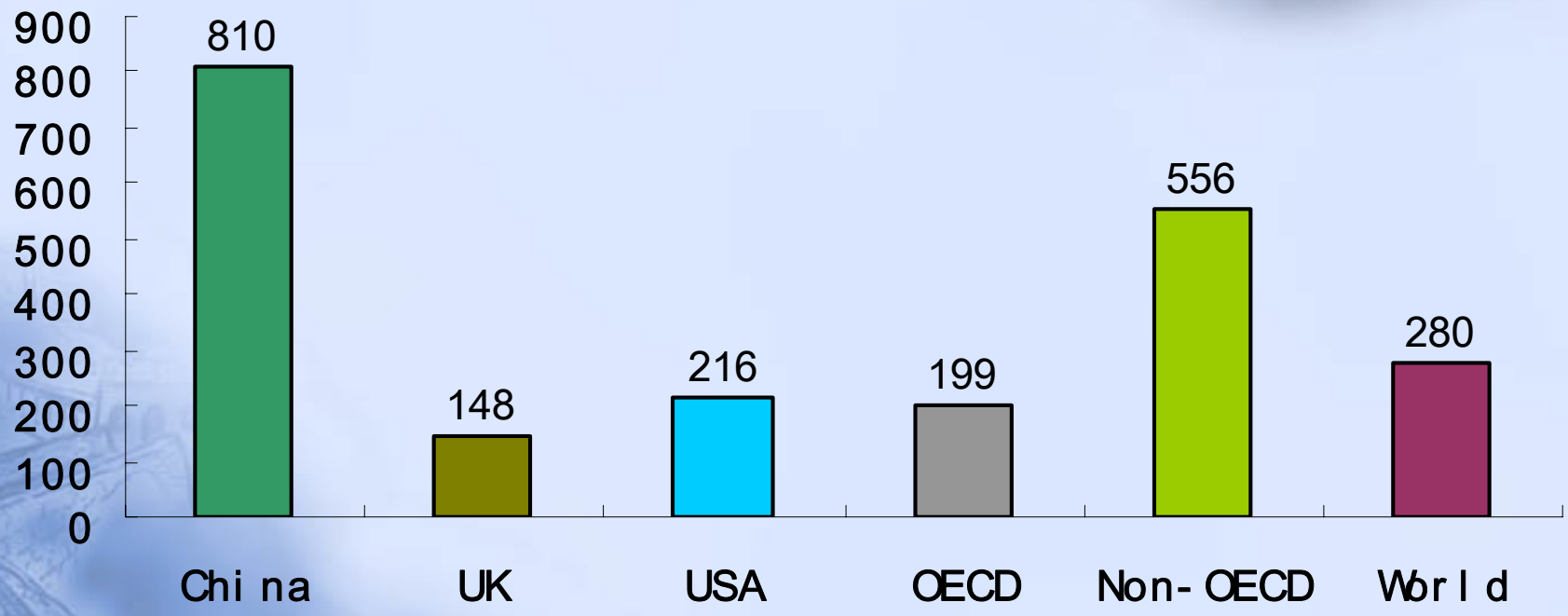
- **Coal-fired industrial boiler**
  - **China 65%**
  - **Developed countries 80-85%**
- **Small and medium electric motor**
  - **China 87%**
  - **Developed countries about 92%**
- **Blower, pump**
  - **Operation efficiency 20 percentile lower**

Other sectors' energy efficiency

- **Transport**
  - **Vehicle: 25% lower than Europe, 20% lower than Japan, 10% lower than USA**
  - **Truck: 7.6L/100km, 1 times higher**
  - **Inner waterway: 10%-20% higher**
- **Building**
  - **Energy consumption per floor area for space heating: 2~3 times higher**

Comparison of energy intensity per GDP

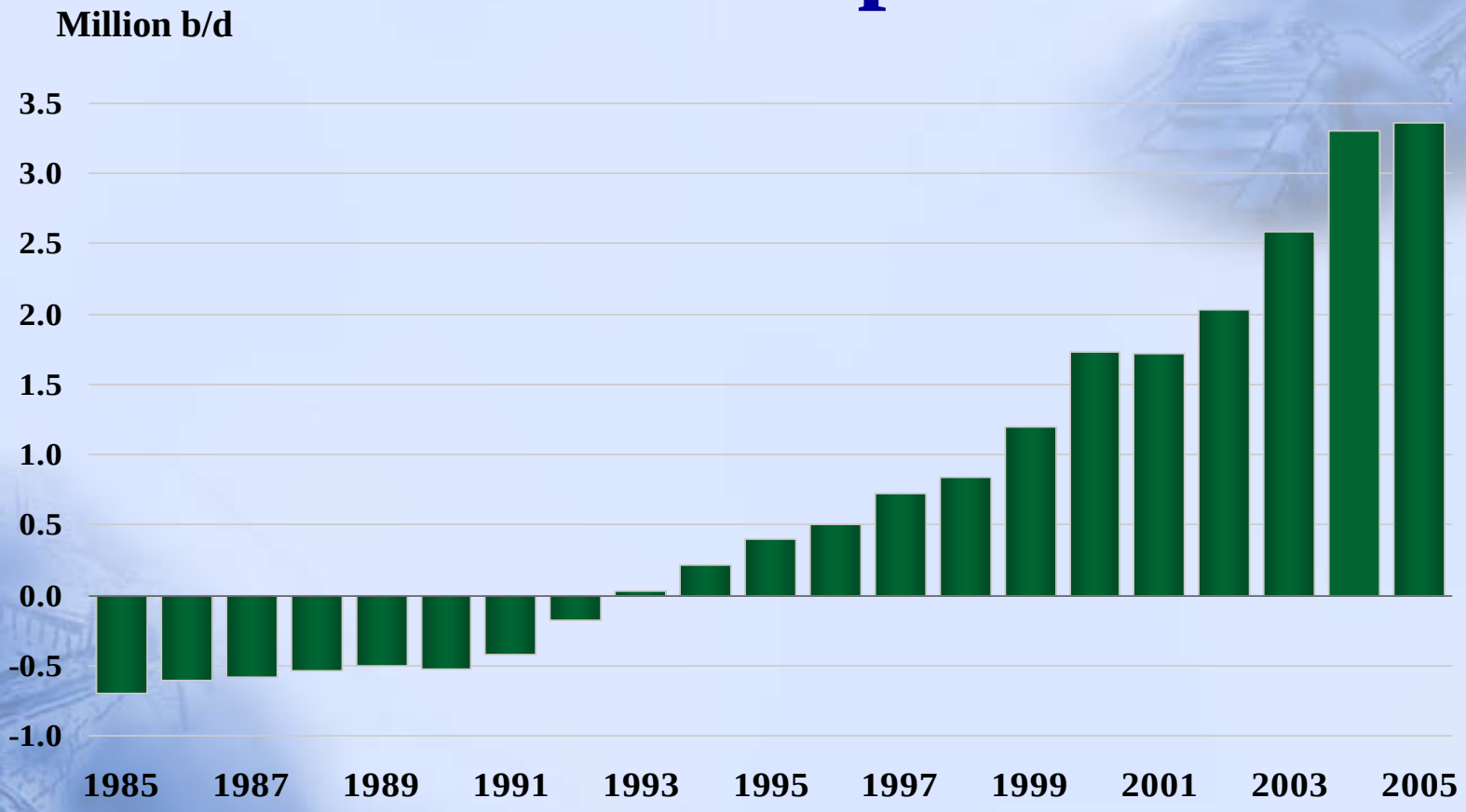
toe/2000MUS$



2004

3. Energy Security

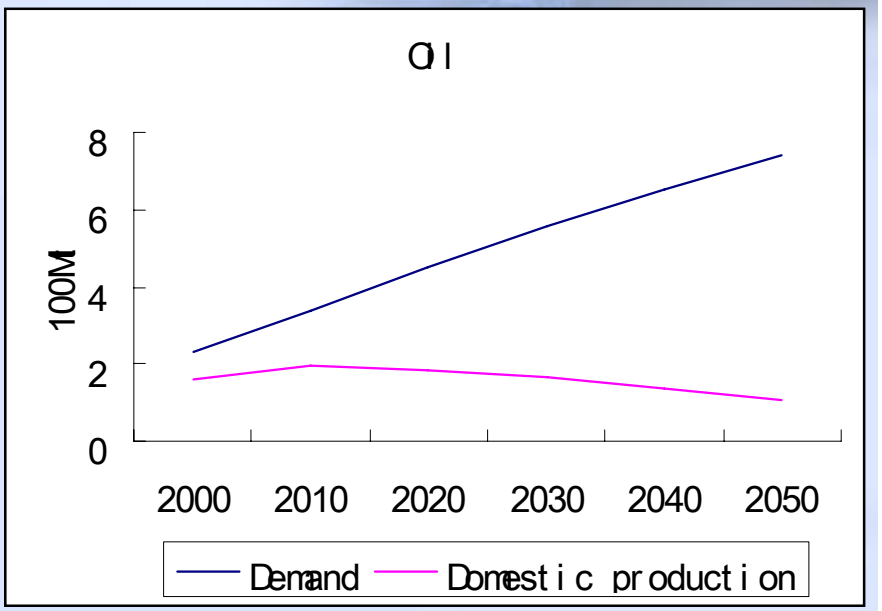
Historical oil import trend



Rapidity in dependency rise: 2005 43.9%

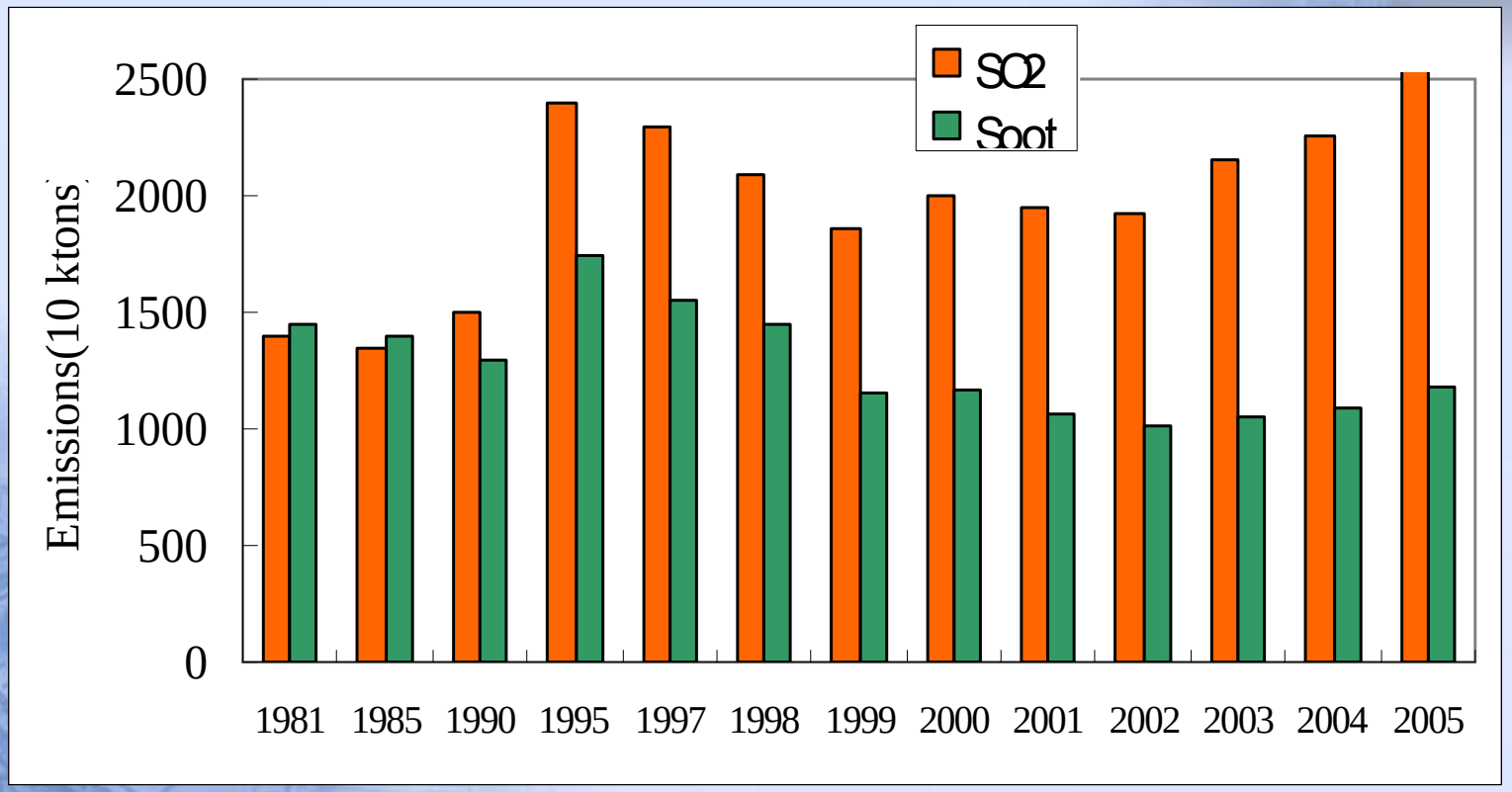
Future oil demand and supply gap

- **Coal, Oil and natural gas reserves per capita in China are 1/2, 1/10, and 1/20 of the global average, respectively. China faces a shortage of oil and natural gas supply in the long term.**
- **Oil will reach the peak production around 200Mt in 2020, after then the production will decrease.**
- **Over 60% oil and 40% natural gas in 2020 will depend on import.**



4. Local environment Protection

SO2 and soot emissions



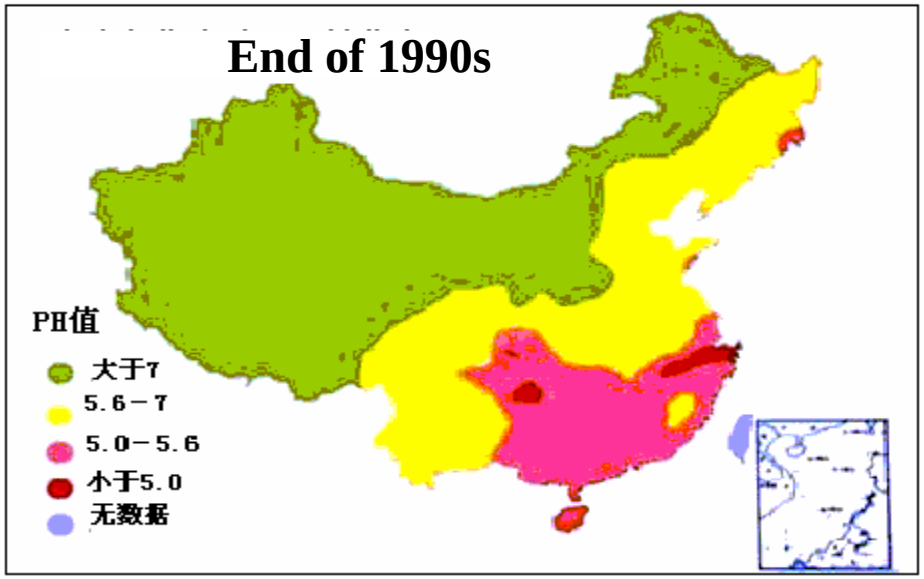
SO2 emission increased 27% during 2000-2005

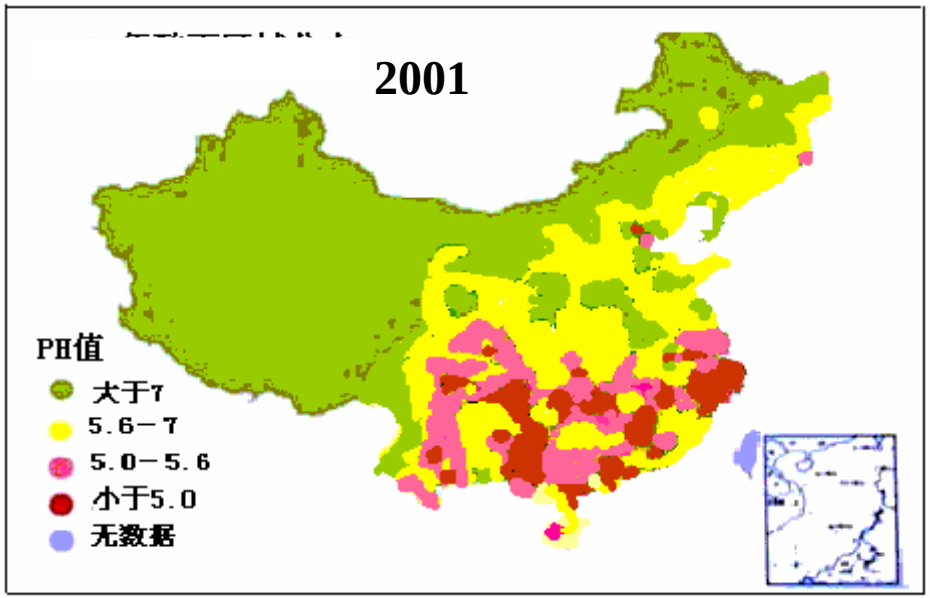
Largest SO2 emitter in the world in 2005

Air Pollution

- **Air pollution**
  - **¾ Chinese cities do not have clean air**
  - **China hosts 10 of world's 20 most polluted cities in 2005**
  - **Direct cost amounts to 3% of GDP, but WB warns pollution could cost 13% of GDP by 2020.**
- **Coal the culprit for:**
  - **70% of soot emissions**
  - **90% of SO_2 emissions**
  - **67% of NOx emissions**
  - **70% of CO_2 emissions**

Acid rain

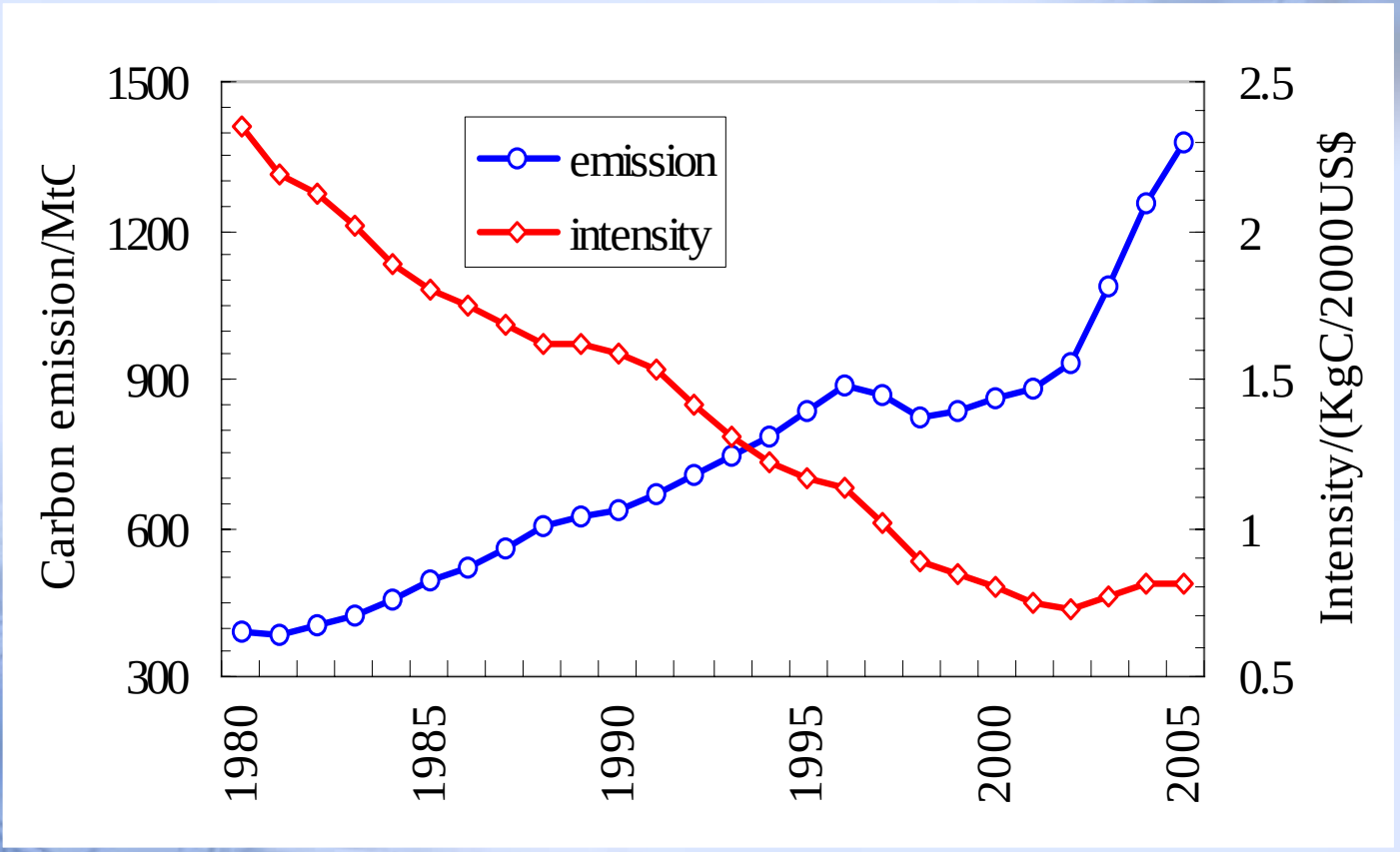




- 40% of land area with pH value of rain <5.6
- The land area with pH value of rain <5 increased

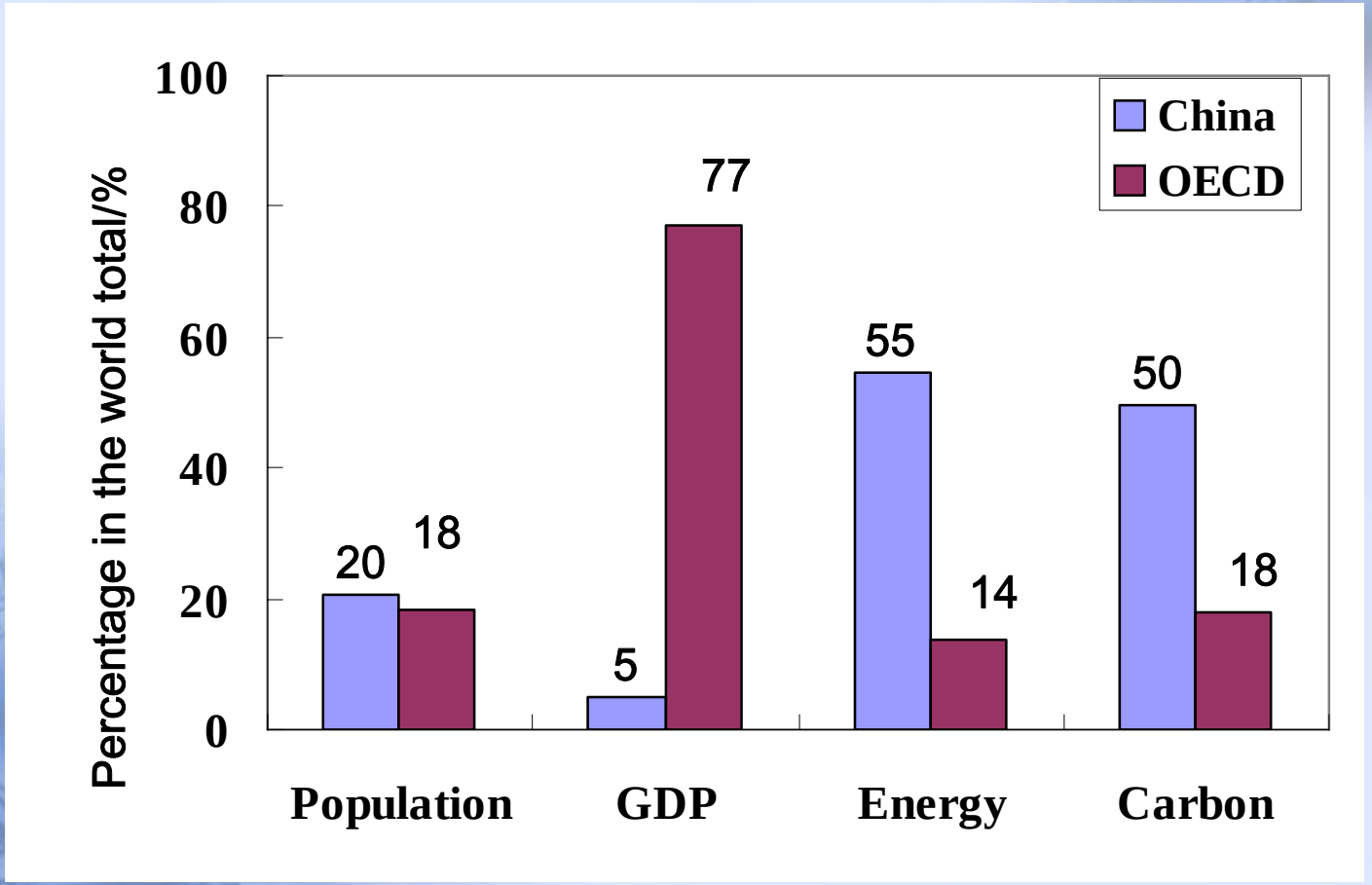
5. Global Climate change

Carbon emission and intensity



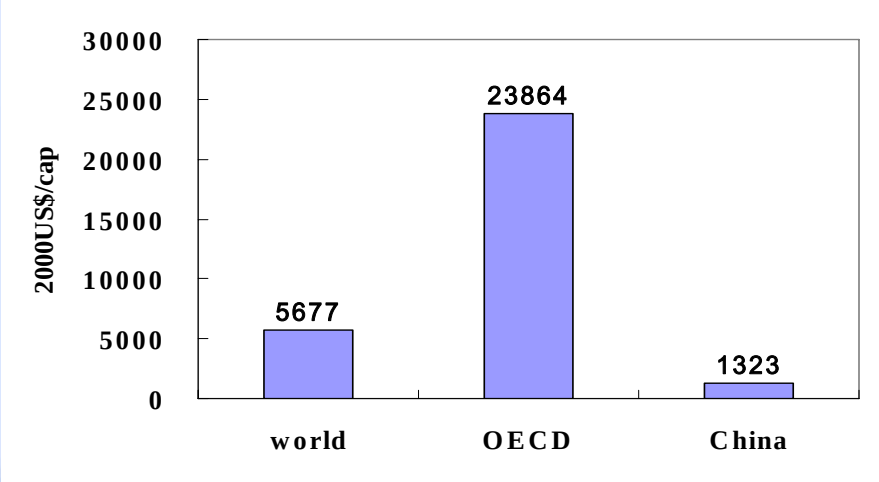
Carbon emission: 1980 387MtC, 2005 1376MtC, AGR 5.2%
Intensity: 1980 2.35KgC/US$, 2005 0.81KgC/US$, ADR 4.2%

Main indicators comparison (1)

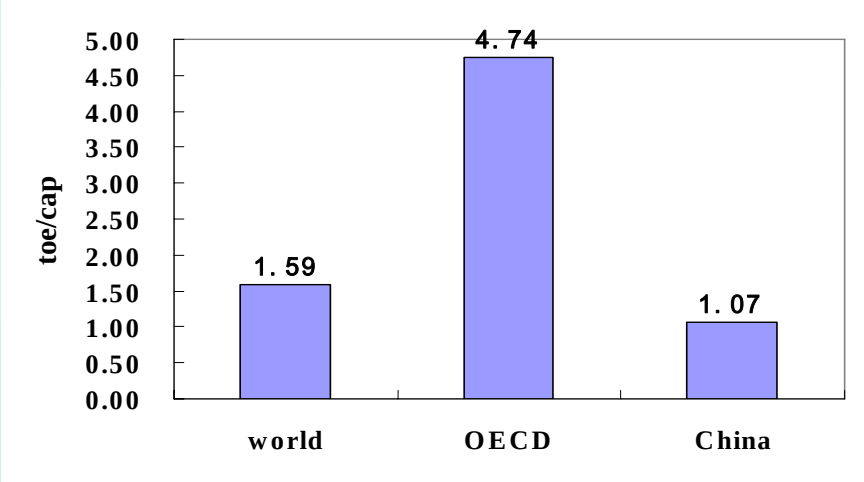


2004

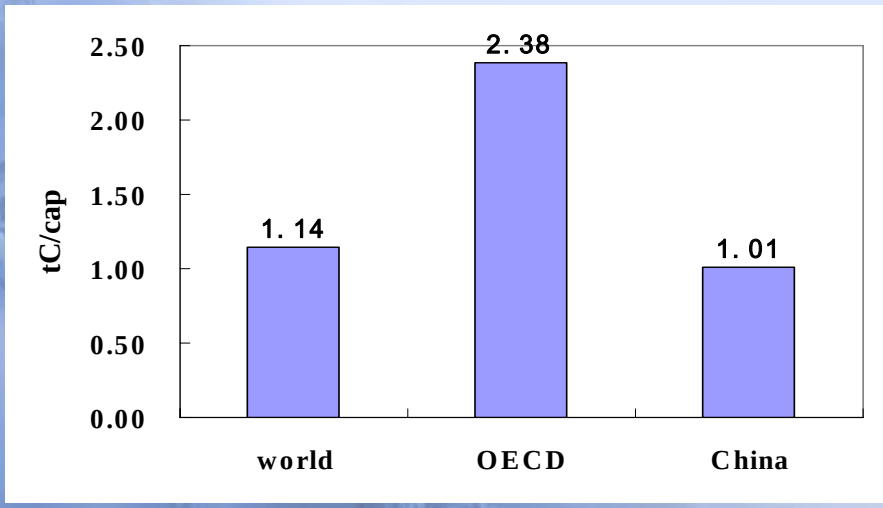
Main indicators comparison (2)



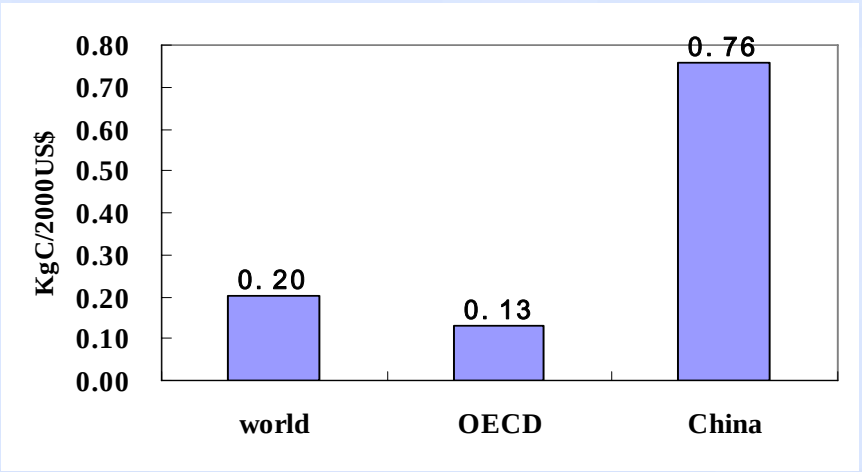
Per capita GDP



Per capita energy consumption



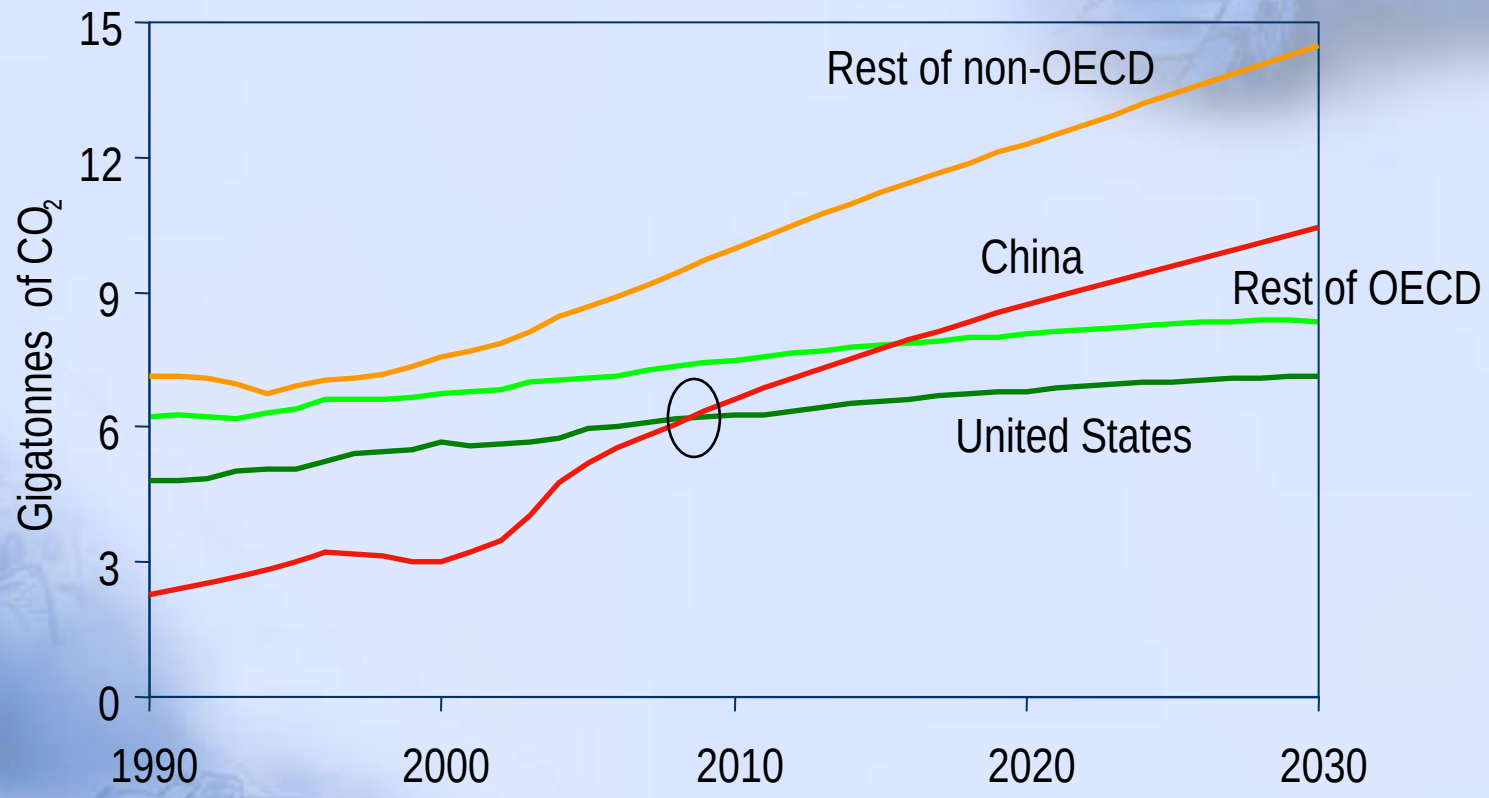
Per capita carbon emission



Carbon intensity

2004

Energy-Related CO2 emissions by Region



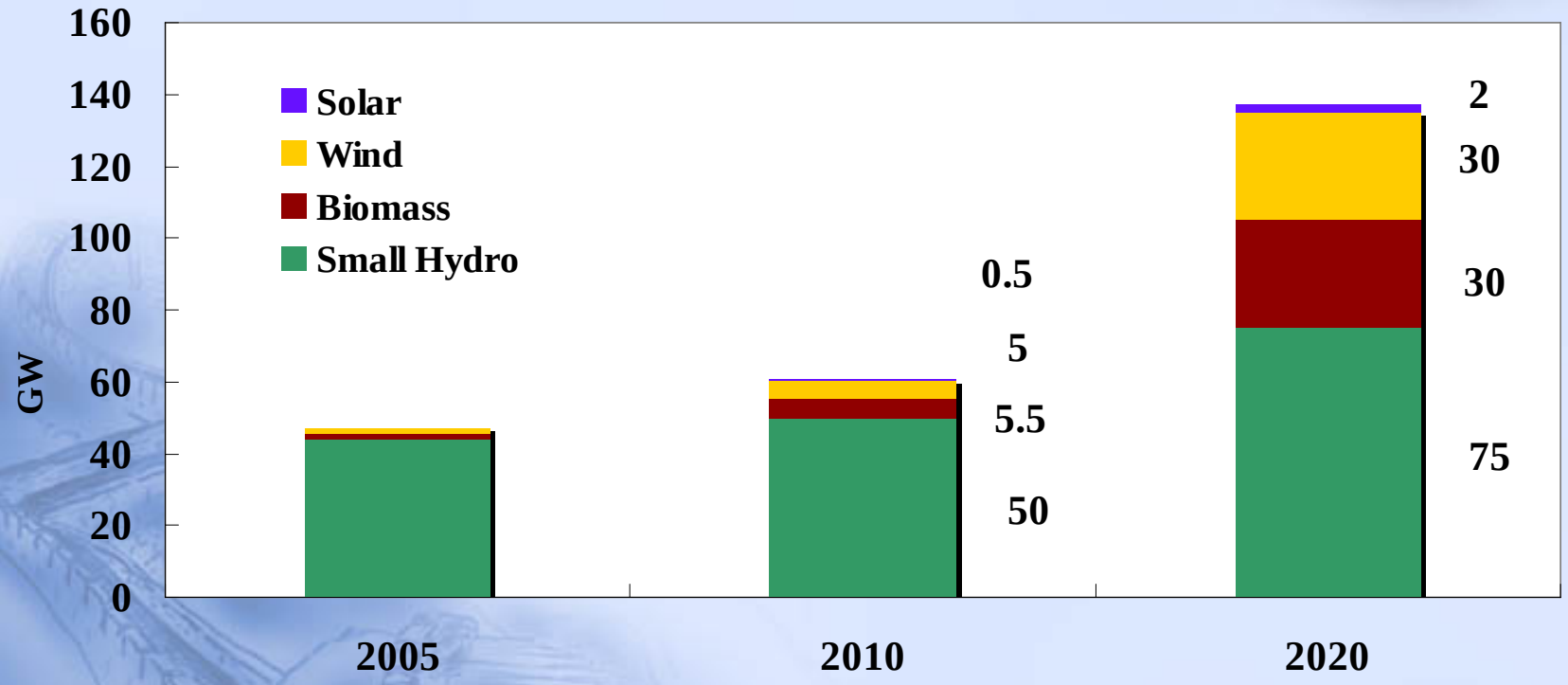
China overtakes the US as the world's biggest emitter before 2010, though its per capita emissions reach just 60% of those of the OECD in 2030

Source: IEA, WEO 2006

Energy development perspective and policies addressing energy challenges

New and renewable energy development target (1)

Renewable energy (power) development target



Hydro total 2005:117GW 2010: 190GW 2020:300GW

New and renewable energy development target (2)

- **Biomass**
  - **Biogas**
    - **2010: 19 billion cu.m/a**
    - **2020: 44 billion cu.m/a**
  - **Bio-fuel**
    - **2010: 2 Mton**
    - **2020: 10 Mton**
- **Solar water heater**
  - **2010: 150 million sq.m**
  - **2020: 300 million sq.m**

New and renewable energy development target (3)

- **2006**
  - **Total renewable energy use (excluding traditional use) about 180Mtce, sharing 7.3% in the primary energy consumption**
- **2010**
  - **Renewable 270Mtce, 10%**
- **2020**
  - **Renewable 540Mtce, 16%**
  - **Nuclear 40GW**

Energy efficiency improvement target

- **Energy intensity per GDP (2005-2010)**
  - 20% reduction by 2010
  - Annual energy saving rate of 4.36%
  - Annual energy saving: 82-83Mtce
- **Energy efficiency**

	2005	2010	2020
Thermal power (gce/kwh	377	360	320
Steel (kgce/ton)	760	730	700
Cement (kgce/ton)	159	148	129
Alumium (tce/ton)	9. 595	9. 471	9. 22
Ammonia (kgce/ton)	1210	1140	1000
Oil refinery(kgoe/ton)	13	12	10

Oil demand and supply

- Oil production target by 2020
  - Oil production: 200 Mton
  - Oil refinery: 400-450Mton
- Oil saving target
  - Annual saving rate 5% during 2001-2020
- Oil trade target by 2020
  - Oversea production base: 60-70Mton
  - Purchase from international market: 130-140Mton
  - Oil import dependency: 50%

SO2 emission control target

- **10% reduction in 2010 compared with 2005**
  - **2005: 25.49Mton**
  - **2010: 22.95Mton**

Policies addressing energy challenges

- **Economic structure adjustment**
  - **Limitation of growth of high energy intensive industries**
  - **Promoting service and high technology sectors development**
  - **Upgrading products towards high value added**
- **Perfecting market pricing and taxation mechanism incentive to energy saving and efficiency improvement**
- **Formulation of energy law and upgrading energy saving law**
- **Accelerating the wide application of new energy technologies by means of finance, taxation etc.**

Policies addressing energy challenges

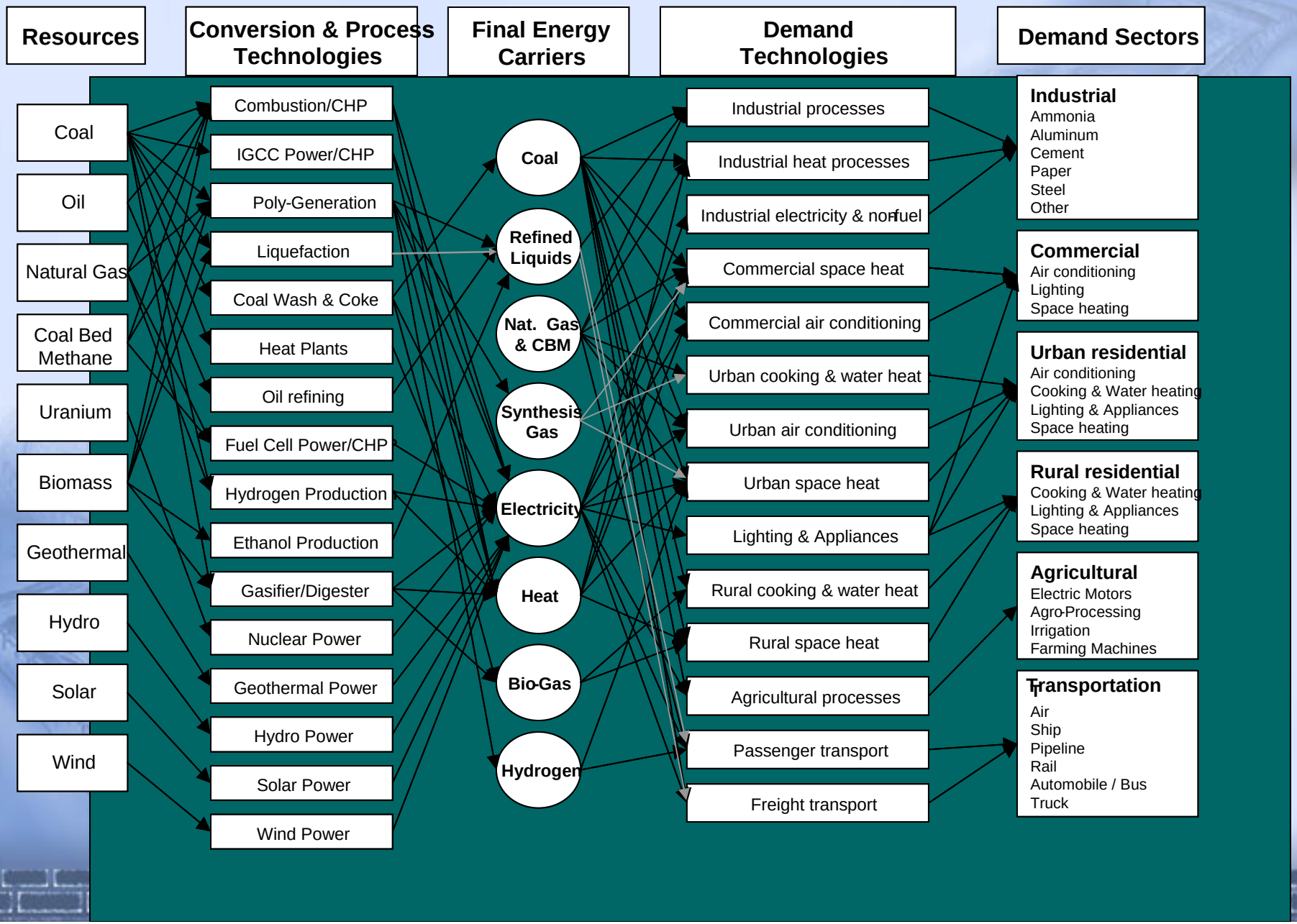
- Establishment of oil emergency reservation system
- Encouraging the enterprises becoming the main forces in technological innovation
- Enhancement on the technical transfer of new energy technologies
- Promoting intelligence properties establishment and protection

Long-term energy development scenario

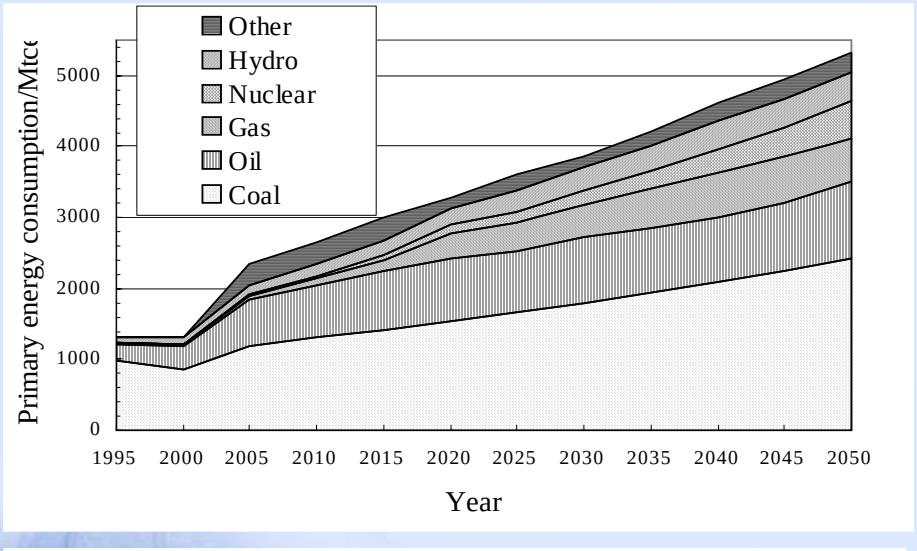
Modeling tool — China MARKAL

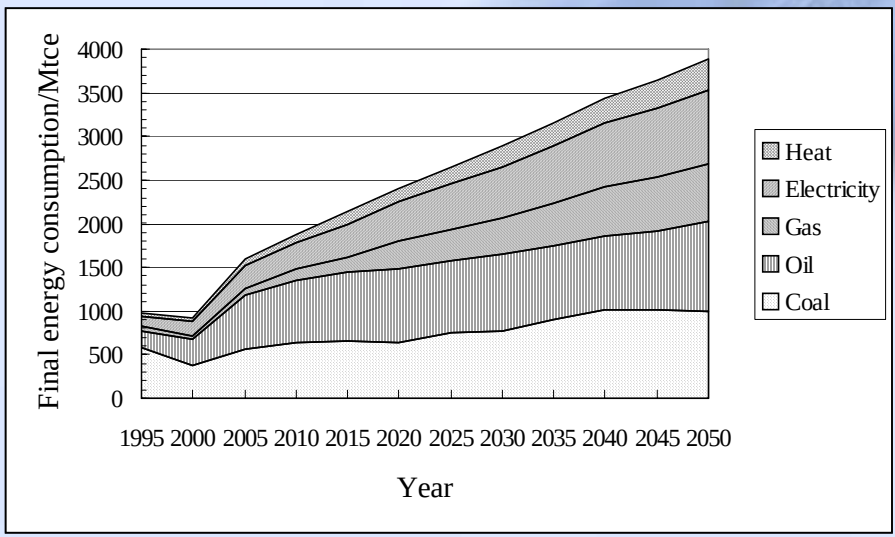
- **Dynamic linear programming model built on the concept of a Reference Energy System, RES.**
- **Incorporates full range of energy processes, e.g. exploitation, conversion, transmission, distribution and end-use.**
- **Searches for a least-cost combination of technologies and fuels dynamically over the planning period to meet user-specified energy service demands.**

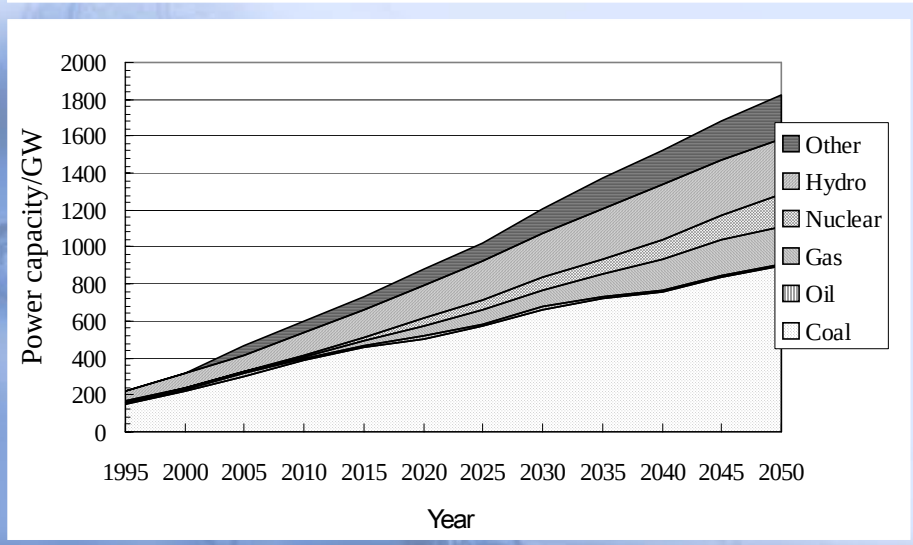
Simplified RES for China MARKAL

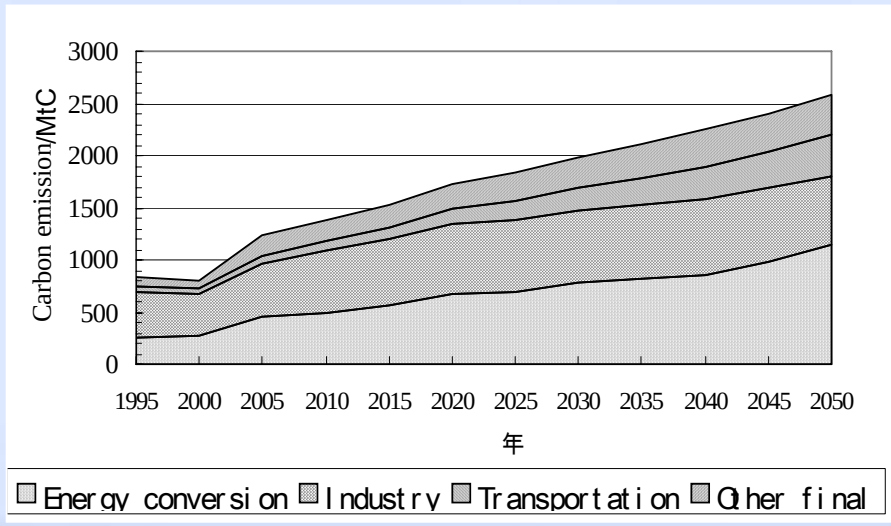


Future energy development scenario









Carbon intensity per GDP in 2050: 0.15kgC/2000US$ (current OECD level)

Thanks