

ECOLE ENERGIES ET RECHERCHES (EER)
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China Energy Panorama

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Abbreviations

CCAS	China Academy of Social Science
CCS	Carbon Capture Storage
DOE	Department of Energy, US
EE	Energy Efficiency
EIA	Energy Information Administration (DOE, USA)
ERI	Energy Research Institute, NDRC, China
IEA	International Energy Agency
IMF	International Monetary Fund
MoEP	Ministry of Environmental Protection, China
MOST	Ministry of Science & Technology, China
NDRC	National Development Reform Commission, China
NEA	National Energy Administration, China
OECD	Organisation for Economic Cooperation and Development
SERC	State Electricity Regulatory Commission, China
WB	World Bank

Introduction

China Context
Social Economics
Urbanisation Development

I. Introduction: China Context

China: an emerging and still developing country:

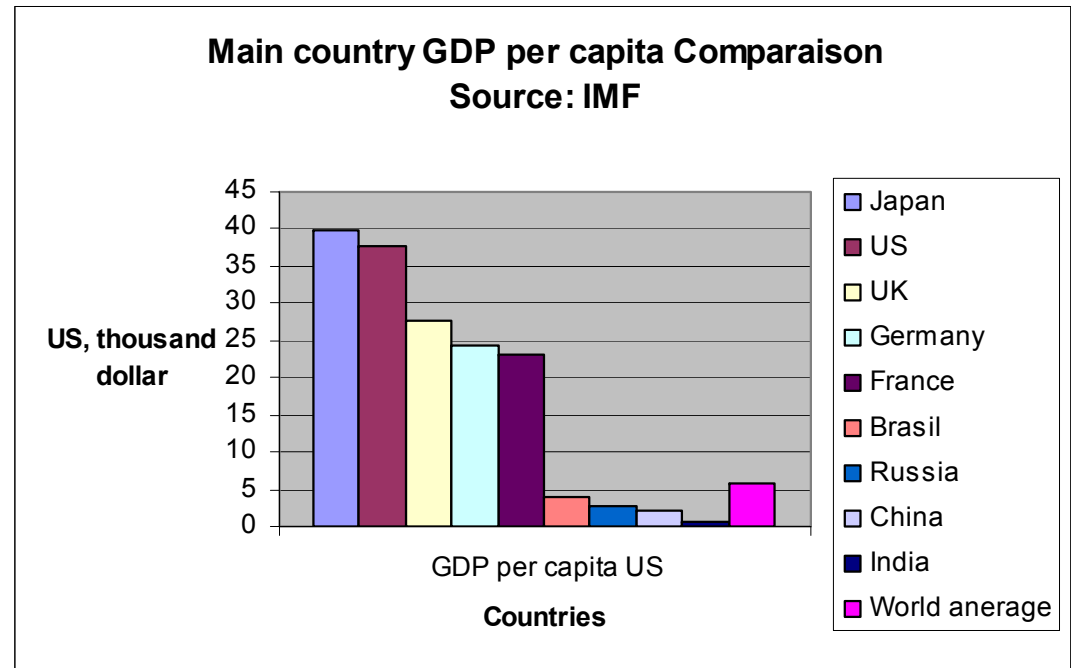
- 1.3 billion population.
- GDP USD 44 trillion in 2008.
- Third largest global economy, expected to be second by 2010.
- Double digit economic growth last ten years.
- Target to build well-off society by 2020.
 - Quadruple the GDP of the year 2000 by 2020
- 2008 urbanisation ratio: 45.7 % (60-70% OECD).
- 57% ~ 60% by 2020.

Source: ERI, 2009

I. Introduction: China Context: Social Economy

Contrast:

- In 2007 GDP per capita USD 3,566 (6,000 PPP) in 2009, listed 99th (IMF), less than half the world average, 1/10 of Japan and the US and 1/4 of OECD countries.
- Eastern area income 1.7 times the national average
- Urban income 3.3 times rural in 2007
- 150 million live below UN poverty line.



I. China Context: Urbanisation

- 1978-1999: 0.8% urban population growth; = 12.6 million annually
- 2000-2008: 1.2%.
- 300 million rural population will move to urban areas by 2020.
- 2030: expected 65%
- Urban per capita energy consumption is 3.5 - 4 times rural (CCEER).
- Energy consumption per GDP per capita much higher than US & Japan.

More Mega cities will be created by 2020

- **100 cities are above 1 million population, 110 cities in 2020**
- **4 cities above 15 million population in 2010, 7 in 2020**

❑ **Urban energy consumption more than twice rural residents:**

	Urban	Rural
Per capita Energy consumption/ Kgce	2150	490
Electricity consumption kWh	3000	593
Residential Electricity/kWh	306	149

Source: Wang QY, 2008 Energy Economies Statistics,

I. China Context: development constrains

Domestic imbalance

1. Increasing rural-urban disparity in education, social security, health system, etc.
2. Regional economic imbalance (West – East)

World Contrast

1. Energy consumption per capita and CO₂ emissions per capita far lower than world average.
2. Carbon Intensity is higher than developed country

II. China Energy Outlook

- **Demand forecast**

 - coal, oil and gas (BAU)

- **Energy security concerns (AIE graphic)**

China Energy Outlook Map



II. China Primary Energy Outlook

1. Energy resources and structure

- Rich in coal and water resources
- Energy use per capita only 1/2 of world average.
- Coal: 96% of proven resources reserves
- Oil and natural gas: only 4% of proven resources reserves.
- Non-conventional shale gas and coal-bed methane potential but not yet proven. Massive investment needed.
- Water energy: 70% is far away from load centre.

Sources: IEA 2008, EIA Energy Review 2008, ERI 2009 and China Energy Review

II. Energy Outlook

Selected Indicators for 2007 (IEA, 2009)

	population (millions)	GDP (billions of 2000 USD)	GDP (PPP°) (billions of 2000 USD)	Energy Prod (Mtoe)	Net imports (Mtoe)	TPES (Mtoe)
World	6,609	39,493	61,428	11,940		12,029
OECD	1,185	30,100	32,361	3,833	1,821	5,497
China	1,327	2,623	10,156	1,814	194	1,970

Energy Resources
Population
Energy Security -Self-reliance

II. Energy Outlook

Selected Indicators for 2007 (IEA, 2009)

	Elec. Cons. (TWh)	CO2 emissions (Mt of CO2)	TPES / Pop. (toe/capita)	TPES/GDP (toe/000 in 2000 USD)	TPES/GDP (PPP) (toe/000 in 2000 USD)
World	18,187	28,962	1.82	0.3	0.2
OECD	10,048	13,001	4.64	0.18	0.17
China	3,114	6,071	1.48	0.75	0.19

Development Country
Energy Security
Energy Intensity and Energy efficiency

II. Energy Outlook Consumption

Selected Indicators for 2007 (IEA, 2009)

	Elec. Cons./pop (kWh/capita)	CO2/TPES (tCo2/toe)	CO2/POP (tco2/capita)	CO2/GDP (kgCo2 in 2000 USD)	CO2/GDP (PPP), (KgCo2 in 2000 USD)
World	2,752	2.41	4.38	0.73	0.47
OECD	8,477	2.37	10.97	0.43	0.4
China	2,346	3.08	4.58	2.31	0.6

Electric Consumption/population (kWh/capital)					
	Inde	China	World	OECD	US
RATIO	0.23	1	1.17	3.6	5.8

Development Country
Carbon Intensity
Energy efficiency

II. China Energy Outlook

1. Primary energy consumption:

- Coal 70.4% of 2008 primary energy consumption.
- 2007 oil and natural gas 23%, compared to world average 59.6%, and 65.2% EU and the US, 59.9% in Japan
- 2007 new energy (including nuclear and renewable) 6.6% compared to 16.6% in EU, 16% in US and 15.9% in Japan.
- Energy consumption per capita 79% of world average level, 17% of US, 28% of OECD.

Source: ERI

II. China Primary Energy Outlook

Coal: related to national energy security, but

□ Reserves

- ↪ 2007 proven reserves 1,140 billion tons, N°3 in the world
- ↪ 13% of total world remaining proven exploitable reserves
- ↪ Most reserves far from industrial east and south-east demand centres, only 6% in coastal provinces
- ↪ Shanxi has 38% of total reserves.

□ Production

- World N°1 producer. 2.7 times more than N°2's of the US
- 2008 produced 47.4% of coal in the world (compared to 18.7% in 1973)
- 2006 production reached 2.4 billion tons (= 1.8 billion standard tons), 90% steam coal
- 2010, expected 3.15 billion tons.
- Over 50% coal production use for power generation.

* Source: IEA, China Outlook 2007 and ERI, 2009

II. China Energy Outlook:

1. Oil (1/2)

❑ **Proven oil reserves 4% of total proven energy resources.**

❑ **Oil Reserves**

✓ Onshore: 949 million tons

✓ Offshore: 134 million tons

✓ End 2007: remaining economical reserves 2.1 billion tons.

✓ Main reserves located in sedimentary basins:

Bohai gulf (35%), Songliao (22%), Tarim (12%), Junggar (11%), and Ordos (6%).

❑ **Oil Production:**

✓ Oil production represents 4.8% of the total world in 2008 (compared to 1.9% in 1973)

✓ Expected 180 million tons 2010

✓ Expected 200 million tons 2020

* Source: IEA, China Outlook 2007 and ERI, 2009

China Energy Outlook:

1. Oil (2/2)

□ Imports:

- Since 2007, 50 % of oil imported
- 53% expected in 2010.

□ Chinese oil companies' foreign equity oil production:

- ✓ Potential foreign equity oil production could reach 11 billion tons, USD 7 billion investment
- ✓ 65 oil and gas projects in 30 countries, obtained totalling 60 million tons of equity oil production shares.
- ✓ 2008, foreign equity oil production 44 million tons
- ✓ Niger, Sudan Kazakhstan, Indonesia etc.

□ Pipelines:

- North-South: Russia, 20 years contract of 15 million tons per year.
- Southwest: Sino-Burma to Yunnan (under construction)

Source. (China) Energy Review , July 2009

China Energy Outlook: Energy Reserves

Gas Resources

❑ Conventional: Few proven reserves

- 3,720 bcm in 2006, 2% of world (Cedigaz 2007)
- 581 bcm newly added reserves in 2006

❑ Production

- 2008: 76 bcm, +9.9%, of 2.4% of world production.
- Target: 92 bcm in 2010 (5.3% of total energy consumption ?)
- Expected 1.5 - 2 tcm by 2020

❑ Consumption :

- Only 3.4% of total energy consumption (world average 24%)
- 2010 :150 bcm, supply shortage 30 - 40 bcm
- 2015 :240 bcm, supply shortage 50 - 60 bcm
- 2020: shortage 90 bcm
- **76% industry, 4.3% commercial, 2.8% transportation, 17% residential.**

Source. IEA, ERI and (China) Energy Review, July 2009

China Energy Outlook: Energy Reserve-Gas

Gas Resources, continued

- ❑ **Non-conventional:** potential, however, massive investment needed for exploration and production
 - Shale gas
 - Coal-bed methane
- ❑ **Imported natural gas**
 - ❖ **Gas Pipelines:**
 - ↪ West-East: mid- Asia; sino-Kazakhstan, Uzbekistan,
 - ↪ Southwest: Sino-Burma to Yunnan,
 - ❖ **LNG** **The first will be in operation in 2010**
- ❑ **Offshore gas:** East (Chunxiao,) and South China Sea,

Source. (China) Energy Review , July 2009

II. China Energy Outlook

Hydropower:

Reserves:

- ✓ World N°1 water energy reserves, 1/6 of world reserves.
- ✓ Total exploitable capacity 676 GW. 51% concentrated in major rivers
- ✓ 70% hydropower resources are from consumer centres.
- ✓ In addition, small hydro of below 25 MW unit:
total 180 GW exploitable capacity.

Production:

- ✓ World N°1 producer, with 196GW installed capacity by 2009.
- ✓ 2007 produced 15.3% of world hydropower (2.9% in 1973)
- ✓ 2010 will reach 200GW installed capacity

Source: IEA 2009 and China Land Resource Ministry 2006

China Energy Picture in 2010

2010 Estimates:

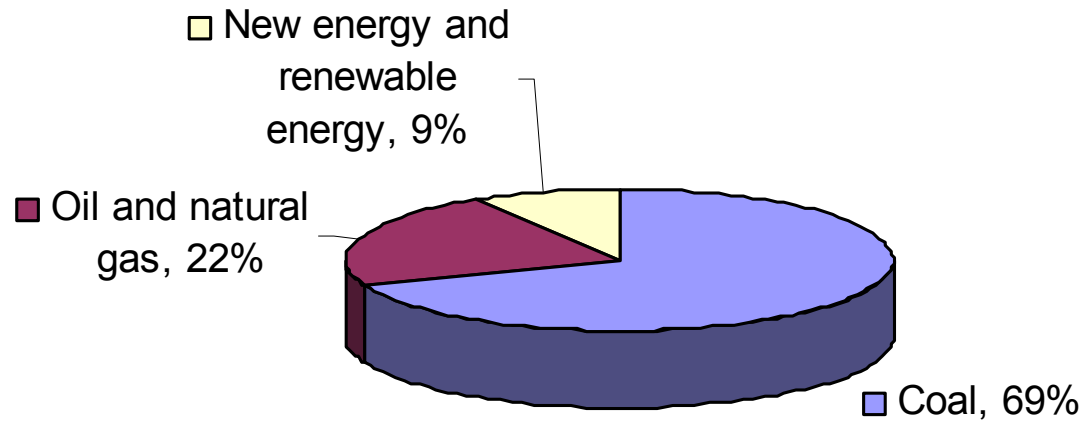
- ❑ Coal production 3.15 billion tons
- ❑ Coal imports 100 million tons, 3% of production.
- ❑ Crude oil production 400 million tons; 210 million tons imported, (199 Mt in 2009), representing 52% production.
- ❑ Electric power production increase 8.5% (to 3,953 TWh), 75 GW new capacity.
- ❑ Hydropower capacity 200 GW

❑ NEA estimation in March 2010:

2010 China Energy Key Picture			
	Production	Imported or new added volume	Imported or new added volume share %
Coal billion tons	3.15	0.1	3%
Crude Oil million tons	400	210	53%
Electric Power (GW)	3,953 TWh	75	7%

II. China Energy Outlook: Energy Structure

China Energy Structure 2008



■ Coal ■ Oil and Natural gas ■ New energy & renewable energy

II. China Energy Outlook

China Primary Energy Demand

Year	2005	2007	2010	2020	2035	2050
Coal	1548	1845	2119	2773	3912	2752
Oil	465	522	608	1116	1451	1779
Natural Gas	64	91	126	290	472	667
Electricity primary		199	248	593	918	1492

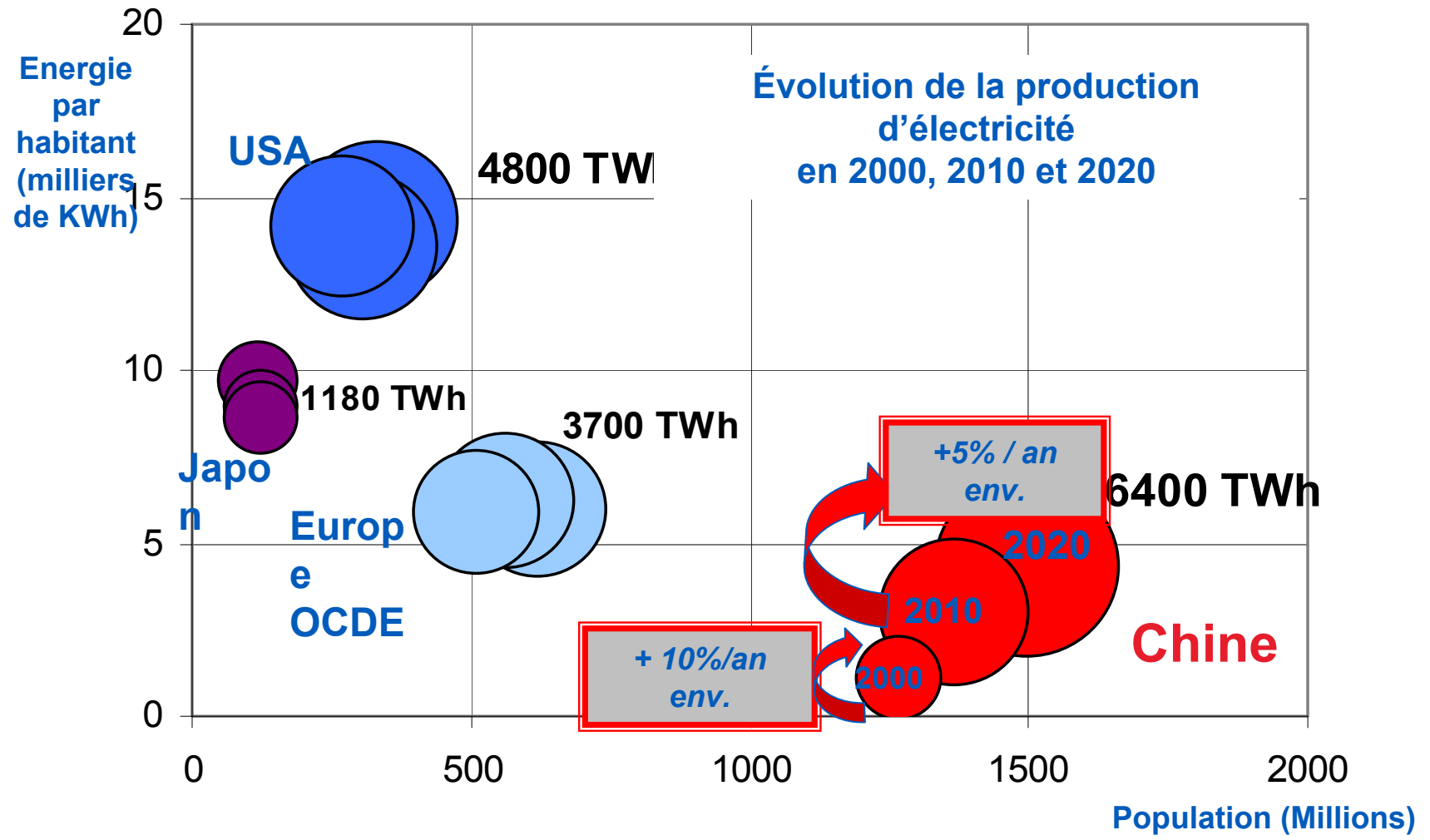
Source: ERI, 2009, China Low Carbon Development Pathway by 2050.

II. China Energy Outlook: Demand Scenario (IEA)

Year	1990	2007	2020 reference Scenario	2030 reference Scenario
Coal	534	1293	2040	2397
Petrol	114	358	557	758
Natural Gas	13	61	147	202
Nuclear	0	16	84	127
Renewable	211	241	288	342
Power generation	181	836	1509	1908

China Energy Outlook: Energy Per Capita

Comparison with US OECD and Japan



III. Electricity Outlook

- 1. History**
- 2. Current Picture**
- 3. New Added Capacity Compared to Rest of the World**

III. Electricity Outlook

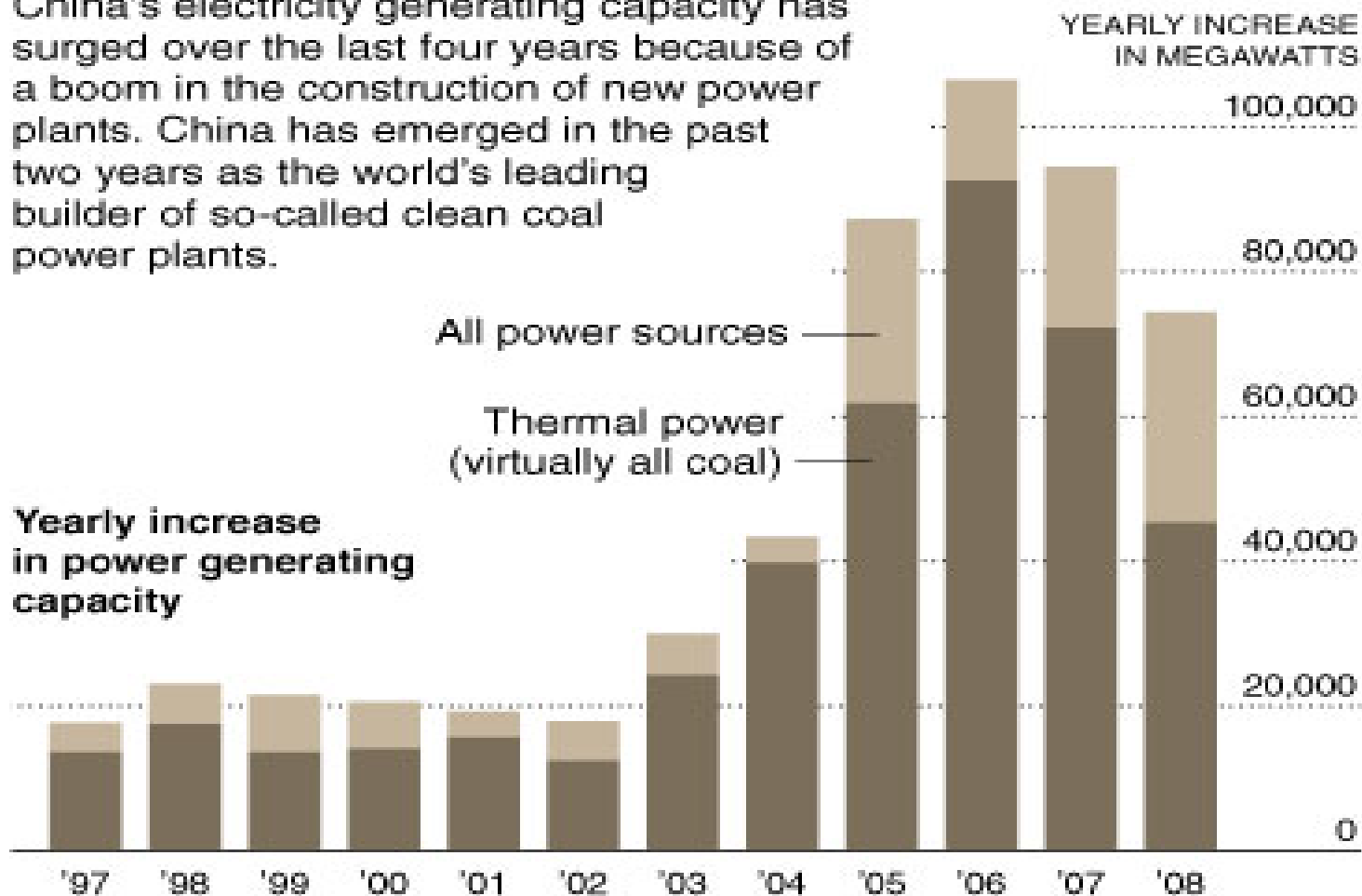
1. Development History

- ❑ Power development beginnings accompanied economic reform
- ❑ 1978 installed capacity could not meet demand
- ❑ 2004 - 2009 average annual new capacity increase of 81 GW, equivalent of UK total capacity.
- ❑ Every week one new EPR unit built

III. China Electric Power Outlook

Power Surge

China's electricity generating capacity has surged over the last four years because of a boom in the construction of new power plants. China has emerged in the past two years as the world's leading builder of so-called clean coal power plants.



Source: China National Bureau of Statistics, via CEIC data

III. China Electricity Outlook China and World Comparisons

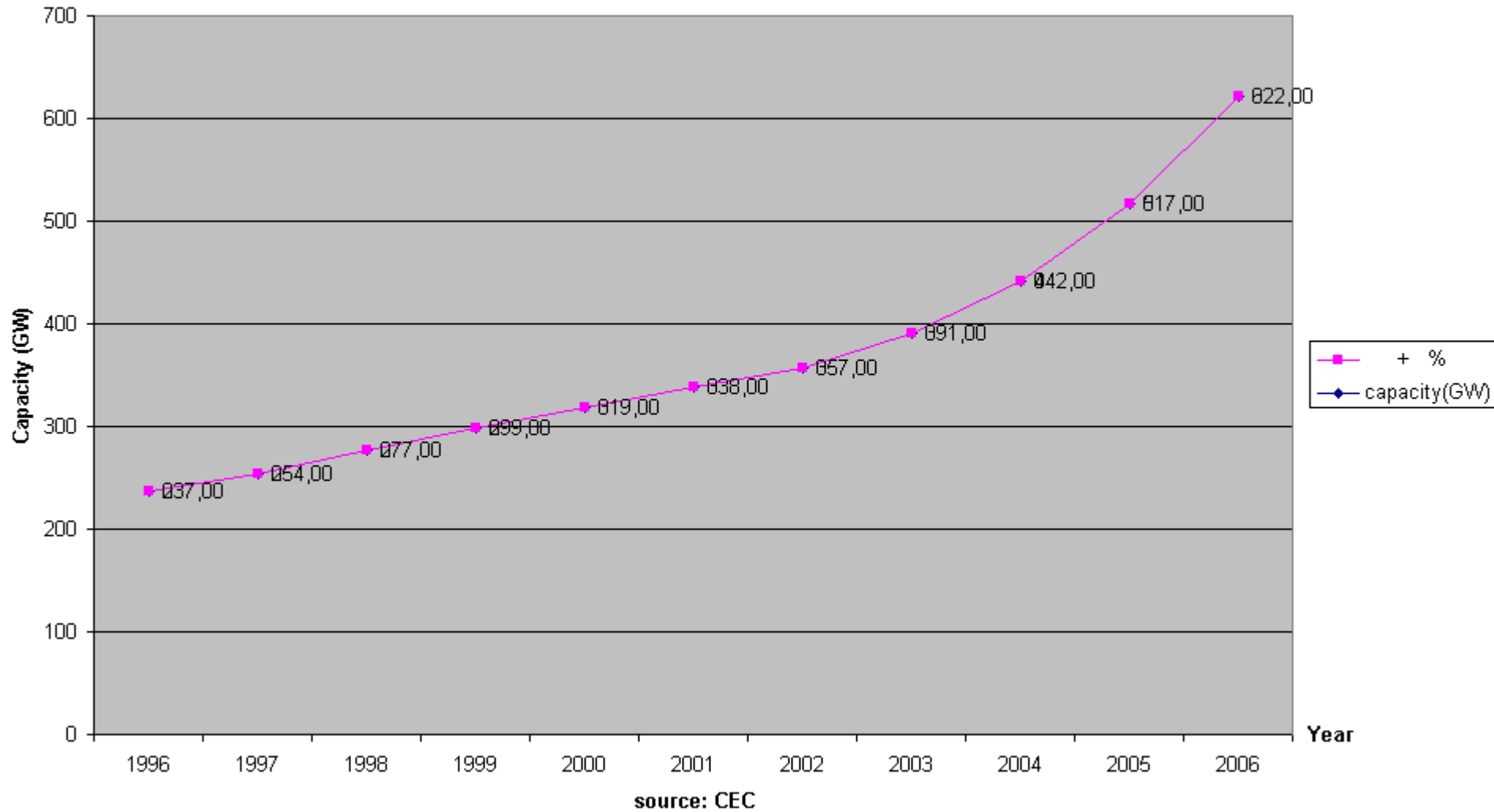
	World		World				
	2007		2030 référence		2030		
Electricity mix	19,755 TWh		34,291 TWh		29,939 TWh		
Coal	8,216 TWh	42%	15,259 TWh	44%	7,260 TWh	24%	y.c. 4.3% CCS
Gas (+fuel oil)	5,243 TWh	27%	7,723 TWh	23%	6,147 TWh	21%	y.c. 1.1% CCS
Nuclear	2,719 TWh	14%	3,667 TWh	11%	5,470 TWh	18%	
Hydro	3,078 TWh	16%	4,680 TWh	14%	5,659 TWh	19%	
other renew.	499 TWh	3%	2,962 TWh	9%	5,403 TWh	18%	
CO2/elec. kWh*		539 g		478 g		237 g	

	China		China				
	2007		2030 référence		2030		
	3,318 TWh		8,847 TWh		7,022 TWh		
	2,685 TWh	81%	6,639 TWh	75%	3,521 TWh	50%	
	75 TWh	2%	285 TWh	3%	223 TWh	3%	
	62 TWh	2%	487 TWh	6%	956 TWh	14%	
	485 TWh	15%	1,046 TWh	12%	1,232 TWh	18%	
	11 TWh	0%	390 TWh	4%	1,090 TWh	16%	
		922 g		722 g		448 g	

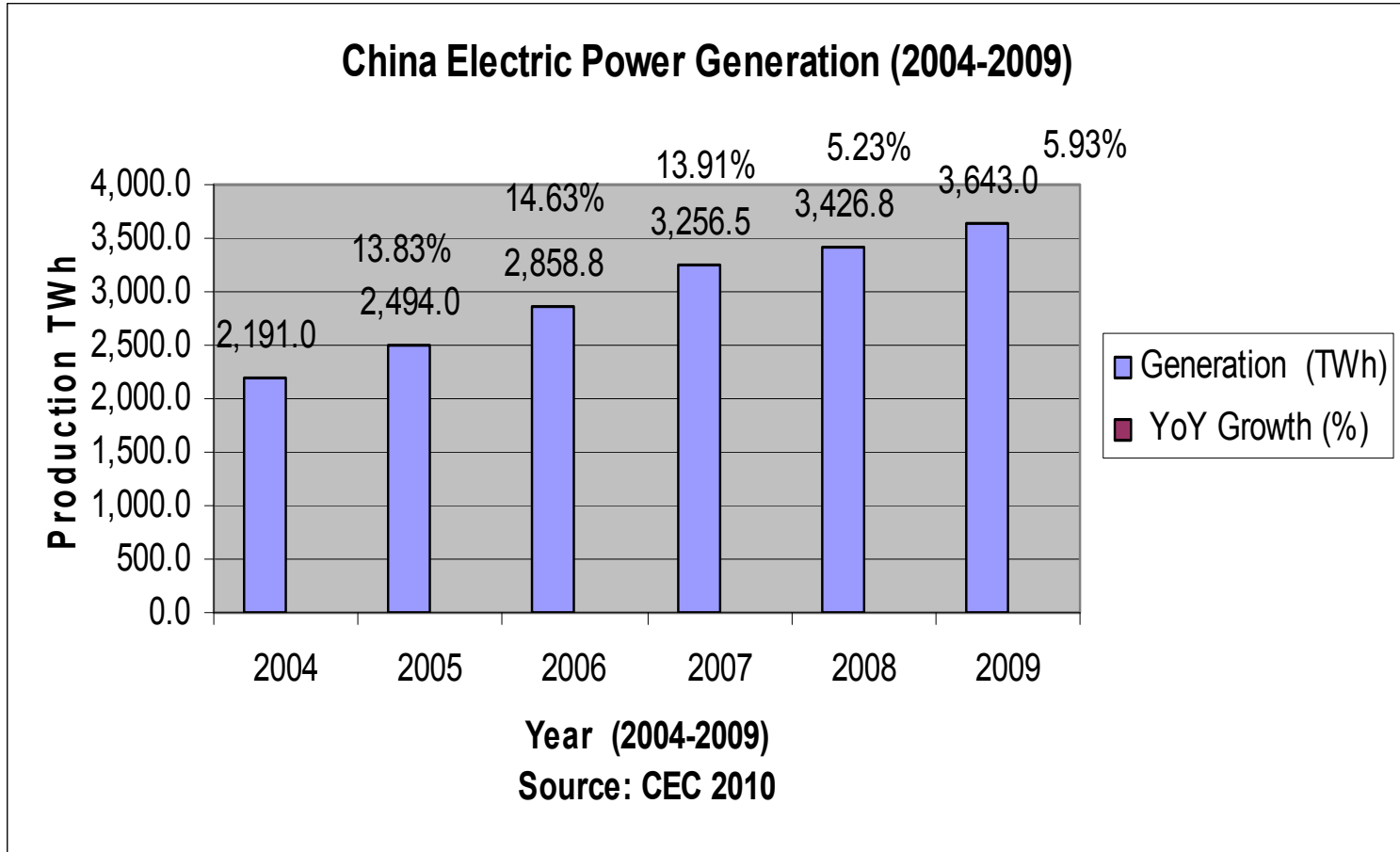
Coal power generation is doubled than world average
Hydropower is at the world average
weak gas and nuclear generation

III. China Electricity Outlook

China Electricity installed capacity (1996-2006)



III. China Electricity Outlook



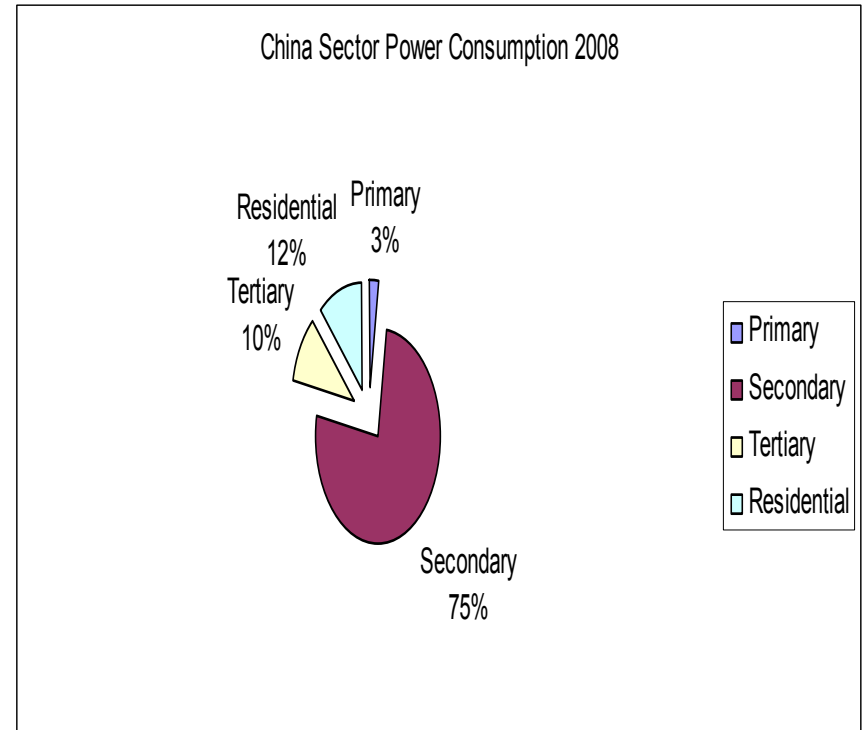
III. China Electricity Outlook

OECD Power Consumption Sector Composition:

- 1) Primary 6-10%(?)
- 2) Secondary 40 %
- 3) Tertiary over 40%
- 4) Residential 20%

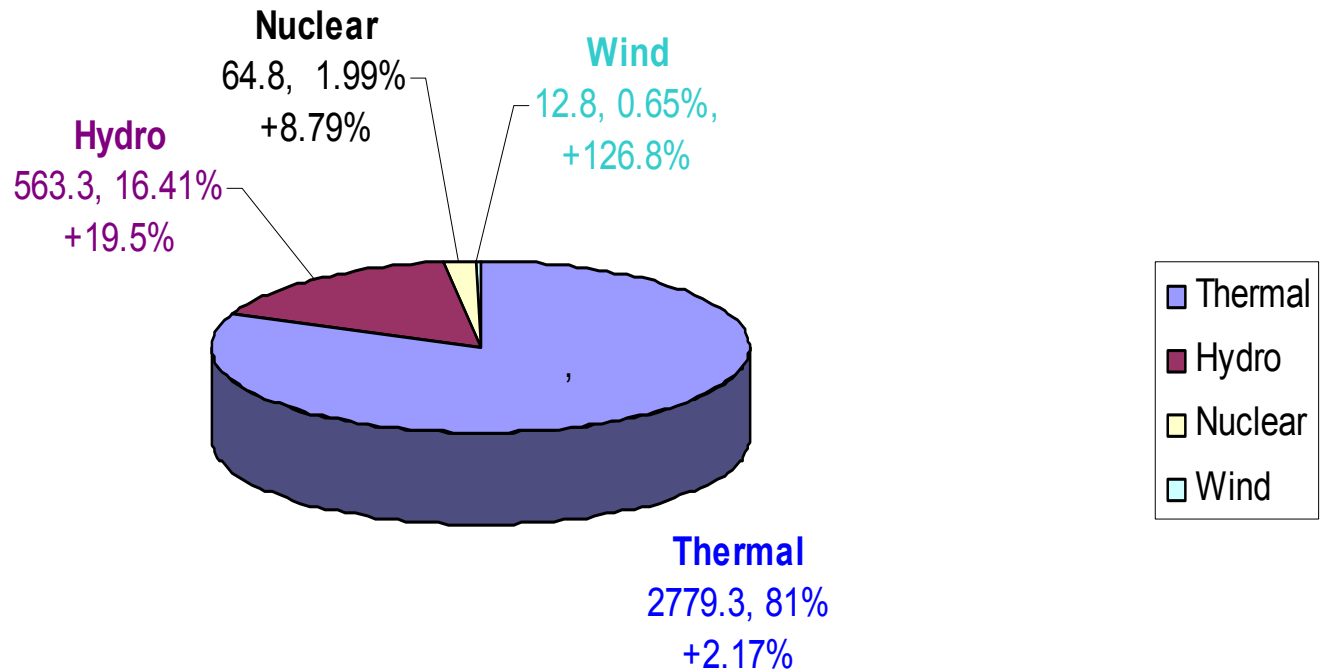
☐ Compared to OECD/France

☐ Power Consumption : sectoral



China Electricity Outlook 2008 Power Picture

China 2008 Generation Production
Total Production 3433.3 (TWh), 2008 growth: +5.18%
(Source: CEC Statistics 2009)



III. China Electric Outlook: Power Technology

1. Thermal

- High efficiency supercritical and ultra-supercritical. (World 60% new added SU and USC units are in China)
- IGCC (with CCS) +Clean coal
- CCGT (resource limit)
- CCS

2. Nuclear

- Second generation: G2+
- Third generation: EPR and AP1000
- Fourth generation (HTR, sodium),
- ITER

3. Renewable Energy

- Hydropower: PSPP, different dams (with Francis, Pelten)
- Wind power: 10 MW
- Photovoltaic: thin-film

4. Smart Grid

- ❑ Infrastructure (Telecom, grid integration)
- ❑ VE development (rechargeable, battery)

III. China Electricity Outlook: Electric Power 2009

1. Total Installed capacity in 2009 :

- 874 GW, new added capacity 89.7GW, +10.23%:
 - Hydropower: 197 GW, +29 GW, +14%
 - Thermal: 652 GW, +61 GW, +8%
 - Nuclear 9.08 GW, -
 - Renewable 25 GW +10 GW

2. Power production 3643TWh

3. Transmission

- ↪ Massive investment for interconnection, West-East, North-South,
- ↪ Transmission distance for above 220KV:
40,988 KM
- ↪ UHV
- ↪ Smart grid

IV. Climate Change and Public Policies

Public Policies

1. Institutions

2. Policies

Emissions Scenario

1. History

2. Actuality

3. Future

China Energy Institutions/Organisations

Energy Authorities:

☐ **National Energy Committee (NEC)** **Under State Council Cabinet**

– Premier Wen Jiabao is Chairman of China Energy Leading Group seconded by Vice Premier Minister Li Ke Qiang

– 21 ministerial members including:

- ↗ **NDRC**
- ↗ **Ministry of Finance**
- ↗ **Ministry of Environmental Protection**
- ↗ **MOST**
- ↗ **NEA is executive cabinet and working administration**

☐ **NDRC**

- Planning (Five-Year Plan and long-term program)
- Major project approvals (nuclear, etc)
- Tariff approval

☐ **SERC: Regulator**

Energy Industry

1. Oil: CNPC, PetroChina, SinoPec
CNOOC,

2. Electricity

Electric Network(2 grids)

- ☐ State Grid Corporation of China (SGCC)
- ☐ South Grid Corporation

Production:

Electric sector monopolised by central or local government energy companies. National Five GENCOs (46% concentration in 2007).

- Huaneng
- Datang
- Huadian
- Guodian
- CPI

- ☐ Provincial Gencos

IV. Climate Change and Emissions Scenario

1. Emissions history

- ❑ China becomes world top CO₂ emitter in 2008.
- ❑ CO₂ increased from 1.38 billion t in 1978 to 6.01 billion t in 2007 (4 time plus).
- ❑ Coal remains largest contributor to global emissions, in particular for China.
- ❑ Fossil energy related CO₂ has increased 5.2% annually.
- ❑ Energy consumption: 570 million tce in 1978;
However, 2.85 billion tce increase in 2008 (five times in 30 years).
- ❑ Power generation contributes over 50% in 2007, of the increase in global emissions from 2005 to 2030.

Source: IEA Key World Energy Statistics" 2008 and IEA World Energy Outlook 2009

IV. Climate Change and Emissions Scenario

2. Current Chinese Situation and Action

- 2000 - 2007, energy related CO₂ total emissions doubled, to 6.1 Gt.
- CO₂ emissions per capita still below OECD countries: 23% of the US and 39% of OECD countries, lower than the world average level.
- Power generation emissions increase by more than 3Gt over project period (50% of 2007).
- Launched National Climate Change Plan, target: 20% cut in energy consumption per unit of GDP during the 11th Plan (2005-2010).
Achieved 14.4% by 2009
- By 2009, 54 GW of small and inefficient plants demolished and replaced by high efficiency and cleaner power units.
- Priority change: Central government set provincial government CO₂ emission reduction targets priority over GDP growth.

Source: IEA Key World Energy Statistics" 2008 and IEA World Energy Outlook 2009 and ERI 2009

IV. Climate Change and Emissions Scenario

3. China's Energy Future

Target:

- **15% non-fossil energy by 2020 (9% in 2009)**
- **40-45% "carbon intensity" reduction by 2020** compared with 2005. (announced in Nov 2009).
- Emissions continue to grow rapidly in the Reference Scenario, to 9.6 Gt in 2020 and 11.6 Gt in 2030.
- By 2030, China accounts for 29% of the world's emissions, more than North America, Japan and EU combined.
- Fast emission growth in large part due to rapidly growing economy, with GDP in 2020 assumed to be around 2.5 times 2007 level.
- Urbanisation will increase energy consumption and emissions.
- With car ownership expansion, road-transport emissions increase more than four-fold between 2007 and 2030
- Energy CO₂ emissions per unit of GDP decline by 37% between 2020 in Reference Scenario.

Source: IEA World Energy Outlook 2009 and NDRC

IV. Climate Change and Emissions Scenario Policies: New Energy Investment

□ Renewable energy investment booming

- Renewable development mid and Long term programme released in 2007
- Renewable Law revised end 2009.
- **USD 34 Bn investment** in renewable energy, **N°1 in World**, ahead of US, quasi overheated investment from private sector.
- Policy making has been modifying the rules to favour renewable energy in connecting to the network (penalty rules)
- Multinational renewable technology suppliers are all present in China in different forms.
- Bottleneck: R&D investment is insufficient, far behind EU and US. Public finance and private finance need to work together to accelerate technology spread.
- Manufacturing industry spreading technologies through patents, licences, and JV by trading market with technology.

IV. Climate Change and Emissions Scenario Policies: Energy Efficiency and Transport

Energy efficiency

- 20% reduction in energy consumption per GDP unit 2005-2010**
- Steel: 40% of world production
- To limit development in small inefficient steel mill
- Cement: 50% of world production. Set up a high entrance step.
- 1,000 energy enterprises
- 54 GW of small coal-fired plants decommissioned

Transport

- Stimulus investment
- Massive railways investment
- Public transportation: metro
- Electric vehicle

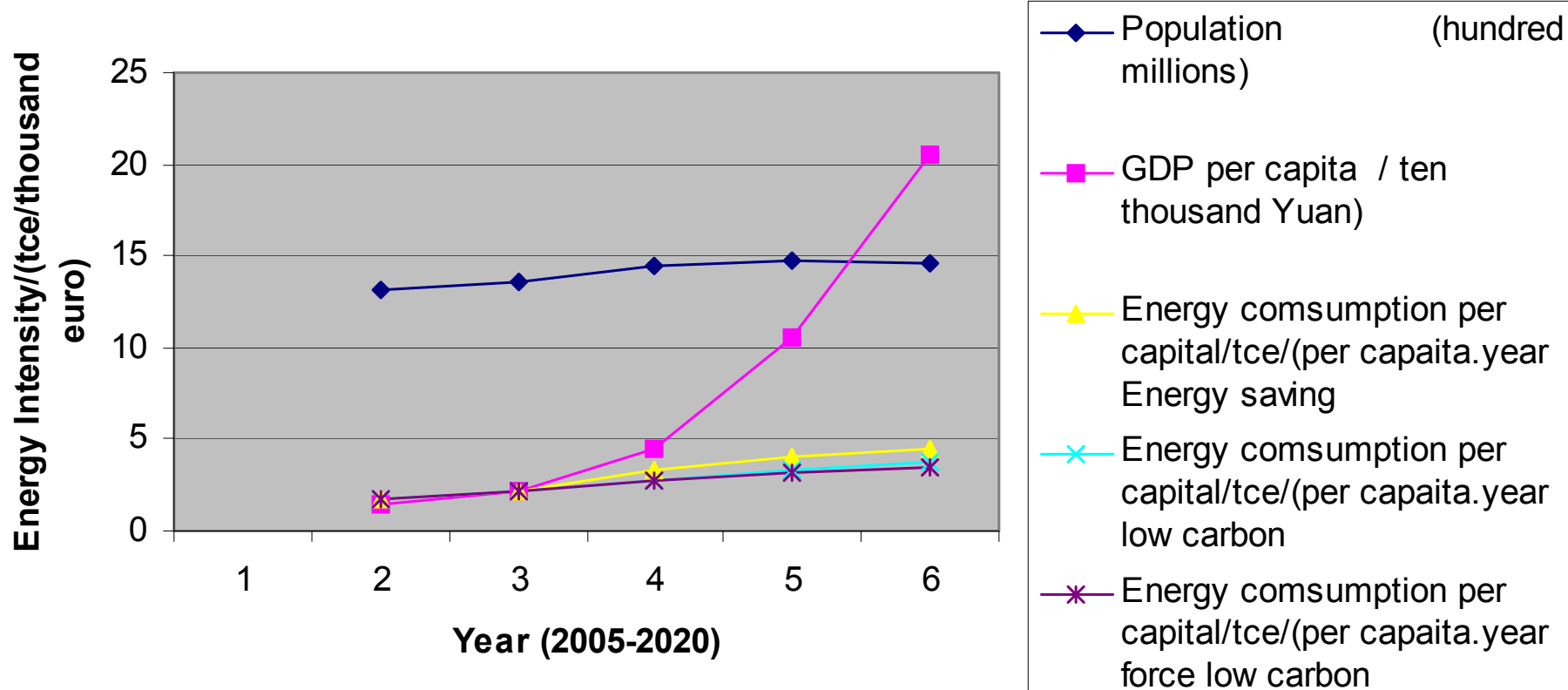
Building

- Improvement of building standards with energy saving
- Materials
- Service

V. Emissions

China Energy Intensity per GDP per capita Scenario 2005-2050
(2005, 2010, 2035 and 2050) Source: ERI 2009

2005-2050 Energy Consumption per capita per GDP



IV. Climate Change and Emissions Scenario

Public Policy: China Nuclear Power Prospective

- ❑ Key solution on low carbon energy:
- ❑ China current nuclear power installed capacity about 9 GW, 1.6% of total capacity.
- ❑ Launched worlds most ambitious new nuclear projects. **20 of 29** new units are under construction(1/3 world).
- ❑ Revised original 2007 40 GW nuclear power plan. New plan could reach 70 or 80 GW.

China Nuclear Power Propsective (2020-2050) Source: CNNC March 2010		
Year	Expected capapcity (GW)	Share of total capacity (%)
2020	70	7
2030	200	15
2050	400	22

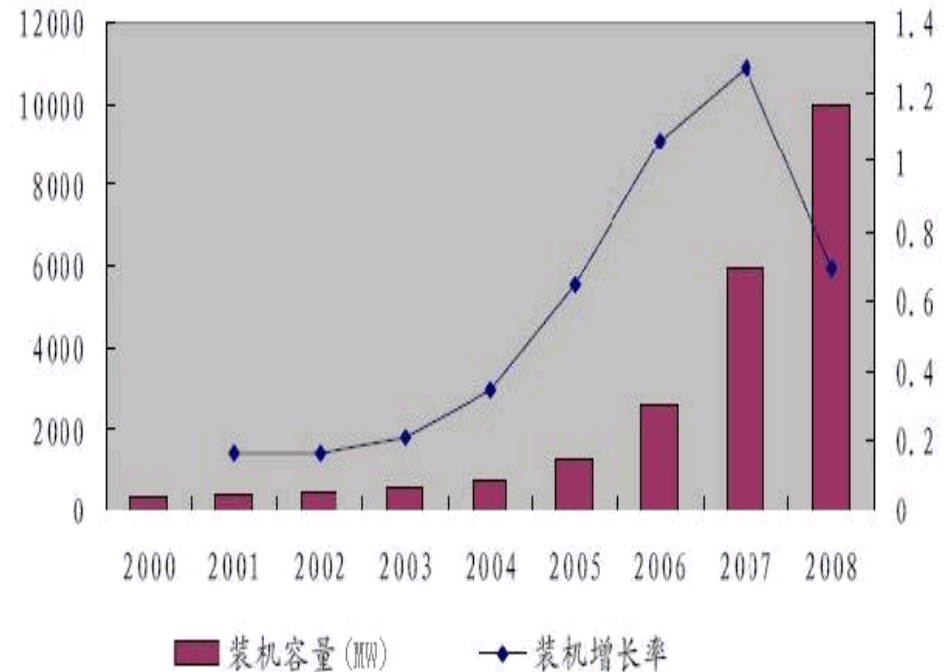
IV. Climate change and Emissions Scenario

Policy: Renewable Energy Development

Wind power

- ❑ Proven wind reserves 2,600 GW
- ❑ Late starter: no capacity to produce complete wind power generator equipment in 2003.
- ❑ Installed capacity doubled annually since 2004 (from 764 MW).
- ❑ 22 GW wind power installed by 2009, N°2 in the World. 15GW new added expected in 2010
- ❑ Off-shore wind power potential estimated 100 to 200 GW.
- ❑ First off-shore wind power built in Shanghai 100 MW.
- ❑ Wind power could overtake nuclear power capacity by 2020.

China Wind power 2000-2008



2000-2008年我国风电装机容量增长图

Source: NEA, March 18, 2010

China Renewable Energy: Photovoltaic

Photovoltaic (PV)

- ❑ China world's first PV battery producer
- ❑ Over 98% of production for export market.
- ❑ Currently only 24 MW installed capacity.
- ❑ Special subsidies applied for building roof solar system
- ❑ First PV Plant of 20 MW with preference tariff is under demonstration
- ❑ Target 20 GW by 2020
- ❑ Technology evolution with cost decline will be breakthrough for PV development

Low carbon technology solution

□ Supply Side

- CCS fossil-fuel power generation
- IGCC & co-combustion
- Nuclear plants
- Onshore and offshore wind
- Biomass • Photovoltaic systems
- Concentrating solar power
- Coal: integrated-gasification combined cycle
- Coal: ultra-supercritical
- 2nd generation biofuels

□ Demand Side

- Energy efficiency in buildings and appliances
- Heat pumps
- Solar space and water heating
- Energy efficiency in transport
- Electric and plug-in vehicles
- H₂ fuel cell vehicles
- CCS industry, H₂ and fuel transformation
- Industrial motoring systems

Scenario requires major changes on public policy front

❑ **Fast nuclear generation development**

- 70-80 GW by 2020

❑ **Increase in hydro generation**

- 300 GW - 400 GW by 2020

❑ **Other renewable: production x10** (half wind, half other sources)

- Wind Power: 100 - 150 GW
- PV: 20 GW
- CCS: More than 200 GW installed by 2030
- Capture: assumes intermediate steps taken (industrial demonstrators)
- Transmission: acceptability of grid build-out
- Storage: long-term viability and acceptance

❑ **More than 100 GW coal capacity phased out early**

- Only high efficiency SC and USC in operation
- IGCC
- CCS

V. Conclusion

Energy Security
Development
Emissions

V. Conclusions

1. Energy Security

- Energy supply limited by domestic resources and modest energy resources per capita.
- Energy demand will continue to increase with economic development
- Energy related geopolitics will be under pressure.
- Energy prices will increase.

2. Economic Development

- Emerging developing country (GDP per capita)
- Not finished industrialisation process
- Still in modernisation process
- Urbanisation development (46-60%).

3. Emissions Mitigation

- Inevitable continuing emissions increase.
- International community pressure
- Carbon intensity reduction target: challenging

V. Conclusions

Conclusions:

1. Strong and effective domestic low carbon development policies and international cooperation with appropriate geopolitics are the way to secure and balance China energy supply and energy demand.
2. Low carbon social development economic model is the way to insure sustainable development.
3. Advanced low carbon technologies are the key solutions for national energy efficiency improvement and reduction in energy intensity per unit GDP.

Merci pour votre attention
Questions?

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