

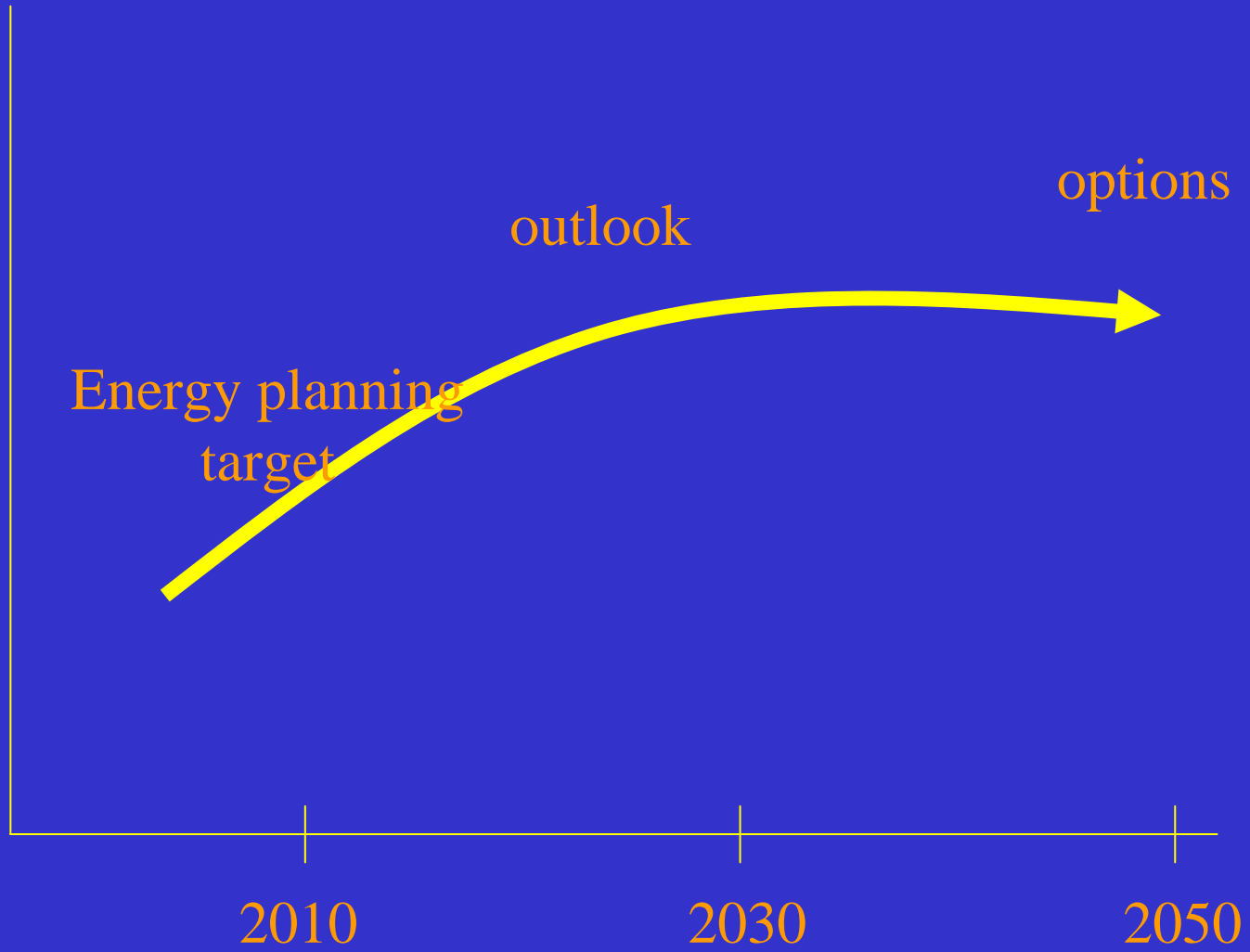
Low-Carbon Options in China

Jiang Kejun

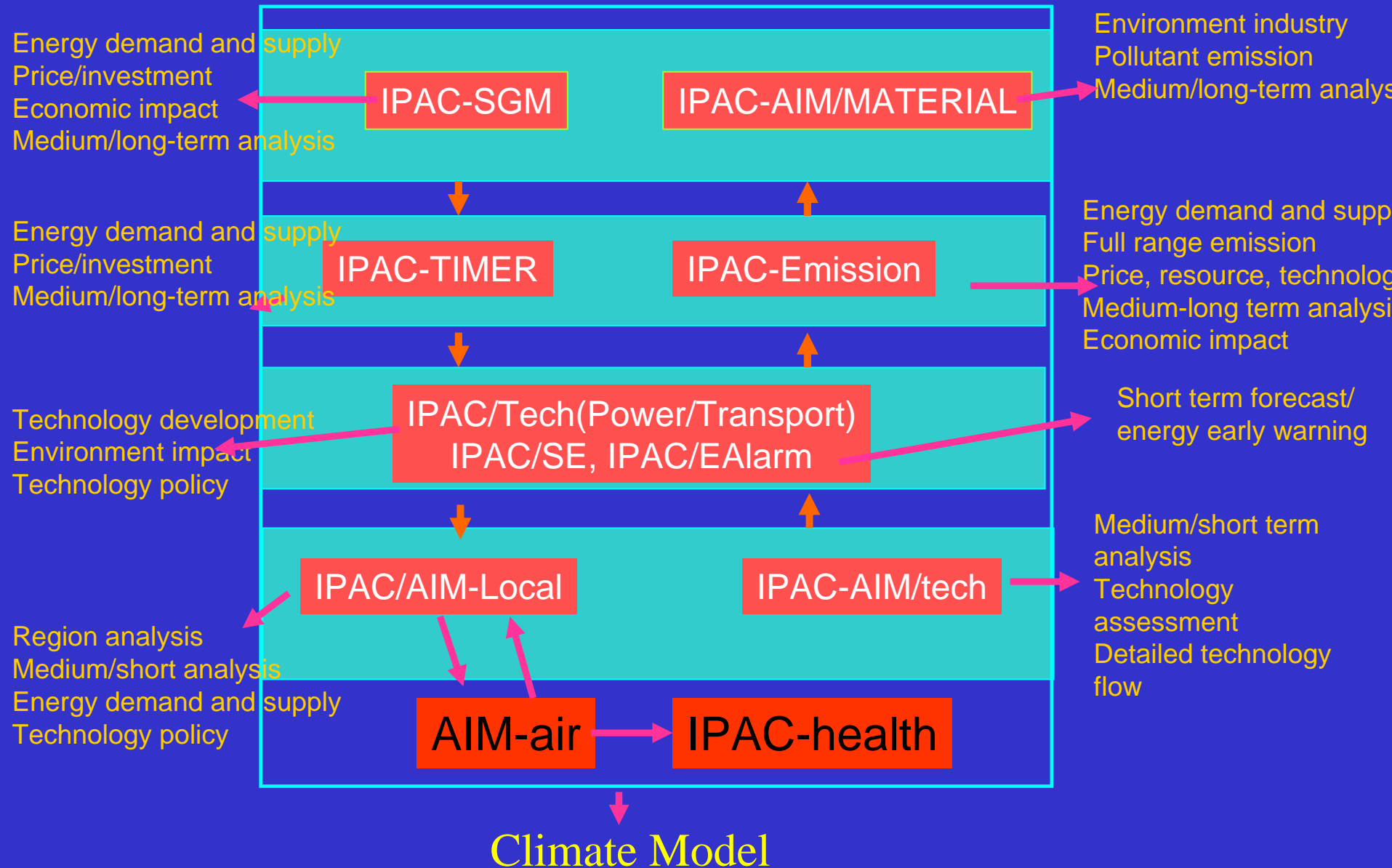
Energy System Analysis and Market Analysis Division
Energy Research Institute, China

EMF 22, Tsukuba, Dec 12-14, 2006

Emission Scenarios



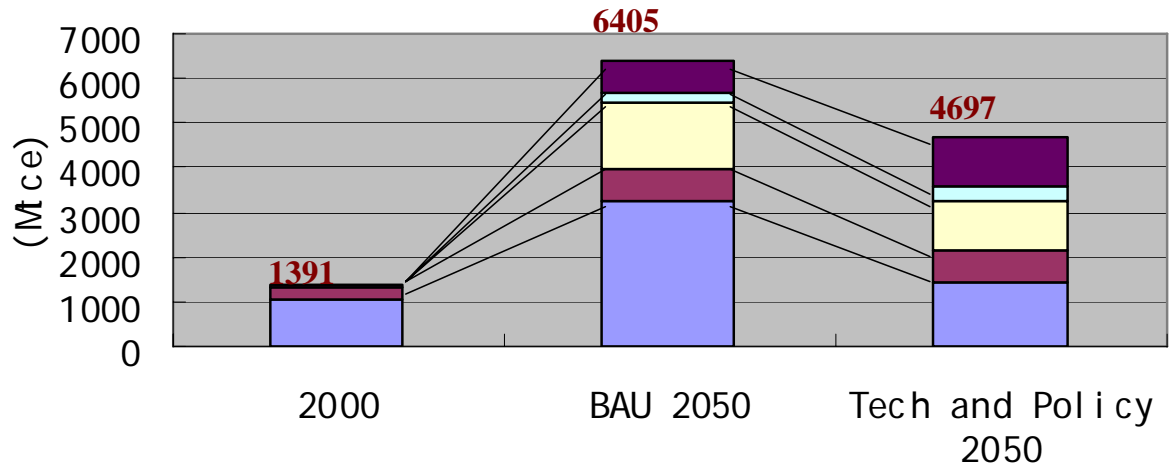
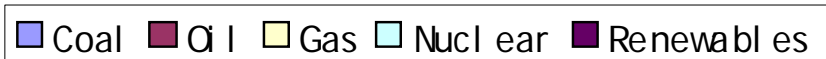
Framework of Integrated Policy Model for China (IPAC)



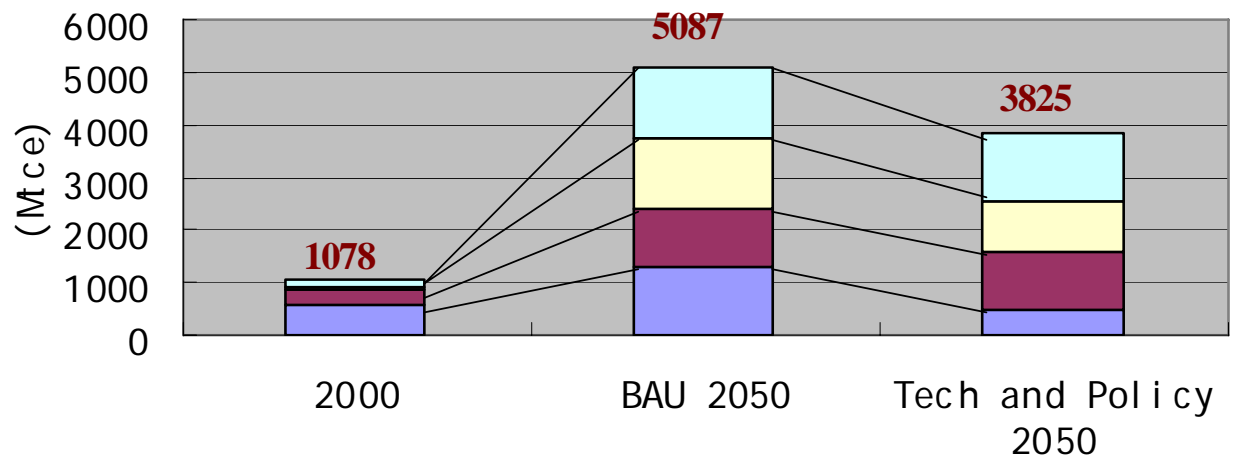
China: Energy demand and CO₂ emission scenarios

		Baseline scenario	Policy and technology scenario
Enhanced Energy Saving	Energy Intensive Products	Annual average energy saving rate 2.7%	Annual average energy saving rate 3.6%
	Building	Annual average energy saving rate 1.9%	Annual average energy saving rate 3.0%
	Transport	Annual average energy saving rate 1.5%	Annual average energy saving rate 2.8%
Renewable energy	Biomass	Annual average reduction rate of cost by 3.7%	Annual average reduction rate of cost by 5.9%
	Hydro	65% of technical potential by 2050	80% of technical potential by 2050
	Solar/wind	0.7yuan/kWh by 2050	0.5Yuan/kWh by 2050
Carbon Capture and Sequestration	Coal fired power plants	4% by 2050	15% by 2050
	Industry	1% by 2050	5% by 2050
Clean coal technology	Power generation	7% by 2050	35% by 2050
	Industry	5% by 2050	15% by 2050
Hydrogen	Power generation	Distributed power generation system by 3% in 2050	Distributed power generation system by 8% in 2050
	Transport	Fuel cell vehicle 5%	Fuel cell vehicle 15%
Transport	Vehicle	Hybrid vehicle diffusion start from 2010, 10% by 2030	Hybrid vehicle diffusion start from 2010, 70% by 2040
Policies	Energy tax	No	50yuan/tce in 2010, 200yuan/tce in 2050
	Subsidy	No	Power from renewable energy 0.3yuan/kWh
	Investment Energy technology R&D	Annual average growth rate 4%	Annual average growth rate 6.2%

Primary energy demand in China, 2050

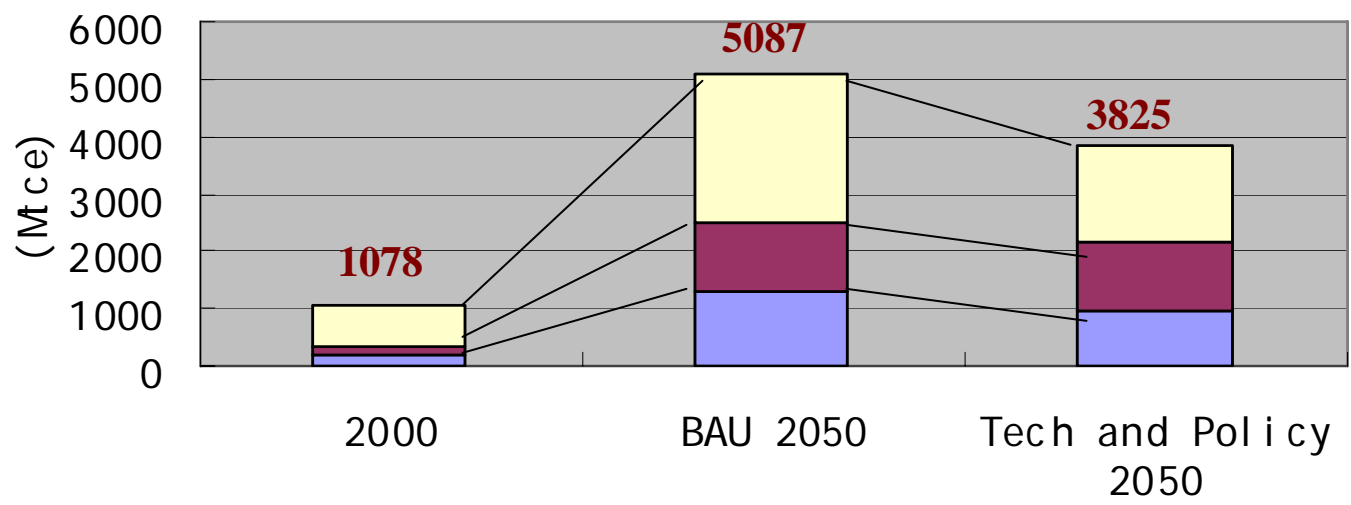


Final energy demand in China, 2050



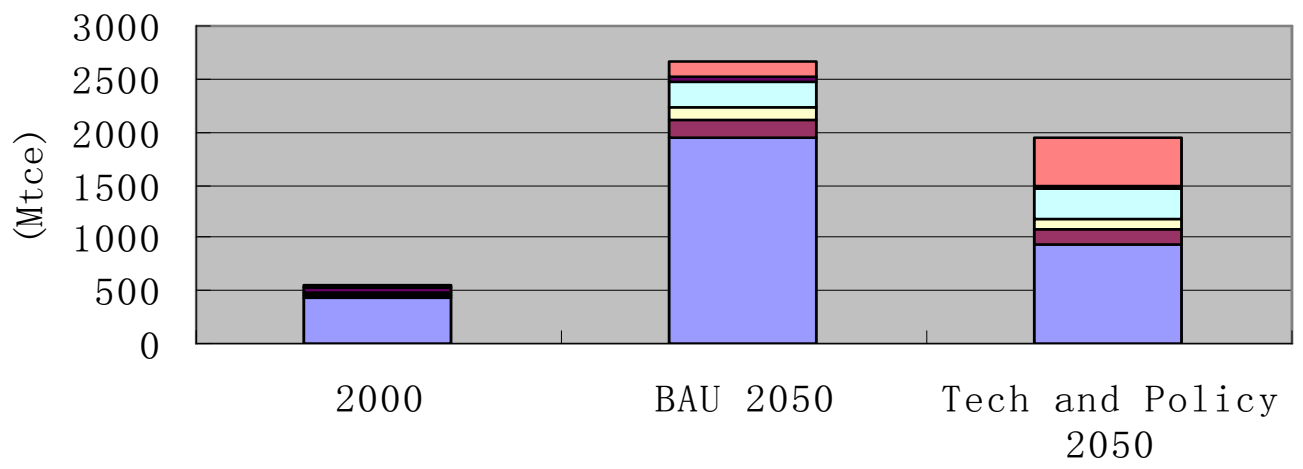
Final energy use by sector

■ Building ■ Transport ■ Industry

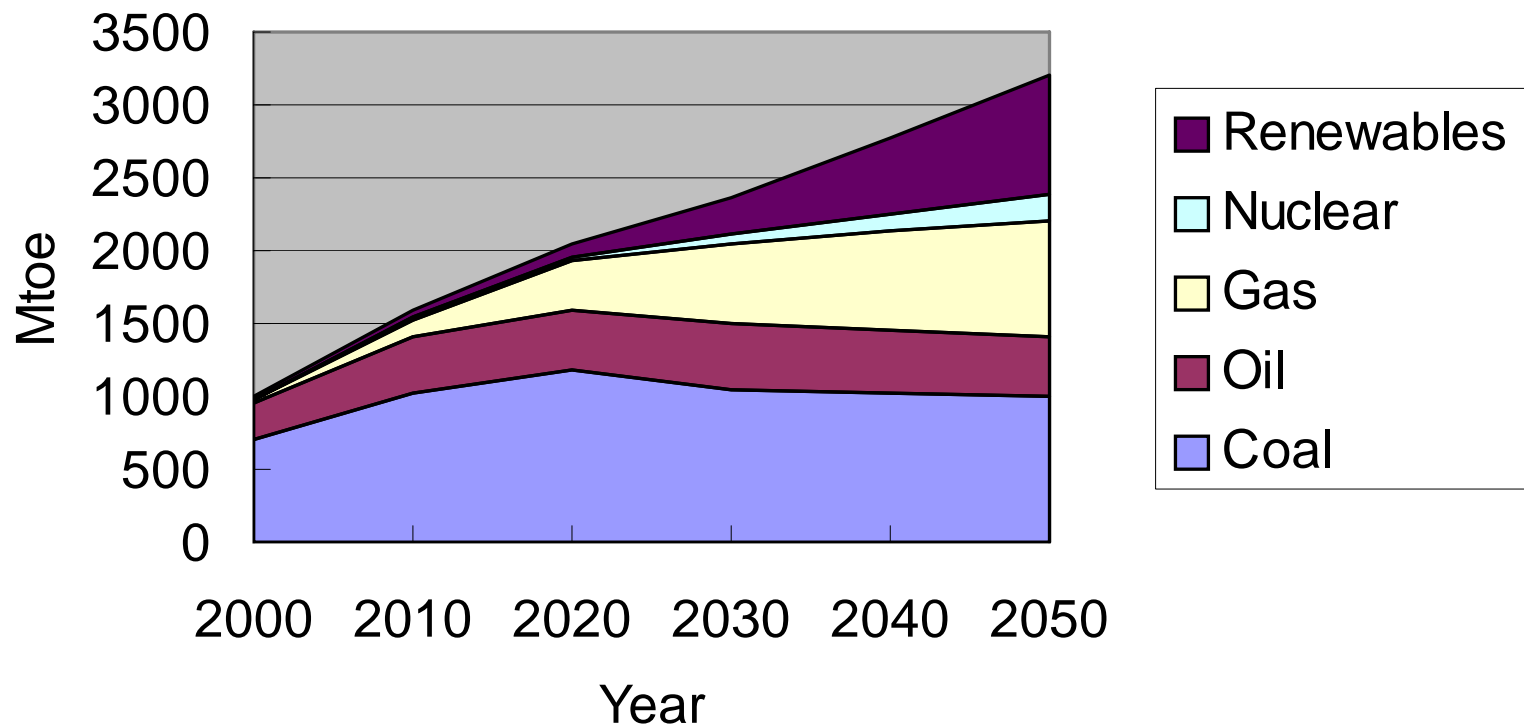


Energy Use in Power Generation in China, 2050

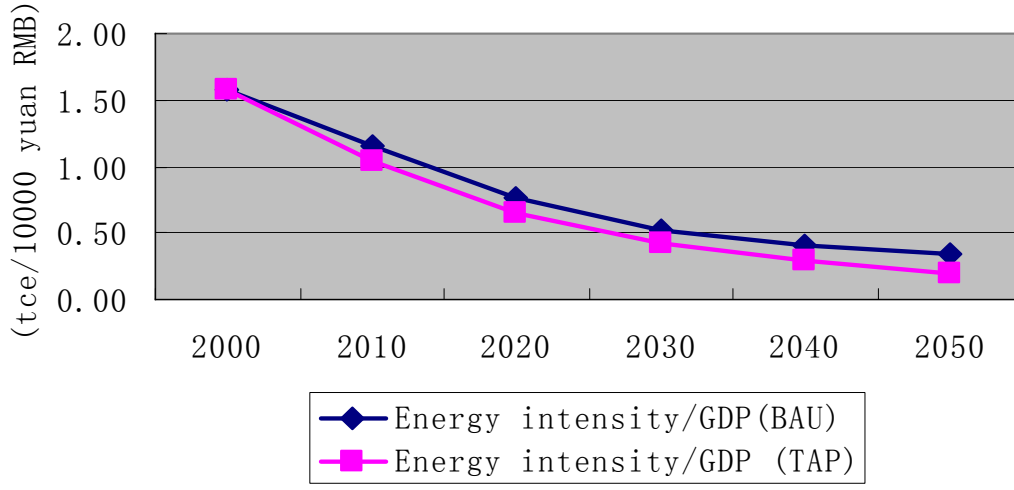
■ Coal ■ Gas ■ Hydro ■ Nuclear ■ Oil ■ Other renewables



Primary Energy Demand in China, Policy Scenario

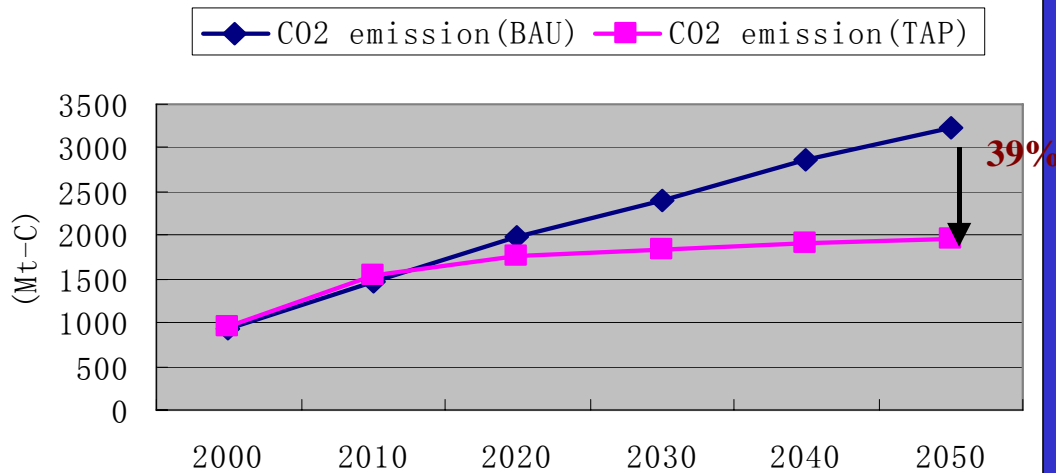


GDP energy intensity in China, 2000-2050



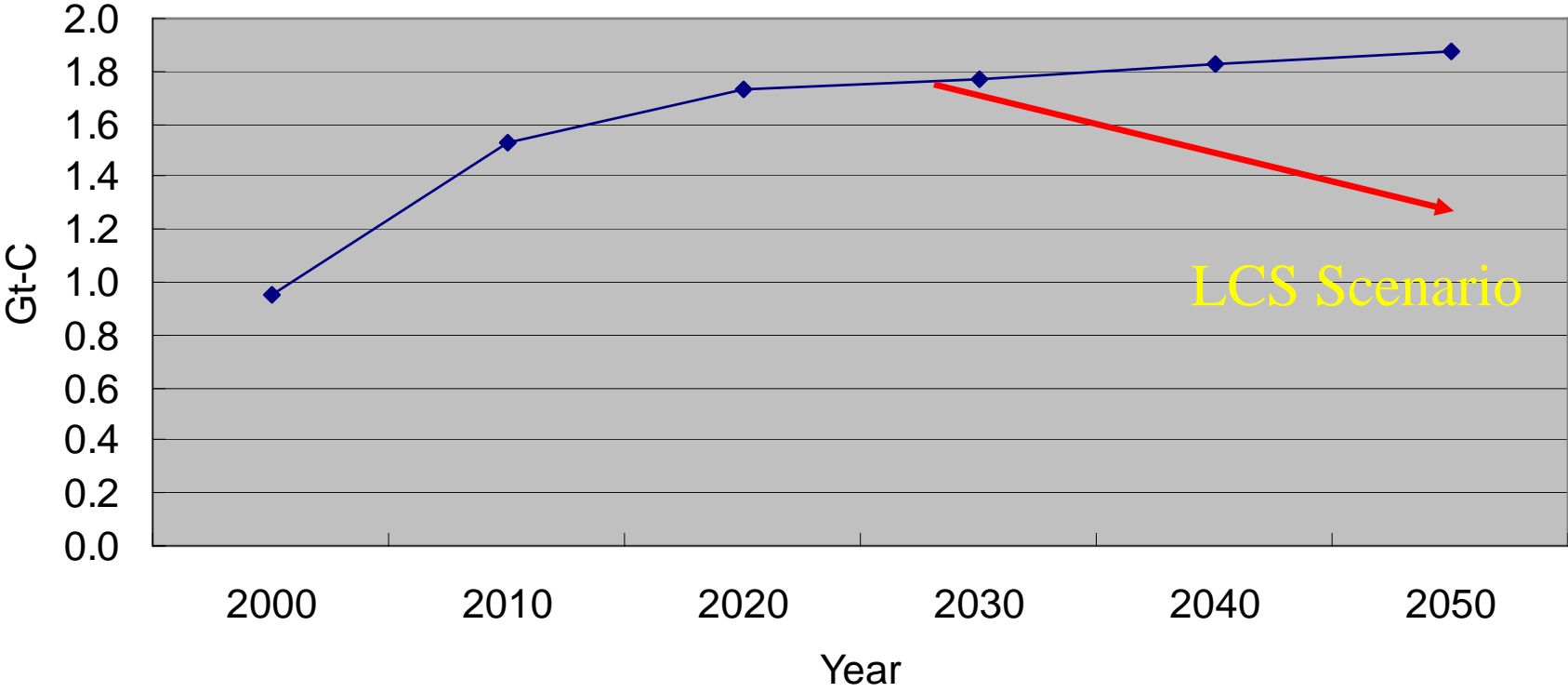
Energy demand will be reduced 27% (1708Mtce) in 2050 by technology and policy scenario compared with baseline scenario in China.

CO2 Emission in China, 2050



CO2 emission will be reduced 39% (1263Mt-C) in 2050 by technology and policy scenario compared with baseline scenario in China

CO2 Emission from Energy Activities in China



Identify efficiency promised technologies: fully used by 2020

Sector	Technologies
Steel Industry	Large size equipment (Coke Oven, Blast furnace, Basic oxygen furnace ,etc.), Equipment of coke dry quenching, Continuous casting machine, TRT Continuous rolling machine, Equipment of coke oven gas, OH gas and BOF gas recovery , DC-electric arc furnace
Chemical Industry	Large size equipment for Chemical Production, Waste Heat Recover System, Ion membrane technology, Existing Technology Improving
Paper Making	Co-generation System, facilities of residue heat utilization, Black liquor recovery system, Continuous distillation system
Textile	Co-generation System, Shuttleless loom, High Speed Printing and Dyeing
Non-ferrous metal	Reverberator furnace, Waste Heat Recover System, QSL for lead and zinc production
Building Materials	dry process rotary kiln with pre-calciner, Electric power generator with residue heat, Colburn process, Hoffman kiln, Tunnel kiln
Machinery	High speed cutting, Electric-hydraulic hammer, Heat Preservation Furnace
Residential	Cooking by gas, Centralized Space Heating System, Energy Saving Electric Appliance, High Efficient Lighting
Service	Centralized Space Heating System, Centralized Cooling Heating System, Co-generation System, Energy Saving Electric Appliance, High Efficient Lighting
Transport	Diesel truck, Low Energy Use Car, Electric Car, Natural Gas Car, Electric Railway Locomotives
Common Use Technology	High Efficiency Boiler, FCB Technology, High Efficiency Electric Motor Speed Adjustable Motor, Centrifugal Electric Fun, Energy Saving Lighting

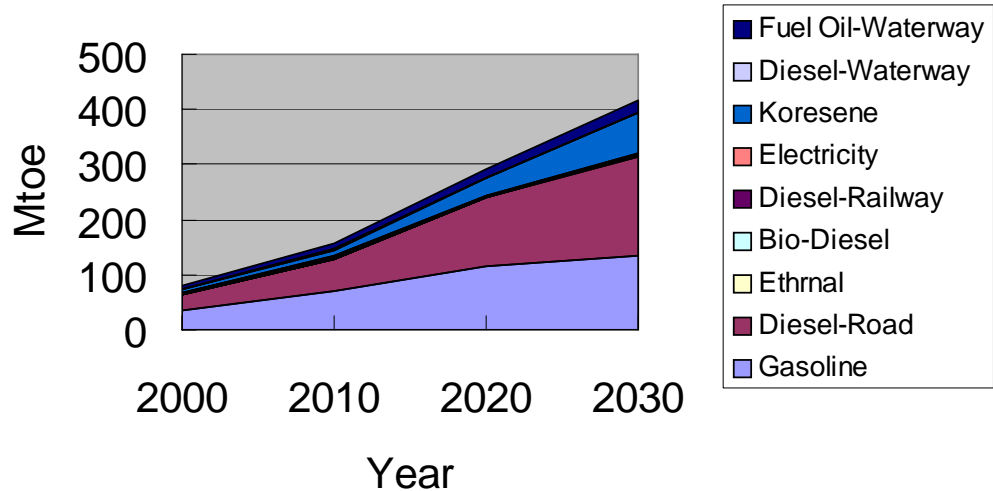
Technologies use in IPAC-AIM/Technology model for transport analysis

Mode	Technology	Mode	Technology
Air, Freight	Airplane, freight	Bus	Gasoline bus
Large Truck	Conventional large truck (Gasoline)		Improved gasoline bus
	New large truck (Gasoline)		Diesel bus
	Conventional large truck (Diesel)		Improved diesel bus
	New large truck (Diesel)		Hybrid Bus
	Hybrid Truck, large		CNG.Bus
Small Truck	Conventional small truck		LPG.Bus
	New small truck	MRT	MRT
	Small Truck Diesel	Car	Electric car
	Hybrid Truck, small		SANATA-Normal Car, Gas
Railway, Freight	Conventional diesel locomotive		Mini-Car
	New diesel locomotive		High Fuel Economy Car
	Conventional electric locomotive		Hybrid Car
	New electric locomotive		Fuel Cell car
	Steam locomotive		Diesel Car
Waterway	Conventional coastal ship		New Diesel Car
	New coastal ship	Railway, Passenger	Conventional diesel locomotive
	Conventional ocean ship		New diesel locomotive
	New ocean ship		Conventional electric locomotive
	Conventional river ship		New electric locomotive
	New river ship		Steam locomotive
	Transportation Others	Waterway, passenger	Conventional river ship
Air, Passenger	Airplane, Passenger		New river ship

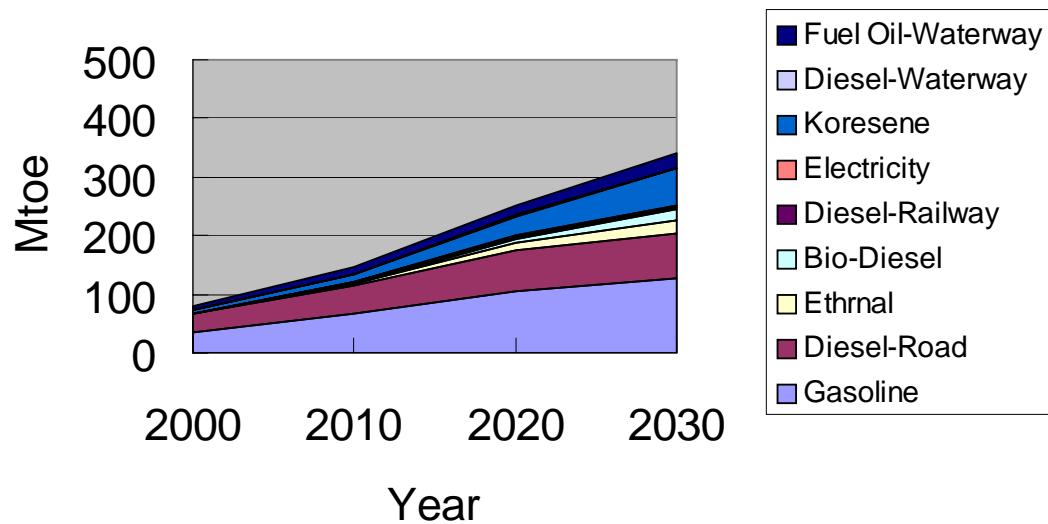
Policy Options for alternative transport scenario

Mode	Policy Options
Air	New Boeing Airplane, AirBus 380
Railway	Efficiency improvement 8% for electric and diesel locomotive
Waterway	15% efficiency improvement by using larger tank and engine
Freight Large Truck	Advanced diesel truck, more than 50%
	Hybrid Truck, 20%
Freight Small Truck	Hybrid Truck, 50%
	New Diesel Truck, 40%
Bus	Hybrid Bus, 70%
Car	Efficient diesel car, 30%
	Hybrid car 50%
Biomass Fule	Ethonal 30% of gasoline use
	BioDiesel 15%
Public Transport	Take 15% more from car use
Bicycle	10% more
Fuel tax	Start from 2010, similar rate by 2020 with that in Japan and Europe

Transport Energy Deamnd, Baseline Scenario



Transport Energy Deamnd, Policy Scenario



Technology Used in Power Generation

Biogas Power Generation

Biogas power generation from husbandry

Biomass Power Generation

Offshore wind turbine

Nuclear Power Plant

Biomass Power Plant

Super Critical Unit

Critical Unit

Coal Cogeneration

N.Gas Co-generation

Coal Power Plant

Gas Power Plant

IGCC

NGCC

Oil Power Plant

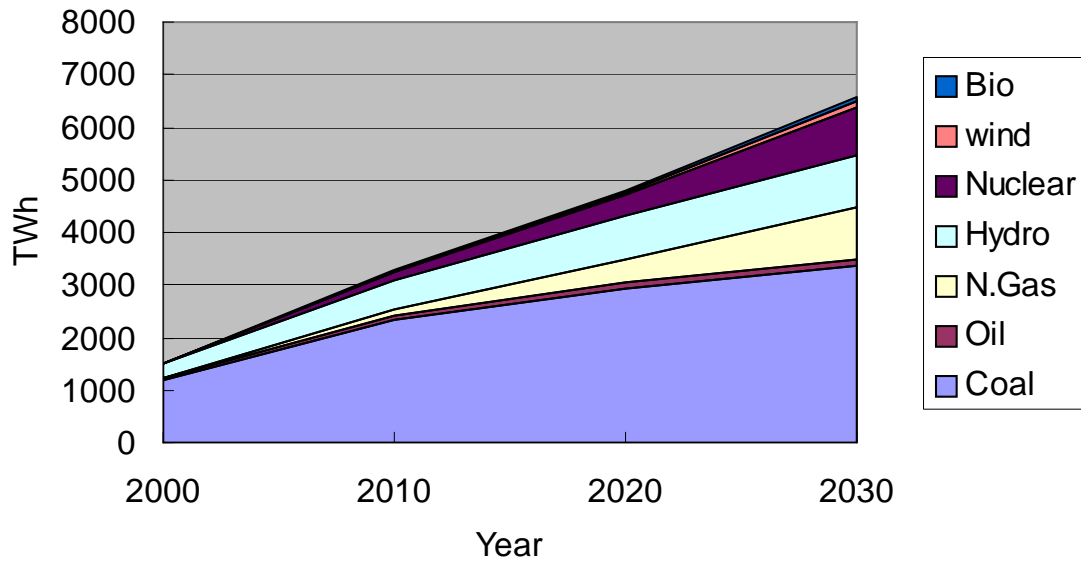
Hydro Power Plant

Wind Power

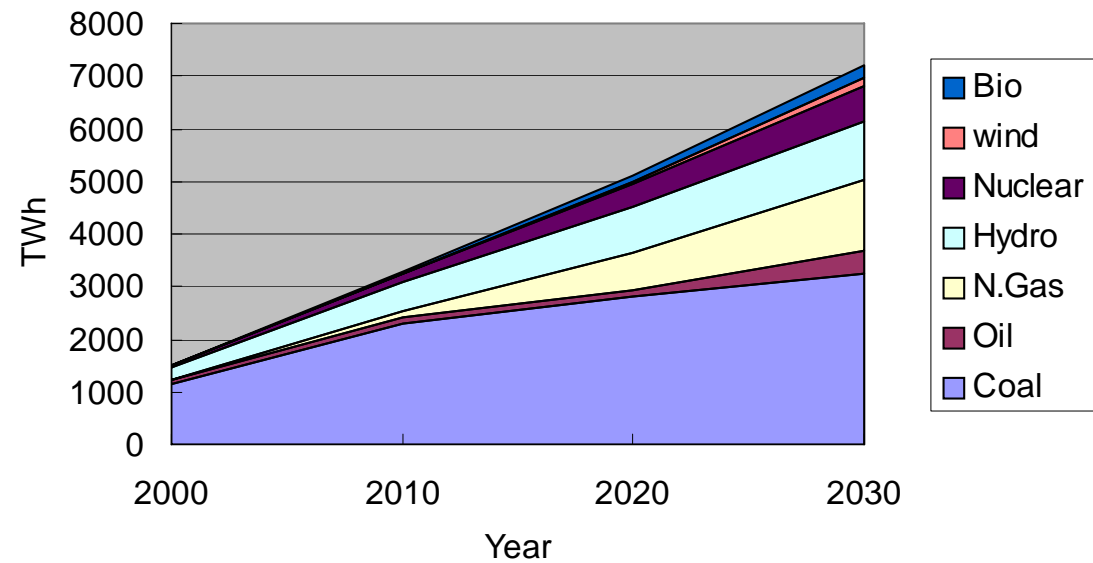
Technology options for alternative scenario

Biogas Power Generation	10GW by 2020
Biogas power generation from hu	1GW by 2020
Biomass Power Generation	2GW by 2020
Offshore wind turbine	10GW by 2030
Nuclear Power Plant	40GW by 2020
IGCC	100GW by 2030
NGCC	100GW by 2030
Onshore Wind Power	25GW by 2020

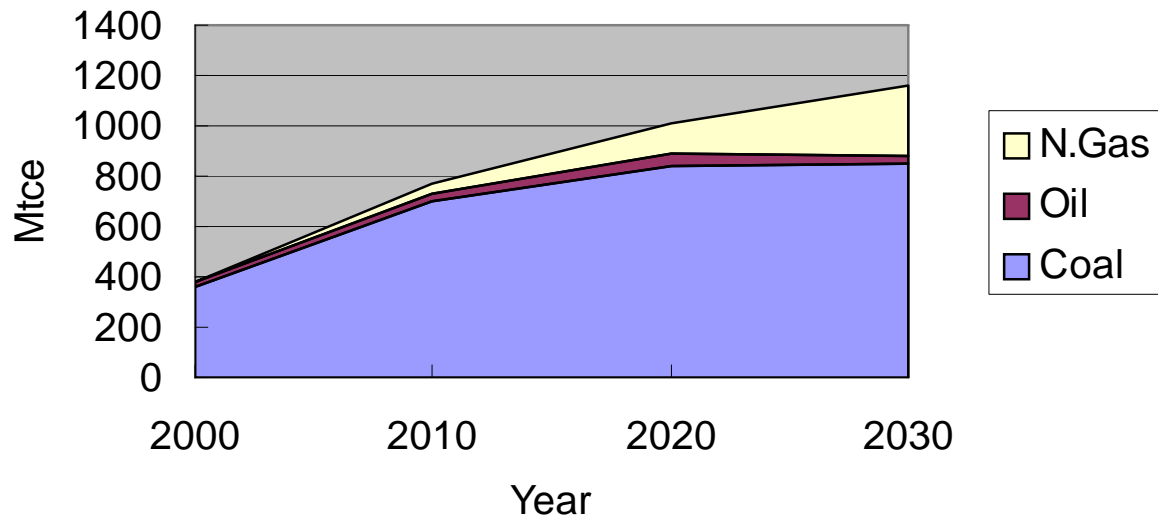
Power Generation Output in China, Baseline Scenario



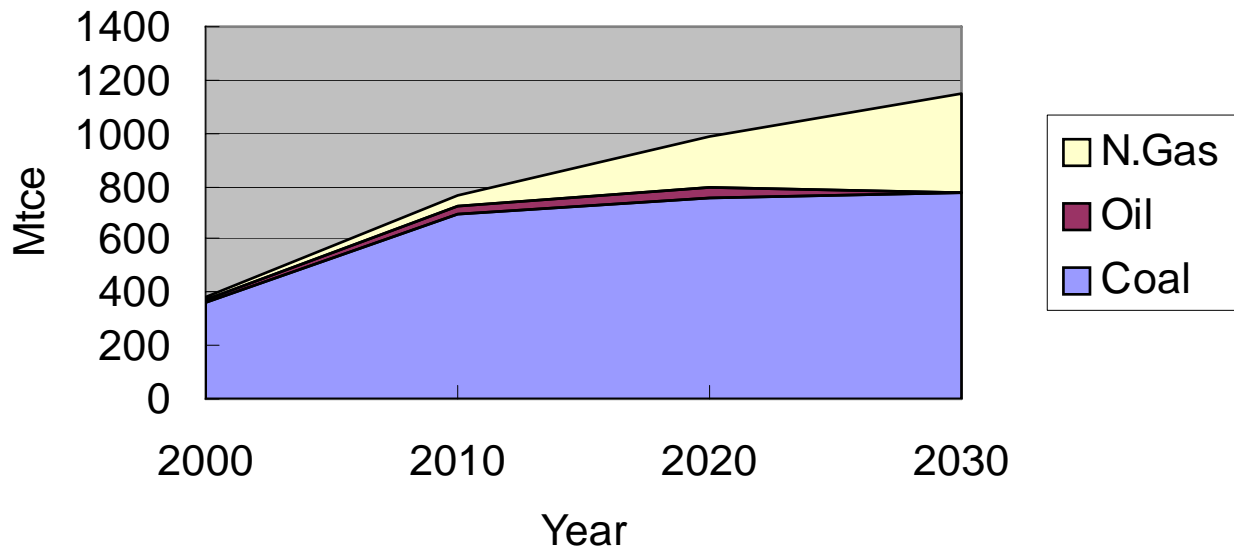
Power Generation Output in China, Policy Scenario



Fossil Fuel Use in Power Sector, baseline scenario



Fossil Fuel Use in Power Sector



Clean Coal Technology: Global Progress

- ✓ In 2000, Version 21 program in United States
- ✓ Early Entrance Co-production Plant(EECP), 2007
- ✓ Pilot phase plants on LPMEOH and LPDME, which are the technologies to produce methanol, Dimethyl Ether, and co-generation. These plants were constructed in 1997
- ✓ Coal integrated generation system by Some famous international companies including BP, GE, Air Products and Chemicals, Shell
- ✓ Investment for clean coal technology R&D is decreasing in Europe due to less use of coal, even in United States

Clean Coal Technology: Progress in China

- ✓ Coal washing: in 2003, coal washing rate is only 24%, remain very low washing rate
- ✓ Coal-Water mixture: There are huge development of coal-water mixture in China. In 1999 the production capacity was less than 900 thousand ton. The production capacity increased to be nearly 7 million ton in 2003
- ✓ Industry briquette: because of high price, progress of industry briquette is slow. Recently air pollution issues raised the possibility to use more industry briquette
- ✓ Ultra-super critical unit: 1GW unit is under construction in Yuantian Power Plant, which started construction in 2004 and will be in operation in 2007. This is one component of National 863 Project

Clean Coal Technology: Progress in China(conti.)

- ✓ IGCC: Project feasibility study was done for Beijing IGCC project and Yantai IGCC project during 1995 to 2000. And now four IGCC project is planned and will start construction soon.
- ✓ Underground coal gasification: Shan Dong Lineng Group made plan for a pilot phase project on underground coal gasification. This project includes four gasification furnace with total capacity 3million m³ per day
- ✓ Poly-Generation: in 973 Program, a preliminary analysis was conducted. 4 to 5 projects are under construction and will start production in 2007 to 2009

Clean Coal Technology: Progress in China(conti.)

- ✓ **Coal Liquefaction:** In 2002, Shenhua Direct Coal Liquefaction project is under construction. This project is expected to start production in 2007. All together there are 29 projects under planning with total capacity 40 to 50 million ton oil.
- ✓ **Desulphurization:** with recent rapid increase of coal fired power plants, newly construct coal fired power plant with sulphur content higher than 1% equipped with desulphurization technology. And due to air pollution in cities, some existing coal fired power plants near cities also started to equip with desulphurization equipments
- ✓ **Low Nox Combustion technology:** still in research process. One pilot project is under construction. As research project, more then ten units equipped with low NOx combustor

Profit to develop clean coal technologies

- Increase energy security: self-supply of energy 93% in 2005. In 2030, self supply will be 76% in 2030 in baseline scenario, 77% in policy scenario, with smaller import.
- Fundamental industry in China with large employment: 7.6 million employees in 2004, 5.8million in 2030. Important thing is this is good for low income people to fine opportunity
- Extend economy activities. Taking lead for clean coal technology in the world will bring economy benefit. Three power equipment companies in China is becoming among top manufactures in the world in 2005(largest power capacity suppliers for coal fired power plants), and started to export advanced coal fired power plants.

Profit to develop clean coal technologies(Conti.)

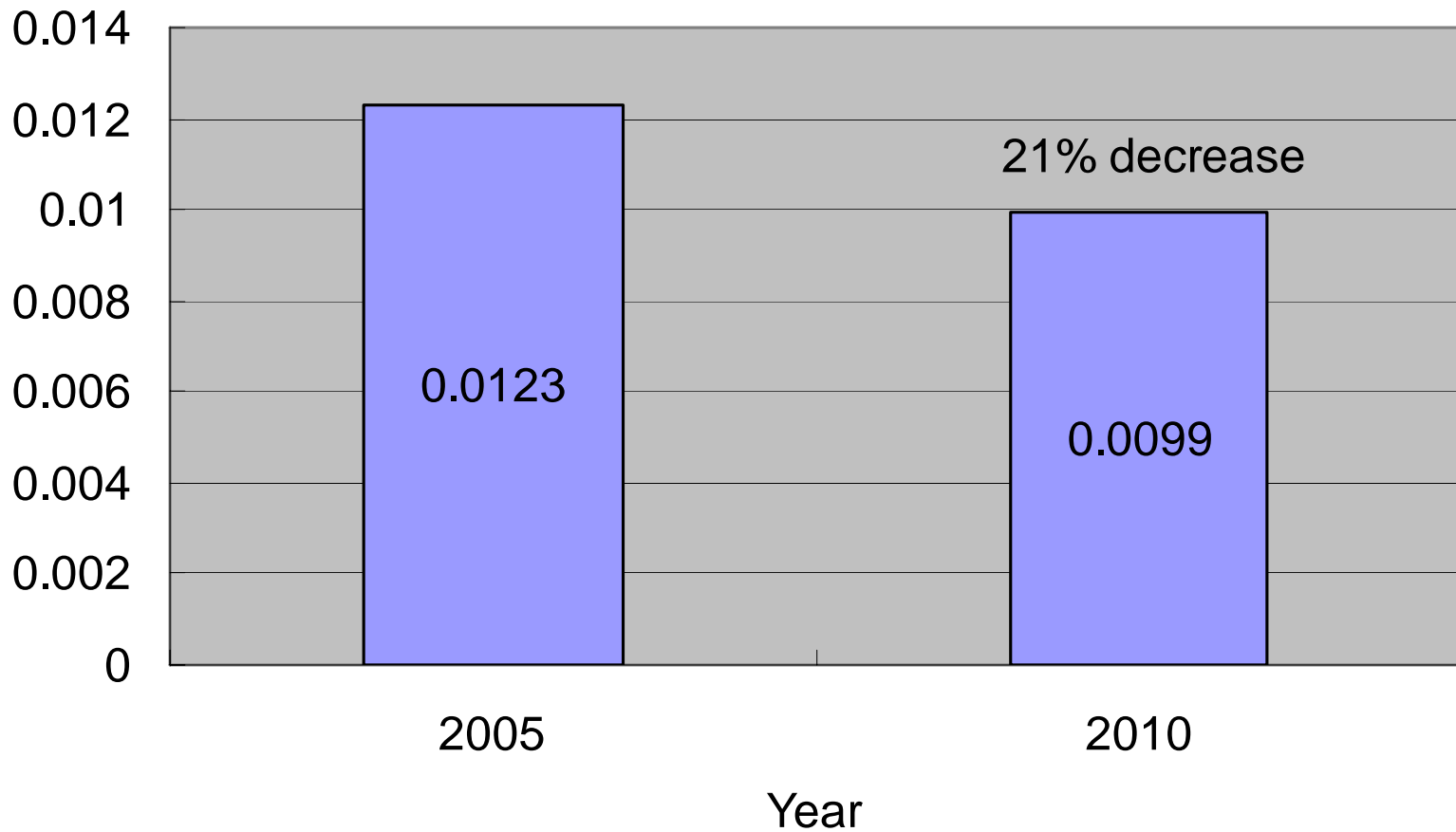
- Very good environment effects. SO₂, NO_x, PM emission, water pollution will be significantly reduced by using clean coal technologies, also very important for GHG emission reduction. Clean coal technology development will be crucial for government environment target in 11th Five Year Plan
- Contribution to global climate change collaboration. Asia-Pacific Partnership on Clean Development and Climate, China-EU Partnership on Climate Change have component of clean coal technology collaboration

Technology is moving fast: coal fired power plants

- Super-Critical Generator is major power generation technology in China for new power plants
- There are more than 10 ultra-super critical units under construction
- Four IGCC under planning and start construction next year

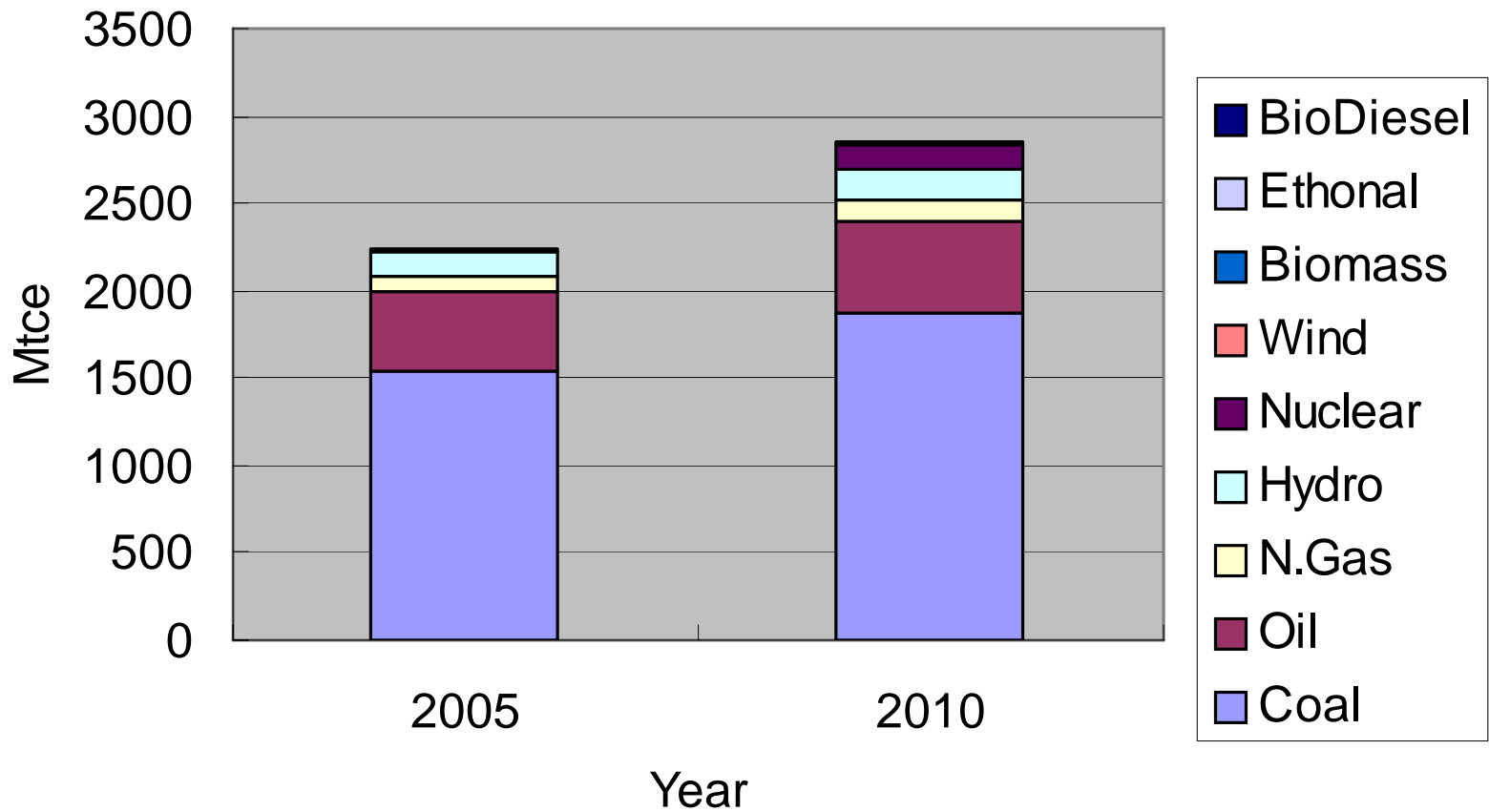


Energy Intensity in 2010, 9.5% growth policy scenario

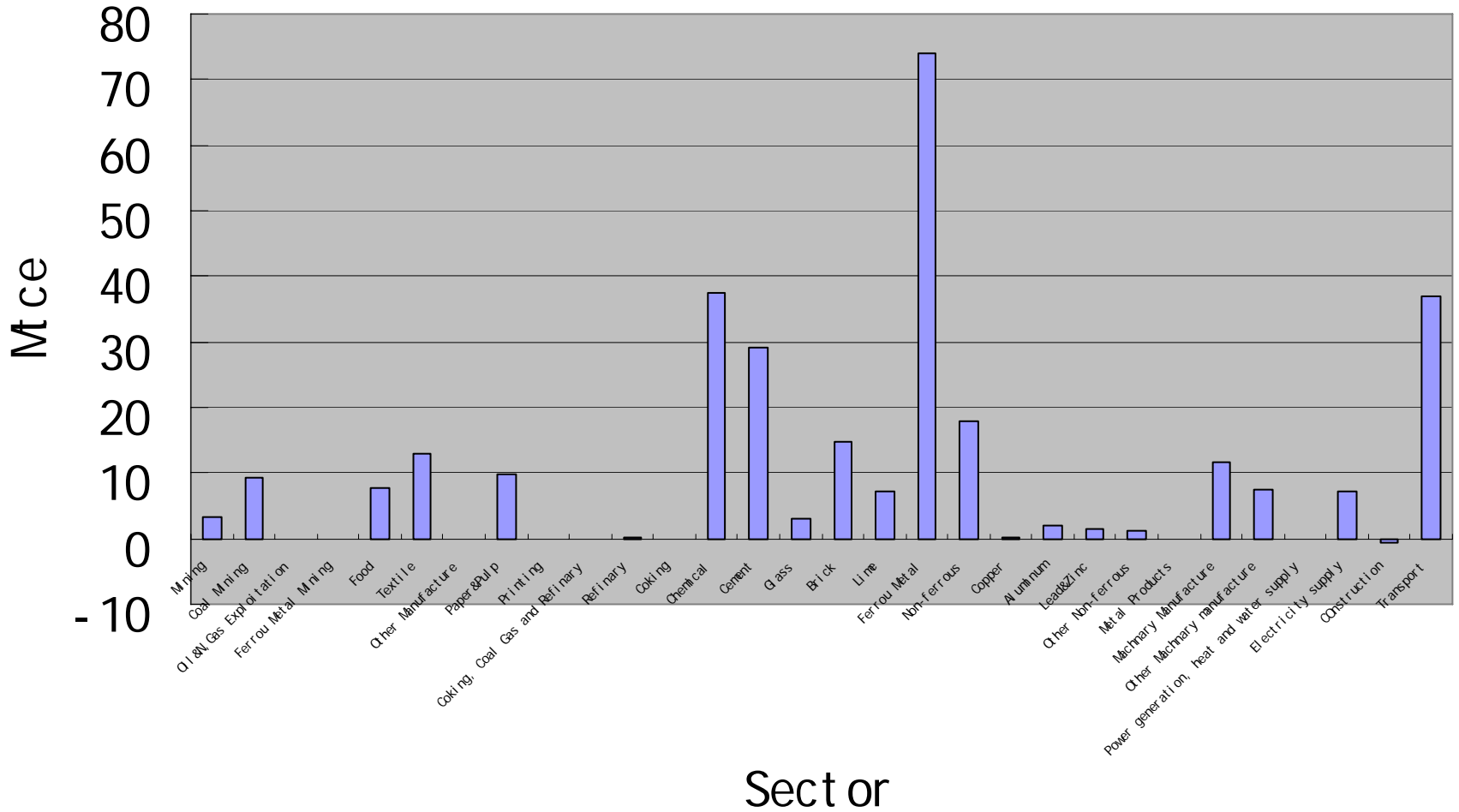


Government target: 20% energy intensity decrease in 2010 compared with 2005

Primary Energy Demand, 9.5% Growth Policy Scenario



Energy Saving by Sector, 9.5% Policy Scenario



Conclusion

- There are already a large amount of new technologies available to be implemented in China. Policies such as fiscal polices including energy tax should be adopted at early time
- New advanced technologies is crucial for future low carbon society, such as advanced power generation system, transport system, higher efficiency electric appliance, building
- More investment is urgently needed now for technology R&D. International collaboration is expected to work on this
- Investment on new technology will benefit on economy development
- Chinese government is making full effort to reduce energy demand increase in China as national strategy. If the strategy could be implemented, there will be strong support for low carbon society in 2050

Policies recommended to government beside policy planning

- Energy tax, to be implemented at early time, such as 2010
- Reduce space heating payment for energy efficient building
- Pay-back price: grid purchase electricity from renewable in the price grid sale to end-users
- Much more emphasizing on new technology development