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Energy demand and emissions in 2030 in China: scenarios and policy options

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Abstract Recent rapid growth of energy use in China now exerts great pressure on energy supply and the environment. This study provides scenarios of future energy development and resulting pollutant and greenhouse gas emissions, taking into account the most up-to-date data and recent policy discussions that will affect future economic, industrial, and energy supply trends. To address uncertainties, especially those surrounding the level of energy-intensive production in the next several decades, three scenarios were defined, which reasonably represent the range of plausible futures for energy development. The results from quantitative analysis show that energy demand in China could be as high as 2.9 billion toe (tons oil equivalent) in 2030, which could exceed the available energy supply. When compared with previous energy scenario studies, this result is much higher. By using various policy options discussed in the article, however, there is potential to reduce this high demand to 2.4 billion toe in 2030.

Key words Energy · Climate change · Modeling · Scenario · China

1 Backgrounds

In China, due to rapid economic growth, total primary energy consumption increased from 400 Mtoe (million tonnes oil equivalent) in 1978 to nearly 1320 Mtoe in 2004, with an annual average rate of increase of 4.7% (see Fig. 1) (State Statistical Bureau 2004a, b). Coal is the major energy source, providing 70.7% in 1978 and 69% in 2004 of total primary energy use (see Fig. 2). Recent years have witnessed a dramatic surge in the rate of increase of energy use in China and widespread energy shortages.

China is the largest coal-producing and coal-consuming country in the world. Between 1980 and 2004, total raw coal output increased from 620 Mt to more than 1900 Mt, with an average annual growth rate of 4.8%. Prior to 2000, the share of coal use in total energy use decreased, but it increased again from 66% in 2000 to 68% in 2004. The heavy dependence on coal has led to serious environmental problems and represents a burden for the transportation system.

From 1980 to 2004, total installed capacity of electricity power generation increased from 66 GW (of which 20 GW is hydropower, accounting for 31%) to

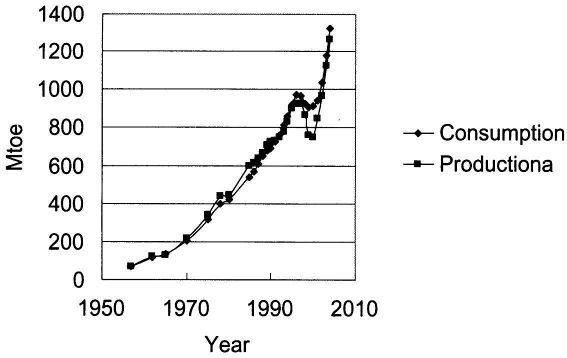

Fig. 1. Energy production and consumption in China. *Mtoe*, million tons oil equivalent

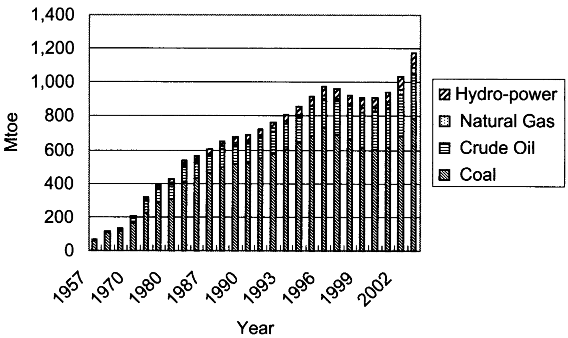

Fig. 2. Primary energy use in China by energy type

440 GW (of which 100 GW is hydropower, 23%). In the same period, electricity output increased from 300 TWh (of which 58 TWh is hydropower, 19%) to 1870 TWh (of which 220 TWh is hydropower, 12%). In 2004, newly installed capacity reached 50 GW, and newly installed capacity in 2005 and 2006 is expected to be around 60–70 GW (Power Industry Information 2005).

Between 1980 and 2004, total crude oil output increased from 106 Mt to 175 Mt (average annual growth rate 2.1%). In 2002, 149 Mt was produced on land and 18 Mt was produced offshore. Crude oil output in China accounts for 4.7% of the world total.

Energy efficiency improvement and energy conservation are given high priority in the energy development strategy in China, as is the efficient and clean use of coal and other fossil energy sources. The objective of developing clean coal technology is to improve coal utilization efficiency, to reduce environmental pollution, and to promote economic development. High efficiency and clean technology will be crucial for China to achieve a low-emission development path. Figure 3 illustrates the way in which energy efficiency improvements in the steel-making industry have been driven by advanced technology diffusion.

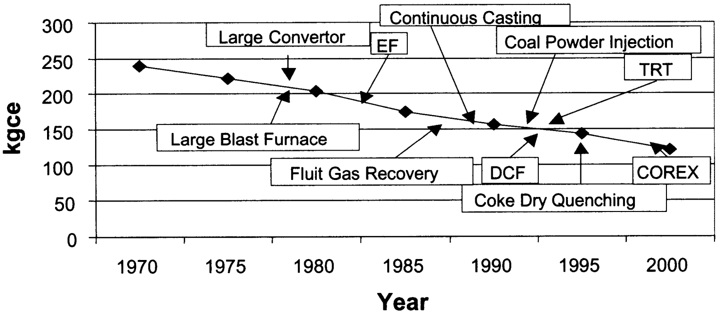

Fig. 3. Technology progress and energy efficiency improvement in the steel-making industry. EF, electric furnace; TRT, top gas pressure recovery turbine; DCF, direct current electric furnace

Rapid energy demand increases in recent years have led to many discussions on future energy demand, which could be significantly different from previous energy scenario study outputs. Energy-intensive industry developed in a very rapid way in last 2–3 years. The purpose of the study presented in this article is to provide energy demand scenarios up to 2030 by reflecting on recent development trends, especially for energy-intensive products. Compared with previous scenario studies, the major change in this study is the assumptions of sector outputs, which are significantly higher than assumptions given previously. This study also tries to identify possible energy import in China by using a global energy model, which has not been widely reported in previous studies. With China being a member of the World Trade Organization (WTO), this study also reflects expectations about China's industrial transformation resulting from its role in global markets (Lu et al. 2003). Discussion on policy options is also provided based on the scenario study and relative studies on policy assessment.

2 Methodology

The IPAC-emission model and IPAC-AIM/technology model—components of the Integrated Policy Assessment Model for China (IPAC)—were used to perform the quantitative scenario and policy option analysis. The models project future energy and pollutant emissions.

The IPAC-emission model is a global model developed for the study of greenhouse gas (GHG) emission scenarios (Jiang et al. 2000b; IPCC 2001b). It divides the world into nine regions covering the United States (US), the Pacific OECD (OECD-P), Europe OECD and Canada (OECD-W), Eastern Europe and former Soviet Union (EFSU), the Middle East (ME), China, other Asia (SE Asia), Africa, and Latin America (LA). Major emission sources, including energy activities, industries, land use, agriculture, and forests, can be simulated in the model framework. The model consists of three modules: (1) macroeconomic module, (2) end-use module, and (3) land use module. The macroeconomic module was developed based on the Edmonds-Reilly-Barns (ERB) model (Edmonds and Reilly 1983; Edmonds et al. 1996), a macroeconomic, partial-equilibrium model, which forecasts energy demand over the long term. It uses gross domestic product (GDP) and population as future development drivers, combined with other energy-related parameters, to forecast energy demand based on the supply and demand balance.

The end use module was originally part of the Asia-Pacific Integrated Model (AIM), a bottom-up, energy-technology model developed by the National Institute for Environment Studies and Kyoto University (Japan). The land use module was developed from the Agriculture Land Use Model developed by Pacific-Northwest National Lab (PNNL) to model GHG emissions from land use (Edmonds et al. 1996).

The IPAC-AIM/technology model is a single-region model for China, developed based on AIM/end use model (AIM Project team 1996; Hu et al. 1996, 2001; Jiang et al. 1998). This model includes three modules (i.e., energy service demand projection, energy efficiency estimation, and technology selection). The demand is divided among the industrial, agricultural, service, residential, and transportation sectors and these sectors are further divided into subsectors. For both demand and supply sides, more than 400 technologies are considered, including existing as well as advanced technologies that may be used in the future. The model searches for the least-cost technology mix to meet the given energy service demand. The most up-to-date information on these technologies was collected from a large number of printed sources, as well as by consulting experts directly.

Linking these two models provides both detailed analyses of various sectors and a global analysis of China's energy future. The same scenarios and related model assumptions were used for both models. Energy demand for China was basically given by the IPAC-AIM/technology model by calculating demand from sectors with detailed technology information; whereas energy price and energy import data are derived from the IPAC-emission model. The global energy analysis is given based on SRES B2 scenario (IPCC 2001b), while the part for China is revised in this study. Figure 4 presents the link between the two models.

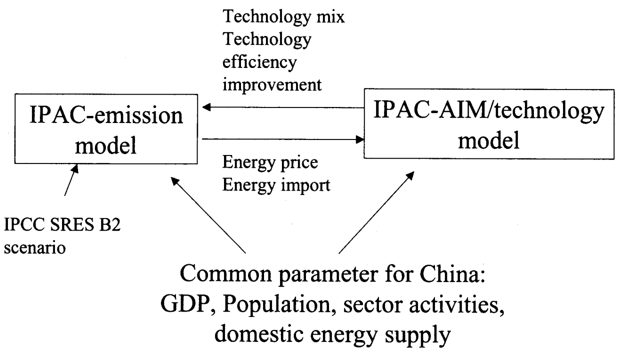

Fig. 4. Link between models

Table 1. Population assumptions

	Year			
Population	2000	2010	2020	2030
Total	1285	1393	1472	1539
Urban	413	531	633	754
Rural	872	862	839	785

Assumption data derived by authors, based on review of relevant studies and given in millions

Table 2. Growth of gross domestic product (GDP) in China

	2000–2010	2010–2020	2020–2030
Annual GDP growth rate	7.8%	6.6%	5.6%

3 Model assumptions and scenario definition

3.1 Model assumptions

The major assumptions used in this study [including population, gross domestic product (GDP) growth, and mix] are given in Tables 1 and 2. The assumptions for population come from other studies. The assumed GDP growth rate is consistent with government targets and research by the Development Research Center (Zheng et al. 2004; Tan et al. 2002; Qu 2003; Liu et al. 2002).

In order to analyze energy trading, we used the IPCC SRES B2 scenario as a global scenario (Jiang et al. 2000b). The IPCC SRES scenario is a scenario family developed by the Intergovernmental Panel on Climate Change in 2001, which includes seven scenario groups. The B2 scenario reflects a world with good intentions, which it is not always capable of implementing. This storyline is most consistent with current national and international developments. On balance, the B2 world is one of central tendencies that can be characterized as neutral progress among SRES scenarios. Human welfare, equality, and environmental protection all have high priority, but the world proves unable to tackle these concerns at a global level and resolves them as best it can regionally or locally. Generally, high educational levels promote both development and environmental protection. Education and welfare programs are widely pursued, leading to reductions in mortality and, to a lesser extent, fertility. This results in a central population projection of about 10.4 billion people by 2100, consistent with the United Nations median projection. Gross World Product (GWP) grows at an intermediate growth rate of 2% per year, reaching about US $235 trillion in 2100. The B2 storyline also presents a generally favorable climate for innovation and technological change, especially in view of high educational levels compared with today and relatively efficient markets at the regional level. B2 is a world of "regional stewardship" that, in some regions, is particularly frugal with energy and many other natural resources. Consequently, energy system structures differ among the regions. Overall high priority is given to environmental protection,

Table 3. Key scenario drivers assumed for the developing Asia-Pacific and the world in IPAC-emission model

Item	Assumptions
Asia-Pacific population	4.7 billion in 2050 5.0 billion in 2100
Asia-Pacific annual GDP growth rate	5.7% from 1990 to 2050 3.8% from 2050 to 2100
World population	11.7 billion in 2100
World GDP	\$250 trillion in 2100
GDP/capita trends	Disparity remains GDP/capita of OECD becomes 7 times that of non-OECD (now 13 times)
Autonomous energy efficiency improvement	1.0%–1.2%
International trade	Low trade across regions High trade cost
Urbanization	Increase in developing world before 2050, decrease in developed world

Table 4. Assumptions for B2 scenario for the developing Asia-Pacific and the world

Item	Assumptions
Resource availability	Oil/gas: medium Biomass: high
Energy exploitation cost	Medium
Noncarbon renewable energy cost	High for nuclear, medium for solar and others
Biomass availability	Medium
End use technology efficiency improvement	Medium
Social efficiency improvement	Medium
Transport conservation	High
Dematerialization trend	Medium
Land use productivity improvement	Medium
Meat-oriented food habit	Low
Desulfurization degree	High

although global policies prove elusive and regional polices vary widely. Major assumptions are given in Tables 3 to 5.

For the developing Asia-Pacific region, the B2 scenario assumes that economic development utilizes resources so as to maintain equity for the future, while maintaining balance among regions as well as between urban and rural areas. Such an approach is introduced based on the recognition of environmental issues and sustainable development. This scenario can be described as regional stewardship from a global perspective, based on a natural evolution of the present institutional policies and structures. It is characterized by limited population growth, medium economic growth, inequality reduction, weak global governance but strong national and regional governance, a strong deurbanization trend, strong pursuit of environmental improvement, and encouragement of renewable energy use. It is a low per capita economic development scenario. In this scenario,

Table 5. Factors influenced by key driving forces

Driving forces	Sectors	Factors	Policies to promote the change
Social efficiency change	Industry	Value-added change by subsectors within the sector (as service demand of some sub-sectors including machinery, other chemical, other mining, other industry sector etc.)	Various policies relative to value added such as price policy, national plan for key industry, promote well working market
		Products structure change within one sector (as service demand in most industrial sectors)	Market-oriented policies, national development policies
	Residential and commercial	Energy activity change within the sector (such as change of use of heating, cooling; use of more efficient electric appliances, etc.)	Public education, price policies
	Transport	Change of transport mode (more public transport, nonmobility, etc.)	Transport development policies, public education
		Traffic volume conservation (less use of private cars)	
Technology progress	For all sectors	Efficiency progress for technology (unit-energy use improvement)	Technology R&D promotion, market-oriented policies, international collaboration
		Technology mix change (more advanced technologies)	Market-oriented policies, environmental regulation
		Fuel mix change (more renewable energy and nuclear)	National energy industry policies, import and export policies, tax system

the per capita GDP in the region is only one fifth that of the OECD countries by 2100.

All of China's emission scenarios were developed under the IPCC SRES B2 scenario. In the IPAC-emission model, international energy trade was included in the study based on the resource cost-effective availability (Jiang et al. 1999, 2000a).

3.2 Scenarios

In order to analyze future energy demand and emissions in China, we consider three scenarios. Considering the uncertainty for energy-intensive product demand with impact of WTO accession, a baseline scenario and a high-demand scenario were given. The third scenario covers low demand in conjunction with policy control measures. The three scenarios are defined as follows:

1. Baseline scenario: this scenario gives a basic trend to describe future economic activities. There will be better international trading and China's economy will be part of the global economy. Therefore, China could rely on inter-

Table 6. Energy-intensive product assumptions in the model

Product	2002	Baseline scenario/policy scenario 2020	Baseline scenario/policy scenario 2030	High-demand scenario 2020	High-demand scenario 2030
Steel (Mt)	182.4	380	320	430	380
Copper (Mt)	1.63	4.5	5.2	5.2	5.8
Aluminum (Mt)	4.51	10	14	12	18
Ethylene (Mt)	5.43	12	16	14	20
Ammonia (Mt)	36.75	47	49	50	56
Chemical fertilizer (Mt)	37.9	48	50	52	58
Cement (Mt)	725	1000	900	1100	1100
Glass (million cases)	234.4	480	530	520	560
Vehicles (million units)	3.25	11	12	15	17

national markets and energy resource imports to meet part of its energy supply needs.

2. High-demand scenario: this scenario presents a high demand for energy in the future. The major driving force is China's assumed role as a center for manufacturing following WTO accession, which will bring more energy-intensive product production to China, such as steel, nonferrous products, and building materials. At the same time, more technology transfer and research and development on high-efficiency energy use technologies is also assumed.
3. Policy scenario: various energy and emission control policies are assumed for this low-demand scenario, which reflects energy supply and environmental constraints.

The basic assumptions for the three scenarios, such as population and GDP growth, are the same. Sector service output for the three scenarios is given in Table 6.

Policy options to be considered in the policy scenario are given in Table 7. These policy options were defined based on policy potential in China and technology trends (Qu 2003; Liu et al. 2002; IPCC 2001a, 2002).

4 Results

Energy demand was calculated using the IPAC-emission model. Baseline scenario results are given in Figs. 5 and 6. Primary energy demand in the baseline scenario could go to 2.1 billion toe in 2020 and 2.7 billion toe in 2030. The annual growth rate from 2000 to 2030 is 3.6%, while energy elasticity of GDP is 0.58. Coal will be the major energy component in China (1.5 billion toe in 2030), with a 58% share in the total energy demand. There is a rapid increase for natural gas demand in China, with its share in total primary energy use increasing from 4% in 2000 to 17.3% in 2030 (average annual growth rate 10%).

With respect to final energy use, electricity and natural gas increase rapidly. Electricity demand increases from 112 million toe in 2000 to 478 million toe in

Table 7. Policy options used in the modeling study

Policy options	Explanation
Technology promotion policy	Increased efficiency of end use technology by using new technologies
Energy efficiency standard for buildings	New buildings reach 75% energy efficiency standard in 2030
Renewable energy development policy	Promote use of renewable energy
Energy tax	Introduce vehicle tax by 2005, and energy tax by 2015
Public transport policies	In cities public transport in 2030 will take 10%–15% higher share than 2000
Transport efficiency improvement	Highly fuel-efficient vehicles widely used, including hybrid vehicles, compact cars, advanced diesel cars
Power generation efficiency	Efficiency of coal-fired power plants increase to 40% by 2030
Natural gas incentive	Enhance natural gas supply, localization of technology to reduce cost
Nuclear power development	National promotion program by setting up capacity target for nuclear power

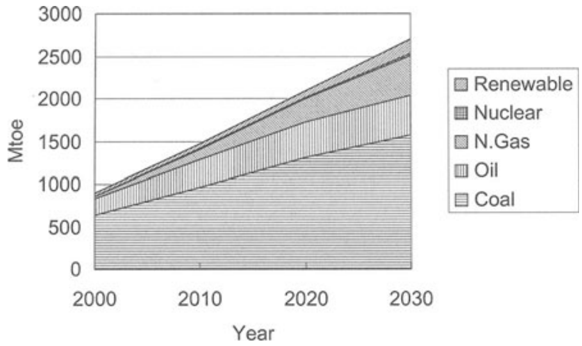

Fig. 5. Primary energy demand in China for baseline scenario

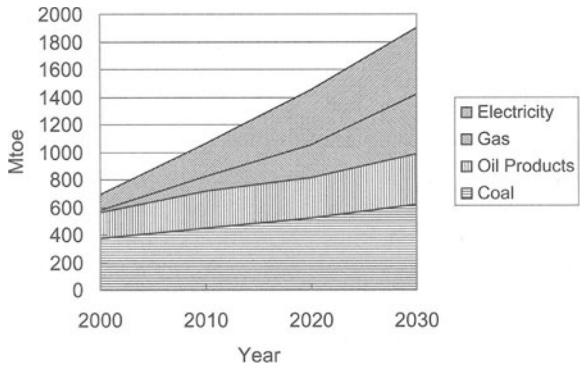

Fig. 6. Final energy demand in China for baseline scenario

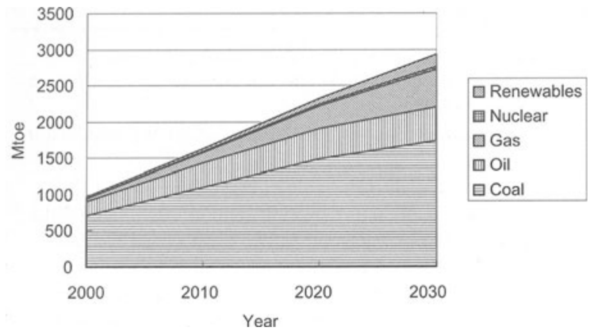

Fig. 7. Primary energy demand in high-demand scenario

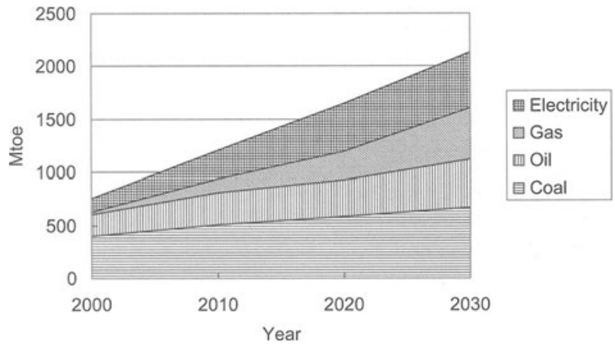

Fig. 8. Final energy demand in high-demand scenario

2030. Natural gas demand increases from 21 million toe in 2000 to 437 million toe in 2030. Coal and oil demand increase slowly. Coal use in the residential sector will generally decrease and be replaced by gas and electricity; coal will be mainly used in large equipment such as industrial boilers. Demand for oil products used for transport will increase quickly, with the rapid growth of vehicle use in China. Oil use in transport will increase from 74 million toe in 2000 to 320 million toe in 2030.

For the high-demand scenario, primary energy demand in 2030 is 2.9 billion toe, which is 250 million tons higher than the baseline scenario. Of the total primary energy demand, coal provides 59.1%, oil 16.1%, natural gas 17.8%, and nuclear 1.2%. Because this scenario assumes better integration in international markets, there is greater reliance on imported energy such as natural gas and oil (see Figs. 7 and 8).

This study also simulated future energy production in China. Figures 9 and 10 give energy production in the baseline and high-demand scenarios. Coal production could reach 1.31 billion toe by 2020 and 1.48 billion toe by 2030. Chinese coal

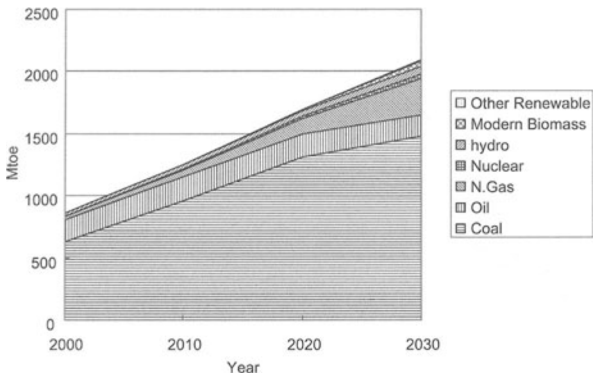

Fig. 9. Energy production in baseline scenario

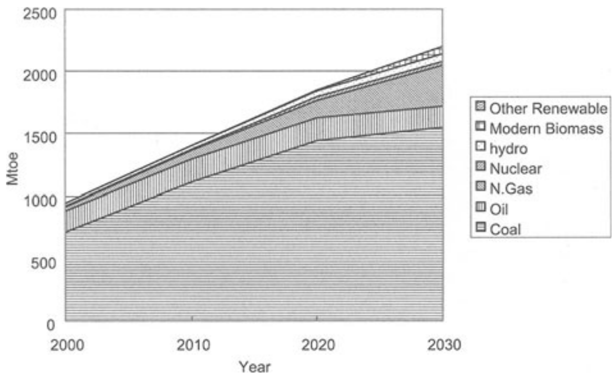

Fig. 10. Energy production in high-demand scenario

industry experts estimate an upper bound of coal production of 1.2 billion toe by 2020. Coal demand, therefore, could exceed domestic coal production in China. Oil production is projected to be 190 million tons in 2020 and 175 million tons in 2030. This is within the forecast of experts from the oil industry, which range from 180 to 200 million tons in 2020. Natural gas production will be 133 billion m^3 in 2020 and 312 billion m^3 in 2030. The production of natural gas is within the range of natural gas production forecasts by energy experts, which range from 130 to 150 billion m^3 in 2020. Nuclear power generation will increase quickly in future, but still represents a small share because of its high cost. The model results shows that nuclear power generation could reach 256 TWh in 2020 and 344 TWh in 2030, compared with 16.7 TWh in 2000. The installed capacity will be 39 400 MW in 2020 and 53 030 MW in 2030. Hydropower output will increase from 224 TWh in 2000 to 555 TWh in 2020 and 722 TWh in 2030, with capacity reaching 154 GW in 2020 and 201 GW in 2030.

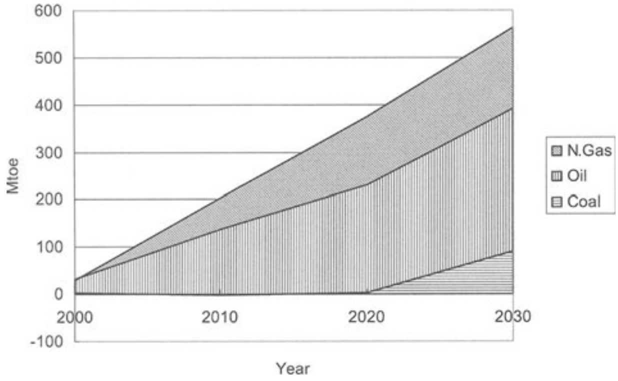

Fig. 11. Energy imports in the baseline scenario

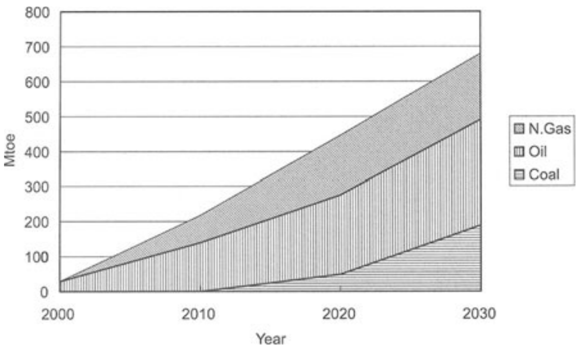

Fig. 12. Energy imports in the high-demand scenario

According to the energy demand and production, we can calculate the need for future energy imports (see Figs. 11 and 12). In the baseline scenario, future fossil energy imports could reach 375 million toe annually in 2020 and 562 million toe in 2030 (for comparison, in 2000, the USA imported 870 million toe). Oil will be the major energy source to be imported: oil imports will reach 230 million tons in 2020 and 300 million tons by 2030. Natural gas imports will amount to 154 billion and 183 billion m^3 in 2020 and 2030, respectively. Even coal will be imported after 2020, with 129 million tons of coal needed annually by 2030.

In the high-demand scenario, energy imports are much bigger. Total fossil energy import will be 445 million toe in 2020 and 680 million toe in 2030. There will be more coal import in this scenario, reaching 189 million toe in 2030.

By assuming the adoption of energy and environmental policy measures, the policy scenario results are described in Figs. 13 and 14. Compared with the baseline scenario, there is an energy demand reduction of nearly 245 million toe in 2020 and 280 million toe in 2030. By exploring the policy options, we found there is big pressure to apply these policy options in order to reach the lower

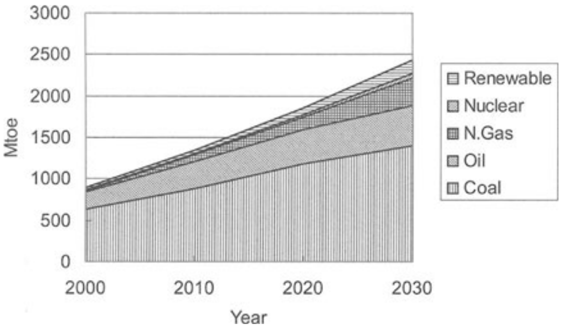

Fig. 13. Primary energy demand in policy scenario

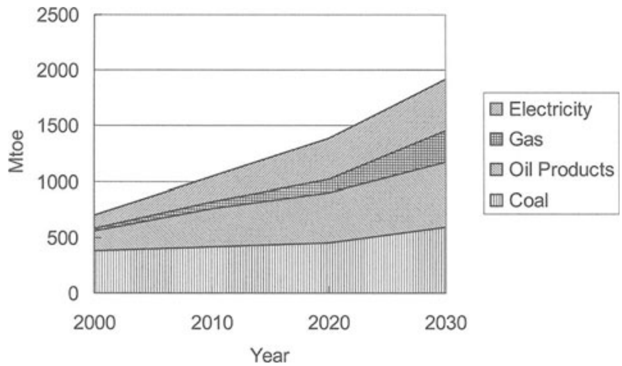

Fig. 14. Final energy demand in policy scenario

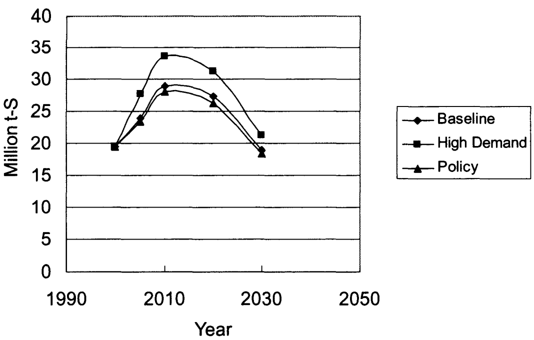

Fig. 15. Sulfur dioxide emission in China

energy demand scenario, and they also need to be introduced early because of the long life span of energy technologies.

With the calculation of energy demand, several pollutant emissions were calculated. Figures 15 to 18 give SO_2, NOx, total suspended particulates (TSP), and

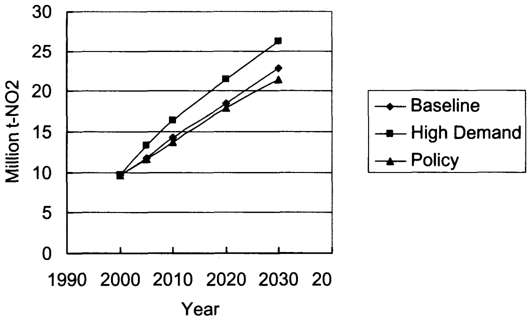

Fig. 16. NOx emission in China

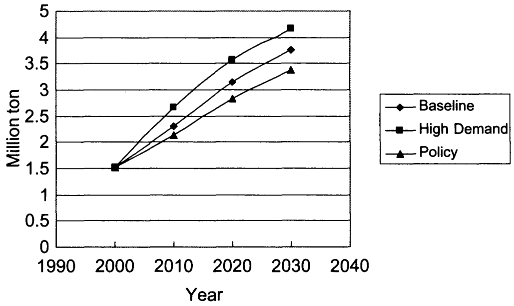

Fig. 17. Total suspended particulates emission in China

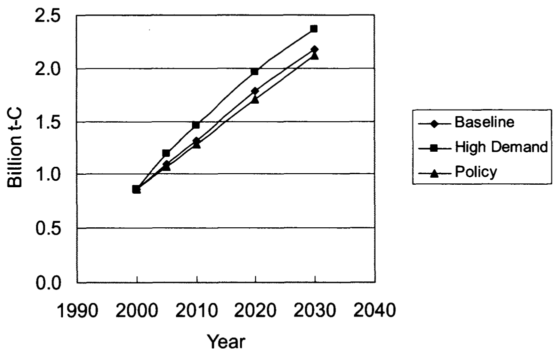

Fig. 18. Carbon dioxide emission in Chinas

CO_2 emission from energy activities. SO_2 emission will keep increasing before 2010 with the rapid increase of coal use in China. After 2010, more and more desulfurization technologies will be used and therefore SO_2 emission will be reduced from fossil fuel use. Compared with the high-demand scenario, SO_2 emission for the baseline scenario in 2010 is 4.5 million tons lower, but still

Table 8. Technologies contributing to energy saving and greenhouse gas emission reduction in short and middle term

Sector	Technologies
Steel industry	Large-scale 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 blast furnace gas recovery, DC-electric arc furnace
Chemical industry	Large-scale equipment for chemical production, waste heat recovery system, ion membrane technology, existing technology improvements
Paper making	Cogeneration system, facilities of residue heat utilization, black liquor recovery system, continuous distillation system
Textile	Cogeneration system, shuttleless loom, high speed printing and dyeing
Nonferrous metal	Reverberator furnace, waste heat recovery system, QSL for lead and zinc production
Building materials	Dry process rotary kiln with precalciner, 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 appsliances, highly efficient lighting, solar hot water, insulation of buildings, and energy-efficient windows
Service	Centralized space heating system, centralized cooling heating system, cogeneration system, energy-saving electric appliances, highly efficient lighting
Transport	Hybrid vehicle, advanced diesel truck, low energy-use car, electric car, fuel cell vehicle, natural gas car, electric railway locomotives, public transport development
Common-use technology	High efficiency boiler, fluid bed combustion technology, high efficiency electric motor Speed-adjustable motor, centrifugal electric fun, energy-saving lighting
Power generation	Super critical unit, natural gas combined cycle, pressured fluid bed combustion boiler, wind turbine, integrated gasification combined cycle, small-scale hydropower, biomass-based power generation

increases by 9.45 million tons from 2000. This will be a big challenge for government targets. Because of lack of policy to control NOx, its emission continues to go up. The same trend is seen for TSP emission.

If we look at the effects of policy options used in the policy scenario, by comparing with the baseline scenario and the high-demand scenario, we found that there is a package of policy options could be adopted now to reduce the growth rate of energy demand. For example, policies to promote the penetration rate of highly energy-efficient technologies (see Table 8), fiscal energy and environment policies including vehicle fuel taxes, subsidies for renewable energy, emission taxes, resource taxes, etc., and policy to promote public involvement, are important for China to go to a low energy-demand scenario.

5 Conclusions

This scenario study shows primary energy demand in 2020 could range from 1.9 billion toe to 2.4 billion toe. This depends on technology progress, energy intensive sector development, and polices applied. Such large energy demand will bring serious pressure on energy supply in China.

Studies show that by 2020 the largest domestic oil supply could reach 200 million tons, natural gas 160 billion m^3, and coal 2.8 billion tons. This means that for the lowest energy demand scenario, 200 million tons of oil and 100 billion m^3 of natural gas shall have to be imported; for the high-demand scenario, nearly 400 million tons of oil, 260 billion m^3 of natural gas, and 300 million tons of coal shall have to be imported.

Such large energy demand and the necessary imports will put high pressure on the energy supply industry in China; therefore, a well-designed strategy for the energy system and energy industry development in China should be prepared. Considering the possibility of policy options analyzed in this study, the following suggestions are given:

- With rapid energy demand increase, a full range of efforts for energy conservation, development of efficient technology, and diffusion of it should be the top priorities. Some countermeasures, such as building energy efficiency standards, renewable energy use in buildings, and fuel tax for vehicles, which were not strictly implemented previously, should now be used.
- There will be a rapid development period for the energy supply industry in the next several decades. The energy supply industry in China should fully realize the pressure it will face. A long-term development strategy is very essential. A clear policy framework for energy development should be given.
- Similar to other developed countries that have large amount of energy import, China should establish an energy security system. However, the size of strategic storage should be decided based on a global perspective of oil demand.
- A multicomponent energy system should be established to diversify energy supply. Renewable energy should be developed as an alternative energy source. Biofuel for vehicle fuel could reduce energy import.
- Technology progress should be emphasized to promote lower energy demand in the future.
- Further policy options such as an energy tax, a resource tax, and an export tax for energy-intensive products should be considered.

Environmental issues will be the major factor to influence energy development in China. So far there are already serious environmental problems caused by energy activities, especially from coal mining, transport, and combustion. If the production and combustion of coal exceeds 2.5 billion tons in China in 2020, the environmental impact will be very large and there is a need to find innovation options to abate the impact. The following observations can be made on the basis of the study:

— With economic development, environment problems could worsen with rapid increases in energy demand, particularly when there are no strong countermeasures to abate pollution.
— A clean energy system should be established with government intervention for covering all the processes in the energy flow.
— Various national laws, regulations, and standards for the energy industry should be prepared to set targets for a clean energy system. So far there is very weak legislation to promote a clean energy system.
— Clean coal technology should be emphasized to mitigate emissions from coal combustion. Only a few of countries in the world are using coal on a large scale; therefore, development of clean coal technologies depends largely on them. China is the biggest user of coal, and in future coal use will increase quickly, rising to more than 40% of world coal use in 2020. Therefore, clean coal technology is crucial for China. China should have a clear development plan to promote clean coal technology. It would be prudent to work in close coordination with other countries to develop a new generation of clean coal technologies.
— Clean energy utilization technologies should be further diffused in China. Some technologies such as hybrid cars and direct-injection diesel vehicles already show large commercial potential in other countries and they should be introduced in China as soon as possible.
— Vehicle emission standards should be introduced to China to control emissions from transport.

Due to low costs of production, it is likely that China will become a major manufacturing center in the world relying on energy-intensive and resource-intensive products. This trend should be controlled to avoid China's becoming a country that must use large volumes of raw materials, thereby damaging the environment. External costs should be included in production costs. Planning for energy-intensive and resource-intensive products should be made to avoid possible environment and economic damage.

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