

Low Carbon Scenario for China in 2050

1. Background

After the long time negotiation process for climate change, now we are getting to a period to think about how to make the further actions. Recently IPCC AR4 was published, together with Stern Review, again confirmed the happening of climate change. Interesting funding also is given to low cost for reaching 550ppmv target. Outside the UN process, international talk on climate change including G8+5, APEC summit, Asia-Pacific Partnership on Clean Development and Climate (APP), bilateral collaboration, are getting much more intensive than before. Several countries in EU are proposing emission reduction target for their own in 2020 and 2050, including EU, UK, Germany etc. And recently Japan is also thinking about to make low carbon society in 2050 by presenting 60% to 80% emission reduction. All these give opportunities for much more action taken by the world with some countries leading.

Recent rapid growth of energy use in China exerts great pressure on energy supply and environment. Total primary energy consumption increased from 400 Mtoe in 1978 to nearly 1520 Mtoe in 2005, with an annual average rate of increase of 4.7% (see Figure 1) (China Energy Year Book 2006, 2007; China Year Book 2006, 2006). Coal is the major energy source, providing 70.7% in 1978 and 69% in 2004 of total primary energy use (see Figure 2). Recent years have witnessed a dramatic surge in the rate of increase of energy use in China and widespread energy shortages.

Rapid increase of energy use in China brought large amount of CO₂ emission in China. Figure 1 presents the recent year's CO₂ emission in China. China is now the second largest country for GHG emissions in the world after United States. If there is no change for the trend of energy increase, it is believed the CO₂ emission will overpass United State in near future to be the No.1 country in the world.

CO₂ emission is given in figure 1.

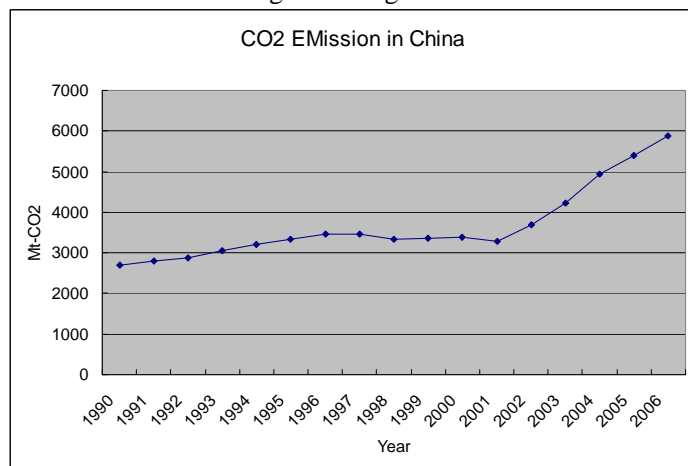


Figure 1 CO₂ emission in China

This gave very big pressure for China to control GHG emission increase in future in order to implement UNFCCC to curb emissions. However we did see a lot of policies are adopted and adopting to reach domestic energy efficiency target and renewable energy target. All these policies are consistent with emission mitigation policies. Most important, Chinese government is taking climate change as one of major issues for government to action. In June 4 2007, the National

Program on Climate Change was released. This is an important document in China to guide the future national and provincial policies on climate change.

An important thinking is, in the case some countries like UK, Japan etc. will have emission reduction by 60% to 80% in 2050, what happen for China? What is the possibility for China to reduce GHG emission? The purpose to do this scenario analysis is to work with modeling team in other countries, to work out mitigation options in their model, and see what happen if China will follow the options, by giving time gap, but taking some leapfrog.

Modeling work for this study is based on previous work in IPAC modeling team, for domestic energy and emission scenarios, IPCC scenarios, EMF studies etc.

2. Emission scenario of China

Three scenarios were defined for the emission scenario analysis:

Baseline scenario: The Baseline Scenario reflects existing policies and measures, and considers current efforts of the Chinese Government to increase efficiency and control emissions.

Low Carbon Scenario: China will make own effort to be a relative low carbon future, by taking Co2 emission control to be one of domestic environment target and make domestic policies. the optimization of the economic structure, including a decrease in the share of high energy consuming industries in the economy; the wide dissemination of current energy conservation technology; and the aggressive diversification of the electricity generation mix. By 2020, the energy efficiency of major high energy consuming industries would reach or surpass the level of the advanced level of developed countries, and new building construction would need to reach a high energy efficiency standard. In general, this would reflect a shift towards highly efficient and clean production; and aggressive standards to encourage a public focus on energy efficiency in the home and the workplace.

Enhanced Low Carbon Scenario: By taking global effort on low GHG concentration target, China will make much bigger effort on GHG emission control. The potential of lower carbon emission technologies will be further explored: zero-emission vehicles, low emission buildings, renewable energy and nuclear reach their maximum potential; decentralized power supply systems are widespread; some coal fired plants employ CCS; China become one of the global leader on low carbon technology.

Three models from IPAC model were used in the analysis. Figure 2 presents the model framework.

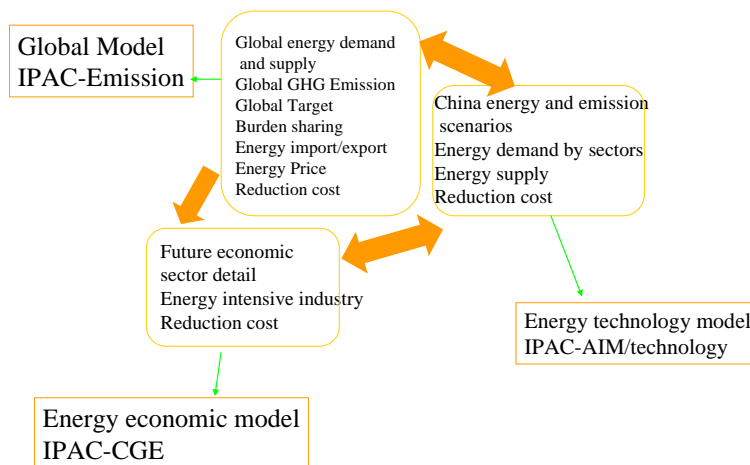


Figure 2 models framework

Results from the scenario study for China by IPAC model were presented in figure 2 to 9.

Emission scenario for China is given in figure 3. CO2 emission keeps increasing until 2030 in mitigation scenario. It is expect to have emission reduction after 2030 by various policy options(discuss below). By 2030, CO2 emission will increase to 2.63billion t-C in mitigation scenario, 3.13 time of that in 2000. By 2050, it is possible to go down to 1.73billion t-C, 66% of that in 2030, and 2.05 times of that in 2000.

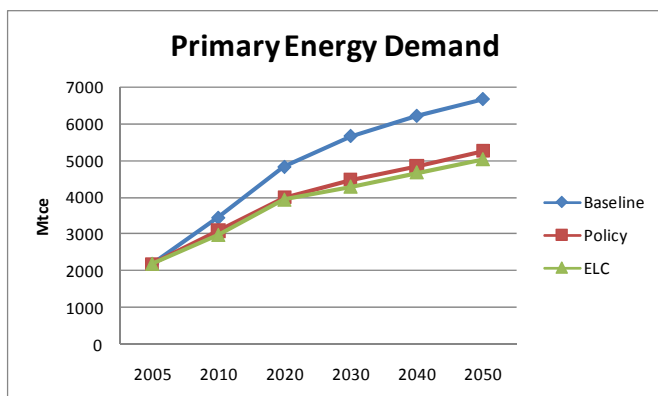


Figure 3 Primary energy demand in China

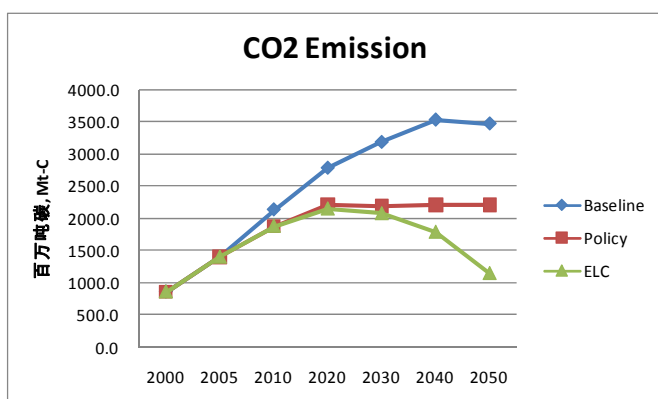


Figure 4 CO2 emission from energy activities in China

By analysis on the policies in mitigation scenarios, it is found the for the low carbon scenarios much of the enhanced policies are well match the policies under the sustainable development strategy. Especially at the early period, because of lack of experience to combat with climate change, focusing on sustainable development is the major way for China to contribute to climate change mitigation.

3. Policy analysis for a low carbon scenario

In the scenario study, we found there is a wide range future even though we do not include any climate change oriented policies. It is interesting to explore the key factor driving to a low carbon future.

Key driving forces used in the scenario study include economic development (GDP growth), social efficiency change, technology progress etc. Factors and relative policies considered in social efficiency change and technology progress is explained in table 1.

Table 1 Factors for key driving force

Driving forces	Sectors	Factors	Policies to promote the Change
Social Efficiency Change	Industry	Value added change within the sector Products structure change within one sector	Various policies relative to value added such as price policy, national plan for key industry, promote well working market Market oriented policies, national development policies.

	Residential and Commercial	Energy activity change within the sector	Public education, price policies
	Transport	Change of transport mode Traffic volume conservation	Transport development policies, public education
Technology progress		Efficiency progress for technology Technology mix change for one fuel Fuel mix change	Technology R&D promotion, market oriented policies, international collaboration Market oriented policies, environmental regulation National energy industry policies, import&export policies, tax system

Technology play key role in climate change mitigation shown in several studies[IPCC, 1996,2001; Jiang et al, 1998]. As a large country at the stage for economy to take off, technologies is very important in the sake of energy, environment and climate change. Technology progress play key role in GHG emission reduction in China, while most of these technologies are also match the demand for energy conservation and environment both in short-term and long-term. Therefore technology strategy could well combined with energy and environment policies. Detailed technology studies on sector level to reduce CO2 emission show well match with technology progress desired by sectors without consideration on climate change (see table 5)[Hu et al, 1996, Jiang et al, 1998]

Many of these technologies already appeared in sector development plan made by government or enterprise. What we should do is to further development of these technologies by including climate change as a factor to raise the demand for these technologies(see table 2).

Table 2 Technologies contributing to GHG emission reduction in short and medium-term

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

The long-term scenario study for China suggested following key technologies for the purpose of climate change[Nakicenovic, 2000, Jiang at al,1999]:

- a. Modern renewable energy production (solar energy etc.)
- b. Advanced nuclear power generation
- c. Fuel cell
- d. IGCC/Advanced clean coal technologies
- e. Advanced gas turbine
- f. Unconventional nature gas and crude oil production technologies
- g. Syn-fuel production technology

Basically these technologies are in the list for government to think about except unconventional energy technologies. Because of lack of investment on technology R&D, most of these technologies are expected to be developed in other countries. Development of these technologies is common requirement by all of the world. However some of the technologies could be made more investment in China for R&D. For example, IGCC and clean coal technologies have large potential market in domestic while it is uncertain to look for market for technology developer in country with small coal use. If China can be leader on development of these

technologies, benefit could be obtained from both environment and economic development. In such case, policy for technology development could be revised by consideration of climate change. International collaboration on development of these technologies is necessary.