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Energy for sustainable development in China ☆

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Abstract

To ensure energy to meet needs for economic growth and sustainable development more emphasis should be given to energy efficiency, renewable energy and new technologies for both energy end-use and supply. One key technology is gasification of coal to produce liquid and gaseous fuels, and electricity. The overall conclusion is that there are plausible energy-technology strategies, well within reach if early action is taken, that would enable China to continue social and economic development through at least the next 50 years, while ensuring security of energy supply and improving local, regional and global environmental quality. Such desired energy futures will not happen in the present policy environment, and options to enhance the energy systems for sustainable development are discussed.

Keywords: Energy for sustainable development; Energy strategy; Energy policy

1. The challenges

China's achievements over the last 20 years are impressive. Economic growth has been rapid, development extensive and poverty has been drastically reduced in rural areas. Food supply and demand has been brought into balance. A socialist market economy is successfully negotiating its difficult initial stages, and there is a wider opening to the outside world. Remarkably, this has been achieved without incurring foreign exchange imbalances. China has also met its soaring needs for energy services while at the same time has improved the efficiency of its energy use by a factor of nearly three. Even coal use has been reduced in recent years notwithstanding the nation's coal dependency and its outstanding economic growth.

At the same time, large challenges lie ahead. Population growth continues and with it a parallel trend of urbanization. The demands of modernization and of rapid economic growth will stretch material and human resources. Poverty alleviation and the satisfaction of basic human needs remain as urgent priorities. Market reform is far from complete and adjusting to globalization and WTO entry will need to be accomplished without further widening disparities between rich and poor. As recognized in the 10th Five Year Plan, growth will have to be more geographically balanced.

Continuous attention needs to be paid to environmental and health issues induced by energy supply and use, including high levels of indoor and urban air pollution, increasing acidification, ongoing climate change, among other environmental challenges, all of which are increasing. China is a Party to the United Nations Framework Convention on Climate Change, and has as all Parties an obligation to mitigate climate change, taking into account common but differentiated responsibilities.

Energy is an important element in all these challenges, in both positive and negative senses. China's economic aspirations will lead to large increases in demand for energy services. So it is crucial to analyze the energy choices confronting China if all the challenges are to be addressed. It is from these options that strategic energy policies will emerge. A long-term view is clearly

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necessary if these issues are to be fully addressed. Step-by-step advances appear the most promising development mode in energy technologies, as do open-ended rather than closed technical pathways.

Equitable access to modern energy services needs to be provided to all people in China. Concerns over energy supply security arise, especially for liquid fuels in light of increased needs for mobility and transportation. Energy transport within China, from north to south (coal) and from west to east (oil and gas, and electricity) is an active trend, and will incentivize continuing growth in the electricity, liquid fuels and gas grids, and limit energy imports from outside China.

If all of the above considerations, derived from China's Agenda 21, are to be addressed, China's energy strategies are required at the earliest opportunity, to fulfill four key objectives:

- to deliver the power needed for economic growth and sustainable development;
- to ensure security of energy supply;
- to ensure that energy supply and use are conducted in ways that safeguard public health and the environment;
- to achieve an equitable distribution of energy services throughout the nation.

2. Energy system aspects

Attainable and affordable energy systems for practical application in China today and tomorrow that are capable of meeting all the above objectives urgently need to be identified and implemented. The Working Group reviewed existing and emerging technologies that already contribute to sustainable development, or which clearly have the potential to do so. Also identified by the Working Group were certain barriers to the establishment of desirable technologies in energy markets, and, conversely, those proven policies and institutional changes that would facilitate their utilization, if put in place.

Various combinations of technological options have been considered, based upon the actual conditions pertaining today in China, together with their respective capacities to satisfy the key energy objectives above.

The technological options considered included improved energy efficiency, especially at the point of end-use, in all sectors. Energy supply options have been studied extensively, logically based upon China's strong energy resource endowments, utilizing coal, oil, natural gas, large and small-scale hydro, nuclear, wind, biomass, solar and other renewable sources of energy. These supply options have been prioritized in ways compatible with the set of short- and long-term objectives. A number of innovative conversion options were also evaluated in light of these requirements.

The recent application by the Working Group of the Markal model to the options reviewed and prioritized has made an important contribution to understanding both the attraction and the urgency of gaining a consensus for action in energy decision-making, in order that the key objectives above can be met in a timely manner. For a summary of the key assumptions and working of the Markal study, see Larson et al. (2003). Two chief cases have been examined, to describe the outlines of two different energy futures for China up to 2050; the first being solely based upon today's commercially available (or soon to be) technologies, the "Base Case". The second "Advanced Case" uses only technologies that are not yet commercially ready but are well within reach when early actions are taken. Some are indeed near to being so, while others are more distant.

The technological options studied were introduced into an energy system modeling tool (called Markal) to study the interactions within the entire energy supply and demand system. Using the model, different scenarios for the evolution of energy supply and demand in China from 1995 to 2050 were explored. The model is provided with demand for energy services, resource limitations, and characteristics for supply and demand technologies. It then calculates the least-cost combination of technologies to meet the demand under specified levels of emissions or other constraints. This work provided insights about the different energy development choices that China might make.

General assumptions were made on China's desired economic growth and development were based on official Government of China reports. For example, population is projected to grow from 1.3 billion in 2000 to 1.58 billion by 2050, urbanization to expand from 31% to 70%, and GDP to grow from US$1104 billion to US$13,900 billion.

Scenarios were developed for unconstrained imports of oil and gas and no emission limitations for sulfur dioxide, and carbon dioxide. Constraints were then applied in these dimensions to reflect some of China's sustainable development objectives. Through 2020 sulfur emissions are capped at levels officially targeted by the Chinese government, which plans to reduce emission from the current level of about 24 million tonnes/year to 16.5 million tonnes/year in 2020, and the total allowed annual SO_2 emission continues to decrease to a level of 10.4 million tonnes in 2050. The case is also shown where, additionally, carbon emissions are restricted to a level that would be compatible with a stabilization of the global atmospheric CO_2 concentration at 450 ppm (up from the present 360 ppm). China's carbon emission rights on an equal per capita basis globally (based on year-2000 population) would be a