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# Recent development of energy supply and demand in China, and energy sector prospects through 2030

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## ABSTRACT

Facing multiple pressures, including its commitment to energy efficiency improvement, the current worldwide recession, and global warming concerns, China is making great efforts to maintain its continuous economic growth and reduce pollutant emissions. Many policies to encourage investing in energy efficiency and renewable energy have been issued. This article provides insights into the latest development of energy production, energy consumption and energy strategic planning and policies in China, and also describes the analysis, carried out by the authors as part of the Asian Energy Security project using the Long-range Energy Alternatives Planning (LEAP) modeling tool, of the impacts of implementing new and expected energy and environmental policies.

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## 1. Introduction

As the largest industrializing nation, China—here meaning the Chinese Mainland—receives global attention in a number of areas related to energy use, including its growing demand for energy as a consequence of its rising economic power, its increasing imports of energy, particularly petroleum, and its greenhouse gas (GHG) emissions.

### 1.1. China in brief

With a total land area of around 9.6 million square km, the Chinese territory spans around 5500 km from north to south, and stretches for some 5000 km from east to west. China's land boundaries extend for 22,800 km. Because of its vast size, China encompasses a range of climate zones, from tropical to frigid temperate. The Mohe area of Heilongjiang Province at the northern most tip of China, located north of latitude 53°, has a frigid temperate climate. Zengmu Ansha in Hainan Province at the southern end, only 400 km from the equator, is dominated by the equatorial climate. There are thus great temperature differences between the south and the north of the country. In the winter, most areas in China are cold, but the temperature varies greatly between northern and southern provinces. In Mohe, the temperature in January averages  $-30^{\circ}$ , while in Sanya, Hainan, winter temperatures are usually above  $20^{\circ}$ .

China had a total population of 1.32 billion as of the end of 2008. Control of population growth has been a fundamental national policy since the 1980s. In line with the requirements of the Outline of National Economic and Social Development, in the Eleventh Five-Year Program period (2006–2010) the goal is for the average annual natural increase in China's population not to exceed 8‰ (0.8% per year), and for the population by 2010 to be less than 1.36 billion.

China has maintained rapid economic growth for three decades. China's gross domestic product (GDP) increased from 365 billion RMB (Chinese yuan) in 1978 to 30,067 billion RMB in 2008 using current prices (NBS—National Bureau of Statistics, 2009). The annual average growth rate in constant prices from 1978 to 2007 was 9.8% (NBS—National Bureau of Statistics, 2008a). The GDP per capita reached 18,934 yuan in 2007. Large and increasing amounts of energy are being consumed to support this rapid development.

### 1.2. Overview of energy policy challenges facing China

Chinese energy policies face many challenges, from how to maintain rapid economic growth while reducing energy consumption, to how to reduce pollutant emissions from energy consumption and master utilization of high-tech clean energy.

The Chinese government makes tremendous efforts to maintain its rapid economic growth, both to create enough jobs for its people and to improve their daily life. Large amounts of investment go to infrastructure construction yearly, which has promoted an extreme boom in the cement, steel, and other energy-intensive sectors. This has naturally resulted in fast growth in energy consumption, a trend that has been particularly

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obvious since 2002, when a supply shortage in oil, electricity, and even coal swept across the nation. As a result of China's experience with supply shortages at that time, an ambitious energy-saving target was set for the 11th five-year-plan period (2006–2010). The government would like non-energy-intensive sectors, like the service industry, to play a greater role in economic growth than previously, but market forces have driven the changes in the economic structure in the other direction. Statistical data show that the value-added of tertiary industry accounted for about 40% of GDP since 2005, down from 41.5% in 2002 (NBS, 2009, 2008a).

Coal has remained the dominant primary energy source for decades. Using coal in unclean and inefficient ways has created most of China's pollution problems. CO<sub>2</sub> emissions are becoming an important consideration in energy policy. Promoting development of nuclear power, renewable energy, and other low-carbon energy sources is a key component of China's energy policy. Unfortunately, development and deployment of low carbon resources, especially renewable energy, face challenges related to market barriers, difficulties associated with technological innovation, and public acceptance.

Final energy products from renewable sources cannot compete with conventional sources in terms of cost under current market conditions, even with governmental subsidies. Low reliability, small-scale, and high investment cost are the main factors that make renewable energy costly. China is still mastering some new technologies for renewable energy utilization, such as very large-scale wind turbines and smart grids. Progress on wind power development in China has been considerable, however, as is shown by recent gains in wind generation capacity, and the cost per kilowatt for imported wind turbines is 30% higher than for domestically made units. The power grid, however, cannot handle significant amounts of reliable renewable power (mostly wind) in some areas due to technical limitations. China exports most of the photovoltaic (PV) panels it makes due to high installation costs in China. The cost of electricity from a PV system is about 2 yuan/kWh (Qian, 2009), compared to 0.5 yuan/kWh from conventional generation sources.

China is making increasing efforts to master technologies for using conventional sources in a clean and efficient way, including development of technologies such as Integrated Gasification Combined-Cycle (IGCC), Ultra-Clean Coal (UCC), and the next

generation of nuclear reactors. Even then, there is still a large gap between mastering technologies and making those technologies affordable in China.

## 2. Recent trends in energy production and consumption

After maintaining low energy elasticity during the last two decades of the twentieth century, with economic growth rates exceeding growth in energy use, China entered a phase of high growth in energy production, imports, and consumption at the turn of the century. Energy production and consumption increased by as much as double digit percentages since 2003, as shown in Table 1. Although year-on-year growth rates for most of the parameters in Table 1 show general downward trends from 2003-on, the overall high growth rates raise a serious question for the Chinese people: How long can available resources support such growth?

### 2.1. Energy resources

According to the latest reports published by the State Energy Bureau, as of the end of 2007 China had recoverable reserves of 176.8 billion tons of coal, 21.2 billion tons of crude oil, 14.3 billion tons of non-conventional oil, 22.03 trillion cubic meters of natural gas, and 400 GW (gigawatts) of hydropower. China also has abundant renewable energy resources, most notably wind energy, as summarized in Table 2. Despite these resources, China has relatively low levels of energy reserves per capita, and many concentrations of resources are located far from major cities, necessitating long distance transport to energy users if these resources are to play a significant role in China's energy future.

### 2.2. Energy production

The trend of primary energy production in recent years has had two main characteristics: a major change in output and only slight changes in the mix. China produced 2.23 billion tce (metric tons of coal equivalent, equal to 1.56 billion tons of oil equivalent, or toe) of primary energy in 2007, 6.5% higher than the previous year. Figs. 1 and 2 show primary energy production and the mix of

**Table 1**

Recent year-to-year growth rates of energy production and consumption (%/yr).  
Source: China Energy Statistical Yearbook (2008).

Growth rate	2000	2001	2002	2003	2004	2005	2006	2007
Energy production	2.4	6.6	4.6	13.9	14.3	9.9	7.4	6.5
Electricity production	9.4	9.2	11.7	15.5	15.3	13.5	14.6	14.5
Energy consumption	3.5	3.4	6.0	15.3	16.1	10.6	9.6	7.8
Electricity consumption	9.5	9.3	11.8	15.6	15.4	13.5	14.6	14.4

**Table 2**

Energy resources of China.  
Source: Zhang (2009).

Primary source	Raw coal (billion tons)	Crude oil (billion tons)	Non-conventional oil (billion tons)	Natural gas (trillion cubic meters)	Hydraulic (GW)
Remaining recoverable reserves	176.8	21.2	14.3	22.03	400
Primary source	On-shore wind (GW)	Off-shore wind (GW)	Geo-thermal ( $\geq 150$ °C) (GW)	Wave power generation (GW)	Biomass (Mtce/year)
Technically feasible potential	380	700	6	28	350

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