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Rural Electrification, Human Development And the Renewable Energy Potential of China

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Peter Meisen
President, Global Energy Network Institute (GENI)
www.geni.org
peter@geni.org (619)595-0139

Nicole Cavino
Research Associate, Global Energy Network Institute (GENI)
ncavino@gmail.com

Abstract

China has experienced remarkable rates of industrial and economic growth over the past several decades. After the establishment of the Chinese state, the communist governments of Mao Zedong and Deng Xiaoping took significant steps focused on the industrial development of the country. These continue today with China averaging 9% economic growth rates per year. Recognizing the successes of other countries, including Bangladesh and Chile, the Chinese government focused on rural electrification programs as a means of stimulating industrial growth and movement towards further modernization. Since the inception of efforts at rural electrification, China has been successful in electrifying 98% of its population. This was accomplished while maintaining high rates of growth and improved human development indicators, like literacy and infant mortality rates, as well as per capita income. Because of China's electrification programs, it has achieved incredible success in moving towards its own development goal, as well as those of the United Nations Millennium; however, there is plenty of room for improvement. As a result of its high reliance on coal to generate electricity, China has seven of the ten most polluted cities in the world. In these cities, air and water quality have suffered significantly. In order to maintain the economic growth that electrification has brought and to establish sustainable development, China must take stronger initiatives to increase the development of renewable energy sources like wind, hydroelectric, geothermal and solar/photovoltaic power. As well, legislation must be introduced that limits pollution and limits the initial costs of renewable development.

Background

Created in 1882, the Chinese electricity industry has faced serious supply challenges, particularly as demand has continued to grow exponentially. Since the 1950s, China has experienced unprecedented economic growth, and the electricity industry has been driven to grow as well, achieving an electrification rate of 98%.[1] The most populated country in the world, China has been challenged with providing electricity to its entire population of 1.3 billion since the conception of the industry.[2] Under Communist rule, China took significant measures to ensure electrification and has undergone several reformations of the industry, although not without severe challenges in the process.

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In 1949, China had a meager 1.85 GW production capacity with only 6500 kilometers of transmission lines; by 2001, that capacity had grown to roughly 338 GW

[1] Jiahua, Pan, Peng Wuyuan, Li Meng, Wu Xiangyang, Wan Lishuang, Hisham Zerriffi, David Victor, Becca Elias, and Chi Zhang. Rural Electrification in China 1950-2004: Historical Processes and Key Driving Forces. Center for Environmental Science and Policy at Stanford University. Stanford: Program on Energy and Sustainable Development, 2006. 174. 24 Jan. 2007. Page 5.

[2] United States of America. Central Intelligence Agency. World Fact book. 22 Feb. 2007 <https://www.cia.gov/cia/publications/factbook/geos/ch.html>.

with 1478 TWh generated.[3] Several phases of electricity reform and rural electrification have driven such development, respectively. A look at the electricity industry, in general, is important to appreciate China's ability to reach such high rates of electrification nationwide and to analyze the influence on development.

Beginning in 1949, when the People's Republic of China and Communist one-party rule was established, the electricity industry was nationalized, strictly vertically integrated and state-owned. Highly centralized, funding for electricity was divided into units along vertical industry lines and horizontal hierarchal, regional lines every five years. These famous Five Year Plans were created to anticipate economic growth and demand for power, plan and implement new projects through coordination of government agencies and local administrations, and to place new electricity projects under the control of the central government. The Economic and Trade Commission planned generation, quotas and allocation of power nationwide with resource distribution based on national priorities.

After Mao's death in 1976, supplies were not satisfying the growing demand for electric power. The government recognized the need to expand power production and began instituting a series of industry reforms. Deng Xiaoping's Open Door Policy resulted in increases in production that were being undercut by chronic energy shortages which were also hindering economic development. New policies were implemented to deal with the supply/demand imbalance and to cope with rapid economic growth. Focused on improved efficiency from 1980-1986, new, non-central government ownership of power production and power plants, without any central government funding, was established. The Communist Party of China (CCP) took serious measures to open the generation sub sector to investment from local and provincial governments, bank loans, corporations, individuals and even foreign investors. Power supply, production, efficiency and investor returns increased. The new reforms allowed for new investors, reset tariffs, and introduced a tax rebate to strengthen the assets of power companies; however, because banks overextended, and government-connected firms were not servicing debt, investor portfolios were not significantly improving.

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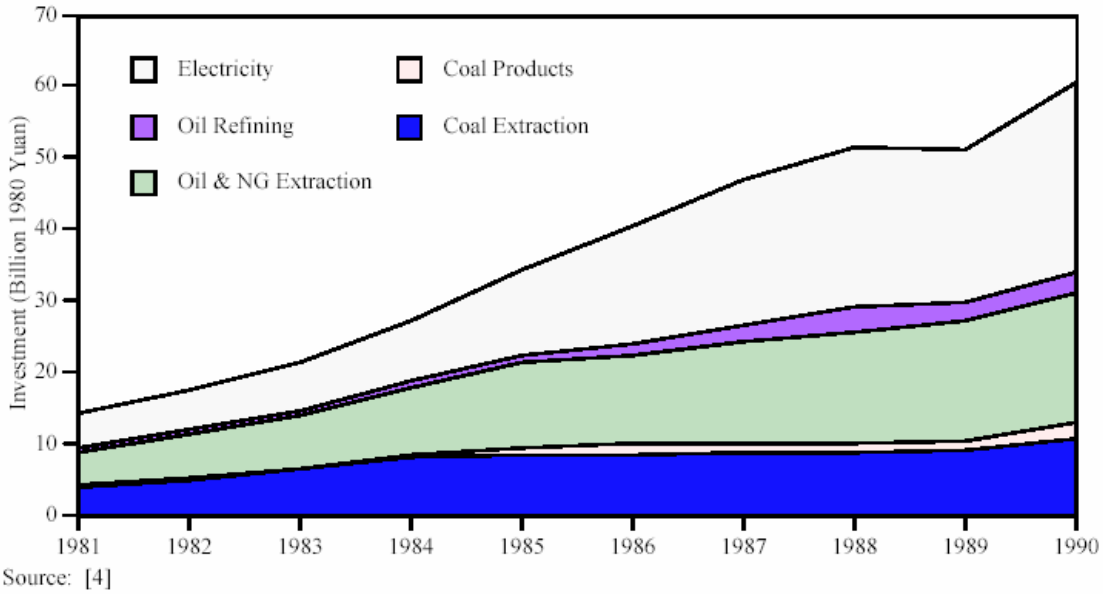
[3] Zhang, Chi and Thomas C. Heller. Reform of the Chinese Electric Power Market: Economics and Institutions. Program on Energy & Sustainable Development, Stanford U. Working Papers. <pesd.standford.edu> page 1.

Figure 2-6: Investment in the Energy Sector, 1981-1990

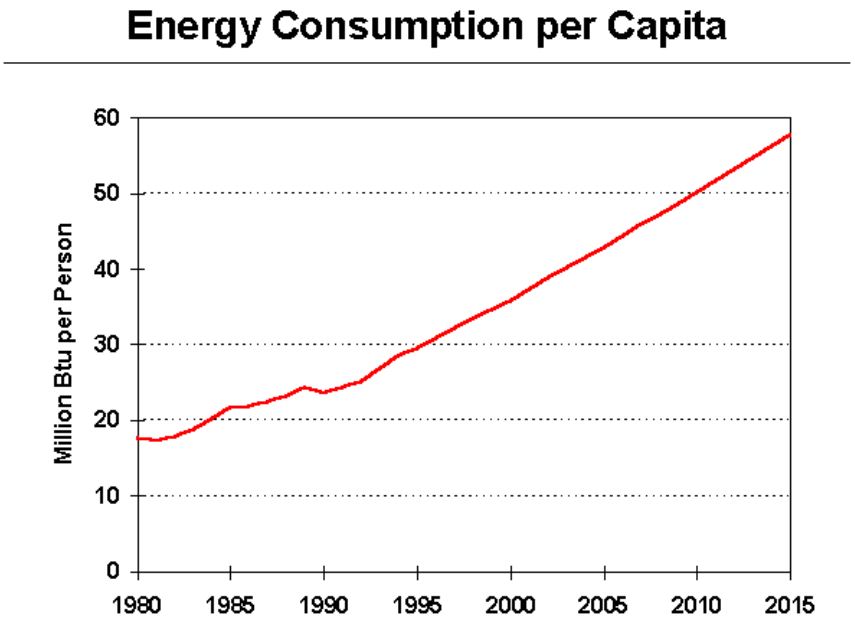


Source: [4]

http://china.lbl.gov/publications/china_e_policy.pdf

From 1986 until 1996, China's electricity industry saw rapid growth and serious reform. Driven by the success and profits of private companies, such as Huaneng, for example, increased foreign and domestic investment, rapid growth of provincial electrical grids (quicker than trans-provincial grids) alongside the inefficiency of the commonly developing small, local thermal generators, the call for unification of the industry framework resulted. During this period, production rates were approaching demands. In 1987, the new Twenty Word Policy took several steps to advance Chinese development and seriously impacted the electricity industry in several ways. In an historic, groundbreaking step for the CCP, the policy separated business from government. The government also took steps to establish provincial power enterprises as independent projects, connect power grids nationally, allocate electricity to the entire country, and diversify the financing of new power production projects. By opening the industry to non-central government investors, the electricity industry became an integral part of Chinese market reforms, a second round of which began in the 1990s.

Compared to 94 GW installed capacity in 1986, by 1995[4], China had 214 GW installed capacity, 51GW of which came from hydropower. More electricity firms and production more or less met demands as a result of applied reforms; however, the industry still faced serious challenges as a booming economy and demand continued to rise rapidly. Under President Jiāng Zémín, the CCP was concerned with the technical, organizational and environmental problems that the electricity industry was facing. They recognized a need for reorganization, coordination and discipline as local protectionism occurred; local governments were acting on behalf of narrow interests, and rapid local regulation created disorder. Connection difficulty and the uneven distribution of electric power also plagued the industry and inspired policy reform.

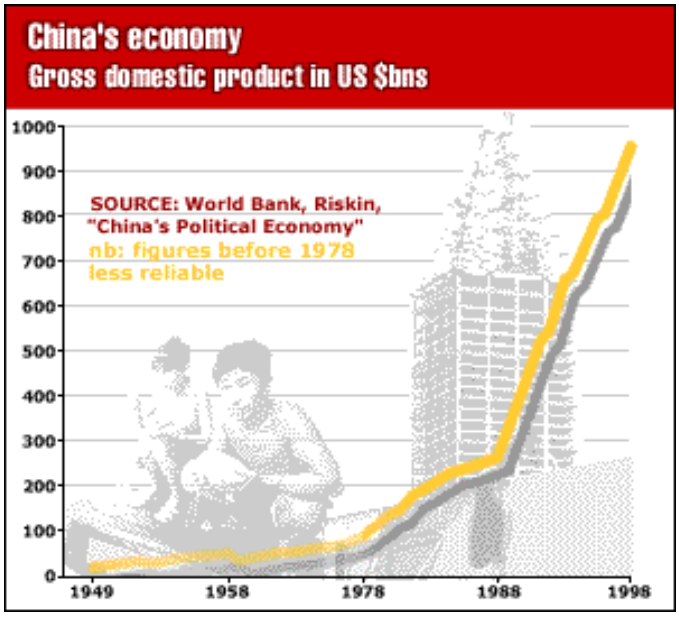


Source: www.eia.doe.gov

By 1996, meeting energy demands was no longer the main issue; instead, reforms focused on efficiency and fair competition. The Chinese government was inspired by the successful development of other countries, increased media and consumer attention directed at the low efficiency and high costs of Chinese electricity and the discrimination against independent plants like the Ertan Hydropower Plant in Sichuan. The independent

[4] Hafsi, Taïeb, and Zhilong Tian. Changing Institutions: the Chinese Electricity Industry from 1980 to 2000. HEC Montreal. Montreal: HEC Montreal, 2004. 1-37. 22 Feb. 2007 <www.cerium.umontreal.ca/pdf/hafsi.pdf>. Page 12.

plant was denied distribution rights by the provincial government, which was charging significantly higher prices for electricity. To remedy this, the Ministry of Electric Power was dissolved, and powers were separated into three organizations. The China Federation Power Enterprises (CFPE) focused on coordination of policies and organizations; the State Power Corporation (SPC) established holding power and economic management; and the China Power Investment had the ability to mortgage publicly owned utility assets, set up investment funds and seek increased foreign capital.[5]



www.news.bbc.co.uk

Power production and distribution were separated, and generators supplied the national power grid. By 2000, policies began instituting moderate competitive market reform in order to promote industry expansion, efficiency and sustainability. By this time, the industry had significantly improved investor diversity with over 4000 companies involved in the electricity industry; however, while the SPC owned 50% of the industry, private ownership, in fact, was relatively small.[6] Generating capacity increased with the establishment of five large, interconnected regional electric grids. Industry reforms helped improve rural electrification, economic development and GDP

[5] Hafsi, Taïeb, and Zhilong Tian, page 20.
[6] Zhang, Chi and Thomas C. Heller, page 2.

growth in China. With these changes, the industry had been changed from a highly centralized system, unable to meet growing demands, into a diversified field of organizations that brought together local and provincial administrations and individual power producers with the central government taking the lead.

The electricity industry is not the only Chinese industry to see expansion and reform. These changes in the electricity industry correlated with China's overall change in values, particularly economic and financial reforms focused on establishing competition and aspects of a market economy. Since the 1976 death of Mao, increased provincial autonomy, fiscal, financial sector and currency reforms have helped China reform its energy industry and provide electricity to nearly all of its population. Although China enjoys high electrification rates, efficiency remains a challenge. With a projected economic growth rate of 7-8% until 2010, the electricity industry will face challenges in meeting energy demands fostered by such growth.[7] Disproportionate consumption and uneven energy distribution, particularly between urban and rural areas, as well as environmental degradation continue to plague the Chinese electricity industry; however, development of the industry has, so far, achieved success in cultivating development and economic growth.

[7] Ibid., page 21.

Rural Electrification in China: How and Why?

Although the motivation for providing nationwide electricity has gradually evolved, providing electricity across China, including the rural areas, has been a main concern since the founding of the nation in 1949. The central government in Maoist China was clearly focused on economic growth, industrialization and social improvements. The government introduced significant state-led programs, particularly for social welfare. Keeping in mind the goal of establishing a modern Chinese military and industry, not of defeating international capitalism, they focused on sustainable economic development and resistance to what they regarded as western imperialism. Freedom from Western domination, strengthened independence, sovereignty and self-determination for China: these were the guiding principles of Mao's party.

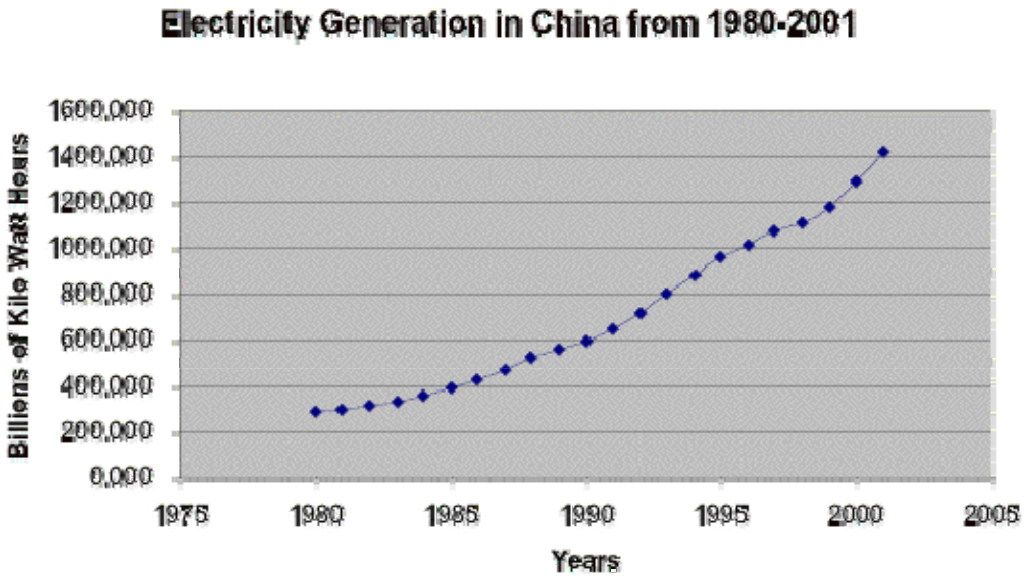
Building solar panels in rural China

http://www.ens-newswire.com/ens/nov2005/20051107_thaipumppanel.jpg

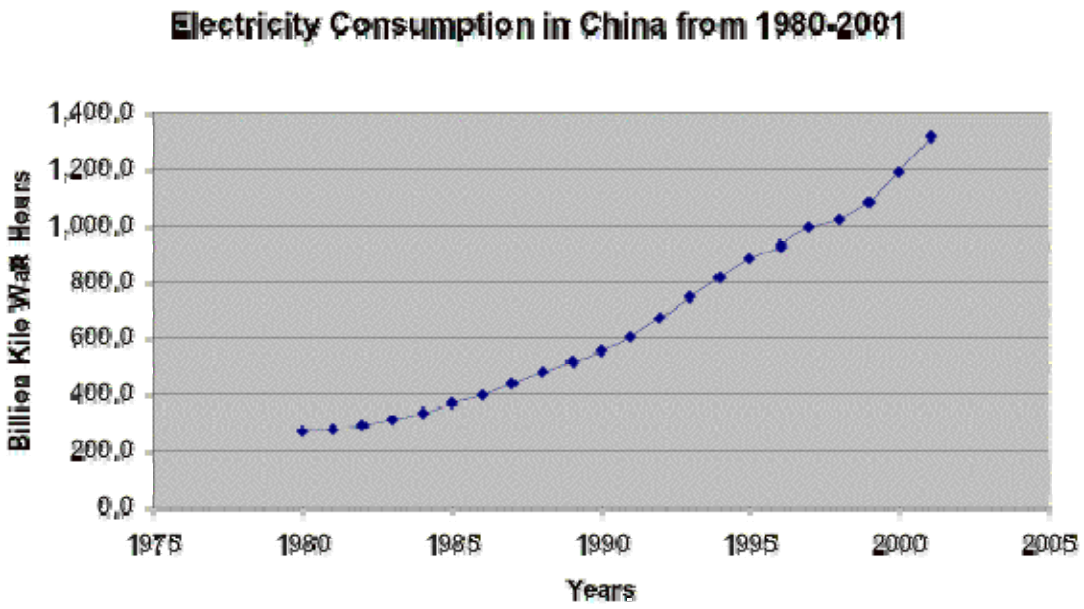
In response to the Great Leap Forward of 1958 and the mass starvation and poverty that followed, federal policy began to focus on alleviation of poverty and development. This included rural electrification, particularly with regards to enhancing irrigation, drainage and agricultural methods. During this time, the federal government allocated 200 million RMB (US$26.3 million) to improve and enlarge electrical capacity,

and safety, of rural electricity grids, the first large-scale grid project initiated in the history of China.[8] They also focused on improving standard quality of life indicators through universalized primary education, lower infant mortality rates, improved nutrition levels, reduction of disease and increased life expectancy rates.

The government also took steps to improve electricity access across the entire country. This required strong central planning from the federal government, state investment and control of the electricity sector with specific aims at rural industrial development. The revenue from electricity production was then put back into the industry, fueling further growth. By 1976, 500 million Chinese had access to electricity, nearly 63.28% of the population. At the time of Mao's death, the Communist Party was looking to continue Chinese economic growth and development.



[8] Jiahua, Pan, Peng Wuyuan, Li Meng, Wu Xiangyang, Wan Lishuang, Hisham Zerriffi, David Victor, Becca Elias, and Chi Zhang. Rural Electrification in China 1950-2004: Historical Processes and Key Driving Forces. Center for Environmental Science and Policy at Stanford University. Stanford: Program on Energy and Sustainable Development, 2006. 174. page 17.
http://iis-db.stanford.edu/pubs/21292/WP_60,_Rural_Elec_China.pdf



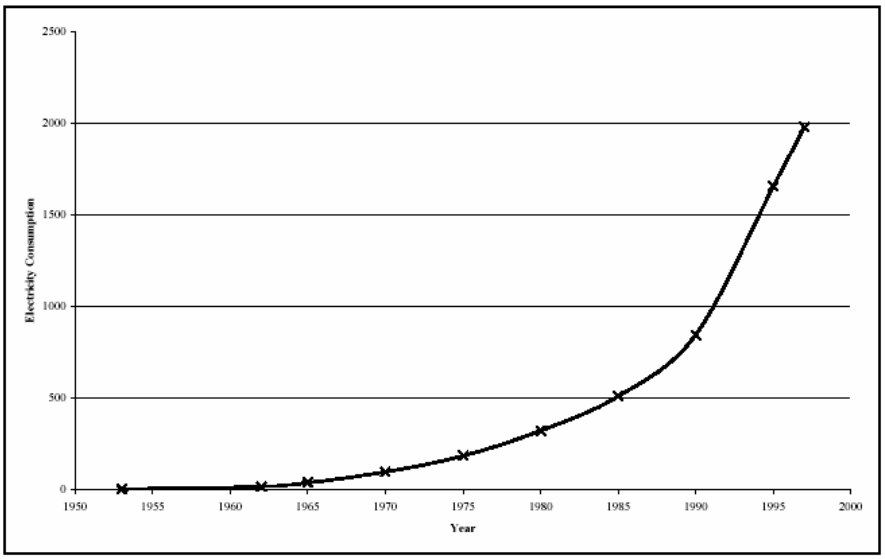
www.eia.doe.gov

When Deng Xiaoping took over as de facto leader of the state in the early 1970s, he was committed almost exclusively to economic growth. His policies were less focused on improving social welfare and were instead aimed at promoting the economic growth and development of China. His "Cat Theory" explains his willingness to accept policies that expanded economic growth but cut welfare programs, saying that those policies would, in turn, contribute to social well-being. Deng set long-term goals of doubling per capita GNP from 500USD in 1990 to 1000USD in 2000 and then again to 4000USD in 2020 with hopes of achieving progress through market reforms. Such lofty goals would require incredible industrial and energy sector growth as a means of support.

China's 6th Five Year Plan serving from 1981 – 1985 exemplified Deng's willingness and desire to fuel economic growth and further established goals of controlling population growth, improving quality of life, strengthening production and government revenue, and maintaining China's 5% annual growth rate. Serious improvements to energy and industry were crucial to moving towards such goals. The government established a policy of "walking on two legs," a strategy that included the development of both thermal and hydropower electrical sources as a means of diversifying the energy sector.

Increasing provincial autonomy and decentralizing command of the energy sector, alongside China's new Open Door Policy, drove rural electrification to new economic activity. The 20 Word Policy of 1987 aligned power grids, diversified electricity financing and regulated countrywide allocation of power. The period from 1979 until 1998 saw rapid expansion and growth of the Chinese economy and energy sector. These included significant improvements in electricity access and industrialization facilitated by increased central government and private investment and other special loans, grid connections and strengthened institutions on all levels. By 1995, China had 214 GW installed, as compared to 94 GW in 1986. By 1998, 823 million people, 98.4% of the population, had access to electricity. The electricity industry became a diversified field of organizations, on the societal and corporate levels, that supported each other and the central government.

Figure 5: Rural Electricity Consumption 100 Million kWh



http://www.nautilus.org/aesnet/2005/MAR0905/worldbank_EGP.pdf

Why was China so interested in rural electrification? Setting grand ambitions of rapid industrialization, nationwide improvement to quality of life indicators and support of a growing population and economy, the Chinese government implemented programs aimed at establishing and, later improving, electricity access. By 1996, the government acknowledged that the rural electrification successes of countries like Bangladesh and

Myanmar allowed for electricity supply to meet demands and improve literacy rates, health and general living conditions. After achieving high rates of electrification, the government of China focused on improvements in connections and efficiency. This was driven by existing technological, organizational and environmental problems that included connection difficulties, electrical waste and the need for improved discipline and coordination.

Significant electrification initiatives in China were fueled not only by the need for rural electrification, but also for improved efficiency of electricity access and grid connections. The added social, public health and overall quality of life improvements served as added benefits of improving nationwide electricity access. Additionally, the inland development of electricity served national security purposes. National electricity policies were aimed at increasing electricity supply to meet overall demand, thus fixing problems of social well being and the status quo by reaching those without electricity. In 1994, the Chinese government committed 720 million RMB (US$94.7 million) and later, in 1996, allocated 2.1 billion RMD (US$ 276 billion) to poverty alleviation programs through electricity access efforts.

Year	Electricity Access			Without Electricity Access				
	Town	Village	Farmer households	County	Town	Village	Farmer households (10,000)	Population (10000)
1993	97.4%	93%	89.6%	26	1269	54858	2501	
1994	97.8%	95%	91.3%	16	1071	37151	2214	
1995	98.25%	96.06%	93.3%	16	828	29783	1731	
1996	98.60%	96.72%	94.67%	11	649	24818	1404	7200
1997	99.03%	97.66%	95.86%	10	442	17462	1107	
1998	99.20%	98.10%	96.87%	8	364	14042	881	5000
1999	98.31%	97.77%	97.43%	7	766	16509	706	
2000	98.45%	98.23%	98.03%					
2001	98.56%	98.53%	98.40%	3	629	10952	478	
2002	98.54%	98.71%	98.48%	3	608	9303	458	

Source: China Electricity Yearbook

Trends in public electricity access in rural China.

The Chinese Brightness Project, introduced in 1996, at the World Solar Peak Conference in Zimbabwe, was aimed at providing electricity to 23 million people in remote areas through the utilization of renewable resources, allocating 100 watts of capacity per person. In the most recent plan, the 10th Five Year Plan, the federal government has promised US$50 million to establish household and village electricity systems to the most underdeveloped provinces of Inner Mongolia, Tibet, Qinghai, Gansu, and Xinjiang. The Brightness Project, which focused on environmentally friendly sustainable development and poverty alleviation with a high return on investment, has seen positive results in its first stages. This includes the establishment of local and national government bureaus of financing, technical training systems for local technicians and engineers and production enterprises geared toward meeting electricity needs. In the project's first phase, electricity reached 1,780,000 new households and 2000 villages. 200 station systems were established.

Changes in Chinese values allowed for the adoption of market economic reforms in 1995, which hinted at the government's willingness to take new approaches to dealing with economic, industrial, and energy development. The new reforms opened paths for continued industrial development aimed at supporting incredible economic and population growth and the ability to adapt to new concerns. For example, during the 1997 Asian financial crisis, electricity consumption rates dropped dramatically in urban areas; in response, the government allocated the surplus electricity to rural areas, increasing rural electrification rates while maintaining energy production. It was the shift in values, ideology and goals of serious economic growth and industrialization that motivated policy initiatives which were focused on providing electricity access as a means of improving the economic and social welfare of China. Such were the cases of nearby successes like Bangladesh and Myanmar.

Rural Electrification Programs Worldwide: Models of Success

After gaining independence from Pakistan in 1971, Bangladesh created its Constitution, which explicitly stated intentions to provide electricity nationwide. At the time of its independence, only 250 of more than 87,900 Bangladeshi villages had access to electricity. In 1978, a rural electrification project commenced, aimed at providing electricity to those outside of urban areas with the initial intent of electrifying irrigation pumps.[9] The Rural Electrification Board (REB) was created to oversee rural electricity distribution. From there, democratically organized, decentralized organizations of electrical cooperatives that are member-owned and operated, called Palli Biddyut Samitees (PBSs), became the key to the electrification strategy of the REB.

Table 1.1: Purposes and Goals of REP

Purposes	Goals
1. Increased farm yields and non-farm production 2. Enhanced productivity and efficiency in agricultural production 3. Greater job opportunities 4. Improved environment and enhanced willingness for education. 5. Greater awareness about health issues 6. Better health care facilities 7. Increased access to information through electronic media 8. Local level democratization in PBSs 9. Expansion of local markets 10. Increased social security and mobility 11. More effective use of working hours.	***Explicit*** 1. Poverty reduction 2. Reduced migration from rural areas 3. Local governance ***Implicit*** 1. Improved living standard 2. Gender development and women empowerment 3. Changed world view.

This organization, alongside continuous government support and funding, allowed for phenomenal electricity development throughout rural Bangladesh. The creation of PBSs and rural electricity cooperatives has provided reliable and reasonably priced electricity to rural populations. As a result, during the twenty-year period between 1978 and 1998, PBSs increased five times, and the average rate of increasing electrified

[9] Barkat, Abul. "Bangladesh Rural Electrification Program: A Success Story of Poverty Reduction through Electricity." Ettore Majorana International Foundation and Centre for Scientific Culture. Aug. 2004, Pg 2.

villages was 17%. By 2003, 39,684 villages, fully 45% of villages, had electricity access. With the newfound ability to reach rural areas, human development indicators have seen improvements throughout Bangladesh.[10]

The government of Bangladesh has made it clear that rural electrification is a national priority, especially with the 2002 National Poverty Reduction Strategy Report. This report identified electrification as one of four priority areas to ensure growth, particularly through the economic, socioeconomic and political infrastructure established through rural electrification programs. Bangladeshi national development policy has focused on "electricity for all" by 2020, specifically aimed at improving education and health and overall poverty alleviation. Ultimately, the initial goals of the REB were met as household electricity consumption contributed to increases in incomes. With the new prospects arising from electrification, like the ability to work at night, business and trade expansion, most Bangladeshis attribute new employment opportunities to electricity.

> "The state shall adopt effective measures to bring about a radical transformation in the rural areas through the promotion of an agricultural revolution, the provision of rural electrification, the development of cottage and other industries, and the improvement of education, communications and public health, in those areas, so as progressively to remove the disparity in the standards of living between the urban and rural areas."
> -- Constitution of Bangladesh, article 16

[10] Barkat page 3.

Table 4.4: Human Development Index by Household Electrification Status

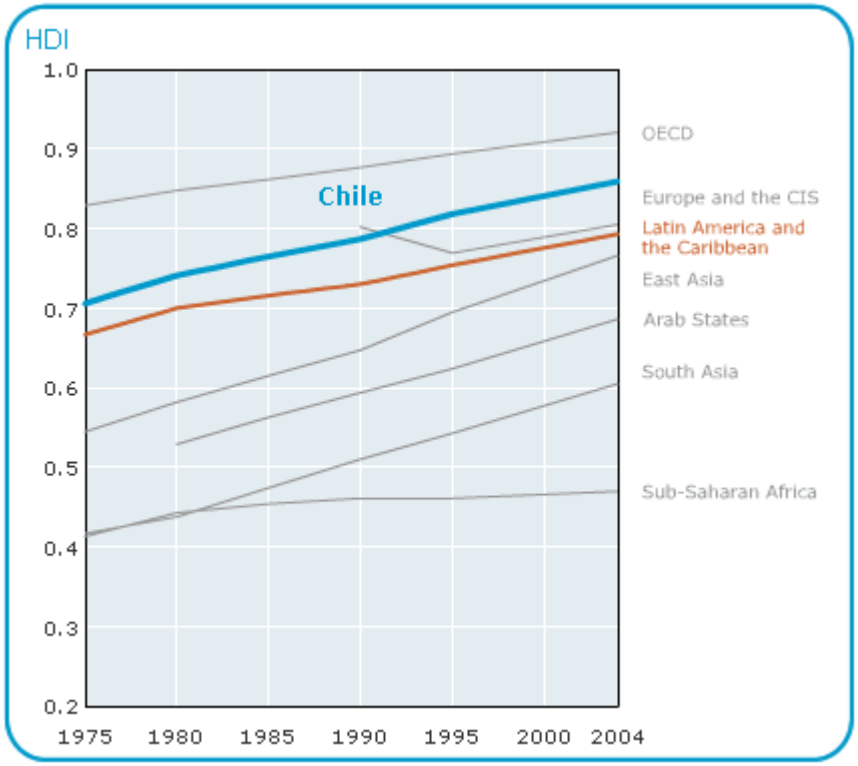
Human Development Indicator	Household with electricity	Household without electricity (in electrified villages)	Household without electricity (in non-electrified villages)
A. Adult literacy rate (%) (AL) (15 yrs and above	73.2	54.9	57.3
B. Combined gross enrolment ratio (CER) (5-24 yrs.)	63.7	54.9	54.0
C. Life expectancy at birth (LE)[a]	74.5	60.0	54.9
D. Per capita income (as proxy of per capita[b] real GDP: PPP)	2519	1238	1612
E. Indexed LE	0.825	0.583	0.498
F. Indexed AL	0.732	0.549	0.573
G. Indexed CE	0.637	0.549	0.540
H. Indexed Education Attainment (EA)	0.700	0.549	0.562
I. Indexed Adjusted Income	0.400	0.188	0.250
Human Development Index (HDI)	**0.642**	**0.440**	**0.436**

Notes:a> Data on Life expectancy at birth (LE) was not available in the survey. Data on child birth and infant death (last year) were obtained, and infant mortality rate has been estimated. LE is function of many factors including IMR. LE and IMR are inversely related. LE for specific IMR has been calculated using formula: 100 - IMR x 1.3 (constructed for Bangladesh). The estimated IMR in the current survey are found as follows: HE = 42.7/1000 LB, WE-EV = 53.8/1000 LB, and WE-NEV=57.8/100 LB.

b> Per capita real GDP for 1999/00 was 1632 PPP$ (Bangladesh Human Development Report 2000: 30). The overall per capita rural income in Bangladesh (estimated using information in Section 4.3.2) in 2001 was Tk. 10,036. This amount equivalent to 1632 PPP$ i.e; Tk.1= PPP$ 0.1626$. The actual per capita found in the survey for HE was Tk. 15,494, for WE-EV Tk. 7,613 and for WE-EV, Tk. 9,916. The PPS$ equivalent to these Taka value has been estimated using the above conversion coefficient.

Education, the "cornerstone to human capital formation," has also seen improvements as literacy rates rose for all groups, women in particular. Literacy rates have been higher in electrified households for both genders, a major indicator of development.[11] New access to electricity has also improved health standards. Improved education helps increase public health knowledge, and while sicknesses were not necessarily reduced, treatment and recovery have improved significantly. This is particularly important as the World Health Organization has stated that health is, in fact, a critical requirement for economic development as well. Infant mortality rates, a key public health gauge, are typically 25% lower in electrified households. With more widespread electricity access, poverty is significantly reduced, and electrified households have demonstrated more improvement of all quality of life indicators, including life longevity, per capita real income and human development index.

[11] Barkat page 16.



World Regional Comparison of Human Development Index

http://hdr.undp.org/hdr2006/images/factsheet/hdi-trends/chl_2.gif

Chile and Kenya also have adopted programs focused on providing nationwide electricity, particularly to rural areas. Chile, adopting substantive rural electrification programs to include joint financing, decentralization, development of appropriate technologies and competition, has seen vast improvements and apparent success with electricity access, reaching 99% of the population, up from 76% with access in 1999.[12] These programs included the creation of competitive markets in which communities compete for subsidies, and no private companies receive sole jurisdiction of the industry. Chile has taken steps to make grid extensions and to establish photovoltaic systems where those extensions were not possible. The incredible success of Chile's rural electrification program has helped it to become one of the fastest growing, most developed countries in Latin America. With the longest running electricity reform in the

[12] "Private Participation in Infrastructure Projects Database." The World Bank Group. http://ppi.worldbank.org/explore/ppi_exploreCountry.aspx?countryId=105

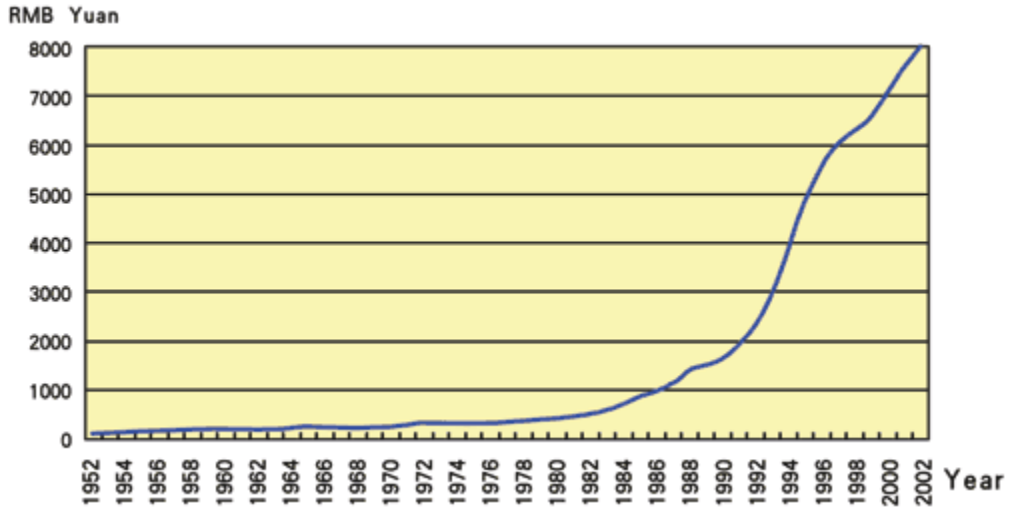
world, Chile has offered some important lessons to countries that are constantly seeking to improve rural electricity access and quality of its connections. This perceived success of Chile's program may have helped serve as motivation for China's rural electrification and development goals.

Under military rule from 1973 to 1990, Pinochet and Chile adopted structural readjustments, large-scale privatization and deregulation reforms based on an economic model and began the process of electricity reform in 1982 with the Electricity Act.[13] Although privatizing the electricity industry, there still remained some regulation in order to establish fair prices and a good rate of return on industry investments. By creating one single regulatory agency, Chile was able to control distribution companies in order to ensure fair prices and efficiency, and create a stable environment that fostered long-term investments that were protected from changes in government policy. Chile saw significant success not only with increased public access to electricity but a solid reduction of inflation and GDP growth, from a $1770 per capita income in 1982 to $4120 in 2002, a 6% growth rate in electricity consumption per year, and improvements in human development indicators.[14] By adopting similar programs that include continued privatization of the industry, accompanied by some regulation, China and other developing nations can take lessons from the Chilean rural electrification programs, not as the sole basis but as a step towards economic growth and human development.

[13] Pollitt, Michael. "Electricity Reform in Chile: Lessons for Developing Countries." September 2004. University of Cambridge. Page 28.
[14] Ibid., page 3.

Development Trends in China

It has become increasingly clear that China has undergone unprecedented economic growth and poverty reduction over the past thirty years. This economic increase has averaged 9% GDP growth, as well as impressive industrial growth rates of 18.8% and 8.9% during the periods of 1990-1994 and 1995-1999, respectively, with electricity shortages being identified as the main constraint on per capita consumption.[15] While poverty remains a serious concern for China, particularly in the more rural western provinces, China has seen a dramatic increase since the inception of rural electrification programs in both energy supply and consumption outside of urban regions.



Changes in Per Capita GNP

Source: China Statistical Yearbook, 2003[16]

Chinese policy has been focused nearly exclusively on economic growth with significant concentration on poverty alleviation by providing access to productive assets. The Rural Energy Reform Program has aimed at providing electricity access nationwide

[15] "Review of Evidence and Case Studies in Rural China." Institute of Development Studies and World Bank. 2003: Washington, DC. Page 70.

[16] http://images.google.com/imgres?imgurl=http://www.npfpc.gov.cn/picture/2005qjsm-7-.gif&imgrefurl=http://www.npfpc.gov.cn/en/fpcn01-en.htm&h=333&w=500&sz=9&hl=en&start=2&tbnid=KKsfipsTbVXCZM:&tbnh=87&tbnw=130&prev=/images%3Fq%3Dchina%2Btrends%2Bmortality%2Brate%26svnum%3D10%26hl%3Den

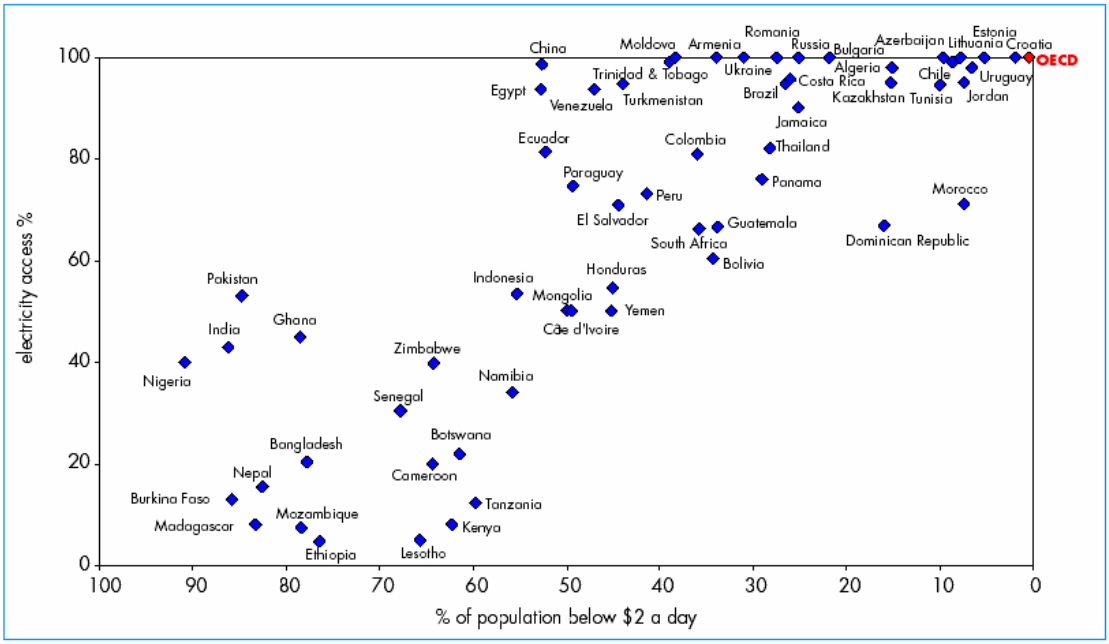
by leveling price disparities between urban and rural populations. With 98% of the Chinese population receiving, at least, minimal electricity access, there have been significant increases in medical personnel, hospital beds and variety and sales of pharmaceuticals. Reform of the energy sector took steps to create local enterprises and infrastructure. At the same time, the government took steps to mobilize investment at the local level by backing it with subsidies and low-interest loans, with the intention of reducing poverty and stimulating industrial development and urbanization. As a result, quality of life indicators have vastly improved throughout China, and poverty rates have been reduced.

Based upon most indicators of the United Nations Millennium Development Goals (MDG), including poverty rates, education, women's and human rights, mortality rates, HIV prevalence rates, clean water access and country debt levels, China has made vast improvements since the 1980's. Illiteracy rates have steadily declined, with adult literacy improving greatly. Access to basic, low-cost healthcare has widened, allowing for increased personal spending and household budgets devoted to health. Mortality rates have dropped and life expectancy at birth has gone up for both Chinese men and women. Furthermore, achieving electricity access has acted as one of the government's key components for generating economic growth, as the development of electrical power plants has correlated with poverty reduction. Programs like the rural electrification programs, like the Brightness Program, are aimed at reducing poverty and socioeconomic disparities through economic growth. The reduction of hunger and malnutrition, as well as increased housing sanitation and safety, are attributed to an increase in per capita electricity consumption, which tripled between 1980 and 1996.

"[Energy] access has become not only means to a better life but a key standard-of-living indicator and a necessary asset for full participation in society."
-- World Bank[17]

[17] "Review of Evidence and Case Studies in Rural China," Page 100.

Figure 13.5: **The Link between Poverty and Electricity Access**

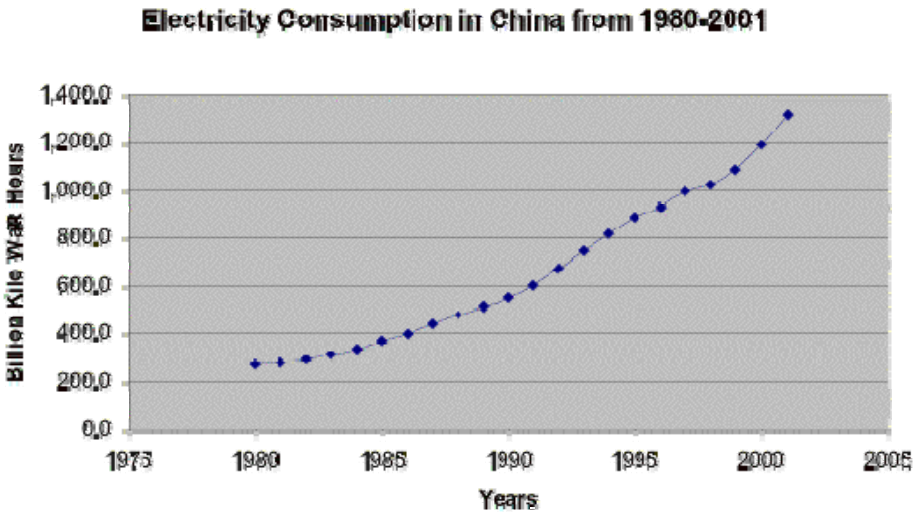


Note: Some transition economies and the OECD average are included for comparison purposes.
Source: IEA analysis; income statistics from the World Bank's *World Development Indicators*, 2001.

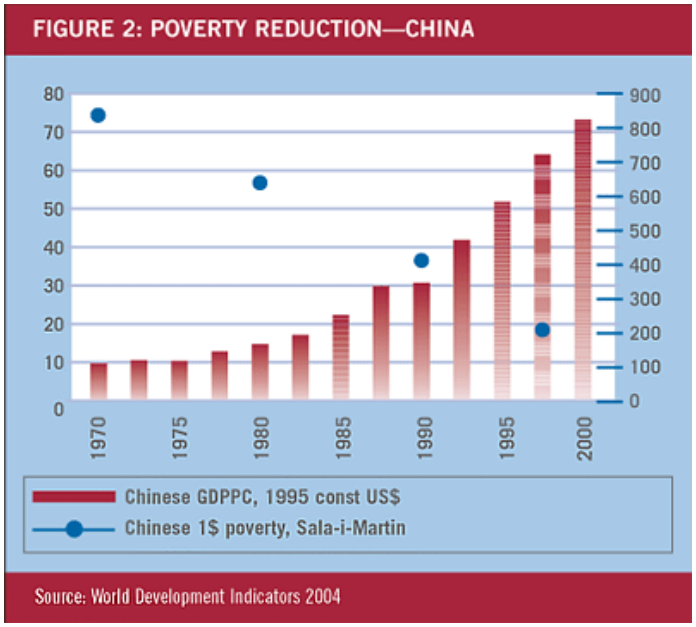
According to the World Bank, electricity and energy access are crucial to reducing poverty and improving human development indices. The World Bank Poverty Reduction Sourcebook states that in order to reduce poverty rates, it is necessary to expand energy access; improve reliability of energy supplies, energy sector governance and regulation; and to reduce the health and environmental costs of increased energy access. According to the World Health Organization, this improvement of energy access will, in turn, improve incomes, literacy, mortality, life expectancy rates and overall health status of a nation, a crucial requirement for economic development.

By introducing the Western Development Initiative, China has taken deliberate steps to increase electricity access nationwide, as a move towards closing both the health and income gaps within the country. China has been able to provide access to 700 million people in roughly two decades, reaching 98% electrification by 1998, levels of electrification on par with developed nations like the United States. The electrification process provides longer workdays and reduced work loads, allowing for diversification of production activities. Classrooms and houses can provide light, permitting nighttime

activity, especially education of adults and children. Areas lacking sufficient energy access are typically excluded from participation in development and poverty reduction initiatives. The lack of electricity access usually implies the absence of adequate roads, clean water sources and communications systems, impeding the quality of education, health and other quality of life indicators. While China clearly needs to make improvements to energy efficiency and sustainability, as well as continued efforts towards leveling access to the poorest provinces, the government's steps so far towards successful electrification have helped fuel its economic and social development.



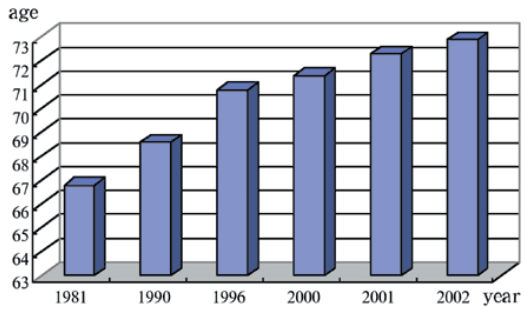
www.eia.doe.gov



http://www1.worldbank.org/devoutreach/oct04/article.asp?id=266

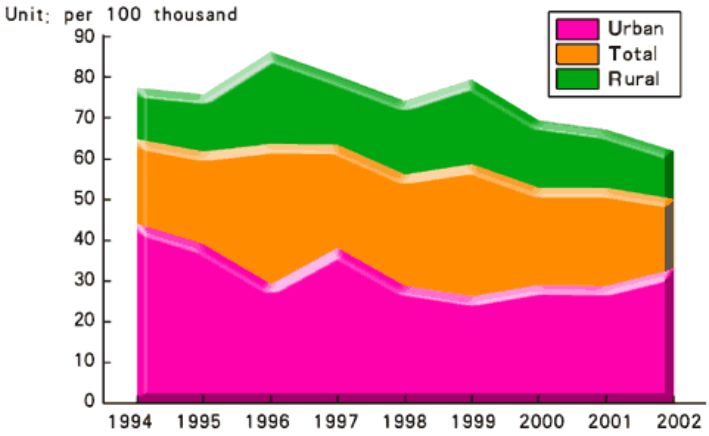
Even the World Bank has noted "the astonishing spread of grid electricity in China during the reform period is a remarkable achievement that has undoubtedly had a major impact on rural development."[18] The spread of electricity access has improved everyday life within most of China. For example, improved stove programs in provinces like Gansu have reduced health hazards, and the general consensus of Chinese citizens is that a lack of household electricity for television and lighting is now associated with a minimal quality of life. The Chinese government has taken significant and successful steps towards providing the entire country with electricity access. In turn, quality of life indicators, including mortality, literacy and life expectancy rates, have improved tremendously, as have economic and industrial growth rates. At the same time, social welfare and financial reform initiatives, as well as the establishment of productive infrastructure, have also contributed to China's development.

[18] "Review of Evident and Case Studies in Rural China," Page 132.



Changes in the Average Life Expectancy in China

Source: Dept. of Development and Planning, NPFPC; China Population and Development



Changing Trend of the Maternal Mortality Rate in China

Source: China's MCH Surveillance Report in 2002, the Ministry of Health

In fact, it is the complex, integrated mix of policy focused on improving energy, credit, transport-infrastructure, agricultural development, credit interventions, marketing and other poverty alleviation projects that have helped China move forward in its development. While China has seen success in achieving high electrification rates, policy now needs to focus on efficient use of energy as well as reducing reliance on fossil fuels and establishing renewable, sustainable methods of providing energy access.

China's Prospects for the Future – Renewable Energy

While industrialization, fueled by increased access to energy, has helped China to increase income levels, improve health indicators and reduce absolute poverty, heavy reliance on coal has proven damaging to health, air quality, and agriculture, and ultimately, it will prove to be an economic challenge as well. Since the 1998 World Health Organization Report, claiming that seven of the world's ten most polluted cities are located in China, the Chinese government, particularly SEPA, has taken steps to recognize growing environmental problems and the need to focus on curbing pollution. The 2002 Clearer Production Promotion Law was established to promote pollution reduction in ten major cities; the Renewable Energy Promotion Law and the Brightness Rural Electrification Program have also been introduced with the goal of providing more widespread electricity access via renewable energy sources.

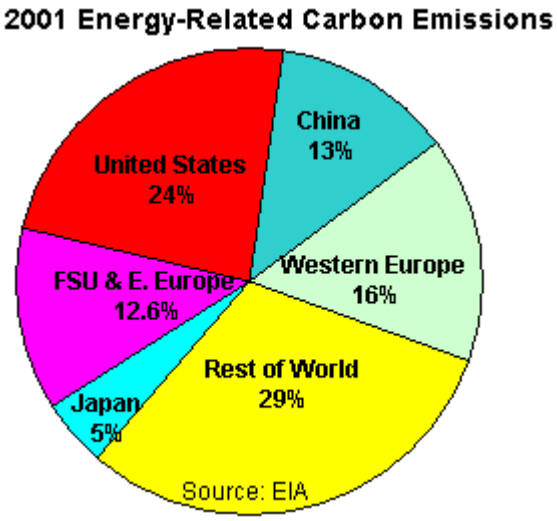
Table 6: Installed Electricity Generation Capacity in China, 1993-2003
(in thousands of megawatts)

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Hydroelectric	40.6	44.6	49.0	52.1	55.6	59.7	65.1	73.0	79.4	83.0	86.1
Nuclear	0.3	1.2	2.1	2.1	2.2	2.2	2.2	2.2	2.2	2.2	4.5
Geothermal/Solar/ Wind/Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Conventional Thermal	125.6	137.1	148.8	163.0	178.8	192.4	210.1	223.4	237.5	253.0	265.5
Total Capacity	166.5	182.9	199.9	217.2	236.5	254.3	277.4	298.6	319.1	338.2	356.1

China has vast renewable resource potential, so efficient policy and action must follow the rhetoric of the government. Contributing 12.7% of the world total in 2001, in mid-2007, China became the world's largest greenhouse gas emitter in the world,. Of the 39.7 quadrillion Btu consumed in 2001, 63.4% came from coal, 25.8% from oil and only 6.9% from hydroelectric sources. Despite the rhetoric of the government and international concern, China has surpassed the United States as the biggest carbon dioxide polluter, particularly with continued population, industrial and economic growth,

as well as increased transportation growth at a rate of 7% per year.[19] The widespread use of coal to meet energy needs has contributed to significant air pollution that affects China, as well as its neighbors and the international community.

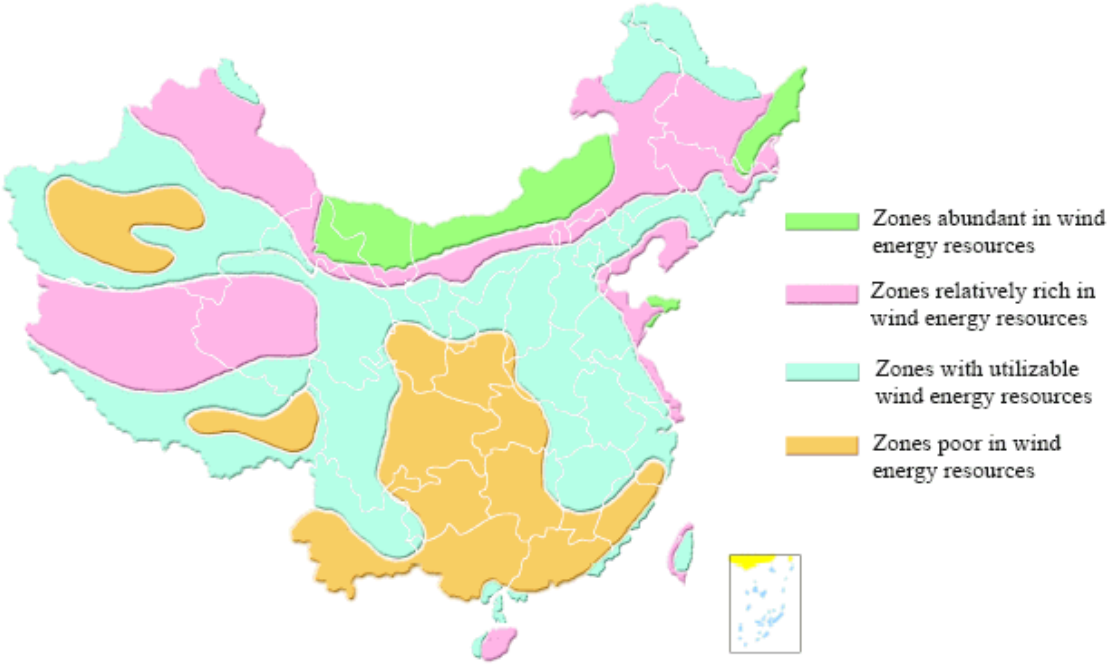
The byproducts of coal burning include increased sulfur particulates in the atmosphere, contributing to respiratory damage, heart disease and cancer. The effects of coal have contributed to nearly 400,000 premature deaths per year in China and atmospheric sulfur and ash are carried to Japan, South Korea and even as far as the west coast of the United States, detected in acid rain. While the government had vowed to cut sulfur dioxide emissions by 10% before 2005 by way of more efficient scrubbers in power plants, levels have actually risen by 27%.[20] The Chinese government has set ambitious targets for dealing with pollution, and while this is a noteworthy and significant change in attitude, it has yet to follow through substantially or see success in reducing greenhouse gas emissions and the switch to renewable energy.



A large, geographically diverse country, China has immense renewable resource potential that will contribute to its economic growth, as well as further enhance the human development indicators that have already advanced through rural electrification programs. The burden of air and water pollution sets the Chinese government back

[19] Bradsher, Keith, and David Barboza. "Pollution From Chinese Coal Casts a Global Shadow." New York Times 11 June 2006. 17 May 2007 <www.nytimes.com>.
[20] Ibid.

roughly $50 billion, or 8% of its GDP each year. Renewable energy development will contribute not only to employment, but also energy security, international economic competition and environmental conditions. Wind power has significant potential for China, although its development has lagged behind other nations like Germany, Spain and India. The government set goals for establishing 1,000 MW of wind power in 2000 but fell behind. With China's total capacity at 350,000 MW (2003), the potential capacity for wind power is as high as 100,000 MW.[21] The upfront costs of developing wind energy are typically high, increasing reluctance to such a program; however, prices are expected to drop by 2010, making wind power competitive with coal as local production of wind generators increases. The government must take the initiative by strengthening its policies and incentives to develop wind power, particularly in areas with the greatest potential -- most notably Inner Mongolia and coastal regions.



Wind Potential in China by Zone

Source: http://www.sp-china.com/images/pic/power%20sources/p9.gif

[21] Zhengming, Zhang, Wang Qingyl, Zhuang Xing, Jan Hamrin, and Seth Baruch. Renewable Energy Development in China: the Potential and the Challenges. San Francisco: Center for Resource Solutions, 2006. 17 May 2007 <www.worldbiofuelssymposium.com/Renewable-Energy-Dev-in-China.pdf ->. Pg11.

Although China began exploring solar power with the development of photovoltaic systems in the 1970s, greater progress can be made. Despite higher prices, sales of photovoltaics have increased by 20%. In 1999, the World Bank donated $25 million to build 200,000 solar home systems. PV systems offer a cleaner alternative to coal, and demand for such systems is predicted to rise. Since 2000, China's polysilicon industry, the raw material needed for solar energy development, has grown rapidly. By developing an independent supply, China has not only secured its own renewable resource but has begun to export polysilicon as well. With construction projects at Yunnan Qujin and Hubei Yichange, China shows potential to fulfill its own polysilicon demand. The Chinese government is expected to continue development and expansion of solar energy production, particularly in light of the 2005 Renewable Energy Law objectives and export goals.

Hydropower, too, demonstrates significant potential for development. It is predicted that economically exploitable hydropower could provide roughly 290,000 MW capacity, a large portion of China's 2003 generation capacity of roughly 350,000 MW. Even small hydropower plants, although less efficient, could supply up to 75,000 MW.[22]

Signs of Pollution from coal generation

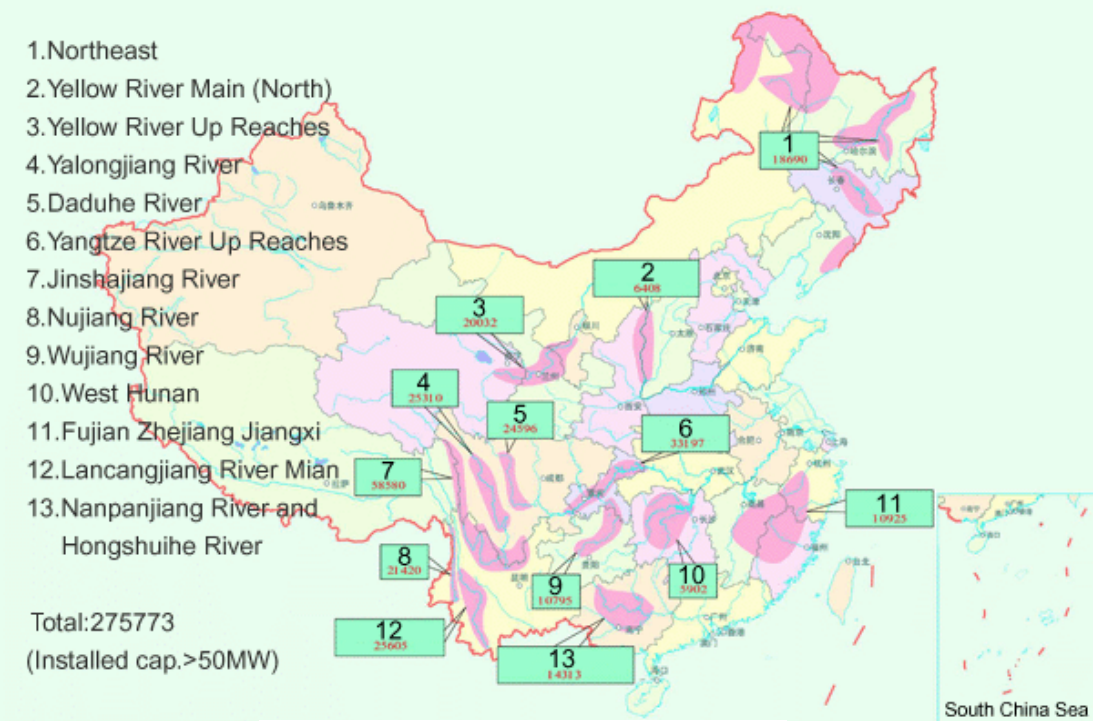
http://img.timeinc.net/time/daily/2006/0611/china_pollution1113.jpg

[22] Zhengming, page 26.

Despite legislation pushing for increasing development of renewable fuels, Chinese cities are highly polluted.
http://img.timeinc.net/time/asia/covers/501041213/images/373_pollution.jpg

Finally, geothermal energy options are predicted to have exploitable potential for generating 6,744 MW in the western and poorer provinces of Tibet and Yunnan alone. Today, only five operational plants exist, but the development of geothermal plants can provide cleaner renewable energy, contributing to industrial growth, particularly in poorer regions, helping to alleviate the severe economic inequity that exists.[23] The continued reliance on coal will not only exacerbate existing health and environmental problems, but will ultimately result in economic damage, increasing the need to repair existing infrastructure and increase energy imports. Instead of continuing down a path of environmental and health degradation, China needs to put more efforts into the development of renewable energies, despite what appears to be initial higher financial costs. In fact, renewable resources become more competitive when reviewed on a life cycle cost basis. Development of cleaner fuels must be accompanied by stricter emissions controls in order to differentiate costs. The government's policies must take action to level the playing field for renewable resources through an integrated combination of policies that include price and cost reductions, much like previous efforts to stimulate rural electrification.

[23] Zhengming, page 38.



Hydropower potential for China

Source: http://www.checc.cn/English/pages/Hydropower/images/hydropower.gif

It is crucial that China develop its domestic renewable energy sources. Not only is the reduction of reliance on coal and oil economically feasible and important; the switch to renewable fuels is also essential to both security and human rights, as China has been facing increased criticism from the international community. Particularly in anticipation of the 2008 Beijing Olympics, the Chinese government has established the Beijing Olympic Action Plan. It outlines the government's initiative to improve the ecological environment of the city by protecting both the air and water by reducing sulfur dioxide, nitrogen dioxide and carbon monoxide indexes to World Health Organization standards by 2008. The government has announced intentions to create urban infrastructure for rational water use and transforming Beijing into an "ecological city" with independent ecological shelters and other city beautification techniques. Initiatives are meant to further improve conservation efforts by preventing soil erosion and desertification, increasing environmental awareness, modernizing road networks and traffic management, and improving the information technology and communications infrastructure.

Through the haze of industrial pollution

China's focus on renewable resources will not only contribute to improvements in health indicators but will help to improve energy security. Instead of relying on the importation of resources like oil and natural gas, the development of renewable resources -- hydropower, wind power, geothermal and solar -- will increase sustainability and reduce reliance on outside sources. This, in turn, will contribute to employment, pollution reduction and overall reduction in global greenhouse gases. It is argued by many that China's switch to renewable energies is actually an ethical situation – that the Chinese government is obliged to further research, develop and utilize renewable resources as a means to improving both the economic and human health of China but also, international environmental improvements and the alleviation of global climate change.

Conclusion Summary

China has reached unprecedented rates of economic growth over the past several decades, with industry and production booming, and, as a result, it has improved trends in quality of life indicators, including life expectancy, mortality rates and per capita income levels. While China has shown tremendous success in establishing high rates of electrification across the country, most notably in rural electrification, the government must now take further steps to promote its clean energy initiatives. Increased development of renewable fuels will prevent the deterioration of these same quality of life trends that have greatly improved with the introduction of electricity to 98% of the population. Expansion of renewable resources will further help bring improvements in employment, alleviate pollution, reduce health risks, create energy security by reducing oil imports, and establish sustainable industrial and economic growth rates. While it is clear that China has achieved enormous economic growth, continued reliance on fuels like coal are not sustainable and will lead to a decline in economic growth rates. Instead, the Chinese government must follow through on its proposed clean fuel initiatives and take action to back up its recent environmentally friendly rhetoric.

It is in the economic and political interest of China to make the switch to cleaner fuels. In addition to taking responsibility for its immense emissions, now surpassing the United States as the top carbon dioxide producer worldwide, China will continue to enjoy great economic expansion across the country, while continuing to improve public health, education and other quality of life indicators nationwide.