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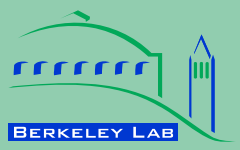

Trends in Energy Efficiency Investments in China and the US

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June 2005

This work was supported by the Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Building Technology, State, and Community Programs, of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231..

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June 2005

Table of Contents

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Abstract

Growth in energy consumption in China has soared over the last three years, driven largely by a booming economy and heavy investment in infrastructure and housing. In response, China has poured billions of dollars of investment in building power plants – at a rate of one large power plant (1000 MW) per week. In fact, China in 2004 has added the entire generating capacity of California or Spain in a single year. In contrast, investment in energy conservation projects has weakened considerably in recent years. This paper examines trends in energy efficiency investments in China and the US. The comparison highlights the potential of energy conservation investments in addressing China's current energy crisis as well as the inadequacy of such investments in China. Finally, the paper outlines a few scenarios for appropriate levels of investments in energy efficiency in China in the future.

Trends in Energy Efficiency Investments in China and the US

1 Introduction

The strong performance of the Chinese economy has been making headlines around the world. So has China's rapidly growing demand for energy -- especially its demand for oil[1]. Volatile and rising oil prices have often been attributed to China's voracious appetite for energy[2].

In China, electricity shortage and rationing have returned starting in 2002. In the summer of 2004, 24 provinces (out of 31 provinces, metropolis, and autonomous regions) have experienced brown-out, causing widespread disruption to industrial production and huge economic losses[3]. In fact, shortages in coal, oil, and electricity, and bottleneck in transportation have emerged as major problems in Chinese economy in 2004, and captured attention of political leaders at the highest level[4]

> "Some new problems have emerged in China's economic activities over the last two years, mainly tight grain supply, overheated investment in fixed assets, excessive money and credit, and shortages of coal, electricity, petroleum and transportation. If allowed to grow unchecked, these isolated problems could have had an overall impact." -- Premier Wen Jiaobao during the *Third Session of the 10th National People's Congress on March 5, 2005.*

It was only a few years ago that China had experienced an oversupply of electricity and declining energy consumption (Sinton and Fridley, 2000). How could the balance of energy supply-demand be altered so quickly? Some attributed the rapid energy demand growth to the hyper-fast pace of the Chinese economy, especially investment in infrastructure. Others blamed the government's planning decisions in stopping power plant construction in the late 1990s – a response to the electricity glut at the time.

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[1] "China's global hunt for oil," BBC News, March 9, 2005; "Appetite for oil: China ravenous -- and dangerous," Houston Chronocle, May 7, 2005; "China Emerging as U.S. Rival for Canada's Oil, New York Times, December 23, 2004; "Outside View: Energy tsunami unleashed," World Peace Herald, January 14, 2005.

[2] "US Watches China's Oil Demand With Concerns," REDNOVA, June 8, 2005, http://www.rednova.com/news/science/154681/us_watches_chinas_oil_demand_with_concern/.

[3] Estimates of economic losses varies significantly. National loss could amount to 0.5% of GDP in 2004, according to China Daily.com, June 6, 2005: "Fast economic growth fuels nation's energy crunch;" while in Zhejiang province alone, the loss in 2004 is estimated at 100 billion yuan, according to an article on finance.sina.com.cn on December 22, 2004. The Zhejiang loss is roughly 10% of the province's GDP that year.

[4] Premier Wen was most recently quoted saying " Energy is an important strategic issue concerning China's economic growth, social stability and national security," during the inaugural meeting of State Council's Energy Leading Group, China Daily, June 3, http://news.xinhuanet.com/english/2005-06/04/content_3043341.htm.

However, little research is available to explain the fact that energy demand growth has outpaced economic growth over the last few years; reversing a long-term trend in China that energy grew only half as fast as the overall economy between 1980 to 2000 (Sinton et al, 1998; Gao et al, 2004).

In fact, China's 2020 development goals are predicated on the premise that it could manage the quadrupling of GDP with only a doubling of energy use. Without reducing the energy growth rate substantially in the near future, China's long-term growth is likely to be endangered.

This paper examines what China has done in the past in managing energy demand growth, and looks at the investment trend in energy conservation. Similar spending in the US on energy conservation is then used to offer a comparative perspective on the inadequacy of such spending in China. Finally, a few scenarios of appropriate levels of energy efficiency investment in China are outlined.

2 Managing energy demand growth in China: the lessons of 1980-2000.

From 1980 to 2000, China managed to produce spectacular economic growth, with an average growth rate in GDP of over 9 percent per year. Even more impressive but less known is the fact that such economic performance was accompanied with an energy growth that is about 40% of the rate of GDP growth, averaging 3.9% per year. Energy intensity of Chinese economy dropped from 0.442 *tce* per RMB1000 yuan[5] of GDP to 0.150, a 2/3 reduction in 20 years[6].

This is remarkable since prior to the Chinese success, it has been long thought that energy growth is likely to outpace economic growth in the early stage of industrialization. While such a decoupling of energy and economic growth has been observed in advanced economies, no other developing country has managed to achieve such a feat yet.

Sinton et al (1998) indicated that China was able to achieve such a decoupling through focused policies and management strategies that encouraged adoption of energy efficient technologies and practices. In particular, Chinese government established dedicated mechanism and allocated significant resources for energy efficiency investment[7]. From 1981 to 1990, total investment in energy conservation amounted to 37 billion RMB and another 31 billion was spent between 1991 and 1993 (Sinton et al, 1998). Industrial sectors received the bulk of the investment.

[5] GDP is measured in 1995 constant RMB yuan. US$1 = 8.27 RMB yuan.
[6] Fridley et al, 2003, China Energy Databook.
[7] China Energy Conservation Investment Corp, by the former State Planning Commission, was set up in early 1980s to channel state investment in energy efficiency. Similar loan programs were also developed by the former State Economic and Trade Commission.

The establishment of an energy quota system also contributed to efficiency improvements. The government simply set limits on the quantity of energy supplied to enterprises and standards for energy intensity. When enterprises exceeded consumption limits, the government cut off energy supply. In the 1980s, the government still had direct control over state-owned enterprises (SOEs) and quotas proved an extremely effective way to cut energy use.[8] While such a quota system has lost its relevance and is unlikely to be introduced in China today, the energy intensity standards remain relevant and could re-emerge under different disguises.

A unique feature of China's early success was the establishment of a network of energy conservation bureaucrats, scientists, experts and policymakers. Of particular importance is some 200 "energy conservation technology service centers" that China created to provide technical assistance to large energy users and to promote energy efficiency. These centers received government mandate and funding to conduct energy audits, to implement demonstration projects, and to provide training to energy managers for end-users (Sinton et al, 1998). Such an infrastructure of energy service centers was instrumental in implementing government policies and enforces regulation on energy intensity standards and energy quotas. Since the mid-1990s, the capacity of many such centers has been weakened due to budget cuts associated with Chinese government's attempt to reform many public sector institutions.[9]

3 Trend in energy efficiency investment in China

In addition to the administrative measures, financial incentives also played a major role in mobilizing investment in energy conservation, especially in the earlier days of China's economic reform, when shortage of capital was a major constraint in the economy. The most widely used instruments included low-interest loan programs, interest subsidies, tax credits, and tax reductions and exemptions.

Low-interest loan programs

There were two major financing programs for promoting investment in energy efficiency, both established in the early 1980s. One was managed through China Energy Conservation Investment Corporation (CECIC), under the direction of former State Development and Planning Commission (SDPC). At the time, there was shortage of capital for investment, and this program provided low interest loans to state firms on energy efficiency projects such as building cogeneration plants. CECIC was charged with project screening and approval, while the Bank of Construction performed the actual lending. Interest rates for these loans were typically 30% lower than comparable commercial loans (ERI, 2004). By 1994, however, the interest rate differential was eliminated, and by 1996, the program was phased out during government restructuring.

[8] Philip Andrews-Speed (2004) *Energy Policy and Regulation in the People's Republic of China* (London: Kluwer Law International).

[9] Attemps to convert these energy service centers to energy services companies have been less successful so far.

The second program was managed by the former State Economic and Trade Commission that provided interest subsidies to enterprises to undertake "technical renovation" for the purpose of energy conservation. The designated bank was required to make such loans -- typically under 5 years, and 50% interest subsidies were provided through national Treasury bond offerings and local government budgets. By 1998, this program was merged with the larger "technical renovation" program (ERI, 2004) and the designated bank was not longer required to provide such loan. However, the bank could still make such loans based on its own lending criteria, and the interest subsidy would still apply (Zhang, 2005). Thus, theoretically, the benefits of this program continues, but are somewhat weaken due to lack of clear rules on program qualification and application process.

Tax credit for investment in energy conservation.

In addition to the interest subsidies, state-owned-enterprises (SOEs) could also claim an investment tax credit for investing in energy conservation projects. Up to 40% of "fixed asset" investment in energy conservation projects such as equipments and buildings can be counted against incremental income tax in the future (up to 5 years). These projects have to be approved by the relevant government bureaus that supervise the SOEs, and evaluated against other competing projects. Each municipalities and provinces would then make appropriate allocations in their annual planning and budgeting process.

Once the projects are finished and verified by relevant government agencies as having achieved its energy conservation purpose, the responsible SOEs could then claim their tax credit in their annual tax filings. However, this credit, which is good for up to five years, could only be used against incremental income tax, therefore, it may take a few years for the applicants to claim the full credit.

For successful applicants and appropriate projects, this tax credit would reduce investment costs of the project by as much as 40%. In contrast to interest subsidies on project loans, the benefit of this credit is much greater. For example, under the typical loan terms for energy conservation projects, the interest subsidy is worth roughly 5% of the project value, while the tax credit could be worth up to 40% of the project value.

From the perspective of the government program sponsors, the impact of the tax credit is also minimal, since it can only be claimed against incremental income tax in the future. So if the applicant's income tax does not increase in the future, no credit could be used and no tax revenue is lost. If the energy conservation projects do lead to increased income and thus income taxes of host firms, the future tax revenue will rise after the tax credit is fully claimed.

The tax reform in China in the late 1990s eliminated many tax benefits for energy conservation projects, this one seemed to have survived, at least in some localities[10]. Due to the weakening of government role in corporate management, the rules and procedures

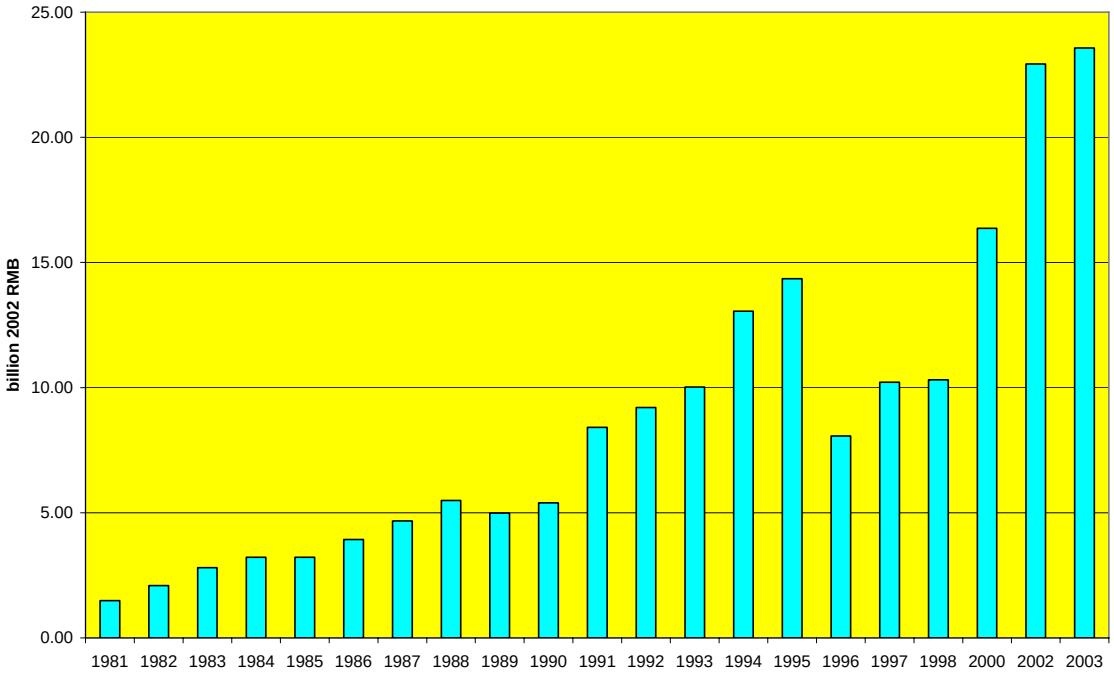
[10] A recent example was an energy conservation renovation project at the New Asia Pharmacutical Company in Shanghai, which obtained about 770,000 yuan tax credit for a project with an 2.5 million investment.

for submitting and qualifying projects have become less transparent. So, most firms are unaware of such an opportunity. In fact, one of the benefits that energy management companies offer is such a service to secure tax credit for their clients.

Trend in Energy Conservation Investment

These financial incentives have greatly helped to boost investment in energy conservation projects, especially in the 1980s and early 1990s. Figure shows the trend in energy efficiency investments in China from 1980 to 2002. These figures are tracked by the National Bureau of Statistics (NBS) since 1980s through various incentive programs. It should be noted that these figures are unlikely to include all investments in energy efficiency projects, especially those made by private sectors. However, they do provide the only consistently defined category of energy conservation investment there is.[11]

Figure 1: Investment in Energy Conservation Projects, China

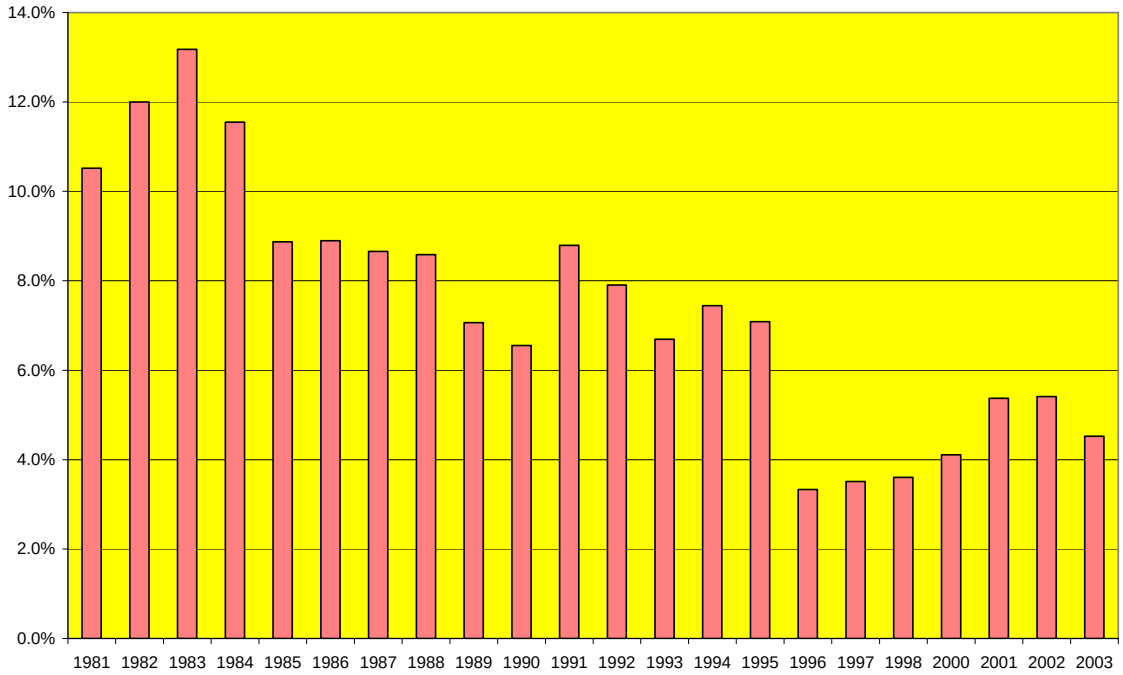


The strong policy support and financial incentives to energy conservation has led to rapid growth in energy conservation investment from early 1980s to mid-1990s. In 1981, this investment was about 1 billion yuan, by 1995, has risen to 14 billion yuan (all in 2002 yuan). The sharp drop in 1996 was due to the phasing out of the investment program managed by CECIC for the former SDPC. The investment program in energy

[11] The primary source of this funding, especially after 1996, is the so-called "technical renovation investment". This funding is supposed to be used on the renovation or replacement of existing technology and is not supposed to be used to expand production (which would fall then in the capital investment category), but it is acknowledged that in cases where, for example, a factory is using such funds to replace an old boiler, the new boiler may end up being larger and supporting expanded production

conservation managed by the former SETC remained in place. Since 1996, this investment has rebounded, reaching 23.5 billion yuan in 2003.

Figure 2: Percent of Energy Investment for Energy Conservation Projects



However, total investment in energy infrastructure has also increased sharply over this period, therefore, energy conservation investment as a percentage of the total energy investment has in fact declined in importance. Figure 2 shows that at its highest level, energy conservation investment was about 13% of energy supply investment in 1983. Even in 1995 this proportion is about 7%. However, by 2003, this proportion has dropped to about 4%. This is one of the indications that support and policy commitments to energy conservation in China have weakened considerably during China's transition to a more market-based economy.

Consequently, after managing to keep energy growth well below economic growth for the last two decades of the 20th century, China has witnessed rapid growth in energy and electricity use since 2001. Energy use grew over 10% per year over the last three years, and electricity use about 15% per year last years (NBS, 2004).

While other factors have contributed to the recent surge in energy use, the weakening in energy efficiency investment played a significant role. Further, public spending to spur investment in energy efficiency remained at about RMB 1 billion yuan per year in the last few years, or below 5% of the total energy conservation investment. This represents roughly 0.15% of China's total spending on electricity in 2003. In comparison, public benefit spending to spur energy efficiency is about 1.5% of utility revenue in the California in the last few years (Kushler et al, 2004). Thus, public spending to stimulate

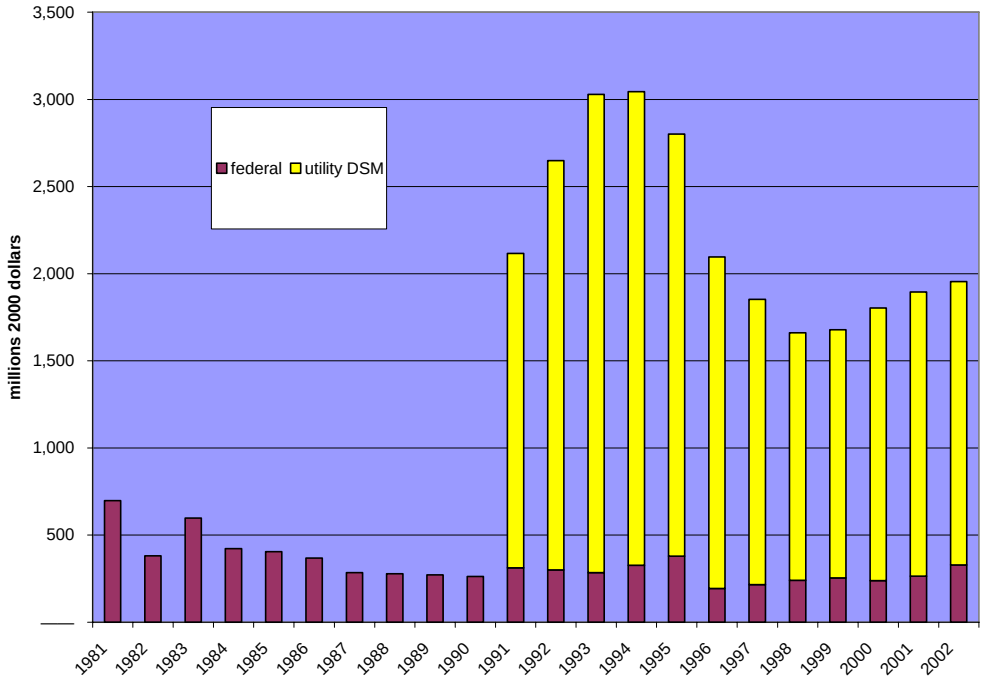
energy efficiency investment in China is roughly one tenth the level of similar spending in California (not even counting funds allocated to procure energy efficiency resource as part of the new resource acquisition plan).

4 Public investments in energy efficiency in the US

In the US, data on private investment in energy efficiency/conservation is not available. However, there are several major sources of public funding for promoting energy efficiency/conservation at the federal, state, and local levels. The largest programs are funded by the local electricity (and gas) utilities through "public benefit charges" on electricity (and gas usage) (Kushler et al, 2004; Goldman et al, 2005; EIA, 2003). The Department of Energy has funds both for research and deployment of energy efficient technologies. Various states also operate their own energy efficiency programs.

Instead of surveying each state on public benefit charges (Kushler et al, 2004), data from EIA is used in this study to track all utility-related spending on energy efficiency.

Figure 3: US Energy Efficiency Deployment Funding

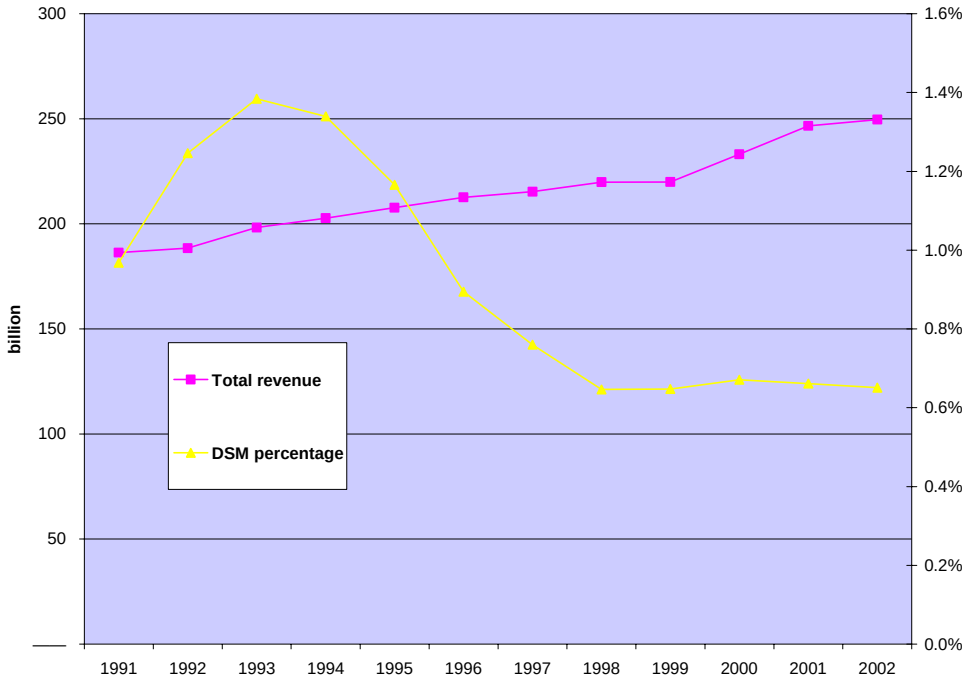


At the federal level, DOE spending in support of energy efficiency deployment has been declining since 1980s. However, since the significant drop in 1995-96 (from $379 to 194 million), DOE spending has recovered somewhat, rising to $317 million by 2004.

Utility DSM spending has seen substantial expansion and contraction in the last 15 years as well. After expanding rapidly in the early 1990s, utility DSM spending declined substantially, from $2.7 billion in 1993 to $1.4 billion in 1998, as the deregulation swept across various states in the US. Since then, DSM spending has rebounded somewhat, as various states adopted the "public benefit charges." There are other state and local spending on energy efficiency, such as the $1 billion California spent in responses to its energy crisis, which are not reflected in this figure due to data limitations.

While public spending on energy efficiency has fluctuated over the last decade, electricity consumption has grown steadily. Therefore, DSM spending as a proportion of total spending on electricity has declined further. By 2002, utility DSM spending across US average about 0.7% of utility revenue, compared to 1.4% of revenue in 1993. However, there are substantial variations across US in support for energy efficiency. For example, Massachusetts and California spent 3% and 1.5% of electric revenue in 2002 to promote energy efficiency, while others spend close to nothing (Kushler et al 2004). New regulations established by California Public Utility Commission would almost double the spending on energy efficiency through its resource acquisition process (CPUC, 2005).

Figure 4: US Utility Revenue and DSM Spending

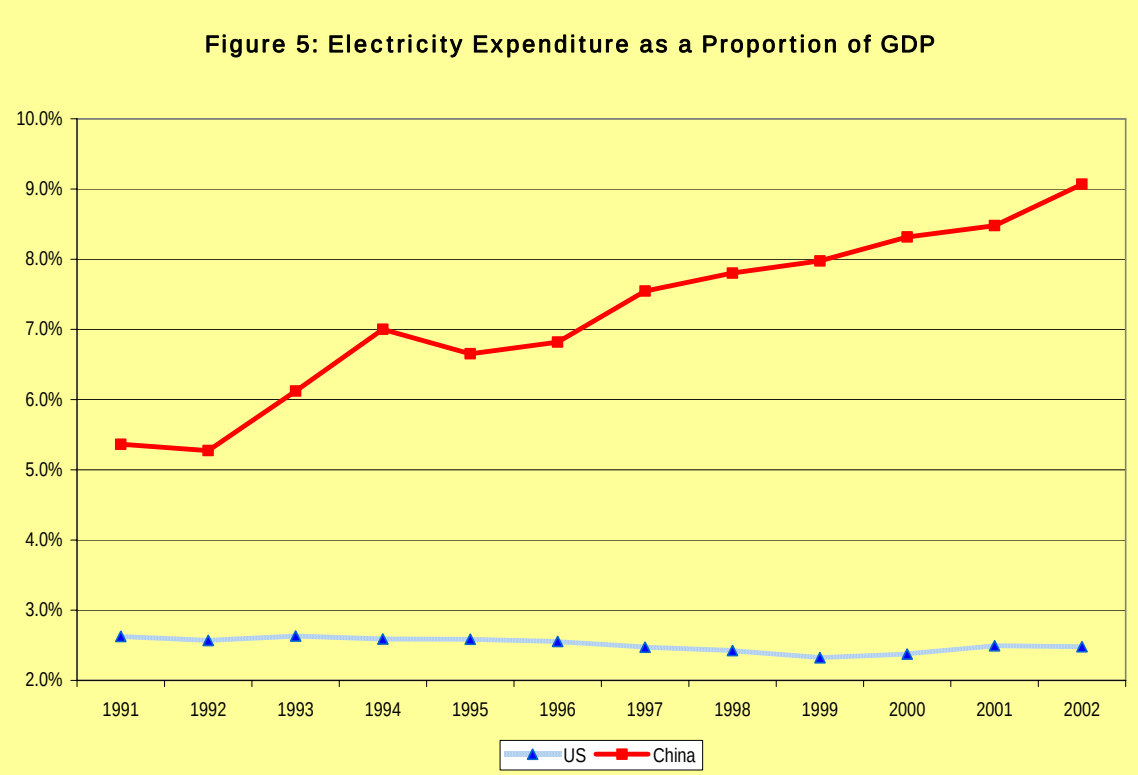


5 Comparison of public spending on energy efficiency between China and US

It is hard to find comparable figures on public spending on energy efficiency in China and US. The Chinese data presented in section 3 tracks total societal investment in energy efficiency in China, although it is likely that those numbers probably do not cover all private investments. In the US, no private investment in energy efficiency is tracked[12]. Instead, public spending by the utilities and governments are collected.

In China, direct public financial support for energy efficiency is much weaker. There is almost no utility sponsored efficiency program at present. At the national level, little financial incentives of the past remain. It is estimated that national government spending in support of energy efficiency is about RMB 1 billion yuan in recent years [Lu, 2003 and 2004]. There are a few provincial government incentive programs for energy efficiency, however, they are fairly modest and are exceptions to the rules (ERI, 2004). Based on these data, it is estimated that total public spending on energy efficiency deployment is roughly 0.15% of electric revenue in China in 2002. The corresponding figure is the US is about 0.8%, if both spending by utilities and DOE are counted. So, there is a large funding gap for energy efficiency between US and China. This funding gap partially explains the fact that the energy intensity of the Chinese economy is much higher than that of the American economy[13]. Figure 5 also shows not only that China is spending more of its GDP on electricity than US, (9% vs 2.5%), but also that percentage has grown steadily in China -- indicating that China is spending more and more of its GDP to pay electric bill, which is a huge drag on China's economy.

[12] Goldman and others have documented the revenue of ESCO industry, which counts only part of total investments in energy conservation by the private sector in the US.
[13] It is often cited that China uses four times of energy than US to produce one unit of GDP.



This growing trend in relative spending on electricity is worrisome since it could suggest that it takes ever more electricity to produce one unit of economic output. However, it could also be an effect of fuel switching, especially from coal to electricity in the end use sectors. Additional research is certainly warranted to understand the energy intensity trend in China.

The silver lining of China's high relative spending on electricity is that potential for efficiency gains is tremendous. And improving efficiency of energy use should be a key component to solving China's current energy crisis.

At present, China has responded to the electricity shortage by investing in billions of dollars to build power plants: in 2004, China built one giant power plant (1000 MW) every week, adding the entire generating capacity of California or Spain in a single year.

In contrast, investment in energy conservation has fallen proportionally to about 4% of the supply investment. Clearly, China needs to boost its investment in energy efficiency substantially and quickly. However, how much China should invest in energy efficiency is open to discussion. Here a few scenarios are outlined.

If the proportion of energy investment for conservation is restored to the 1990's level (10-15%), then investment for energy efficiency need to reach 40-60 billion yuan per year[14], which is two to three times of what is observed today.

If the level of public spending for energy efficiency reaches the level observed in the California (1.5% of electric revenue), then roughly 15 billion yuan of public spending per year would be needed, which could potentially leverage 300 billion yuan private investment a year toward energy conservation projects. This would make investment in energy conservation closer to supply investment (521 billion yuan in 2003).

Another way to examine the investment need is to look at what it would take to reduce the growth rate of energy to the half of the projected growth rate of Chinese economy over the next 15-20 years, which is implicitly built in China's development goal for 2020 and all major forecast of China's future energy demand. Based on current energy demand and prices, it is estimated that roughly RMB 150 to 200 billion of investment in energy efficiency is needed every year to accomplish this goal (Lin, 2005; Levine, 2005).

Table 1: Scenarios of appropriate energy efficiency investment in China

	Scenario 1	**Scenario 2**	**Scenario 3**
	10-15% of energy supply investment	Public spending on energy efficiency @ 1.5% of electric revenue	Reduce the rate of energy demand growth to half of the rate of economic growth
Annual investment in energy efficiency	*40-60 billion*	*About 300 billion*	*150-200 billion*

All these scenarios indicate that the level of investment in energy efficiency needs to be increased substantially. While it goes beyond the scope of this paper to explore how feasible these scenarios are, the level of investment need to be mobilized for energy efficiency is enormous. However, this is not unfeasible since this amount is certainly dwarfed by capital investment need to build China's growing energy supply infrastructure. According to IEA, China needs to invest over $2 trillion by 2030 in its energy supply infrastructure to keep pace with its economic growth (IEA, 2003). Most of the investments are needed for power generation and transmission.

Experience in utility DSM programs in the US has demonstrated that the cost of energy conserved is much lower than the marginal cost of supply (Kushler et al 2004). Therefore, not only could investment in energy efficiency in China defer supply investment in the future with much lower cost, but also bring tremendous economic and environmental benefits.

[14] These numbers are calculated based on supply investment in 2002, and could be higher if more recent data is used, since supply investment has soared since 2002.

6 Discussions

Despite China's long-standing policy on treating energy supply and conservation equally, investment in energy efficiency in China has fallen substantially in proportion to the supply investment in recent years. Many of the successful conservation policies in the 1980's and 1990's have been significantly weakened in China's transition to a more market-based economy. The declining commitment to energy efficiency in policies and in financial support have contributed to the remarkable reversal in the relationship between economic and energy demand growth since 2001.

If this trend continues, China's economy would face multiple bottlenecks in energy and transportation, and serious environmental problems in the near future. These consequences would certainly go beyond China as well. China's growing demand for energy and other raw material could have significant impact on the global market for energy and other essential resources, which in turn would affect global economic performance.

The comparison in public spending on energy efficiency between China and the US indicates that the level of public as well as private investments in China needs to be increased substantially. Experience elsewhere has demonstrated that investment in energy efficiency can be far more cost-effective than equivalent investment in adding supply capacity. Given the relatively low level of energy efficiency in Chinese buildings and industries, the potential of demand reduction could be particularly large. Further, investment in energy efficiency would also bring added environmental benefits of reducing local air-pollution and GHG emissions.

In order to meaningfully reduce the energy intensity of the Chinese economy, the required energy efficiency investment in China over the next two decades are tremendous. Therefore, China needs to initiate institutional reforms that would combine China's own policy success and the world best practices to mobilize both the public and the private sector resources. The success of such efforts not only would affect China's own long term prospects, but also the global economy and environment.

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