

CHINA'S ENERGY SAVING EXPERIENCE AND LESSONS CAN BE LEARNED FOR VIETNAM

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Abstract

DSM is a set of tools and practices taken by utilities to influence the amount and/or timing of customers' energy demand in order to use electricity most efficiently. DSM decreases the cost of meeting customers' energy needs through increased investment in end-use energy efficiency and load management. Demand-side resources can reduce or postpone investment in generation, transmission, and distribution capacity, and decrease fuel consumption, and improve environmental quality. DSM also reduces emissions of acid rain related pollutants and damaging greenhouse gases. DSM also has been demonstrated to be a fast, inexpensive, and effective way to address power shortages without hurting productivity. China's very large opportunity to increase energy efficiency is one of its most promising untapped options. This experience lessons can be learned for Vietnam.

Keywords: *DSM programs, Energy efficiency, Fuel substitution, Load Management Experience, EVN.*

1. Introduction

By modifying the level and timing of electric consumption by end-use customers, DSM offers important tools to balance the operation of electric power systems. DSM can enhance the total social benefit of the power system, improve the safety and stability of electric grid operation, and ultimately lower the cost of electric service. China has substantial DSM experience and achievements, which have generated obvious social and economic results. DSM programs to date have focused on the following three goals:

Load management. Load management is one of China's main DSM programs. Load management's objective is to adjust the load curve by (a) clipping the peak load, (b) increasing the valley load, or (c) moving peak loads to off-peak hours. Load management has been pursued through pricing reform (mostly TOU and interruptible pricing), information, and the application of new technologies. It has reduced peak capacity demands and flattened the overall load curve in many locations. A major tool in load management has been TOU pricing: power prices have been increased in the peak period and reduced in the off-peak period. This guides consumers to adjust their production schedules and to employ off-peak storage techniques such as ice-storage air conditioners and heat-storage electric boilers. Large industries have been encouraged to modify their

maintenance schedules and their daily and weekly work schedules. All of these steps have flattened the load curve.

Energy efficiency. Economic and environmental benefits have been achieved by adopting a number of policies and measures to encourage the use of efficient equipment such as energy-saving lamps, adjustable-speed motors and water pumps, and high-efficiency transformers, among others.

Fuel substitution. Local governments have formulated policies to replace coal-burning facilities with more efficient and less-polluting technologies such as heat-storage electric boilers, gas boilers, and electric furnaces in urban areas and at tourist attractions. Although these policies were pursued to improve local environmental conditions, significant efficiency improvements were achieved.

This discussion of China's DSM experience is divided into a load management section and an energy efficiency section. This is because China has much more experience with load management and because the barriers to load management and energy efficiency are very different, as are the needed policy responses.

Like China, Vietnam is experiencing unprecedented economic growth, which averaged 8.2 percent annually from 1992 to 1997. During this same period, energy demand grew 30 percent faster than GDP, and electricity 70 percent faster. The ability of Vietnam to continue to meet such an aggressive economic growth rate will require substantial expansion of the electric power sector as well as aggressive demand reduction efforts.

2. Method

Load Management Experience

China has a long history of experience with load management. Recent experience with load management to address the power shortage has been especially successful, and has reduced the number, severity, and duration of wider power outages while improving system load factors. Load management strategies have focused on rapid implementation of TOU pricing, adoption of interruptible tariffs, and deployment of energy storage (cooling and heating). Efforts have been aimed at reducing peak load and shifting use from on-peak periods to off-peak periods. In essence, the new concept of load management involves a kind of "cooperative partner" relationship between the electric power consumers and the electric power corporations.

As shown in Table 1, government action reduced peak load by over 10 GW in selected provinces in 2003. But, as discussed below, only about 30 percent of the peak load reduction, or 3 GW, was due to DSM. While this is a significant achievement, as described in more detail later, California and the Pacific Northwest in the United States achieved far greater savings in response to a less serious power shortage.

Table 1: 2003 Peak Load Reductions

Province	Peak load reduction (MW)
Jiangsu	2,800
Zhejiang	1,400
Shanghai	1,700
Guangdong	2,250
Hubei	1,000
Hunan	700
Hebei	250
Total	10,100

Source: Study Team

The remaining 7 GW of reduced demand was essentially rationing imposed by government orders, requests, or advice to enterprises to modify work schedules, maintenance schedules, and production schedules.

Over the past 10 years, China's DSM efforts have produced significant economic and environmental benefits. The savings are summarized in table 2.

Table 2: China's DSM Results (1990–2000)

Electricity savings (TWh)	130.4
Peak load shifting (GW)	3.8
Peak load reduction (GW)	36.5
Coal saving (millions of tons)	58.6
SO2 emission reduction (million of tons)	1.33

Source: Study Team

Note: The average investment of coal plant units is \$605 per kW.

DSM experiences at the provincial and municipal level are described more fully below.

Beijing

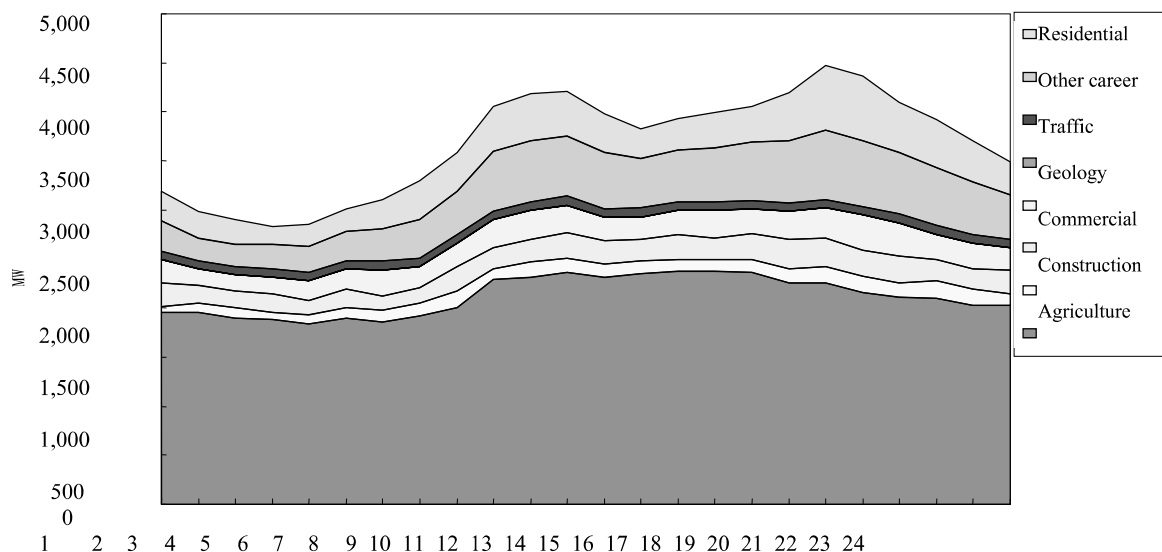
In the past 10 years, the electric load of Beijing city has grown steadily and rapidly. The peak load increased from 3.01 GW in 1992 to 4.47 GW in 1996, a growth rate of 10.4 percent annually. Peak load has grown faster than electricity sales so the annual load factor decreased from 86.81 percent in 1992 to 82.31 percent in 1996. Much of Beijing's DSM efforts have been aimed at the declining load factor.

Before developing peak load management measures, Beijing carried out a survey to determine the customers' consumption patterns. The results are shown in figure 1. The survey revealed that in 1996, industrial consumption accounted for over 55.43 percent of the total power in Beijing (winter typical load curve). Industrial customers accounted for 51 percent of the system's morning peak load and around 50 percent of the evening peak

load. Residential and commercial customers accounted for about 16 percent of total load and their load factor was about 60 percent. After 1996, Beijing was able to obtain substantial additional load shifting from these three customer classes.

Figure 2 shows the effect of load management on Beijing's load factor. The actual load factor has been maintained at about 81 percent from 1997 to 2003. The figure also shows what the load factor would have been without the load management activities. If DSM were not taken into account, the load factor would have decreased to 76.59 percent in 2003.

Figure 1: The Structure of the Load Curve of Beijing in 1996

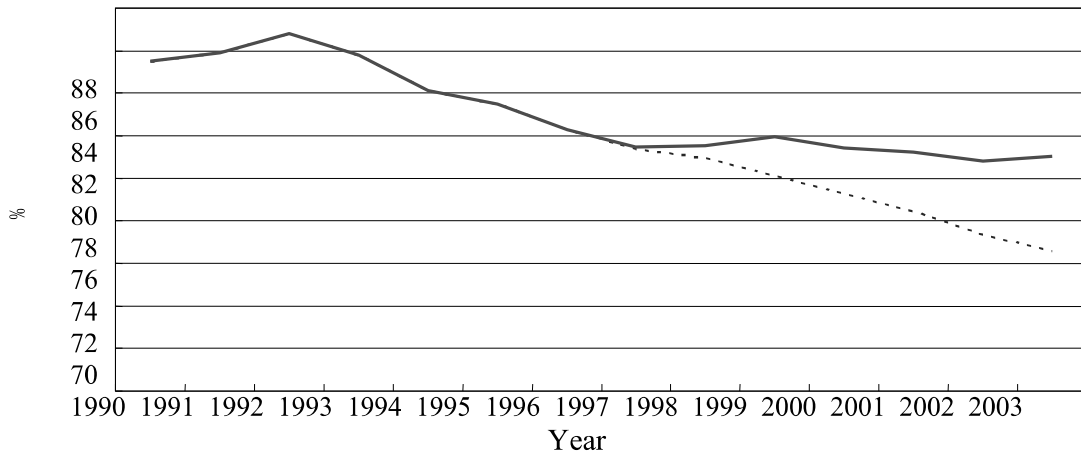


Source: Study Team

In order to capture the peak-shifting potential, the following measures were used from 1997 to 2003:

- widening the price difference between on- and off-peak periods
- helping enterprises arrange their production plans rationally (for example, maintaining and testing machines should be arranged in peak-load time)
- setting interruptible load protocols with industry customers, first on a pilot basis, then on a more widespread basis
- implementing special policies for energy-storing equipment such as ice-storage air conditioners and heat-storage electric boilers.

Figure 2: Beijing Actual and Forecasted (Excluding DSM) Load Factor



Source: Study Team

After implementing the above measures, more than 50 MW of peak load was shifted to off-peak periods in 1997, and another 50 MW in 1998. Valley-period sales increased by more than 150 GWh in the two years.

The investment in the peak-load shifting was \$1.46 million in 1997 and \$0.69 million in 1998. The benefits were about \$3 million in saved generation capacity costs per year.

Other DSM accomplishments in Beijing include:

- **TOU.** By the end of 2003, 77,431 consumers representing 61.69 percent of total consumption were on TOU prices. Compared to 2002, the proportion of valley consumption increased 0.75, and the proportion of peak consumption dropped 0.81. About 700 MW was shifted by TOU prices. In April 2004, the Beijing Development and Reform Commission decided to widen the difference between the peak and valley tariff. During the summer, the off-peak price will fall 11 percent, and the on-peak price will increase between 5.5 percent and 20 percent.

- **Energy storage.** Beijing has now added 443 ice-storage air conditioning units and heat-storage boilers. These devices have reduced peak load by more than 300 MW.

- **Promoting electric heating.** Beijing encourages the use of electric-storage space heating to reduce the direct consumption of coal in the city. By the end of 2003, 23,175 residential customers had installed storage heat units in more than 9 million square meters of living space. These units consumed 221 GWh, of which 149 GWh or 67.36 percent was off-peak.

- **Using interruptible tariffs.** Beijing Distribution Company has interruptible load protocols with major enterprises such as Capital Steel Corporation, Special Steel Corporation, and Yanshan Chemical Industry Corporation. About 100 MW of peak load may be shifted per year.

- **Load control at Electric Load Management Center.** The Wireless Electric Load Management Center in the Beijing Grid has been playing an important role in balancing power supply and demand. The facility has the potential of connecting over 5,000 locations. In 2003, 1,600 locations with 2,800 MW of load were connected, and about 500 MW, or about 6 percent, of Beijing's total load could be directly controlled.

The Beijing DSM projects were successful primarily because they focused on peak load management, which is generally easier to implement than other DSM programs. In many cases, load management can be accomplished with properly designed and progressive tariffs, such as TOU and interruptible tariffs. Yet load management programs are largely short-term responses that do not exhaust the cost-effective demand-side potential. Beijing may now turn its practical experience with load management towards developing DSM programs that result in long-term reductions in demand through efficient end-use technologies.

Jiangsu

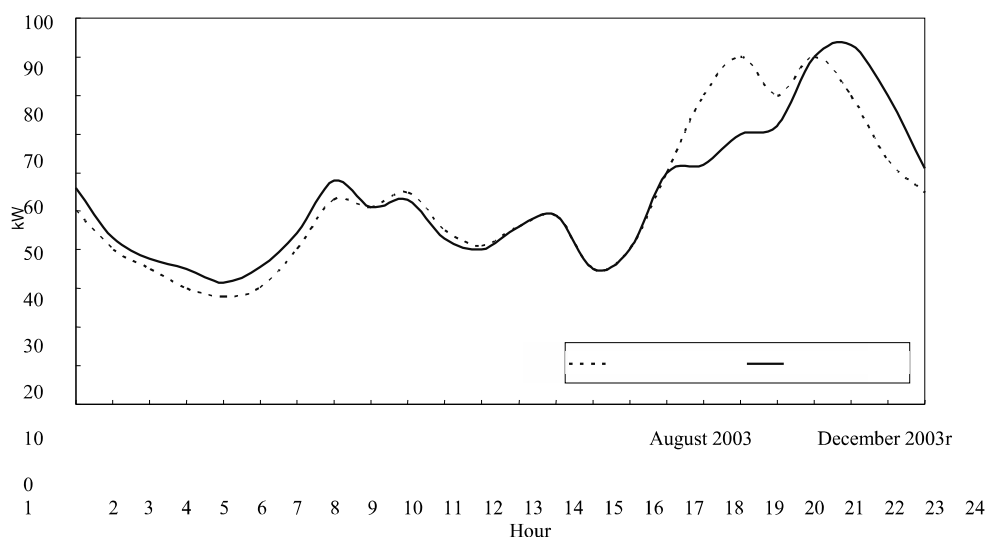
Jiangsu Province has gained a great deal of DSM experience in the past two years. As a result, DSM is now playing an important role in addressing the power shortage. In 2003, the gap between demand and supply in Jiangsu was 3,890 MW. To address this shortage, the government and power corporation implemented the following DSM measures:

- industrial facility maintenance scheduled to reduce peak period use
- business shut-downs and vacations rotated (956 MW)
- interruptible tariffs (780 MW)
- voluntary shifted load (592 MW)
- TOU prices (see figure 3)
- load control system—Electric Load Management Center (475 MW).

Beginning in August 2003, TOU prices were offered to residential consumers on a voluntary basis. The price for the residents who do not use TOU is \$62.88 per MWh. TOU prices are \$66.51 per MWh on-peak (8:00–21:00 Beijing time), with a valley price of \$36.28 per MWh (21:00–8:00 Beijing time).

The utility incurs the cost of a new TOU meter, about \$30. By the end of 2003, about 750,000 families selected TOU. The proportion of peak consumption and valley consumption has been changed to 55:45 from 64:36. Figure 3 shows how the load curve of these customers has changed. The time of peak load was deferred about 2.5–3 hours, and about 20 percent of peak load was shifted (about 100 MW) to off-peak periods.

Figure 3: Load Curve Changed By Using TOU —Summer 2003



Source: Study Team

Together these measures reduced peak load by 2,800 MW. Demand, however, still exceeded supply by about 1,090 MW, so the load control center imposed curtailments on some customers.

Additional experience in Jiangsu includes the following:

- From October 1999, industrial TOU prices were applied to six large industries representing 83.12 percent of the total industrial consumption in 2002. The on/off-peak price difference was 3:1. (The difference was widened to 5:1 in July 2003). The peak load reduction from this action was about 600 MW. The load factor in Jiangsu increased 0.18, 1.57, 1.12, 1.00, and 1.47 percent from 1999 to 2003 respectively (The load factors were 79.19, 79.37, 80.94, 82.06, 83.06, and 84.53 from 1998 to 2003 respectively).

- About 30 percent of the total peak load in Jiangsu in these years is due to air conditioners. Jiangsu Power Company has invested about \$7.2 million to spread the use of ice-storing air conditioning. The ice-storing cooling reduced peak load by about 70 MW per day in 2003. For example, Nanjing Yuhua Distribution Company has installed ice-storing air conditioning and heat-storing boilers. The result is that 750 kW can be shifted from peak to off-peak periods. This has saved the company \$37,850 in power costs.

- Interruptible tariffs have been made available to some industrial consumers, mainly the steel corporations. Customers are compensated \$0.12 per kWh for interruptions. In 2002, 5 steel corporations took part in the program. Consumers were interrupted 15 times in 10 days for a total of 28 hours. The power corporation paid them \$950,000 for these interruptions, and peak load was reduced by about 400 MW. In 2003, 12 steel corporations took part in this project, and peak load was reduced by about 800 MW. This program could be considered a buy-back program where the utility buys back the energy at a given or negotiated price. Wholesale markets are not yet operational but the price paid here may be a

proxy for the market price.

- In 2002, Jiangsu implemented about 65 DSM projects, including ice-storage air conditioners, heat-storage boilers, green lighting, and variable-frequency speed controls at high-consumption industries. The enterprises invested \$75 million, with government providing about \$5 million as an incentive. The projects reduced peak demand by 100 MW and reduced energy use by 280 GWh. Industrial power costs were cut by \$25 million per year.

- Communication with about 237 industrial customers (in steel, chemical fertilizer, and electrolysis industries) resulted in rescheduling industrial maintenance schedules. Peak load was reduced by 66 MW. In addition, some customers agreed to reschedule their day off from Sunday to Saturday or from weekend to weekday.

- By the end of 2003, each city had built an Electric Load Management Center.

These centers monitor and can control the use of about 20,000 industrial machines with a total monitored load of about 11,230 MW and 4,590 MW of demand under control. For example, the Electric Load Management Center of Nanjing Distribution Bureau was built in 1997 at a cost of \$8.6 million. The annual operating cost of the center is \$240,000 per year. The Center allows Nanjing to monitor 2,430 MW, or 71 percent of the district's total load. The Center has direct control over 600 MW, or 18 percent of the maximum load. In 2003, the Center shifted enough demand to avoid serious outages.

- Energy-intensive consumers pay a capacity charge and an energy charge. The capacity charge is either based on actual demand or the transformer capacity. If the customer chooses to be charged on the basis of actual demand they will have an incentive to control peak use. For example, Nanjing Steel Corporation used a computer control system to limit their maximum demand to 50–70 MW (the transformer capacity is 90 millivolt-amps). Their power cost was reduced by about \$500,000 per year.

In total, Jiangsu's DSM efforts reduced peak demand by about 2,000 MW in 2002 and 3,000 MW in 2003. These efforts saved about \$1.21–\$1.81 billion of investment in new coal plants. Annual energy savings are about 2,300 GWh, equal to about 1 million tons of coal and 23,000 tons of sulfur dioxide.

3. Results

China has a great deal of experience with energy efficiency, although most of this experience is not directly within the utility sector. For example, from 1981 to 1990, China spent 4.5–6.5 percent of the total energy investment budget on energy conservation each year. Significant energy savings have been achieved through these investments, which began in 1981 and were aimed mainly at industrial boilers and energy-intensive industries such as steel, cement, and chemicals.

China also has gained some excellent experience with energy efficiency from working with private energy efficiency services. China, with assistance from the World Bank, has been involved in developing the energy service company (ESCO) model of

delivering energy efficiency services. As of June 2004, the three ESCOs have entered into 315 energy performance contracts with aggregate investments of over 95 million USD. Their businesses are successful and growing rapidly.

These ESCO projects have demonstrated that, like other countries, China has large amounts of cost-effective energy efficiency potential, but also that China has similar barriers to energy efficiency. Other countries have found many remaining barriers to ESCO-led efficiency programs, and that power utility and government support has been necessary for broad ESCO success.

China's utility-related energy efficiency experience is much more limited than its experience with load management. In the early 1990s, China conducted a number of studies aimed at energy efficiency but the recommendations were not implemented. For example, a 1992 study found that the DSM programs alone could reduce electricity use in Hainan by 21 percent in 2000, with savings of \$200–\$400 million.

In recent years, several energy efficiency programs have been implemented, such as Green Lights in Hebei and Jiangsu and variable-speed drives in industrial applications in Jiangsu. But their deployment has generally been limited in scope.

It will be very difficult to implement DSM more broadly in Vietnam without the adoption of new policies. The critical task in Vietnam is to identify the policies that are needed to allow DSM to have a role in the reformed power system. This is especially important now because Vietnam's power sector is in the process of reform. In some respects, Vietnam's power sector is like a centrally planned industry where command-and-control approaches to increasing investment in DSM work best. In other respects, the power sector is becoming a market-driven industry where more market-oriented DSM policies will be needed. This paper identifies and recommends that the government of Vietnam consider a number of near- and long-term policy options to encourage DSM. Some of these policies rely on regulations, standards, and other measures that could be considered command-and-control mechanisms. Other policies rely on illuminating true costs and incentives so that the market will lead to the lowest-cost solution.

The generation business has been unbundled from the transmission and distribution business. However, if the reform process fails to accommodate the potential of demand-side resources in its structure and rules for power sector reform, Vietnam will overlook an important mechanism in the pursuit of efficient and sustainable economic development. The good news is that senior leaders in Vietnam are interested in DSM and as a result, new regulations on strengthening DSM have been issued.

Vietnam is facing a serious power shortage, which is making power sector reform even more difficult. The lesson learned by public officials and utility managers in other countries that have faced shortage conditions is that solving the shortage with a supply-side-only approach may be possible, but relying heavily on DSM can solve the problem faster, at a lower cost, and with less pollution.

As described in this paper, there are still some barriers to implementing DSM in Vietnam. Vietnam's power sector reform and reform plans must remove these barriers to DSM. The following policy recommendations would support reform efforts while reducing barriers to DSM.

4. Discussion and Conclusion

The World Bank estimates that in a business-as-usual scenario, the power utility, Electricity of Vietnam (EVN), will face a threefold increase in demand over the next 10 years, from 25,700 GWh in 2000 to more than 77,400 GWh by 2010, with annual demand growth of 10 to 13 percent. Generation level peak power demand is also projected to increase from the 1999 level of 5,700 MW to about 16,000 MW by 2010. Meeting this demand through supply-side resources alone would require a capital investment of about U.S.\$18 billion (GEF 2003).

In the current context of our country, with the rapidly increasing demand for electricity along with socio-economic development, DSM plays an increasingly important role in the overall solution to ensure the balance of electricity supply and demand, contributing part to ensure sustainable economic growth and conservation of national fossil fuel resources. It should be affirmed that a basic tenet of DSM is that the cost to save one kWh of electricity will be cheaper than the cost to provide an additional 1 kWh of electricity by building a new plant. This is especially meaningful for our country when investment in electricity development is requiring huge annual capital needs that may exceed domestic investment capacity.

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