DEMAND-SIDE MANAGEMENT IN CHINA

Benefits, Barriers, and Policy Recommendations

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

A major challenge for China's policy makers is to determine how best to provide the necessary energy to fuel China's extraordinary economic growth. The traditional approach has been to rely on increasing the supply of conventional energy resources, particularly coal, which accounts for nearly three-quarters of China's current energy consumption. Yet energy is not an economic output that must be maximized at all costs. Rather, it is an input to the generation of goods and services, such as heating, lighting, mobility, industrial products, and consumer goods. Reducing the input needed to provide these goods and services would have benefits that reverberate throughout China's economy, including improved environmental quality, economic competitiveness, and energy security.

China has achieved tremendous success over the last 20 years in reducing its energy intensity—the energy consumed per unit of Gross Domestic Product (GDP). China's energy consumption per 10,000 RMB (Chinese dollar) (U.S. $1,211) of GDP has fallen from the equivalent of 5.58 tons of standard coal in 1990 to 1.71 tons in 1999. Yet despite these achievements and its low per capita consumption, China's energy intensity is still three times higher than that of the United States and Japan. The energy efficiency in China's rapidly growing power sector, which is the second largest in the world, is three-quarters that of advanced international standards. As growing power shortages in China threaten its continued economic growth, it becomes more important than ever to find ways to use energy more efficiently.

One tool that has proven effective in many countries for delivering energy efficiency, but has not yet been widely adopted in China, is demand-side management, or DSM. DSM is a mechanism in which a utility or some other state-designated entity uses funds derived from the electrical system to promote energy efficiency through targeted educational or incentive programs whose effects are measured quantitatively. Demand-side management is an important mechanism that can complement and extend government, private sector, and international assistance efforts to help electricity end-users capture the full range of efficiency opportunities available today in China and induce the development of next-generation energy efficiency measures. Although DSM programs in a number of countries have faltered in the wake of electric utility restructuring, new approaches to financing and administering DSM and incorporating demand-side resources into competitive markets are meeting with considerable success.

A number of barriers stand in the way of implementing effective DSM programs in China. These barriers are similar to those facing most other countries: a traditional rate design that provides a built-in disincentive to utility DSM programs; the lack of a sustainable mechanism to generate necessary funding for DSM programs; and a lack of positive incentives that would motivate utilities to maximize energy savings. Yet as China restructures its electric power industry, it has a valuable opportunity to take advantage of the lessons learned (both positive and negative) in other countries in order to harness the benefits of demand-side resources in a manner that will suit China's particular circumstances and fulfill its own goals.

After summarizing the benefits of DSM for China, exploring China's experience to date in developing DSM policies and programs, and analyzing the main structural, financial, and regulatory barriers to further implementation, the report describes a number of recommended policies and strategies for overcoming these barriers. These recommendations include developing a new rate design that decouples utility profits and electricity sales, establishing a DSM financing mechanism through a system benefit charge or rate recovery mechanism, and introducing performance-based regulations that provides positive incentives for utility-based DSM. The report also discusses the option of independent DSM program administration and recommends strategies for incorporating demand-side resources into China's emerging wholesale markets. As China restructures its electric utility industry, it has an important opportunity to develop power market rules and regulatory structures that would make DSM profitable for utilities or independent DSM program administrators, provide adequate funding, and permit demand-side resources to compete with new generation in the marketplace.

CHAPTER I

INTRODUCTION

China has achieved remarkable success in economic development since the beginning of reforms in 1978, transforming the country from a planned system to a market economy. Its official average annual economic growth rate over the last 20 years was 9.6 percent, about four times higher than developed countries. This growth has enabled China to lift more than 200 million people out of poverty and raise the average standard of living dramatically (World Bank 2001). China has also raised its level of electrification to more than 93 percent, although more than 75 million rural Chinese are still without electricity (Gerner and Stern 2003).

China has now begun intensive development of its more remote western regions and further integration into the global economy through membership in the World Trade Organization. These dynamics, along with deepening reforms and growing domestic demand, are expected to help sustain the pace of economic growth. As it enters the twenty-first century, China hopes to become a medium-developed country by 2050 through a strategy of sustainable development.

A major challenge for China's policy makers is to determine how best to power this extraordinary economic growth. China's power generation capacity—which has been growing about eight percent per year over the last decade and reached 350 gigawatts (GW) in 2002—has made it the second largest power generator in the world. Of this total, thermal capacity accounts for 73 percent, hydropower 25 percent, and the rest (mostly nuclear and renewables) 2 percent (Songbin 2003). It is estimated that China's power sector will be responsible for more than 50 percent of China's total coal consumption this year (HKTDC 2003). See Appendix I for more details on energy supply and demand in China.

Environmental Impacts. China's heavy reliance on coal to power its economy has come at a high cost to the environment and human health. China's utility sector is currently responsible for an estimated 50 percent of its sulfur dioxide emissions, 80 percent of its total emissions of nitrogen oxides (NOx), and 26 percent of its carbon dioxide emissions (World Bank 2001; RAP 2002). Thermal power generation, which requires large amounts of process water, is contributing to severe water shortages and deterioration in many parts of the country. China also discharges more than 70 million tons of solid waste each year from thermal power plants, a number that is expected to grow to about 160 million tons by 2010 (World Bank 2001). Coal-fired power plants also discharge significant amounts of mercury, exposure to which can cause neurological and developmental effects in children.

Power Sector Reform. On April 12, 2002, China's State Council announced sweeping plans to reform its electric utility sector in light of China's current conditions and the lessons of international power restructuring. The main goals of China's reform are to encourage the long-term development of the power industry; ensure a safe, efficient, and reliable power supply; and protect the environment. To achieve these ends, the reform plan calls for, among other things, breaking up the State Power Corporation into five new generation companies and two national grid companies; establishment of a competitive power market overseen by an independent regulatory commission; development of a new pricing system; incentives for clean energy development; and new power plant emission standards. In June 2003, the new State Electricity Regulatory Commission (SERC) unveiled a timetable for the first part of these reforms, which includes the development of regional power grids in the northeast and eastern parts of the country and the January 2004 launching of competitive bidding for about 20 percent of the power in east China (Reuters 2003).

Growing Power Shortages. In the midst of these reforms, and after a period of relative equilibrium between electricity supply and demand during the late 1990s, China is once again experiencing power shortages. Demand for electricity, which was projected to increase by five percent annually during the tenth five-year plan (FYP) (2000-2005), instead surged by 16.5 percent in the first four months of 2003 compared to the same period last year (Xinhua 2003). China's State Grid Company announced in May that these power shortages have reached crisis proportions, with more than half of China's provinces likely to be short of electricity this year. These shortages, which began to appear in the summer of 2002, currently affect about 15 provinces in north China, northwest China, and part of central China. The Cambridge Energy Research Associates projects that China's installed power capacity at the end of 2003 will be 374 GW, about 30 GW short of what is needed to meet demand (SCMP 2003).

China's top leaders are concerned about these developments and have taken a number of steps to address the situation. The State Council, China's highest executive body, issued a "Notice on Issues Related to Power Supply" in April 2003, calling for coordinated action to relieve local power shortages. The State Development and Reform Commission (SDRC), SERC, and the newly formed State Grid Company held a joint meeting in May and announced a comprehensive series of measures addressing both power supply and demand (Wang 2003).

Bridging the Gap: Supply-Side Resources. On the supply side, the State Council has revised the tenth five-year plan for the power sector, which originally called for 60 to 80 GW of new capacity during 2000–2005. The new plan adds a total of 30 GW in additional capacity, which will require an average of 25 GW to be installed during each of the next three years. Thirty to 40 percent of this new capacity will be hydropower, the rest mostly coal, although China is also planning to step up development of nuclear power and renewable energy. In addition, China plans to speed up the construction of power plants currently in the pipeline and develop pump storage power plants in areas where thermal generation dominates and there is a large gap between peak and off-peak demand. On the transmission side, China also plans to strengthen the grid to handle the increasing demand (Wang 2003).

Demand-Side Resources. China also recognizes the value of demand-side resources in bringing its power system back into balance. SDRC and SERC have called for urgent efforts to study policy options for demand-side management, or DSM, as well as measures to guide rational consumption and energy conservation. The purpose of this paper is to assist in these efforts by analyzing the potential for incorporating DSM into China's ongoing electric utility reforms in order to address its power shortages in a cost-effective manner.

CHAPTER II

BENEFITS OF DEMAND-SIDE MANAGEMENT

Demand-side management (DSM) refers to measures sponsored, funded, and/or implemented by utilities that modify end-use electrical energy consumption, either reducing overall consumption through energy efficiency or using load management to reduce demand at times when the cost of reducing demand is less than the cost of servicing it. Cost-effective efficiency and load management measures could significantly improve the reliability of China's electric system and close the gap between supply and demand, while lowering the economic and environmental costs of electric service (Cowart 2001).

LOAD MANAGEMENT

Load management programs involve reducing loads on a utility's system during periods of peak power consumption or allowing customers to reduce electricity use in response to price signals. Such programs use mechanisms like interruptible load tariffs, time-of-use rates, real-time pricing, direct load control, and voluntary demand response programs. In response to the current power crisis, SDRC has issued a notice calling for the development of national time-of-use tariffs, with peak rates that could be in the range of two to five times higher than off-peak rates. SDRC is also considering the development of seasonal tariffs in regions of the country served primarily by hydropower, as well as the development of interruptible power tariffs where appropriate. These changes will likely become part of a package of tariff reforms already under way as part of China's overall power sector reforms (Wang 2003).

Load management programs can be effective in reducing peak demand, which in turn helps to reduce utility construction costs as well as lower electric rates. Yet load management programs are largely short-term responses that alone do not exhaust the cost-effective demand-side potential. The multiple long-term benefits that investments in energy efficiency can bring to the entire electric system are often overlooked. Combining load management programs with end-use energy efficiency programs can heighten the effectiveness of both approaches and lead to the greatest demand reductions.

ENERGY EFFICIENCY

Demand-side management also refers to a mechanism in which a utility or some other government-designated entity uses ratepayer funds to promote energy efficiency through targeted educational or incentive programs, the effects of which are measured quantitatively. DSM programs are designed to reduce the market barriers that prevent consumers from taking advantage of energy efficiency opportunities, such as lack of information and limited investment capital. DSM energy efficiency programs can be implemented in a variety of ways, such as:

- Providing financial incentives to end-users to modify energy use or change end-use equipment (*e.g.* switching to more efficient light bulbs or refrigerators);
- Entering into energy efficiency performance contracts and other third-party initiatives;
- Educating end-users on available efficiency opportunities; and
- Developing suppliers or end-use energy products and services, including energy service companies (ESCOs).

(World Bank 2002). Investing in energy efficiency is often cheaper, cleaner, safer, faster, more reliable, and more secure than investing in new supply. In addition to reducing the need to construct new generation, transmission and distribution facilities, improving efficiency also reduces maintenance and equipment replacement costs, as many efficient industrial technologies have longer lifetimes than their less efficient counterparts. Relying on efficiency also avoids a number of costly risks associated with generation, such as lack of demand, cost overruns, interest rate risk, volatile fuel costs, technological obsolescence, catastrophic failure, and political and national security risks.

Efficiency can come online much faster than expanding energy supply, without any problems of surplus or shortage. Retrofitting motors and pumps, adding insulation to buildings, or even changing a light bulb takes much less time than constructing a new power plant (Cowart 2001). In 1985, the third largest investor-owned utility in the United States was cutting its decade-ahead forecast of peak demand through DSM by about 8.5 percent per year, at roughly one percent of the cost of new supply (Lovins 2002).

In addition to the power shortage described above, system stability problems are prominent in China because of weak network configurations, insufficient peaking power, reactive power compensation, and voltage regulations. The transmission capability of the highest voltage level (500kV) is low, and in most regions the 220K-voltage level still operates as the trunk network. Much of China’s urban power network equipment is old and overextended, unmatched to the needs of urban development and the promotion of electric power consumption. Even rural power equipment is unsatisfactory and lagging behind. Energy efficiency measures can help address this situation by providing a number of reliability benefits, such as:

- Reducing load, wear, and maintenance needs on the entire generation, transmission, and distribution chain;
- Reducing demand for generation fuels across both peak and nonpeak hours, thus improving fuel availability generally;

- Reducing loading in strategic locations, thus reducing transmission congestion and other system reliability problems;
- Reducing losses at the system, transmission, and distribution levels; and
- Releasing capacity to serve other customers.

(Cowart 2001). In a competitive electricity market, the benefits of both energy efficiency and load management are multiplied. The ability to reduce peak demand reduces the power cost paid to every generating unit running at the time of the peak. This market-wide cost reduction greatly exceeds the savings previously achieved by demand reduction in fully regulated wholesale markets (RAP 2000).

U.S. EXPERIENCE WITH DSM

DSM energy efficiency programs evolved in the United States during the 1980s primarily as utility demand-side resource investments. Regulators considered efficiency investments an integral part of a utility's overall resource portfolio, and required these investments when they lowered costs as compared to utility supply-side resources, a process known as integrated resource planning, or IRP. Utilities designed and implemented energy efficiency programs for their customers, while regulators determined how to measure cost effectiveness, approved budgets, verified results, and, in many jurisdictions, provided regulatory incentives designed to align utility financial motives with ratepayer interest in achieving cost-effective efficiency investment, thus avoiding more expensive supply-side alternatives (Harrington and Murray 2003).

In the United States, more than 500 utilities implemented DSM programs from 1985-1995, saving more than 29 GW of peak load. The average upfront cost of implementing this energy savings was only 2 to 3 cents per kilowatt-hour, far below the average tariff. The Rand Corporation issued a report in 2000 that quantified the benefits of California's utility energy efficiency programs, finding that DSM programs operated since 1977 have provided benefits to the state economy of U.S.$875 to 1,300 per capita (1998) and reduced air pollution emissions from stationary sources by approximately 40 percent (Nadel 2000).

DSM programs in the United States, as in many countries, faltered in the wake of electric utility restructuring and the belief that market forces would be sufficient to provide energy efficiency. In the United States, investment in ratepayer-funded energy efficiency, not including load management expenditures, declined dramatically from $1.6 billion in 1993 to $900 million in 1997. Much of this decline can be attributed to the elimination of regulatory requirements for utilities to conduct IRP and DSM programs (York and Kushler 2003).

More recently, however, many jurisdictions have come to realize that comprehensive DSM programs are essential, even after power sector reform, to fill in the gaps left by the market in providing energy efficiency. Total U.S. spending on utility DSM has risen steadily to $1.10 billion in 2000. Even more important, a wide variety of states and utilities have realized the benefits of DSM in providing long-term solutions to electricity system reliability concerns (Kushler and Witte 2003).

California Success Story. The most prominent example is California, whose leadership in energy efficiency and DSM substantially reduced the economic and environmental damage associated with the state's severe energy crisis of 2001. In response to the crisis, Californians reduced their total electricity consumption in 2001 by 6.7 percent (weather adjusted) compared to 2000, even as the economy continued to grow. These demand reductions did not occur spontaneously, but in response to a series of coordinated DSM measures and policies that were already in place (NRDC/SVMG 2001).

By 1999, California's energy efficiency investments and standards had already removed about 10,000 megawatts from its peak demand, the equivalent of 20 large power plants. In 2001, the governor was able to use these programs, including public education programs, rebates and other financial incentives, to coordinate the most successful statewide energy conservation program in history. Consumers bought record numbers of energy-efficient appliances in 2001, including nearly 100,000 high-efficiency refrigerators (more than five times that in 2000) and 4 million compact fluorescent light bulbs (NRDC/SVMG 2001).

These concerted efforts on the part of millions of Californians in 2001 enabled the state to avert a recurrence of its 2000 electricity crisis. A 2003 study examined the magnitudes, sources, and costs of the savings contributing to California's successful DSM deployment. The following table summarizes the results of the study by Global Energy Partners of the impacts and costs of California's combined efforts:

Program Category [a]	Number of Programs Identified	Reported Cost ($millions)	Reported First Year Energy Savings (MWh)	Reported Demand Savings (MW)	Cost per First Year kWh Saved ($/kWh)	Cost per Lifetime kWh Saved [e] ($/kWh)
#1 PGC-Funded, IOU Administered	149	$294	1,254,539	323	$0.23	$0.03
#2 CPUC-Funded Summer Initiative	16	$70	266,556	132	$0.26	$0.03
#3 CEC Programs	8	$19	124,766	61	$0.15	$0.02
#4 Major Municipal Programs [b]	31	$30	60,660	104	$0.49	$0.06
#5 Locally Administered Programs [c]	10	$5	663	-	$8.21	$1.04
#6 Other Targeted State Programs	2	$60	na	152	na	na
#7 20/20 Rebate & Residual Effects [d]	2	$415	3,053,000	2,616	$0.14	$0.05
Total	218	$893	4,760,184	3,388	—	—

na = Not Applicable
[a] For a complete definition of the program categories, please see Table ES-1.
[b] Los Angeles Department of Water and Power (LADWP) and Sacramento Municipal Utility District (SMUD).
[c] City of San Francisco and City of Berkeley.
[d] Includes 20/20 Rebate program (discounted for double counting), and residual effects, including the Flex Your Power public awareness campaign, free media coverage, and increasing rates.
[e] Based on weighted average lifetimes of measures for each program category, and a discount rate of 8%.

In all, the study found that 218 programs spent a total of U.S.$893 million in 2001 to save 3,389 MW of summer peak demand and 4,760,184 MWh of annual energy usage at a lifetime cost of 3 cents/kWh (Global Energy Partners 2003).

Recognizing the value of DSM programs, especially in a restructured electricity market, California substantially increased funding for utility DSM programs in 2001 to more than U.S.$480 million, an increase of more than 50 percent over 2000 levels. The legislature also extended until 2012 the use of the system benefit charge, a small surcharge on every California utility bill. This surcharge will raise more than U.S.$5 billion of investment in energy efficiency, renewable energy, and technology development, the largest sustainable energy fund ever created by a single legislative action (NRDC/SVMG 2001). In addition, in May 2003, the state's three largest investor-owned utilities announced plans to expend U.S.$2 billion over the next five years on DSM. Of this total, U.S.$720 million is for procurement of resources above and beyond the U.S.$1.1 billion funded by the current system benefit charge (SBC), a small surcharge on customers' utility bills. As part of this renewed commitment, the utilities are seeking clarity on regulatory treatment, including cost recovery rules (McCarty et al., 2003).

Substantial inexpensive efficiency resources are still available in California. New evidence shows that over the next decade, California could realistically and cost-effectively reduce its electricity needs by an additional 900 MW—the equivalent of 12 giant power plants—while avoiding the environmental damage associated with electricity generation. This added investment in efficiency would save California an estimated U.S.$12 billion (NRDC/SVMG 2003).

Electricity Resource Portfolio Management. In the wake of the California energy crisis, the concept of integrated resource planning, or IRP, is also beginning to reemerge in the form of electricity resource portfolio management. Portfolio management means assembling a mix of demand- and supply-side resources designed to ensure reliable, affordable, and environmentally sustainable electricity service with an acceptable risk of price and delivery risk. To achieve a range of economic, social, and environmental benefits, a healthy portfolio would consist of a diverse mix of power plants, contracts, spot energy purchases, demand-side management investments, and load management (RAP 2002).

U.S. jurisdictions are beginning to restore utilities' responsibility to manage a portfolio of resources to meet customer demand and to reaffirm the utilities' obligation to consider investment in "all cost-effective energy efficiency" in resource procurement, including resources above and beyond those being acquired through the limited system benefit charge. Full integration into resource procurement is essential to ensure that utilities avoid commitments to more costly generation, since utilities that do not integrate all cost-effective energy efficiency into their portfolios cannot provide least-cost electricity service (NRDC/SVMG 2003).

INTERNATIONAL EXPERIENCE WITH DSM

As detailed in Appendix IV, more than 30 countries around the world have successfully applied DSM to increase energy savings, reduce the need for new power plants, improve economy and reliability in power network operation, control tariff escalation, lower customer electric expenses, save energy resources, and improve environmental quality. DSM has become an important strategy for achieving sustainable energy and electricity development. Two examples are given below:

Thailand

Thailand has been recognized internationally for its success in designing DSM programs that fit within an Asian context. In 1993, Thailand initiated a U.S.$189 million DSM program to help curb electricity demand growth and promote more energy-efficient equipment and cost-effective energy services. The program was financed primarily through automatic tariff mechanism/fuel adjustment clause, with other funding from the Global Environment Facility (GEF), Australia, and Japan. The program was largely successful and substantially exceeded its original peak reduction and energy conservation targets. From 1993 to 2000, the DSM program succeeded in reducing peak load by an aggregate of 556 MW, or four percent of Electricity Generating Authority of Thailand's total 1999 capacity. Cumulative annual energy savings were 3,140 GWh, representing more than double the original energy savings program targets. The program also reduced carbon dioxide emissions by 2.32 million tons per year (Singh and Mulholland 2000).

A number of lessons were learned from the experience that could prove useful to other countries, including the recommendation that, in those countries that still have vertically integrated utilities, any introduction of DSM efforts should explicitly involve distribution staff and provide for gradually shifting appropriate DSM program responsibilities to distribution utilities as reforms progress to make use of their established and unique customer relationships (Singh and Mulholland 2000). More details are available in Appendix IV.

Vietnam

Another relevant Asian example is that of Vietnam. 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. 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).

The Global Environment Facility is assisting Vietnam in the development of four large DSM programs as part of the country's long-term power sector strategy. The program would, in the course of 3 to 4 phases, test, develop and scale up successful and sustainable business models to promote DSM and energy efficiency (EE) and facilitate investments. This would be achieved by: (i) developing a large-scale DSM program within Electricity of Vietnam to reduce loads during peak periods and in congested networks; (ii) testing, developing and expanding a commercially sustainable EE service industry; and (iii) developing domestic sources and mechanisms for project financing to support a large-scale EE investment program (GEF 2003).

The project is expected to achieve major reductions in peak load, improve system load factors, transform select lighting markets, and assist customers with ongoing tariff reforms. Detailed estimates of direct energy savings benefits over a 10-year period total about 120 MW in peak load reduction and 2,928 GWh, resulting in more than 724,000 tons of oil equivalent (toe) and 3.5 million tons of carbon. In addition to the environmental benefits, EVN will substantially benefit from reduced peak loads, network congestion, and new investment requirements from its DSM programs (GEF 2003).

EVN's compact fluorescent lighting (CFL) program is also expected to offer major social benefits to households, particularly in rural areas, by reducing the impacts of recent and planned electricity tariff increases. EVN's DSM programs could also help reduce public resistance to expected tariff reforms as the utility offers information and support in helping consumers use their electricity more efficiently.

EFFICIENCY RESOURCES IN CHINA

Over the past two decades, China has made tremendous progress in improving its energy efficiency. Energy consumption per unit of production decreased from 7.89 tons of coal equivalent (tce)/10,000 RMB (Chinese dollar) in 1981 to 3.14 tce/10,000 RMB in 1998 (1990 price), a 60.2 percent reduction. According to the Global Environment Facility (GEF), between 1981 and 1998, the accumulated saved energy in the country as a result of energy efficiency initiatives and national structural adjustments that were imposed during this period amounted to 834 million, equivalent to 526 million tons of carbon reduction (based on a 1995 emission factor) (GEF 2002).

Yet as detailed in Appendix II, although great progress has been made, the remaining efficiency resources available today in China are enormous. The level of final energy use efficiency in China is still 20 percent lower than that of industrialized countries. The energy use of unit production value in China is onefold higher than that of developed countries. The unit energy use of main energy-using products still averages 45 percent higher than that of international levels (GEF 2002).

Of the end-use sectors, the industrial sector has the largest potential for energy savings. GEF estimates that in a baseline scenario without enhanced energy savings policies, the industrial energy demand in 2010 will be nearly 1,260 million. Assuming an enhanced energy savings policy, the demand will be more than 1,130 million tce, a reduction of about 125 million tce, which is nearly 9.9 percent of the baseline total industrial energy demand (GEF 2002).

Likewise, great opportunities exist to improve the efficiency of new and existing buildings in China. GEF projections indicate that by 2010, the energy consumption in buildings will be more than 570 million tce, compared to about 370 million tce in 2000. Compared to current buildings, the potential exists to lower new building energy consumption by 50 percent, reducing energy consumption by about 100 million tce. Major opportunities also exist to reduce energy consumption in existing and commercial buildings (GEF 2002).

CURRENT ENERGY EFFICIENCY PROGRAMS IN CHINA

China has had more than 15 years of experience in the active promotion of energy conservation, with a solid record of achievement (Martinot 2001). China currently is making impressive efforts to accelerate energy efficiency in every sector of its economy. In accordance with its 1997 Law on Energy Conservation (see Appendix III), and with the help of numerous international assistance organizations, China is developing a wide range of programs, regulations, and incentives designed to transform the market for efficient technologies, with a goal of reaching zero annual growth in energy consumption by 2040. Although a complete description of these programs and activities is beyond the scope of this report, they include promulgation of efficiency codes and standards, product certification and labeling programs, development of private energy service companies (ESCOs), energy efficiency demonstration projects, training courses, and public education programs (GEF 2002). The tenth five-year plan (2001–2005) also calls for the formulation of market-based incentive policies to promote energy efficiency, such as tax policies and financial incentives, energy price reforms, and bank lending policies. These efforts play an essential role in developing the market for energy efficiency technologies.

Most recently, with the support of GEF and other international donors, the Chinese government has developed a four-phase, 12-year strategic plan for end-use energy efficiency projects in China that is designed to dramatically improve the efficiency of its major end-use sectors, buildings and industry. The project fosters a strategic approach to developing, implementing, and enforcing a comprehensive and effective energy conservation policy and regulatory system consistent with the objectives of the Energy Conservation Law of 1998. The project's purpose is the removal of barriers to the widespread application and practice of energy conservation and energy efficiency in the major energy consuming sectors (buildings and industrial) in China (GEF 2002).

BENEFITS OF DSM FOR CHINA

Given the impressive work that is already under way, the question might arise as to what additional benefits China might obtain by undertaking DSM programs in addition to the extensive energy efficiency programs that are currently ongoing. As described above, integrating energy efficiency into utilities' resource procurement decisions provides multiple benefits in terms of providing least-cost energy services, reducing costly investments in new generation, and improving electricity system reliability. In addition, as shown below, ratepayer-funded DSM programs can complement and extend government, private sector, and international assistance efforts to help electricity end-users capture the full range of efficiency opportunities available today in China and induce the development of next generation energy efficiency measures.

DSM Benefits for Government Regulatory Programs

DSM programs can increase compliance with regulatory programs such as new building or appliance standards by helping customers bear the costs. DSM programs can also help develop the market for efficient technologies more quickly, demonstrate the feasibility of tightening existing efficiency standards, and induce next-generation energy efficiency measures once the current generation has been broadly commercialized and is understood (Goldstein and Watson 2001; Nadel 1995). For example, refrigerators were the largest residential user of electricity in 1972 in the United States, but their energy consumption declined fourfold over the next 30 years as a result of policy at the same time that the size and features were increasing and the price to the consumer decreasing in real dollars. Much of the impetus for this improvement came from DSM programs (Goldstein and Geller 1999).

DSM Benefits for Private Sector Efficiency Programs

Experience in a number of countries, including the United States, New Zealand, Chile and Argentina, indicates that neither a restructured electricity sector nor the market itself will automatically deliver energy efficiency. In fact, DSM will generally be a casualty of restructuring unless active steps are taken to include it. When the United Kingdom began to restructure its electric industry, for example, no special provisions were made for energy efficiency or DSM. It was assumed that market forces would meet demands for energy efficiency measures as they arose. Experience proved otherwise, and three years later the United Kingdom established an independent Energy Saving Trust (EST) to design and oversee DSM programs (Holt 1995).

China has made significant progress in the development of private energy service companies (ESCOs). With support from the European Union, GEF, and the World Bank, for example, China has developed three energy management companies (EMCs), located in Beijing, Liaoning and Shangdong. These companies have executed more than 100 energy performance contracts with host enterprises and are approaching financial viability (GEF 1997). The second phase of this project supports the development of an EMC association and a guarantee fund to provide partial risk guarantees to local financial institutions that lend to the EMCs (GEF 2001).

Yet experience in other countries has shown that while the ESCO industry provides a very valuable role in delivering energy efficiency to institutional and large commercial markets, it has been less successful in serving other market segments, particularly residential and small commercial and industrial customers. Even in market segments where ESCOs have been most successful, DSM funding programs have played a major role in creating and supporting the ESCO industry, and continue to do so today (Kushler and Witte 2001).

Combining DSM and private sector efficiency efforts has proven successful in many countries. Utilities can help develop a strong ESCO industry rather than competing with the private sector. A number of U.S. utilities have formed affiliated enterprises to provide energy services to customers, by forming their own ESCOs for example. Utilities can also subcontract with ESCOs, acquire their own ESCOs, or contribute financially to a DSM group or agency that is common to a number of utility companies. Utilities that are required to achieve DSM results can look to private ESCOs to provide innovative solutions and lowest costs through a process of demand-side bidding (Kushler and Suozzo 2001).

DSM Benefits for Donor-Assisted Efficiency Programs in China

DSM programs in China can complement and extend the extensive donor-sponsored activities already under way in China to remove the barriers to end-use energy efficiency. In particular, ratepayer-funded DSM programs can provide a long-term, cost-effective and stable source of funding for energy efficiency investments. This can help overcome one of the major barriers to end-use energy efficiency—namely the consumers' unwillingness and/or inability to pay the first costs of purchasing and installing energy efficient equipment and building energy-efficient facilities. Ratepayer-funded DSM programs can and do provide funds for a range of financial incentives such as consumer rebates for purchase of energy-efficient equipment, rebates to manufacturers for producing energy-efficient equipment, and even performance incentives to utilities for providing cost-effective energy services.

The recently approved GEF-sponsored End-Use Efficiency Project in China recognizes that financial barriers play a major role in stifling good energy efficiency investments in China. It therefore calls for a review of international models and experiences with energy efficiency financing in a market economy, the development of proposed financing models appropriate for China's situation, and the design of a strategy and plan for demonstrating innovative energy efficiency financing mechanisms in two or three local regions (GEF 2002). Ratepayer-funded DSM programs, which have proven successful in many countries even after electricity sector restructuring, represent one innovative financing model that China could study, adapt, and test on a demonstration basis.

DSM PROGRAM ADMINISTRATION

Utilities have certain inherent advantages over government and the private sector in helping consumers reduce their energy consumption. Utilities have already established relationships with their customers and often have detailed knowledge of energy use patterns and local circumstances. They also have a billing system in place and an established delivery capability, often over a large territory. Utilities generally have the necessary technology, experience, and expertise to conduct DSM activities (Kushler and

Suozzo 1999). Utilities, moreover, can implement pricing mechanisms, such as time-of-day pricing and tiered rates, discriminate between types of customers in setting rates, and pass through to customers variations in the costs of programs.

Even after restructuring, distribution companies have demonstrated their effectiveness in delivering DSM given the proper incentives. Distribution utilities are natural vehicles for performing two essential functions—portfolio management and market transformation—that are best conducted by a single state-designated entity rather than a variety of different entities, such as ESCOs. They are still responsible for comprehensive planning to ensure sufficient transmission and distribution capacity and can consider DSM as a cost-effective alternative to building such capacity. As a natural monopoly, distribution companies are still subject to government regulation, which can be crafted carefully, along with incentives and rate designs, to utilize the power of the marketplace to promote DSM (Martinot 2002).

It should be noted that not everyone in the West considers utility-based DSM a panacea. Many believe that utilities are ineffective purveyors of energy efficiency because of their traditional supply-side orientation and the inherent conflict of interest between increasing electricity sales and reducing electricity demand. Yet as shown in Chapter IV, new approaches to financing and administering DSM and incorporating demand-side resources into competitive markets have been developed to address these issues and are meeting with considerable success. These options include, among other things, the creation of new independent private entities, often called Energy Trusts or "energy efficiency utilities," to administer DSM programs using system benefit charges.

As China restructures its electric utility industry, it has a valuable opportunity to integrate DSM into the power sector reform process. Many options exist for developing power market rules, regulatory mechanisms, incentive policies, and institutional structures that would promote cost-effective DSM and national energy and environmental goals. These mechanisms could make DSM profitable for utilities, or at a minimum remove existing disincentives so that utilities will not block the administration of DSM programs by other state-designated entities. Experience indicates that if DSM is to be part of a restructured electricity sector, then the DSM model should be incorporated beforehand because it will likely influence the structure of the reformed power sector, and because it will be much harder to change the rules of the game once they have been established.

CHAPTER III

CHINA'S EXPERIENCE WITH DEMAND-SIDE MANAGEMENT

China was first introduced to the concept of DSM in the early 1990s. Since that time, government agencies, medium and large power consumers, research institutes, universities, and other organizations have worked hard to promote the use of DSM in China. Activities to date include international exchange and cooperation, training courses, pilot studies, demonstration projects, and educational activities. These activities have provided important experience regarding the challenges and opportunities of implementing DSM in China.

International Exchanges and Cooperation. In January 1994, the first international Integrated Resource Planning (IRP) symposium was held in China. Participants included the chairman of the International Energy Promotion Association and experts from the United Nations Educational, Scientific, and Cultural Commission (UNESCO), Lawrence Berkeley National Laboratory, Oak Ridge National Laboratory, and U.S. and European utilities. Chinese participants introduced the results of China's first IRP/DSM pilot project in the Shenzhen Power Network.

In 1995, the E7 group (electric utility groups from the G-7 countries) sent experts to China for cooperation on a DSM demonstration project with the Ministry of Electric Power. Since 1997, China has participated actively in the DSM Experts Committee of the Asia-Pacific Economic Cooperation's (APEC) Energy Working Group. The State Economic and Trade Commission and the State Power Corporation have sent numerous delegations to investigate DSM programs in the United States, Canada, Western Europe, and Northern Europe.

DSM Promotion Activities. The main government organizations promoting DSM have historically been the former State Development Planning Commission's Department of Infrastructure, the State Economic and Trade Commission's Department of Electric Power and Department of Resource Conservation and Comprehensive Utilization, and the former State Power Corporation's Department of Generation, Transmission, and Operation. The State Power Corporation and the Asian Development Bank also established a DSM Management Center in Jiangsu Province in 1998. This center has carried out numerous training and other DSM activities and publishes a *Power DSM* journal.

Training Activities. International DSM training for Chinese experts has been conducted in the United States, Western Europe, and Canada. In addition, China has held more than 30 domestic training classes for more than 3,000 trainees, including classes on power supply and utilization of management personnel. Two-thirds of the trainees have been planning and design engineers from provincial planning companies. Other participants include energy conservation personnel, industrial and commercial power customers, energy service company managers, and energy-efficient product suppliers.

Pilot Studies and Demonstration Projects. Over the last decade, China has conducted several pilot DSM studies, all of which found tremendous electricity savings potential and environmental benefits. None of these initial pilot DSM studies were ever implemented, except for a demonstration project in Beijing involving peak load management, which is generally easier to apply than other DSM programs. More recently, however, Jiangsu and Henan Provinces has begun to carry out a number of DSM projects. With GEF support, China is also embarking on a DSM demonstration project involving utility financing of efficient lighting products. An analysis of these case studies reveals a number of barriers and opportunities for DSM in China.

DSM CASE STUDIES

Hainan Integrated Resource Planning Pre-feasibility Study

In 1992, the International Advisory Council on the Economic Development of Hainan in Harmony with the Natural Environment worked with the U.S. Oak Ridge National Laboratory to conduct a pre-feasibility study of resource options to be included in an Integrated Resource Planning (IRP) process. The study recommended that Hainan conduct an IRP process, with a focus on using electricity pricing as a DSM strategy, developing efficient building codes for new construction, implement DSM programs in all sectors, and exploring the possibility of large-scale wind resources. The study found that the DSM programs alone could reduce electricity use in Hainan by 21 percent in 2000, with savings of U.S. $200 million to $400 million (Nadel et al. 1995). The Hainan IRP pre-feasibility study was the first such analysis conducted in China, soon after DSM and IRP were first introduced. Relevant decision makers and institutions most likely lacked adequate capacity, understanding, and interest in the IRP process to carry it out.

Shenzhen Power Network DSM Pilot Study

The State Planning Commission, along with the Energy Research Institute and Lawrence Berkeley National Laboratory, conducted a DSM pilot study in 1993 for the Shenzhen Power Network. The study analyzed the potential for both end-use efficiency and load management activities. The study recommended that the following highly efficient technologies be substituted for existing inefficient technologies:

- Compact fluorescent lamps for incandescent lamps;

- Electronic ballasts for ordinary induction choke coils;
- Variable speed drives for low load factor, large operation fans and pumps;
- High efficiency distributed air conditioners for ordinary distributed air conditioners; and
- Ice storage air conditioners for traditional central air conditioners.

The study used internationally accepted cost/benefit evaluation methods and technical and economic analyses for various technical measures employed in the Shenzhen industrial, commercial, and residential sectors. The study concluded that improving the efficiency of the industrial and commercial/service sectors would have significant benefits. The unit electricity savings cost of most of the recommended technical measures came to only one-tenth to one-half of the avoidable cost of new generation resources, or 0.62 to 0.67 RMB (Chinese dollar)/kWh. The study estimated that 970 MW of electricity could be saved in 2000, which corresponded to 3.9 percent of total electric consumption of the Shenzhen Power Network, as well as 460 MW of peak power, corresponding to more than 9 percent of estimated peak load at the time.

The study found that implementing the recommended efficiency measures would eliminate the need for construction of a planned 600 MW generating unit. The cost of the recommended efficiency measures was 330 million RMB, only half the cost of the planned power plant (the plant’s unit construction cost was 5,500 RMB/kW). Canceling plant construction would also eliminate the need for 500 kilotons of coal production and associated pollution discharges. Power customers, utilities, and Shenzhen City would share the common benefits of the DSM program.

The Shenzhen pilot study suggested two possible mechanisms for establishing a special DSM energy efficiency fund to cover the costs of the program. The first suggestion was to draw some of the funds from the existing fuel surcharge for use as a DSM special energy efficiency fund, thus avoiding the need to increase the electricity tariff. The fuel surcharge was part of the existing tariff structure and was used specifically to level the electric tariff and compensate for fluctuations in fuel price and foreign exchange rates. The second suggestion was to establish a special DSM energy efficiency fund by adding a small new surcharge to the electricity tariff. The study proposed adding 0.005 RMB to the electricity tariff for a DSM energy efficiency fund (less than 0.8 percent of the average electricity tariff) during the period 1994 to 2000. This surcharge would have collected an annual fund of 35 million RMB in 1994 and 124 million RMB in 2000.

The recommendations of this study—which also occurred shortly after the concept of DSM was first introduced into China—were also never implemented. One set of barriers appears to have been institutional. Shenzhen encountered difficulties in defining the roles of the municipal and provincial governments and utilities in supplying electric services, including DSM services. Different organizations were responsible for power generation and the power network. Several power generation companies, but primarily the Shenzhen Municipal Energy Group Company, were responsible for energy construction and operational management under the auspices of the city government. The Shenzhen Power Supply Company, also under the auspices of the city government, was responsible for urban power network construction, maintenance, dispatching, and operational management. It may have been difficult for these different organizations to coordinate in order to achieve project objectives. In addition, during the course of the project, as part of nationwide power sector reforms, Shenzhen began to separate the government functions of the provincial power bureau from the enterprise functions. As a result, the Energy office responsible for organizing the IRP/DSM pilot study was closed, but no new corresponding governmental office was established or identified to take over the project (Nadel et al. 1995).

The second set of difficulties concerned the proposed alternatives for funding the recommended DSM measures. On the one hand, Shenzhen felt it would be difficult to draw on the existing fuel surcharge for DSM purposes without compromising the original purposes of the surcharge, which was to level the electric tariff and compensate for fluctuations in fuel price and foreign exchange rates. On the other hand, Shenzhen was unwilling to adopt a new surcharge specifically for DSM, because at that time Shenzhen had the highest electricity tariff and highest rate of electricity consumption in China (Nadel et al. 1995).

Shanghai DSM Cost/Benefit Analysis

In 1994, with the assistance of the Asian Development Bank, Shanghai conducted a cost/benefit analysis of a range of potential DSM measures in certain secondary and tertiary industries, including commercial facilities, catering services, office buildings, and public institutions. The analysis was based on a consideration of Shanghai's power consumption mix and load curves, as well as conventional DSM energy-efficient technologies. The analysis focused on DSM opportunities in lighting, air conditioning and cooling, district and industrial heating, fans, pumps, and electric traction. Typical energy-efficient technologies assessed include efficient pumps, fans, and electric heating equipment; waste heat recovery generators; ice storage cooling; gas fueled air conditioners; and electric-heat-cooling triple generation.

As shown in Table 1, the analysis concluded that the DSM technologies mentioned above would save Shanghai 2 terawatt hours (TWh) of electricity and 663 MW of peak leveling capacity in 2000, avoiding the need for 80 MW of additional installed capacity. These savings would grow to 6.1 TWh of electricity and 2030 MW of peak leveling capacity in 2010, avoiding 245 MW of new capacity. The DSM program would also eliminate 880,000 tons of carbon dioxide and 5,900 tons of sulfur dioxide emissions each year. By the year 2010, these DSM measures would eliminate 1.5 million tons of carbon dioxide emissions and 10,000 tons of sulfur dioxide emissions per year.

Table 1

Year (Base Year 1994)	Annual Electricity Savings (TWh)	Peak Shifting Capacity (MW)	Deferred Generating Capacity (MW)
2000	2	663	80
2010	6.1	2,030	245

	Capacity Installed (BAU) GW	Ratio of DSM Peak Load Avoided %	Additional Peak/Valley Difference (BAU) GW	DSM Peak/Valley Difference Avoided %
2000	7.80	10.25	2.41	27.5
2010	21.5	11.40	8.12	25.0

Despite the clear benefits revealed by the cost-benefit analysis, Shanghai never conducted the DSM project. As with the other pilot projects, lack of financing and utility incentives were likely culprits.

Peak Load Management in Beijing

Beijing began engaging in DSM activities primarily for load management purposes in response to rapidly escalating peak demand. The peak load grew from 3 GW in 1992 to nearly 4.5 GW in 1996, a yearly average load growth of 10.4 percent. The minimum load had increased slowly, while the daily max-min had grown quickly, decreasing the annual system load factor by around 86 percent in 1992 to 82 percent in 1996. This made it difficult for Beijing to ensure the safe, stable and economic operation of the power system. In order to promote the load factor increase, Beijing's main goal was to open up the power market in off-peak hours.

The first step was to investigate the consumer power market. Before developing effective measures for peak load management, Beijing carried out a survey to determine the condition of customers' electric equipment and consumption patterns. Models and software programs were developed, based on the load survey, to analyze the efficiency opportunities available from major customers in key industries.

The survey revealed that in 1996, industrial consumption accounted for more than 55 percent of the typical winter daily electricity consumption in Beijing, including 51 percent of the system's morning peak and around 50 percent of the evening peak. Even though the industrial load is the baseload of the Beijing system, there is still a large potential for load shifting through the rational arrangement of discretionary load (Hu 1999).

Based on the above analysis, Beijing decided upon the following measures to improve its system load factor:

- Further expand the price differential between the peak and valley hour tariffs in order to encourage load shifting;
- Sign interruptible load agreements with large customers, first on a pilot basis, then on a more widespread basis;
- Encourage enterprises to rearrange their production schedules so that scheduled maintenance took place during peak hours;
- Encourage enterprises to establish schedules to upgrade and retrofit high loss electrical equipment, such as motors and transformers; install reactive power compensators for

high and low voltage equipment; and arrange equipment with higher diversity factors to operate at peak hours with a minimum operating scheme and at off-peak hours with a maximum operating scheme;

- Encourage customers to use highly efficient electric devices, retrofit existing production processes in order to improve productivity, and invest in technologies that shift usage from peak to valley periods, such as ice storage air conditioning and storage electric heaters; and
- Provide financial assistance based on actual upgrading and retrofitting needs.

The net effect of these measures was a reduction in the peak demand of 50 MW in 1997 and another 50 MW in 1998 and an improvement in the load factor because of the 150 GWh increase in consumption during the valley load period. The investment to produce the peak load shift was 12.05 million RMB in 1997 and 5.67 million RMB in 1998. The annual benefit based on the avoided cost of new generation capacity was estimated at 24.8 million RMB (Hu 1999).

The Beijing DSM project was successful primarily because it 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 time of use and interruptible tariffs. After successfully completing the load management program, Beijing has now gained practical experience that should prove useful for the development of DSM programs that result in long-term reductions in demand through efficient end-use technologies. Beijing is now conducting a detailed study of DSM policy options and incentive mechanisms with the support of the Energy Foundation.

DSM in Jiangsu Province

Jiangsu Province, which is one of the most economically developed provinces in China and ranks second in both power generation and power consumption, is struggling to cope with growing power shortages that are hampering its further economic development. The home of the national DSM Management Center, Jiangsu officials and experts have been studying DSM policies and technologies since the launching of the center five years ago. With the help of the Energy Foundation, they have now begun to put DSM principles into action through a series of coordinated regulatory actions, pricing mechanisms, and demonstration projects. Jiangsu believes that DSM is a major tool for rationalizing resource allocation and use of electric power, optimizing grid operation, improving power efficiency, and mitigating environmental pollution.

The first step was governmental coordination. Jiangsu organized a high-level project steering committee led by the deputy directors of the Jiangsu Economic and Planning Commissions. Jiangsu then brought together members of the provincial Pricing Bureau, Construction Bureau, Environmental Protection Bureau, and Power Corporation to conduct extensive DSM investigation and research prior to launching the project.

The second step was to strengthen the legal and regulatory framework for DSM. Based on national *Power Conservation Regulations* that were promulgated jointly by the

State Economic and Trade Commission and the State Planning and Development Commission in 2000 (see below), Jiangsu was the first province in the country to implement those regulations by issuing its own corresponding provincial measures, the *Jiangsu DSM (Pilot) Regulations*, in April 2002.

As detailed in Appendix III, the Jiangsu regulations consist of seven chapters, including general rules; clarification of the responsibilities of relevant government bodies, power corporations, power customers, and ESCOs; planning and implementation efforts; policy and technical measures; and rewards and punishments.

The third step was to experiment with load management in several high energy-consuming enterprises. Jiangsu chose to test the use of interruptible loads in blast furnaces in five steel plants in Suzhou and Wuxi, areas that were suffering from peak power shortages. After the steel plants and the provincial government completed detailed negotiations and arrangements, the tests succeeded in cutting load demand by 300 MW, equivalent to a savings of nearly 2 billion RMB. This test ensured the safe and economical operation of the provincial network. Jiangsu compensated each of the steel plants at a rate of 1 RMB/kWh of interrupted load, for a total of 7.86 million RMB in 2002.

The fourth step was to launch several DSM end-use efficiency projects in order to encourage the extension and application of DSM techniques, encourage power customers to use power rationally, lesson peak hour pressures on the grid, and improve power efficiency. Jiangsu decided to focus on several high power-consuming industries, including the metallurgy, textile, chemical, and building materials industries. The Jiangsu Economic Commission established a set of Implementation Methods of Jiangsu DSM Projects in order to standardize project approval and funding criteria. Based on these criteria, the province has identified 71 potential DSM projects that would save a total of more than 280 GW at a cost of 40 million RMB and achieve an annual profit of 203 million RMB. These projects would also lower the production costs of participating enterprises, cutting peak load by 100 MW and increasing the valley load by 41.8 MW.

The fifth step was to develop a pilot project to gradually apply time-of-use (TOU) prices to major industrial customers, commercial customers, and nonindustrial users. Jiangsu is also investigating the possible extension of TOU rates to residential customers through pilot programs in certain newly built residential communities.

The sixth step was to develop a plan to address the peak load problem in southern Jiangsu, where the load factor is decreasing rapidly, making it increasingly uneconomic to install new generators to meet the short peak load. Based upon a directive by the East China Power Corporation to shift a total of 1,200 MW in that region, Jiangsu set a corresponding target for five key cities: Nanjing, Suzhou, Wuxi, Changzhou, and Zhenjiang. Load shifting measures include arranging equipment maintenance and repair during summer peak hours, rotating weekly work shifts, and establishing an interruptible load program for 12 steelworks. If these measures are insufficient, Jiangsu will consider taking additional measures, such as limiting power in order to control electrical network safety.

Finally, Jiangsu analyzed the costs and benefits of using various load management technologies, such as energy storage air conditioners. Jiangsu estimates that the average cost of load shifting using these technologies is about 1,113 RMB/KW, which is less than 28 percent of the 4,000 RMB/KW average investment for constructing new peak load adjustment generators.

Jiangsu has learned a great deal from its successful DSM pilot projects and has developed a series of recommendations for further development of DSM. First, the government should further strengthen the legal and regulatory environment by integrating DSM into comprehensive energy structure optimization planning and decision making. Jiangsu will also have to conduct additional load shifting measures in order to compensate for the additional peak loads caused by new environmental controls on power plants.

Second, the province should develop a sustainable DSM financing mechanism. The funding for both the DSM demonstration projects and the interruptible load pilots came from a gap in the power tariff created when generators produced electricity above their annual quotas and sold that power to the grid on the basis of price competition. The conditions that gave rise to this power tariff gap will not last once Jiangsu establishes a competitive power market. Jiangsu would also like to reward enterprises that participate most effectively and vigorously in DSM projects, but needs a source of funds for these bonuses.

Finally, Jiangsu realizes the need for improved management of the DSM demonstration projects and suggests that the pilot projects should be completed before the government provides the promised compensation. Although this recommendation would ensure that the projects are completed, it might also deter some industries from embarking upon DSM projects in the first place because of the lack of up-front funding.

DSM in Henan Province

Henan established China's first utility-sponsored ESCO, known as Henan First ESCO (HFEESCO), in November 1996. HFEESCO is a wholly owned subsidiary of Electric Power Henan and its affiliates. Henan First ESCO focuses its activities on load management, particularly the sale and leasing of electric heat storage boilers in order to help customers reduce peak electricity load (BECon I). Henan Province has instituted a small system benefit charge of 0.1 fen/kWh in order to help finance the activities of Henan First ESCO (Jiangsu 2003).

Load Management in Shanghai

Shanghai is the first large city in China to widely adopt time-of-use rates, although such rates have been applied in other jurisdictions to large industrial customers. Beginning in May 2001, the cost of electricity in Shanghai became 50 percent lower at night than during the day. Four hundred thousand households now have the option of installing electricity meters with separate rates for different time periods. Estimates show that residents can save up to 25 percent of power per day and cut power bills by 12.7 percent (China Online 2001).

China Green Lights Program

After many years of experience, China recognizes that the higher initial costs of efficient lighting products, although they have lower life-cycle costs, are a major barrier to the adoption of efficient lighting technologies by end-users, particularly in the residential and government/institutional sectors. Therefore, with GEF assistance, China is developing a utility-financed DSM demonstration project as part of the second phase of its China Green Lights Program (GEF 2000).

The project document for the China Green Lights Program describes some of the opportunities and challenges of developing DSM, and China recognizes that electric distribution utilities are in a unique position to deliver energy efficiency information and technology to their customers by virtue of their role of providing energy services. They also can implement innovative financing schemes to help overcome consumer resistance to the higher initial cost of efficient lighting products. Utilities would also have strong incentive to participate in such financing programs for efficient lighting products, because, if structured properly, they could generate additional revenue for the utilities, help to defer costly and uncertain long-term investments in generation assets, and increase customer satisfaction and loyalty in the competitive environment (GEF 2000).

The initial DSM pilot programs undertaken as part of the GEF project will be used to demonstrate the benefits of these programs to utilities, which generally lack experience in running these types of programs, are unaware of the benefits described above, and currently are in a period of uncertainty due to ongoing power sector restructuring. Existing utility program information and results, both domestic and international, will be reviewed in coordination with the national DSM center. Innovative new programs will then be designed, including leasing and tariff-based initiatives, which will be piloted in selected municipalities and results disseminated for wider program activity. Incentives will be used only in the residential sector, given that this sector is the hardest to reach. Incentive funds will come partially from the GEF and partially from utility and local government contributions (GEF 2000).

CHINA'S RECENT AND CURRENT DSM POLICIES

In the last few years, China has begun to incorporate the concepts of DSM into national plans, policies, regulations, and standards, although they have not yet been widely implemented.

Tenth Five-Year Plan. One of the five major objectives of the tenth five-year plan (FYP) (2001–2005) is to improve the quality and efficiency of economic development. Among other things, the FYP calls for the development of DSM provisions that can guide the rational planning and allocation of resources utilization, government procurement, and voluntary agreements.

Power Conservation Management Provisions. These provisions, which were enacted jointly in 2000 by the State Economic and Trade Commission and the State Development Planning Commission, contain a chapter specifically devoted to DSM. Article 16 requires provincial and municipal economic and trade commissions to facilitate DSM efforts. Utilities must conduct load management and expand the use of interruptible and direct load management. Article 18 requires power planning and integrated resources planning to cover DSM, although it provides no specific details on how this should be implemented.

Article 19 calls for a gradual increase in basic electricity rates, a reduction of kilowatt-hour rates, an expansion of time-of-use rates and an increase in the price differential, and an expansion of the use of interruptible load rates. Article 20 permits power users that utilize certified efficient products to apply for a reduction or exemption of the capacity charge in their electricity rates. Article 21 encourages utilities to popularize and facilitate DSM and permits them to recover the costs of DSM education and information efforts in their management budget.

Top-Level Power Supply Enterprise Qualification Standards (Tentative). The State Power Corporation incorporated DSM as a qualification factor in its 2001 Top Level Power Supply Enterprise Qualification Standards (Tentative). These standards stipulate that top-level power supply enterprises must take active steps to plan and launch effective DSM programs.

State Council Decision Reference. In August 2002, the State Power Economic Research Center and the Beijing Energy Conservation Center (BECon) submitted a report to the State Council entitled "Recommendations on Expediting the Promotion of DSM." This report was published as a Decision Reference by the policy department of the State Council. This was the first time that the State Council has stressed the role of DSM in China. The recommendations of the report include:

- Develop detailed DSM regulations to clarify the main DSM policies and roles of various stakeholders, particularly government agencies and power grid companies;
- Establish a rational power tariff system, including time-of-use prices, increasing the volume of customers with load valley and seasonal power prices, increasing the discrepancy of peak/valley load and seasonal prices, appropriately increasing base power tariffs, and gradually extending interruptible power prices;
- Develop a DSM public welfare fund based on the system benefit charges adopted in other countries. The fund could equal 1 to 3 percent of customers' power bills and could initially be taken from a portion of the urban surcharge that is currently added to power tariffs. Fundraising and spending of the DSM public welfare fund should be put under the regulatory supervision of relevant government bodies in terms of fund management, contract management, program planning, evaluation of project outcome, and auditing supervision;
- Make full use of existing organizations such as the SETC Energy Conservation Information Dissemination Center and the State Power Company's DSM Center to assist with DSM project recommendation, information dissemination, and policy advocacy. Necessary funding and policy support should also be provided to these bodies; and

- Develop quality standards for high power-using equipment, adopt mandatory national standards to phase out outdated power-using equipment, and expedite the extension of energy-efficient and technology-intensive products and equipment (State Council Policy Research Office 2002).

SETC/SDPC Management Measures for Electricity Conservation. In June 2003, SETC and SDPC issued a joint circular entitled "Announcement of Issuing Management Measures for Electricity Conservation." This joint circular recognized the importance of DSM as an electricity saving strategy, and included a number of suggestions for further advancing DSM work in the power sector. These guiding suggestions include:

- Local economic commissions, in collaboration with other relevant government bodies, should utilize various means to promote the healthy development of DSM work in their respective areas, including using industry policies, tax policies, and pricing policies. Through induction, coordination, monitoring, and providing services, they should mobilize various resources, actively develop the market, and encourage stakeholders to participate in and benefit from DSM. Where conditions allow, they should immediately carry out well-coordinated and organized testing and demonstration in order to gain experience before they scale up the effort;
- Each provincial grid operator should systematically study its local situation for DSM and provide timely suggestions to pertinent central government departments. Power DSM should be integrated into grid development plans and be placed at the same importance level as the expansion of generating capacity. DSM can raise grid capacity and generator utilization, thus increasing economic efficiency of system operation;
- Utilities should strive to implement DSM. Based on electric power resources and demand levels within their respective service regions, utilities should gradually establish information networks on electric power DSM. They should disseminate, advocate, and introduce electric power DSM technology, knowledge, and demonstration projects through appropriate means at such places as their custom service centers and exhibition rooms. The aim is to guide end-users to adopt a scientific way of consuming electricity and use advanced electric technologies, appliances, and materials;
- Electricity users, especially large users, should increase their awareness of resource conservation and environmental protection, and actively seek to use technologies and equipment that are energy efficient, energy saving, or can store energy for use during peak hours. Through technology upgrading and enhanced management, end-users can optimize their usage patterns, reduce electric consumptions, cut production costs, and raise economic benefits;
- Local economic commissions should encourage, guide, and support, as appropriate, energy service and conservation institutions and energy dealers to play an active role—using their technological and managerial expertise—in such activities as DSM advocacy, energy audit, energy conservation monitoring, information dissemination, project consultancy, bidding, procurement, technical exchange, and training, etc.;

- Technologies and products for power DSM should be able to offer the following: peak shaving to optimize grid operation, improving energy use structure, reducing environmental pollution, and increasing energy use rate;
- Technologies and products to be immediately promoted include:
  - Power load management technologies;
  - Heat and cold energy storage technologies;
  - Green lighting technologies;
  - Energy-efficient home appliances;
  - Heat pump and gas and steam combined cycle power generation technologies;
  - Ultra-infrared, microwave, or high-power/mid-frequency inducted heating technologies;
  - High-power/low-frequency electric source metallurgical technologies;
  - Speed adjusting operation technology for alternate current electric motors;
  - High efficiency fans, water pumps, electric motors, and transmitters;
  - Heat treatment, electric plating, molding, and oxygen production technologies;
  - Nonpower automatic supplement technology;
  - High efficiency batteries; and
  - Renewable energy power generation technologies; and
- Local economic commissions may develop more detailed implementation plans according to local conditions (China Electric Power News, June 6, 2003).

Around the time these DSM management methods were announced, however, the SETC was abolished and the SDPC renamed and reorganized as the National Development Reform Commission (NDRC). Some SETC departments were moved to the new NDRC, but as of this writing it is unclear which government organization, if any, will take the lead in implementing these electricity conservation management measures.

CHAPTER IV

BARRIERS TO AND RECOMMENDATIONS FOR DEMAND-SIDE MANAGEMENT IN CHINA

As illustrated by the DSM case studies described above, a number of barriers stand in the way of implementing effective DSM programs in China. This chapter describes some of the main structural, regulatory, and financial impediments that China faces in carrying out its new DSM initiatives, followed by recommended policies and strategies to overcome those barriers.

This report does not address the barriers to energy efficiency that customers face, such as a lack of information about efficient technologies, the low quality or unavailability of efficient technologies, the higher upfront costs of efficient technologies, or the lack of available capital. These are the market barriers that an effective DSM program is designed to address once it is in place.

TRADITIONAL RATE DESIGN PROVIDES DISINCENTIVE FOR UTILITY DSM

One of the major barriers facing utilities in pursuing cost-effective, demand-side management in China, as in most countries, is that under current rate designs, utilities make money by selling electricity, not by saving electricity. The rate design itself provides a disincentive to utilities to make even the most economical investments if they are likely to reduce electricity sales.

According to China's current tariff system, generation prices for plants built after 1985 are set on a plant-by-plant basis. The price for each plant is set at a level designed to provide sufficient revenue for the repayment of loan capital and interest within a reasonable time, plus a margin of profit. For plants built before 1985, which generally belong to the State Power Corporation, tariffs are set to cover direct operating costs such as depreciation, labor, fuel, and maintenance costs, but not any return on investment.

In either case, the amount of money a utility or independent power producer receives is directly linked to the amount of electricity it sells. The more kilowatt-hours (kWh) sold, the more the power company earns. Actively promoting end-use energy efficiency would represent a conflict of interest to the power company, seeing as it would reduce the amount of electricity sold, and therefore negatively affect its own earnings. As a result, rather than determining the most cost-effective way to meet customers' energy service needs, the power companies focus on capacity expansion as the primary response to projected load growth, to the exclusion of investments in energy efficiency. This rate design is not only economically inefficient, but also obstructs the achievements of numerous national objectives served by DSM, including the provision of affordable and reliable energy services, environmental protection, economic competitiveness, and energy security. This barrier will remain even after electric industry restructuring unless active steps are taken to break the link between sales and earnings (Carter 2001).

Recommendation: Decouple Utility Profits and Electricity Sales Via a Revenue Cap

China's traditional rate design leads utilities to focus exclusively on traditional distribution and generation capacity expansions—often in direct conflict with China's important energy, economic, and environmental objectives. A new approach is needed to allow utilities to select the least-cost resource options for meeting customer energy needs without threatening their own profits.

One of the most important steps in removing the barriers to utility DSM is revenue regulation that removes the conflict of interest that exists when utility profits are directly linked to sales of electricity. The most promising policy tool for removing this conflict of interest is a revenue cap. Revenue caps (also known as decoupling, revenue indexing, or revenue-per-customer mechanisms) are a key tool for breaking the link between utility profits and electricity sales. The purpose of a revenue cap is not to create a bias in favor of energy efficiency, but to remove an existing regulatory bias against energy efficiency. This mechanism makes a utility financially indifferent as to whether kWh sales increase or decrease (Carter 2001).

Revenue caps can be applied to regulated, vertically integrated monopolies before restructuring and to regulated, natural monopoly distribution utilities after restructuring. Under a revenue cap, utilities receive a set amount of money each year that is designed to cover all utility costs plus a reasonable profit as determined by the regulatory authority. The preferred method is to allow the utility a set amount of revenue per customer. This amount of revenue remains the same regardless of how many kilowatt-hours each customer uses. Customers continue to pay for electricity on a per kilowatt-hour basis, which provides an incentive to use electricity in an efficient manner. The government regulator sets electricity rates based on expected costs and sales.

At the end of each year, the government regulator compares the actual revenues collected by utilities to the allowed revenues. If the actual revenues are higher than the allowed revenues, the extra amount will be refunded to customers. If the actual revenues are smaller than the allowed revenues, a small charge will be added to the electricity price in the following year to make up for lost revenues.

A revenue cap allows monopoly utilities to recover all costs and earn a reasonable profit while protecting it from price volatility. At the same time, it removes both the incentive to increase electricity sales and the disincentive to carry out cost-effective DSM programs. Utilities are now able to make least-cost investments to deliver reliable energy services to customers, even when it lowers electricity usage, without threatening their profits. This approach merges utility and society interests and results in better energy resource decisions. Additional incentives or mechanisms would also help promote active utility DSM investments (Cowart 2001). The Australian state of New South Wales has adopted a revenue cap mechanism to break the link between utility revenues and kWh sales.

California adopted a revenue cap mechanism (known as an electric rate adjustment mechanism, or ERAM) for its three major utilities in the early 1980s, which, along with performance-based incentives and a system benefits charge, helped pave the way for California utilities to lead the United States in energy conservation efforts. A detailed study by Lawrence Berkeley National Laboratory found that ERAM had a negligible effect on rate levels and actually reduced rate volatility. Although California suspended the ERAM mechanism in 1996 during the restructuring transition period, all of the major utilities in California have now approved or are developing proposals to institute a revenue-per-customer mechanism. The same is true for Oregon. Together, these utilities account for more than 10 percent of U.S. gas and electric revenues (Carter 2001).

Revenue caps and revenue-per-customer rate designs have proven successful in removing perverse incentives while allowing the utilities to recover their costs plus a reasonable profit. Revenue caps can be applied at any stage of the power reform process and regardless of which administrative organization is selected to implement the DSM programs. Additional mechanisms such as performance-based incentives (described below) will be required to ensure that utilities make the most economically and environmentally efficient resource decisions. China's current efforts to reform electricity prices and develop a competitive power market provide a valuable opportunity to re-examine and revise its outdated rate design.

LACK OF DSM FINANCING MECHANISM

Lack of Cost Recovery Mechanism. Capital funds are a key requirement for any successful DSM program. Yet even if power companies in China were willing to invest in DSM, there is no mechanism currently available for them to recover their investments. The catalog tariff for plants owned by the network only allows for the recovery of direct operating costs such as depreciation, labor, fuel, and maintenance. As a result, these older plants lack funds to carry out their own technical renovation or install required pollution control technologies, let alone funds to help customers improve energy efficiency.

Similarly, the generation price for plants built after 1985 is currently designed to allow a return on past capital investments, not new investments in end-use energy efficiency. This rate design also deters investments to upgrade the efficiency of the transmission and distribution network, given that these generation prices do not include a separate charge for the transmission network. As the generation price continues to increase for each new plant due to increased construction costs and pollution control requirements, fewer funds are available for desperately needed network upgrades and maintenance, let alone new DSM programs.

Lack of Guaranteed Repayment. A related barrier to DSM programs involving utility financing of customer efficiency upgrades is the lack of strong repayment guarantees under a DSM performance contract. Utilities point to energy theft and the failure to pay electric bills as serious problems already plaguing the power sector. They would likely be reluctant to provide major financing for customer efficiency upgrades without a strong guarantee of repayment. Unfortunately, private sector ESCOs in China have already encountered performance contract repayment problems. This is due in part to the lack of strong contract enforcement mechanisms in China, but also to specific limitations on the ability of enterprises to engage in financial activities in China.

In 1994, the People's Bank of China (PBC) issued Regulations on Administration of Financial Institutions, which were designed to maintain financial order, safeguard the financial and legal interests of the public, and promote a socialist market economy. Under these regulations, the PBC maintains strict control over all domestic financial institutions. The definition of "financial institution" is extremely broad and applies to all types of banks, credit card companies, financial leasing companies, insurance companies, and any other institution engaging in financial business as determined by the PBC. All financial institutions must meet minimum eligibility requirements, apply for a permit, and receive approval from the appropriate PBC office. The PBC may order any financial institution to cease operations for violations of the regulations or any other reason as determined by the PBC (Wan 1999).

If the PBC determined that a utility was operating as a financial institution according to the terms of a performance contract, the utility would have to meet the criteria for a financial institution and obtain a permit. Otherwise, the contract would be unenforceable, and the utility would be unable to rely upon the contract to demand repayment from the consumer.

Recommendation: Introduce a System Benefit Charge

Prior to restructuring, the costs of utility DSM programs were often embedded in utility rates. The deepening of competition means that regulatory pricing approaches, such as passing costs through to customers, have become problematic. In a competitive market, greater responsibility falls on the government to develop funding mechanisms and financial incentives for DSM.

A system benefit charge (also known as a public benefit charge, wire charge, or surcharge) is a relatively new mechanism designed specifically to fund DSM programs in restructured power markets. A system benefit charge is a small, non-bypassable surcharge—in the United States, around 1 to 33 mils/kWh (a mil is 1/10 cent)—added to the electric rates of all electric consumers. Non-bypassable charges apply to all sales, and thus no competitive provider is disadvantaged by the collection mechanism. They can be applied regardless of the status of electric industry restructuring. System benefit charges are a fair, nondiscriminatory way of promoting the public interest, as they apply to all customers. They can be used to fund DSM programs that take advantage of cost-effective energy efficiency opportunities, reduce electricity expenditures, and therefore lower customers' electricity bills. System benefit charges can also be used to fund other public benefits, such as renewable energy development and low-income energy services.

A number of countries throughout the world have adopted system benefit charges, including the United Kingdom, the United States, Spain, Norway, Denmark, and Thailand. For example, the United Kingdom instituted a system benefit charge in 1994 to support DSM activities for small consumers. The fund collected U.S.$165 million by 1998, which was invested in more than 500 energy efficiency projects that saved customers 6,800 GWh of electricity. Thailand's pilot DSM program was financed primarily by an automatic tariff mechanism, although its main purpose was a fuel adjustment mechanism (Singh and Mulholland 2000).

At least 20 states in the United States have established statewide funding mechanisms for DSM programs. The revenue from these programs totaled about U.S.$750 million in 2000 (Cowart 2001). California alone collected U.S.$872 million in system benefit charges from 1998 to 2001, and has now extended the program to 2012. In 1998, the California system benefit charge, which averaged less than 0.6 percent of each consumer's electric bill, funded more than U.S.$173 million in DSM expenditures and saved 582 GWh of electricity.

China has had many years of experience with surcharges designed to raise money for the construction and renovation of power generation facilities. In 1987, China established a "power construction" surcharge of 0.02 RMB (Chinese dollar)/kWh on industrial and commercial power consumers. This surcharge was used for building large and medium-sized power stations. The collection of this surcharge was discontinued at the end of 2001 without a clear explanation (Songbin 2003). China currently adds an official surcharge to retail electricity prices to collect revenue for construction of the Three Gorges Hydroelectric Power Project. A DSM surcharge would apply the same principle to the development of saved energy resources, or "negawatts."

China may be reluctant to impose a surcharge on electricity to provide revenue for DSM programs because it is currently working to eliminate electricity surcharges in an effort to keep down consumer electricity prices. In addition to phasing out the power construction surcharge, the central government is also cracking down on illegal surcharges imposed for a variety of purposes by local governments, particularly in rural areas. In a 1997 investigation, the central government uncovered a total of 24 billion RMB in illegal surcharges, equivalent to a nationwide increase of 0.03 RMB per kilowatt-hour.

Yet most of the eliminated surcharges imposed by local governments have nothing to do with electricity production. A DSM surcharge is compatible with China's existing policies because the DSM programs funded by the surcharge will ultimately reduce all customers' electricity bills, especially in a competitive power market. Moreover, a system benefit charge of 0.5 fen/kWh (approximately one percent of China's current electricity price) would have little impact on a consumer's electricity rates. Yet it would generate 5 billion RMB each year, assuming an annual energy consumption of approximately 1 trillion kWh.

As described in Appendix III, Article 11 of China's national Law on Energy Conservation requires that energy conservation funds be taken from the capital construction and renovation funds that have already been collected using surcharges. This provision provides legal authority for a decision by the government to use these existing funds for DSM programs. China could eliminate or reduce the impact on a consumer's electricity rate by using the funds collected for power construction purposes instead for DSM programs.

Recommendation: Capitalize DSM Investments and Allow Recovery in Rates of Amortization Expenses Over Time as a Cost of Electric Service

It has become standard ratemaking practice in North America and elsewhere to recover the capital costs of long-lived generation, transmission, and distribution assets over time. Because these facilities provide service over 20 years or more, the costs of supply investments are ordinarily recovered through electricity rates. The costs of debt service to support capital expenditures—interest payments and depreciation expense—are routinely treated as another cost of electric service recoverable through rates.

Such basic ratemaking treatment applies equally to capital expenditures made to acquire DSM resources. As do supply investments, DSM investments provide service over many years. By reducing growth in electric energy usage and peak demand, electricity savings from DSM also defer the need to add generation, transmission, and distribution facilities. Since the capital costs of investments that would be required absent DSM would be recovered over time, it stands to reason that demand-side investments should be accorded the same rate treatment.

It was this economic logic that led most U.S. electric utilities pursuing aggressive DSM investments in the early 1990s to recover program expenditures over time. For example, the Potomac Electric Power Company (PEPCO) spent roughly a quarter of a billion dollars (US$ 1991) on DSM in its Maryland and Washington, D.C., service territories over the period 1992–1996 (Obeiter et al. 1994, p. 10.206). In order to better align the pattern of costs recovered from ratepayers with the pattern of benefits received, PEPCO at that time amortized each year's DSM expenditures costs over five years. This rate treatment allowed PEPCO to expend several times more in any given year on new DSM than it was recovering through rates at the time. Electric rates included interest charges on unrecovered capital balances, which were drawn down annually as they were recovered gradually over the five-year amortization period.

The onset of electricity restructuring in the United States prompted some utilities to abandon the pursuit of DSM as a substitute for generation by the late 1990s, and with it, the recovery of DSM costs over time. This led in turn to the creation of system benefit charges (SBCs) discussed above. The deployment of DSM as a substitute for supply is undergoing something of a renaissance in parts of the United States where supply-demand imbalances have emerged. Nowhere is this reversal more apparent than in California over the last several years. Conservation, efficiency, and load management together were largely responsible for averting large-scale service disruption that had been expected in 2001 as demand outstripped available supplies (Global Energy Partners 2003). As described above, the overwhelming success of DSM as a resource has led

California utilities and their regulators to redouble efforts to pursue cost-effective demand-side resources.

As with many countries, extended cost recovery for long-lived capital assets remains a key barrier to China's investment in generation, transmission, and distribution. Overcoming these barriers will be critical if China is to acquire the most economical supply resources. This imperative is equally strong if China is to successfully deploy and integrate DSM in its long-range electricity resource plans.

LACK OF INCENTIVES FOR UTILITIES TO PURSUE DSM

Even if all disincentives were removed, utilities in China would likely still refrain from pursuing efficiency opportunities absent either mandatory requirements or positive incentives to do so. In fact, many countries have found that mandatory DSM requirements alone are ineffective unless coupled with positive incentives. Indeed, China's recent calls for DSM, as found in the SETC/SDPC power management provisions, the State Power Corporation's enterprise qualification standards, and the tenth five-year plan itself, appear so far to have gone largely unanswered.

Recommendation: Develop Performance-Based Regulation

Performance-based regulation (PBR) is an emerging approach to utility regulation in which economic incentives, often adjustments to allowed rates of return, are attached to a number of performance indicators, such as outage minutes and service response time. This approach could be used to encourage utility investment in DSM by rewarding compliance with energy efficiency indicators, such as energy efficiency spending or the number of customers served. A portion of the funds raised through the SBC could be used to fund these incentives.

California, Massachusetts, and Michigan negotiate annual efficiency targets with utilities and tie specified dollar amount bonuses to achievements of these targets. In Massachusetts, the distribution utility is eligible to receive a fixed incentive per kWh and kW saved if it achieved at least 50 percent of targeted electricity savings. The incentive was scaled according to the proportion of targeted benefit-cost ratio achieved, up to a maximum of 8 percent of net program benefits. In California, a portion of the funds raised through the SBC can be used as performance awards to utilities (Kushler and Suozzo 2001).

Recommendation: Consider Independent DSM Program Administration

If China adopts the three recommendations described above—revenue caps, a system benefit charge, and performance-based regulation—it will pave the way for effective utility administration of DSM in China, both before and after electric industry restructuring. Absent any of these mechanisms, however, it is likely that utilities will lack the necessary incentives and financing to implement DSM and would continue to have a built-in conflict of interest between increasing electricity sales and promoting demand-side reductions. In such a case, the Chinese government should seriously consider selecting an independent entity to administer its DSM programs.

Of the 14 U.S. states requiring energy efficient-funding, about two-thirds rely primarily on utility administration of energy efficiency public benefit funds (Kushler 2001). Yet utilities need not always assume responsibility for the actual implementation of DSM programs. There are three basic options for the administration of publicly funded DSM programs: utility administration with regulatory oversight, administration by a new or existing government agency, and administration by a private statewide, provincial, or regional institution. Important considerations would include: (1) each institution's past performance, current ability, and level of interest; (2) the ability to provide appropriate incentives and motivation; (3) the geographic scope needed to implement policies; (4) the duration of DSM program funding; (5) utility conflict of interests and the ability to manage those conflicts; and (6) the degree of political support for the expansion of government functions and/or the creation of new nonutility institutions (Eto et al. 1998).

Various combinations of these alternatives are also possible. For example, utilities could play an important role in facilitating DSM programs that are implemented by a private entity or government agency. Utilities could collect program revenues through a SBC, which would take advantage of their existing billing services and established customer contacts. If the fund administrator provides financing for energy efficiency upgrades to a consumer under a performance contract, utilities could even ensure repayment under the performance contract by threatening to cut off power. These creative arrangements utilize the comparative advantages provided by utilities, government agencies, and the private sector (World Bank 2000).

The newest approach in the United States, which has proven successful in Vermont and Oregon, is DSM program administration by a newly created independent entity that is selected, licensed, and regulated by the government. Because these entities are not in the business of supplying energy to customers, they avoid even the possibility of a conflict of interest between increasing electricity sales and assisting consumers in reducing their electricity consumption. They can focus all their efforts on DSM program implementation, and are subject to performance-based incentive contracts that encourage them to maximize their demand reductions.

In Vermont, the new private entity, called "Efficiency Vermont," won the DSM contract through a competitive bidding process. It administered DSM program funds raised through a system benefit charge of about 2.5 mills per kWh. In its first year, Efficiency Vermont saved residents U.S.$17.7 million on their electric bills, reducing demand by enough power to supply 3,000 homes (Cowart 2001). In light of this success, the governor of Vermont abandoned plans to build a major new power plant. Instead, he announced in September 2001 that Vermont could meet electricity demand for the next decade through a combination of renewable energy, efficiency, and small power plants (Gram 2001).

Public accountability and oversight are essential, regardless of what administrative structure China chooses. The fund administrator's procedures should be as transparent as possible to allow for public oversight of, and accountability for, program expenditures (Hagler Bailly 1998). The independent regulatory commission that China is now establishing to oversee the restructured power industry could be required, among other tasks, to ensure that expenditures of DSM funds are cost-effective.

INADEQUATE ATTENTION TO DEMAND-SIDE RESOURCES DURING RESTRUCTURING

As in many other countries, China's policy makers have focused to date on issues other than DSM during the power sector reform process. One possible reason is that China's energy crisis began to ease just as the restructuring process began. Another is that China has its hands full with structural issues such as the separation of generation and transmission and the establishment of a new pricing mechanism. A related possibility is that decision makers believe that higher energy prices and the workings of a natural market will achieve an economically rational level of investment in end-use efficiency. Yet other countries' experiences show that the lack of a market for energy efficiency is largely due to market barriers that persist after restructuring. Moreover, many of the barriers to DSM described above may be exacerbated unless they are addressed during the restructuring process.

If China fails to incorporate demand-side resources in the deliberations on power reform structure and rules, China will miss an important opportunity to develop market rules that will address barriers to DSM and achieve important national objectives such as efficient and sustainable economic development. On the other hand, the incentives for DSM in a restructured power industry can be developed or strengthened by the use of targeted regulatory and policy measures. The most effective time to do so is at the beginning of the transition period, which is a time of maximum government influence. If DSM policy tools are not added from the beginning, it will be much more difficult to add them later on in the restructuring process. The following policy tools will help utilities take full advantage of the energy efficiency resources available in China.

Recommendation: Require Distribution Utilities to Use Least-Cost Planning

Providing China's energy services in the least-cost manner should be the guiding principle governing reform of the electricity sector (RAP 2002). Several of China's policy guidelines indeed call upon utilities to implement integrated resource planning. As China begins to unbundle its generation assets from transmission and distribution assets, it should implement these policies by requiring distribution utilities to investigate whether demand-side alternatives are more cost-effective than building new transmission and distribution capacity. This would ensure that the benefits of electricity market reforms are not lost through poor investment decisions in the network. This requirement should be used in conjunction with economic incentives and revenue regulation that removes the distribution utilities' conflict of interest in pursuing DSM. SERC could evaluate the plans to ensure that they are being conducted efficiently and effectively. This policy tool would increase the demand for energy efficiency, resulting in increased business activity for ESCOs and other private and public organizations, including the financial community (Crossly et al. 2000).

A number of other jurisdictions require distribution utilities to use a least-cost IRP process to investigate whether DSM alternatives are more cost-effective than building new transmission and distribution capacity. To implement this planning requirement, distribution utilities need to obtain customer-specific retail sales data and monitor and verify DSM results. Australia's New South Wales and the U.S. states of Maine and New Hampshire have adopted this approach. Norway allows distribution utilities to recover only a portion of their investment in new network capacity, which provides a financial incentive for utilities to examine alternatives to expansion (Crossley et al. 2001).

In Canada, gas distribution utilities in Ontario must consider the full avoided cost benefits of DSM regardless of whether the gas commodity itself is procured competitively or not. This approach is intended to ensure that the decision making process captures the full value of DSM when compared to the costs of new capacity (Kushler and Suozzo 2001).

Recommendation: Incorporate Demand Response into Wholesale Markets

Demand response is a mechanism that enables consumers to actively participate in electricity trading by offering to undertake changes in their normal patterns of consumption. Demand response programs currently implemented across the United States include real-time pricing tariffs, emergency load curtailment programs, voluntary demand response programs, demand bidding programs, all source bidding (ASB), and direct load control.

Any consumer can participate in a demand response program so long as they have the flexibility to make changes to their normal electricity demand profile and install the necessary control and monitoring technology to execute bids and demonstrate bid delivery. Consumers gain a financial reward, via a direct payment for the electricity they did not consume at an agreed time or a reduced tariff or participation payment. This mechanism needs a competitive electricity market that allows demand reduction bids to compete with generation bids. Technologies must also be developed and deployed that allow customers to receive accurate price signals that form the basis of decisions to reduce or shift consumption to off-peak periods (Crossley et al. 2000).

Demand response programs have been used for years, although historically consumers have had little control over how and when they participated and did not capture the true market value of the load reduction they contributed to the system. With restructuring, demand response programs are increasingly designed and administered by different entities, involve new market participants, and are triggered by economic considerations as well as electric system considerations. Demand response programs offer many benefits to both utilities and their customers, including the avoidance of unwanted blackouts and brownouts and serious price spikes during periods of high demand. They can also reduce peak prices, mitigate risk, and ensure system stability (Energy Info Source 2002).

Demand response should be required and built directly into the structure of China's emerging wholesale markets. This was one of the strongest lessons to emerge from the California energy crisis and other markets that have suffered similar kinds of price level and price volatility problems. Large consumers, energy service companies, and distribution utilities should all be in position to quickly respond to high spot market prices in a way that helps all consumers save money. This requires China to develop competitive electricity market rules that allow demand reduction bids to compete with generation bids (Regulatory Assistance Project 2002).

For China and other developing countries in the process of restructuring their power sectors, DSM bidding of ASB can be a very effective way to introduce demand-side technologies while keeping the cost of energy supply to a minimum. Demand-side resources that can be acquired through ASB or DSM bidding programs can be solicited and contracted in smaller increments than most supply alternatives. Demand resources require much smaller construction lead time, and maximize the use of local materials and labor. DSM bidding can also be helpful in stimulating private energy efficiency markets, including the development of a local ESCO industry, in areas where there is not already an active market. Lessons learned in developed countries indicate that DSM bidding works best in areas where there is no significant overlap between the bidding program and other utility DSM programs operating at the same time. It is also critically important to describe as specifically as possible the attributes that are desired in the bidding program (Hinge 1998).

CONCLUSION

China has achieved remarkable progress in reducing the energy needed to fuel its rapid economic growth, and is continuing to develop an impressive array of programs and policies designed to accelerate energy efficiency in every sector. Yet if China is to tackle its escalating power shortages without exacerbating the environmental and health impacts of coal use that are eroding 10 percent of its GDP, it needs to take immediate advantage of all feasible and cost-effective approaches. Demand-side management is an important mechanism that can help bring supply and demand back into balance much faster and more cheaply than increasing supply. DSM can also complement and extend government, private sector, and international assistance efforts to help electricity end-users capture the full range of efficiency opportunities available today in China, and induce the development of next generation energy efficiency measures.

The barriers to DSM facing China are similar to those facing most other countries: a traditional rate design that provides a built-in disincentive to utility DSM programs; the lack of a mechanism to generate critically needed funding for DSM programs; and a lack of positive incentives that would motivate utilities to maximize energy savings. Yet as China restructures its electric power industry, it has a valuable opportunity to take advantage of the lessons learned (both positive and negative) in other countries in order to harness the benefits of demand-side resources in a manner that will suit China's particular circumstances and fulfill its own goals.

Many options exist for developing power market rules, regulatory mechanisms, incentive policies, and institutional structures that would promote cost-effective DSM and national energy and environmental goals. Recommended policies and strategies include developing a new rate design that decouples utility profits and electricity sales, establishing a DSM financing mechanism through a system benefit charge or rate recovery mechanism, and introducing performance-based regulations that provides positive incentives for utility-based DSM. These mechanisms could make DSM profitable for utilities, or at a minimum remove existing disincentives so that utilities will not block the administration of DSM programs by others.

Providing China's energy services in the least-cost manner should be the guiding principle governing reform of the electricity sector. This can be achieved by requiring distribution to use a least-cost IRP process to investigate whether DSM alternatives are more cost-effective than building new transmission and distribution capability. A variety of programs are also available to incorporate demand response into wholesale markets, including load curtailment programs, voluntary demand response programs, demand bidding programs, all source bidding, and direct load control. Experience indicates that if DSM is to be part of a restructured electricity sector, then the DSM model should be incorporated beforehand because it will likely influence the structure of the reformed power sector, and because it will be much harder to change the rules of the game once they have been established.

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APPENDIX I

ENERGY SUPPLY AND DEMAND IN CHINA

China has relied heavily on its historically abundant reserves of conventional energy, particularly coal, to fuel its rapid economic growth. However, the mix, geographic distribution, and per capita supply of conventional energy reserves are all unfavorable. China is rich in coal but relatively poor in oil and gas reserves. Per capita conventional energy reserves in China are less than half the world average, and the per capita oil reserve is only one-tenth of the world average. Moreover, most of China's conventional energy resources are located in the less populated and less economically developed regions of the north, west, and south, while the greatest energy demand is in the east and along the coastal areas. Transporting the energy to where it is needed has placed a heavy strain on China's transportation system and natural resources.

Reserves. As shown in Table 1, coal accounts for nearly 53 percent of China's conventional energy reserves, hydro-energy 45 percent, and oil and gas only 2 percent. Per capita exploitable coal reserves are less than 100 tons, about half the global average. Except for the coal-rich provinces of Shanxi, Inner Mongolia, Shaanxi, Henan, Anhui, Guizhou, and Heilongjiang, most provinces must import coal from other provinces, mostly by rail. In 2000, the total domestic coal trade amounted to nearly 367 million tons (Mt), over half of which came from Shanxi Province.

Table 1: Conventional Energy Resources (Excluding Nuclear) and Production Quantity

Energy Resource Type	Remaining Exploitable Reserve	Equivalent Coal Quantity	Production in 1999	Reserve/Exploited Ratio
Coal[*1]	114.5 billion tce	81.7 billion tce	1.25 billion tce	92
Oil[*2]	1.56 billion tce	2.23 billion tce	0.1116 billion tce	10
Natural gas[*3]	747.9 billion m3	1.0 billion tce	25.2 billion m3	330
Hydro-energy[*4]	1920 TWh/year	70 billion tce	213 TWh/year	
Total		154.93 billion tce	1.233 billion tce	126

*1 Coal production in 1998. The factor used to convert to coal equivalent is 0.714.
*2 The factor used to convert oil quantity into coal equivalent is 1.43.
*3 The factor used to convert natural gas into coal equivalent is 11.33t/kWh.
*4 The factor used to convert hydro-energy into coal equivalent is 365tce/kWh, counted on 100 years.

Some experts believe that the highest annual coal supply available in 2020 will be 2 to 2.1 billion tons, up to a maximum annual available supply of 2.8 to 3 billion tons in 2050. With increasing environmental awareness and knowledge of the ecological impact of mining and development, however, other experts believe that the current technical and economic assessments of mineral resources should be revised to consider environmental costs. For example, the China Coal Field Geology Administration has introduced the concept of “effective coal resource supply.” This can be defined in economic terms: For economically feasible coal resource exploitation to take place, environmental impacts must be limited and the external costs internalized. In other words, mine exploration must be technologically feasible, economically rational, and in compliance with relevant national environmental protection standards and practices.

The China Coal Field Geology Administration estimates that in 2010 the effective coal resource supply in China will be able to meet development goals, assuming that key coal mines will be explored by standard wells and that the coal demand does not exceed 1.4 billion tons. By 2020, however, the effective coal resource supply will be insufficient to satisfy national economic development, assuming growing power demand and continued reliance on coal. Effective coal resource supply will soon become a resource constraint on China’s coal-dominated power development (BECon 2001).

As a result, the development of new and renewable energy has become increasingly important in China. In 1996, the Ministry of Science and Technology, SDPC and SETC launched a fifteen-year program on new and renewable energy development in China. The major objectives of this program are to develop 13.4 million hectares of fuel wood plantations, supply 4 billion cubic meters of biogas to 12.35 million households, and generate 117 GWh of electricity from small hydropower stations, 4.67 metric tons of coal equivalent of solar energy, 1,000–1,100 MW of wind power capacity and 50 MW of tidal power capacity. Many investment projects and preferential policies have already been established (Interfax 2002).

Production. The total production of primary commercial energy declined in China during the Ninth Five-Year Plan (1996–2000), mainly due to a decline in coal production (Table 2). Raw coal production reached 1.36 billion tons in 1995 and hit a maximum production of 1.397 billion tons in 1996, but declined to 1.0 billion tons in 2000. China’s primary energy consumption also declined nearly 2 percent during that period (Table 3). Reasons for this decline in coal production and consumption include the closure of small coal mines and inefficient plants, a slowdown in economic growth, improved end-use efficiency, and reform of the coal and energy industries (Sinton and Fridley 2001; Streets et al. 2001).

Table 2: Primary Energy Production and Mix (% of Total Production) 1980–2000

		1980	1985	1990	1995	1998	2000
Total primary energy (108 tce)		6.37	8.55	10.39	12.90	12.43	10.90
Mix (% of Total Production)	**Coal**	69.4	72.8	74.2	75.3	71.9	67.2
	Oil	23.8	20.9	19.0	16.6	18.5	21.4
	Natural gas	3.0	2.0	2.0	1.9	2.5	3.4
	Hydropower, Nuclear power	3.8	4.3	4.8	6.2	7.1	8.0
Production 108 tce	**Coal**	6.2	8.72	10.8	13.6	12.5	10.0
	Oil	1.06	1.25	1.38	1.50	1.61	1.63
	Natural gas (108m3)	142.7	129.3	153	176	232.8	277.3
	Hydropower (108kWh)	582	924	1,267	1,868	2,080	2,212
	Nuclear (108kWh)	0	0	0	128	141	167.3

Consumption. Primary energy consumption totaled 1.28 billion tce in 2000, a 1.5 percent decrease from 1995. This translates into a yearly decrease in energy consumption of 1.4 percent over the last five years, a period when the average growth of GDP was 8.3 percent.

As shown in Table 3, China's energy consumption mix is still dominated by coal, but the percentage of coal in energy consumption declined from 75 percent in 1995 to 63 percent in 2000. In 1998, 471 million tons of coal were used for power production, more than 38 percent of total coal production. The percentage of coal used in power production is currently estimated to be more than 60 percent. In 1998, industry consumed 60 percent of all energy in China, residential and commercial uses 33 percent, and transportation 7 percent (EIA-DOE 2002).

Table 3: Primary Energy Consumption and Mix (% of Total Consumption)

		1980	1985	1990	1995	1998	2000
Total primary commercial energy consumption (108 tce)		6.03	7.67	9.87	13.11	13.22	12.80
Mix (% of Total Consumption)	**Coal**	72.15	75.81	76.20	74.4	69.6	67
	Oil	20.7	17.1	16.6	17.5	21.5	23.6
	Natural gas	3.1	2.2	2.1	1.8	2.2	2.5
	Hydropower, nuclear	4.0	4.9	5.1	6.1	6.7	6.9
Primary energy consumption (108 tce)							
	Coal	—	8.16	10.55	13.77	12.95	—
	Oil	—	0.92	1.15	1.61	1.98	—

Imports. During the last five years, China has shifted from being a net exporter of energy to a net importer. In 1995, net coal exports totaled 27 million tons and net oil imports only 12 million tons. In 2000, although net coal exports increased to nearly 57 million tons, China imported a net total of nearly 70 million tons of oil and oil products (Table 4). This corresponds to a 5 percent increase in China's energy imports during this five-year period.

Table 4: Energy Imports and Exports

	1980	**1985**	**1990**	**1995**	**1998**	**2000**
1. Total energy imports (108 tce), including	.0262	.0340	.1310	.5456	.8474	(1.2760)
Coal (108 tce)	.0199	.2307	.2003	.01635	.01586	0.202
Oil and its products (t)	.0083	.0090	.07556	.3673	.5739	.8831
2. Total energy exports (104 tce)	.2953	.5774	.5875	.6776	.7153	.6876
Coal (108 tce)	.0632	.0777	.1229	.2862	.3230	.5884
Oil and its products (108 tce)	.1751	.3630	.3110	.2455	.2327	.1871
3. Net imports						
Total (108tce)	-.2692	-.5447	-.4455	-.0188	+.2681	+.5883
Coal (108tce)	-.0433	-.0546	-.1529	-.2699	-.3071	-.5682
Oil and its products (108tce)	-.1668	-.3540	-.2354	.1218	.3412	.6960

Demand. China's Energy Research Institute has prepared an Energy Development Strategy Study, which estimates that under a business-as-usual scenario, the nation's total energy demand would reach 2.8 billion tce in 2020 and 4.2 billion tce in 2050, nearly four times the energy produced in 2000 (Table 5). The study also concludes that under an "ecological drive" scenario, the demand could rise much more slowly to 2.6 billion tce in 2020 and 3.7 billion tce in 2050.

Table 5: Energy Demand Forecast

	1998 Actual	2010	2020		2050	
			Ecological Drive Scenario	Business-As-Usual Scenario	Ecological Drive Scenario	Business-as Usual-Scenario
Total (10^8 tons coal equivalent)	15.44	19.37	26.11	27.48	37.18	41.85
Coal	60.6%	51.6%	49.2%	54.6%	26.9%	42.7%
Oil	21.4%	20.7%	17.5%	18.7%	20.0%	25.2%
Gas	1.8%	6.9%	10.2%	7.8%	10.8%	8.0%
Nuclear	0.3%	2.0%	3.8%	2.9%	11.6%	5.2%
Total renewable	19.7%	18.8%	19.3%	16.0%	30.7%	18.9
Hydro	5.0%	5.8%	6.9%	5.8%	7.5%	5.8%
Traditional biomass	14.4%	7.2%	7.2%	3.4%	1.1%	1.1%
New energy	2.26%	6.6%	11.1%	8.6%	24.1%	14.1%

APPENDIX II

ENERGY EFFICIENCY OPPORTUNITIES IN CHINA

Industrial Efficiency Opportunities

Much of the end-use electric energy saving potential is in industry, which accounted for 75 percent of total electricity use in 1995. One ton of steel produced in China consumes twice as much energy as a ton of steel produced in the United States and three times more than in Japan. The per-unit energy consumption by less advanced Chinese companies is four times the consumption of the most advanced companies. If China upgraded the production technology used in the iron, steel, cement and ammonia industries alone, the production capacity would increase by 10 to 20 percent without any increase in energy consumption.

Motors. About 60 percent of the total electricity consumed in China is consumed by electric motors, which are used to drive mechanical equipment such as fans, pumps or compressors. Yet the overall technology level of motor-driven systems is equivalent to that of developed countries during the 1960s. Three quarters of China's motors are small and medium-sized, of which 70 percent are inefficient J-series motors representing late 1950s technology. The Y-series motor that China developed in the early 1980s approached international standards in many respects, but had an efficiency of about 87 percent, an improvement of only 0.4 percent over the J-series motors. The Yx-series motors China developed in the late 1980s has an efficiency of 92 percent, approaching the 94.5 percent efficiency of the motors used in the United States, but their share in China is minimal (ACEEE 1997).

The International Energy Conservation Research Institute calculates that improving the efficiency of Chinese motors to the level reached in the United States would save 33 terawatt hours (TWh) of electricity. The American Council for an Energy-Efficient Economy estimates that the widespread use of high-efficiency motors and appropriate motor speed controls can reduce motor energy use in China by approximately 15 percent, reducing nationwide electricity use by nearly 10 percent (ACEEE 1997).

Fans, Pumps, and Air Compressors. According to a study report on energy efficiency of Chinese industries, fans, pumps and compressors together accounted for 40 percent of industrial electricity consumption in the early 1990s. The level of design, manufacture, and operation of this equipment, however, is only one-third that of advanced countries. The main problems affecting the efficiency of fans, pumps, and compressors are an inappropriate match between motor drives and machines, incomplete field testing, irrational piping and lining arrangements, and incorrect management and maintenance. Strictly enforcing national standards regarding the economic operation of fans, pumps, and air compressors would save about 20 to 30 percent of their energy use. Switching to variable speed drives alone would increase energy efficiency by more than 25 percent. Increasing the efficiency of this equipment by only one-third would save about 30 TWh of electricity each year.

Electric Furnaces. Electric furnaces, which are used for smelting and heat treatment, consume 5 to 7 percent of the nation's electricity. About 90 percent of the electric arc furnaces used in smelting are old, highly inefficient equipment. Retrofitting these furnaces would save about 10 to 20 percent of their energy use. For heat treatment furnaces, substituting medium frequency furnaces for power frequency induction furnaces would save about 30 percent of their electricity use. Retrofitting low temperature heat treatment and drying furnaces with infrared heating technology would save about 25 percent of their electricity use. Retrofitting all inefficient electric furnaces would save an estimated 9 TWh per year.

Steel Production Equipment. China has 500 steel enterprises, with nearly 1,000 rolling mills and large numbers of mining lifters and roller mills. Substituting transistorized converters for frequency converter units would increase efficiency by 20 to 25 percent, while the use of variable frequency speed regulators would save about 30 percent of the electricity used. Retrofitting all power utilization equipment with electronic technologies would save about 8 TWh per year.

Electric and Internal Engine Locomotives. Substituting variable frequency speed regulators for DC traction systems in electric and internal engine locomotives would improve the power factor by 20 to 40 percent and the system efficiency by 6 to 7 percent. This translates into energy savings of about 2 TWh each year.

Electrolysis and Electroplating. The production of most nonferrous metals, such as aluminum, copper, nickel, and zinc, as well as some chemicals like chlorine and alkaline, involves electrolytic processes using high power rectifiers. Replacing these rectifiers with highly efficient electronic technology could save more than 2.5 TWh. Substituting pulse power for DC power in electroplating would save time, materials, and electricity, as well as improve electroplating quality, with an additional annual electricity savings of 2.5 TWh. The combined electricity savings for both electrolysis and electroplating would be around 4 TWh per year.

Electric Welders. China has 3 million electric welders, with an electric consumption of about 0.8 to 0.9 percent of total electricity. About 30 percent of the electricity consumed by these welders could be saved by (1) substituting power electronic silicon rectifier and transistorized thyratron for ignitron, (2) substituting secondary rectify resistance welders for AC welders, and (3) developing cordless DC and converter power source dual function DC arc welders and inverter welders. Retrofitting one million welders would save 1.8 TWh of electricity.

Building Efficiency Opportunities

Space Heating. According to the Ministry of Construction, China currently consumes about 130 million tons of standard coal equivalent (tce) per year just for space heating of urban residential and commercial buildings. Most of this energy is wasted. According to the World Bank, although comprehensive analyses have not been conducted, residential buildings in China consume 50 to 100 percent more energy for space heating as compared to buildings in similar cold climates in Western Europe or North America and still provide far less comfort. Heat loss through exterior walls, which is the greatest single source of heat loss in these buildings, is about 3 to 5 times as high in Chinese buildings as in similar buildings in Canada and other northern countries (World Bank 2000).

Lighting. More than 10 percent of China's total electricity consumption is used for lighting. Ninety percent of residential lighting is from inefficient incandescent lamps. Substituting high-efficiency fluorescent lamps for incandescent lamps would save about 75 percent of the electricity used. Replacing induction ballasts with electronic ballasts would save 39 percent of the electricity used. According to the International Energy Conservation Research Institute, if 55 percent of residential lighting used fluorescent lamps—as is the case in Japan—and all used electronic ballasts, 15 terawatts would be saved annually.

Electric Appliances. As living standards improve, the use of electric appliances grows dramatically. The total stock of refrigerators grew from 4 million in 1985 to 60 million in 1996, and refrigerators now account for half of all residential energy consumption. Television use grew from 7 to 80 sets per hundred households in cities and townships, and from 12 to 101 sets per hundred households in rural areas. Air conditioner use in cities and townships grew from 8 units per hundred households in 1995 to 31 units per hundred households in 2000. According to official forecasts, national residential electricity consumption will hit 360 TWh in 2010. Improving the efficiency of this consumption by only 3 percent would save up to 10 TWh per year.

APPENDIX III

CHINA'S LAWS AND REGULATIONS RELATED TO DSM

1. Law on Energy Conservation, promulgated on November 1, 1997, effective January 1, 1998 (selected provisions)

Selected Provisions

Article 5. The state makes energy conservation policies and compiles energy conservation plans, which shall be incorporated into the national social and economic development plan, consistent with economic development and environmental protection.

Article 9. The State Council and local governments at various levels should enhance their leadership in energy conservation, and on an annual basis deploy, coordinate, supervise, review, and promote energy conservation efforts.

Article 10. The State Council and People's governments of provinces, autonomous regions, and municipalities directly under the central government should, according to the principle of giving importance to energy conservation and energy exploitation, putting energy conservation first, choose in an optimal way energy conservation and energy exploitation investment projects, and develop energy investment plans, based on a technical, economic, and environmental assessment of energy conservation and energy exploitation.

Article 11. The State Council and People's governments of provinces, autonomous regions, and municipalities directly under the central government shall arrange energy conservation funds from capital construction and technical retrofit funds to support rational energy utilization and exploitation of new and renewable energy sources.

Article 12. Special assessment of rational energy utilization should be included in the feasibility analysis reports of fixed capital investment projects.

Article 13. New industrial projects that employ backward technology, consume excessive amounts of energy, and waste energy significantly are prohibited from being constructed.

Article 14. The administrative agency of the State Council in charge of standardization formulates national standards of energy conservation.

Article 15. The authorized energy conservation agencies of the State Council, in association with relevant agencies of the State Council, should enhance supervision of sectors producing large numbers of widely used energy-consuming products, and urge them to apply energy conservation measures, make efforts to improve product design and manufacturing technology, and reduce energy consumption per physical unit of production within these sectors.

Article 16. The responsible energy conservation management authorities at and above the provincial level, in coordination with relevant departments at the same level, shall set limits in terms of energy consumption per physical unit of product, for products that are energy-intensive to produce.

Article 17. The state applies a system for discontinuing backward, over energy-intensive, energy-consuming products and equipment.

Article 18. Enterprises may voluntarily apply to the product quality supervision and management agencies of the State Council or to the relevant certification agencies, in accordance with relevant national product certification regulations, for energy saving quality certification for their energy-consuming products.

Article 19. The statistical agencies of the People's governments at and above county level, in association with relevant agencies at the same level, organize statistics on energy consumption and utilization, publicize periodically statistical bulletins, and report energy consumption per physical unit of production for major energy-consuming products, etc.

Article 20. The state shall enhance energy conservation management in key energy-consuming entities. The responsible energy conservation management agencies of the State Council, in association with relevant agencies of the State Council, formulate energy conservation requirements, energy conservation measures, and management methods for key energy-consuming entities.

Article 21. Based on the principles of rational energy use, energy-using entities shall strengthen energy conservation management capabilities, formulate and implement energy conservation technical measures, and reduce energy consumption.

Article 22. Energy-using entities shall enhance energy audit and management and establish and improve energy consumption statistics and systems of analysis in energy conservation.

Article 23. Energy-using entities should establish an energy conservation responsibility system and grant awards to groups and individuals who make achievements in energy conservation.

Article 24. Entities producing energy-intensive products should comply with legal limits for energy consumption per physical unit of product.

Article 25. Entities or individuals producing or selling energy-using products shall stop producing and selling energy-using products that the state has determined will be discontinued or discharged.

Article 26. Organizations and individuals producing energy-using products shall display energy conservation labels or indicators on product specifications and product identification.

Article 27. Organizations and individuals producing energy-using products shall not use forged certificates or labels of energy conservation quality, or use misleading information on the label.

Article 28. In accordance with national regulations, key energy-using organizations shall submit reports of energy use periodically.

Article 29. Key energy-using organizations shall establish energy management positions and select qualified energy management personnel.

Article 30. Employees as well as rural and urban residents shall comply with national regulations to meter and pay for energy used. It is prohibited to use energy for free, or charged at a fixed fee.

Article 40. Each economic and management sector shall formulate sectoral energy conservation technology policies, develop and popularize new energy conservation technologies, techniques, equipment and materials, limit or discontinue use of old and outdated technologies, techniques, equipment, and materials with high energy consumption rates.

Article 41. The energy conservation management department in the State Council, in coordination with relevant departments of the State Council, shall: formulate common and sectorally detailed energy conservation technology indicators, requirements, and measures, modify them in ways consistent with technological and economic goals and needs, increase energy-use efficiency, reduce energy consumption, and help the nation step-by-step to achieve advanced international levels of energy utilization.

2. Electric Power Law promulgated on December 28, 1995, effective April 1, 1996 (Selected Provisions)

Article 5. The construction, production, supply, and utilization in relation to electric power shall abide by the principles of protecting the environment according to law, adopting new technology, decreasing the discharge of harmful substances, and preventing pollution and other public hazards. The state encourages and supports the use of renewable and clean energy resources for electricity generation.

Article 9. The state encourages the adoption of advanced technology and management methods in the construction, production, supply, and consumption of electric power, and shall reward units or individuals that have made significant achievements in research, development, and/or application of advanced science and technology and management methods.

Article 10. The planning for electric power development shall be drawn up according to the requirements of the national economy and social development and shall be incorporated into the national economic and social development plan. The planning for electric power development shall reflect the principles of rational use of energy resources, coordinated development of electric sources and electric networks, improvement of economic results, and conducive to environmental protection.

Article 24. With respect to supply and consumption of electric power, the state shall implement the management principles of safe, economical, and planned power consumption. The procedures for supply and consumption of electric power are subject to formulation by the State Council pursuant to the provisions hereof.

Article 31. A consumer should install a metering device [to measure] its power consumption. The amount of electric power consumed as adopted by the consumer should conform to the amount as recorded by a metering device that has been approved according to law by a meter rating organization. The design, installation, and operations management of a consumer’s device [for measurement of] consumed electricity should comply with standards [established by] the state or electric power industry standards.

Article 32. No consumer may endanger the supply or safe use of electricity or disturb the regular order of electric power supply and consumption. In the event of such threat to the supply or safe use of electricity or disturbance to the regular order of electric power supply and consumption, the Power Supply Enterprise has the right to halt [such abuse].

Article 33. A Power Supply Enterprise should assess electric power fees to its consumers in accordance with the electricity price ratified by the state and the recorded [usage] as shown by the metering device in use. A consumer should pay electric power fees in accordance with the electricity price ratified by the state and the recorded [usage] as shown by the metering device in use.

Article 34. Power Supply Enterprises and electricity consumers should obey the relevant regulations of the state and take effective measures to implement safe, economical, and planned consumption of electric power.

Article 41. The state shall implement electricity pricing [system based on] different types of usage and different [consumption] times. The standard for defining usage types and the method of calculating consumption times are subject to determination by the State Council.

Article 42. The standards for assessment of fees based on a consumer's increased capacity are to be formulated jointly by the State Council's Electricity Department and its department in charge of pricing administration.

Article 44. Any unit or person is forbidden to levy surcharges in addition to the electricity price; however, if otherwise provided in laws and administrative regulations, such provisions shall apply. For surcharges in addition to the electricity price on electricity produced by locally funded power enterprises, the people's governments of the provinces, autonomous regions, or municipalities directly under the central government shall formulate measures therefore in accordance with the relevant regulations of the State Council. Any power-supplying enterprise is forbidden to collect surcharges in addition to the electricity price on other's behalf.

Article 49. Local people's governments at the county level and above and their departments for comprehensive economic administration should, when allocating quotas for electricity consumption, preserve an appropriate ration between the consumption of electricity [earmarked] for agriculture and by rural communities [in general] and should give priority to electricity consumption for the purposes of flood diversion, drought protection, and seasonal agricultural activities required for production in rural communities. Electric Power Enterprises should carry out the above provision in their allocation of electricity consumption, and may not reduce electric power quotas for [other] agriculture of rural communities.

3. Law on the Prevention and Control of Atmospheric Pollution, promulgated September 5, 1987; amended in 1995 and April 2000

Article 19. Enterprises shall give priority to the adoption of clean production techniques that are instrumental to high efficient use of energy and to reducing the discharge of pollutants so as to decrease the generation of atmospheric pollutants.

Article 25. The relevant departments under the State Council and the local People's governments at various levels shall adopt measures to improve the urban energy structure and popularize the production and utilization of clean energy.

Article 30. Where any newly built or expanded thermal power plants and other large or medium-sized enterprise that discharge sulfur dioxide more than the prescribed standards for pollutants discharge or the quota of total control allow, supporting facilities for desulphurization and dust removal must be installed, or other measures for controlling the discharge of sulfur dioxide or for dust removal must be adopted.

In the acid rain control areas or sulfur dioxide pollution control areas, if an existing enterprise discharges atmospheric pollutants more than the standards for pollutants discharge allow, the discharge of atmospheric pollutants of the enterprise shall be controlled within a time limit.

Construction Law, promulgated November 1, 1997, effective March 1, 1998

Article 4. The state supports construction sciences research to improve the designing level and encourage energy conservation and environmental protection and advocate for the use of advanced technologies, equipment and processes, new building materials, and modern management methods.

Rules on Electric Power Supply and Use, State Council Order No. 196, issued April 17, 1996, effective September 1, 1996

Article 5. The state [government] will implement, for the electric power supply, and sue the management principle of using the electric power in a safe, saving, and planned way. Power Enterprises and Users shall obey the relevant regulations, take effective measures, and make the works in respect of using the electric power in a safe, saving, and planned way to be well done.

Article 26. Users shall install [their] power consumption metering devices. The capacity and energy consumption shall be determined by the records of a power consumption–metering device recognized by a measurement verification organization pursuant to the laws. Such metering device shall be installed at the boundary point between the titles of a power supply facility and a power receiving facility.

Article 27. Power Enterprises shall compute the electricity charges payable by their Users according to the electricity rates approved by the state [government] and the consumption records measured by a metering device.

Article 29. The electric power administrative departments of the People's governments above county level shall implement the state industrial policies and shall work out the plan of electric power use in accordance with the principle of overall planning and all-around consideration, securing key [Users] and supplying power to those that are outstanding [profit-making Users]. Both Power Enterprises and Users should lay down their own projections in respect of power saving and should promote and utilize new technology, new materials, new techniques, and new equipment in connection with power saving so as to reduce electric power consumption.

Article 30. No User shall have any following actions hazardous to the safety of power supply or use and actions disturbing the order of normal power supply and use: (1) voluntarily changing the type of power use; (2) voluntarily overconsuming the capacity as provided in a [power supply and use] contract; and (3) voluntarily overconsuming [the capacity or energy] amounts as allocated pursuant to a [power supply and use] plan.

Power Conservation Management Provisions, State Economic and Trade Commission, and State Planning and Development Commission promulgated and effective December 29, 2000

These joint regulations cover power energy efficiency improvements and rational electricity use.

Chapter Three: Power Demand-Side Management

Article 15. Defines DSM as power management measures that meet the same power performance through improving power efficiency and optimizing power utilization at the side of end-users while reducing power consumption and demand, with a view to energy conservation and environmental protection.

Article 16. Requires economic and trade commissions to facilitate DSM efforts. Measures shall be taken to conduct load management at the side of end-users and extend interruptible load management and direct load management, so as to make full utilization of off-peak power supplies.

Article 17. Encourages a range of power conservation technologies.

Article 18. Power planning and integrated resources planning should include DSM.

Article 19. Efforts should be made to expand the application of double-layer rate systems by gradually raising basic rates and reducing kilowatt-hour rates; expedite the extension of time-of-use rates and expand the time difference; research, develop, and extend interruptible load rates.

Article 20. Power users that apply power saving electric products recommended or certified by the state may apply to provincial pricing and power administrative bodies for reduction or exemption from capacity charge. Key power saving technologies and products shall be entitled to preferential tax policies promulgated by the state.

Article 21. Utilities shall enhance efforts to popularize and facilitate DSM. The cost of these [education] efforts may be covered by their management budget.

Regulations on Developing Combined Heat and Power, State Development and Planning Commission, State Economic and Trade Commission, Ministry of Construction, and former MFI

Regulates combined heat and power technical indicators and exempts from grid fees new or expanded CHPs that meet the technical indicators.

Regulations on the Formulation and Assessment of the "Chapter on Energy Conservation" in Feasibility Studies of Fixed Asset Investment Projects, effective January 1, 1998

Article 2. Feasibility studies of fixed asset investment projects shall include a "Chapter on Energy Conservation," which shall be assessed by qualified construction firms.

Article 3. The "Chapter on Energy Conservation" shall analyze the energy consumption level of construction, equipment, and processes of the project, as well as efficiency and energy consumption indexes of energy-using products.

Article 4. State industrial policies and state and sectoral standards of energy conservation shall be implemented in newly constructed, transformed, and expanded projects.

Article 5. Specific requirements for rational utilization of energy and energy conservation contained in existing construction and technical standards shall be revised every five years.

Top Level Power Supply Enterprise Qualification Standards (tentative), State Power Corporation, issued in 2001

These standards stipulate that top-level power supply enterprises must take active steps to launch DSM programs in a planned and effective manner.

Research Office of the State Council, Reference of Policy-Making Recommendations on Expediting the Promotion of DSM (August 21, 2002)

Demand Side Management (DSM) refers to power management activities aimed at energy conservation and environment protection through improving power efficiency of end-users, optimizing ways, and altering the timing of power use. DSM represents one of the advanced energy management techniques that is widely extended in the rest of the world, particularly extensively adopted in the Western developed countries.

Worldwide energy shortage and aggravating environment problems in the late ’70s gave rise to DSM. DSM application in China has achieved some progress and experience over last decade. Under the new circumstances of the utilities restructuring and surmounting peak load, priority significance should be attached to how to take more effective measures to facilitate DSM (in China).

1. Strategic Significance of DSM to the Sustainable Development of China’s National Economy

Implementation of DSM will be beneficial to the country, the utilities, users, and all participants. From a social perspective, DSM may stimulate upgrading and retrofiting of power-use equipments, reducing pollutant emission and lowering energy consumption ratio of per unit GDP, thereby facilitate sustainable economic development.

From the perspective of power users, DSM may help reduce their energy bill and cost of production, and improve competitiveness of their products.

For distribution companies, DSM may help remove the pressure of load adjustment at peak hours. It may greatly reduce the need of blackouts, especially in the context of shortage of power supply, thus improving load ratio and operation safety of grids.

For power plants, DSM may maintain smooth operation of power generating equipments, improving the efficiency and lowering cost of power generation.

By and large, DSM represents a low-cost and efficient power management tool that benefits sustainable economic development.

The developed countries have been attaching great significance to DSM and have achieved gigantic benefits from the implementation, such as the United States, Japan, Canada, Germany, France, Italy, etc. Over the last two decades, the United States has developed a series of laws, decrees and incentive policies to facilitate the extension of DSM. Take the year of 2000—962 power utilities companies are participating in DSM projects and more than 20 million people are involved. This effort in the United States has saved 53.7 billion kWh and cut peak load by 22 million kW, which greatly mitigated the pressure during peak hours.

China began its effort to research and implement DSM in the early ’90s. SETC established Energy Efficiency Information Dissemination Center in 1998, disseminating and extending DSM programs. SPC also set up its DSM Steering Center to promote DSM application. SETC and SPC jointly developed Regulations of Power Conservation in 2001; SETC issued the Steering Opinion on Facilitating DSM in 2002, which represents a major step of DSM in China. Under the policy support and macro-steering of relevant government bodies, some power enterprises have been working with their customers, ESCOs, research organizations, and equipment manufacturers on extending DSM programs by developing several pilot projects, which has accumulated some successful experience and laid the foundation for overall implementation of DSM.

In general, China is remaining in the beginning stage of introducing and extending DSM. There is a big gap between current DSM progress and the demand of power conservation. China has a promising prospect of DSM application. It is estimated that 40 billion RMB (Chinese dollar) could be saved from power source construction should 10 million kW (some 3 percent of installed capacity nationwide) of peak load nationwide be shifted through effective management. International experience and DSM market potential in China shows that this aim is quite possible.

2. Main Elements and Management Tools of DSM

DSM is a system project with a wide range of elements being covered. The fundamental elements include: investigation of power efficiency resources, identifying management objects, setting up management targets, development of policies, regulations, standards, selecting management means, developing plans, project implementation, assessment of project outcome, etc. Main management measures of DSM are:

2.1 Technical Means:

Technical means refer to production processes, materials, equipment, and techniques that are conducive to energy efficiency, load adjustment, and environment protection, *e.g.* energy-efficient lighting fixtures, energy-efficient motors, energy-efficient transformers, thermal storage electric boilers, electric vehicles, electric bicycles, energy-efficient and environmentally friendly appliances, heat/ice storage technologies, energy-efficient speed adjustment technology, efficient heat insulation techniques, ultra-infrared heating technology, power generation with surplus heat and pressure, tri-generation, and power load control technology. Use of such techniques may achieve obvious improvement of power efficiency on the part of end-users in a view to cut and shifting of peak load, control of peak load demand, and improving load ratio of grids.

2.2 Financial Means:

Financial means refer to specialized government fiscal allocations aimed at the implementation of DSM, which mainly include loans at discounted or low interest rates, price rebates, free installation (of energy-efficient devices), refund of power efficiency benefit, special awards of power efficiency, and competitive bidding of power efficiency projects. These are the main tools to expand the energy efficiency market and improve the vitality of energy efficiency efforts.

2.3 Pricing Means:

Pricing means refer to the use of a pricing mechanism to directly stimulate power users to positively participate in DSM. Based on the need of peak load management, different forms of power tariffs have taken shape in the rest of the world, *i.e.*, time-of-use rate, seasonal prices, prices for holidays, capacity-based adjustable tariff, load-based price, heat-storage price, interruptible price, and real-time price, etc.

2.4 Guiding Means:

Guiding measures are meant to rationally guide the activities of power users to the benefit of power efficiency and rational consumption. Main guiding measures include publicity of energy efficiency knowledge, dissemination of energy efficiency information, energy efficiency consultancy services, seminars on energy efficiency, exhibitions of energy efficiency products, and publicity of energy efficiency policies.

2.5 Administrative Means:

Administrative means refer to the development of laws, regulations, standards, and policies on the part of relevant government bodies to harness power consumption and market behaviors. Administrative means are meant to make use of administrative power of governments to promote energy efficiency, constrain waste of energy, and protect resources and environment by ensuring healthy development of DSM.

3. Outstanding Problems of DSM Application in China

The extension of DSM in China still faces several issues that call for priority attention.

3.1 Allocation of Responsibilities for DSM:

DSM is closely linked with various walks of life. The current inadequate necessary coordination mechanism affects the depth and width of the extension of DSM. As a result of the utilities restructuring, grid companies and power generating enterprises are now separated and both are aimed at profit-making. They both tend to expect their customers to increase power use while neither of them is interested in energy efficiency on the part of the users or would exercise DSM on a voluntary basis. Under the new circumstance of the utilities restructuring, therefore, we will be facing a realistic problem of lacking the main player of DSM.

3.2 Shortage of Policy and Funding Support:

Implementation of DSM in other countries is backed by government policy support. Usually 1 to 3 percent of power bills are used to support DSM in these countries. In spite of existing Law of Energy Conservation and Regulations of Power Conservation among other laws and regulations, DSM effort in China is still in short of supportive policies of relevant departments of finance, taxation, pricing, and standards.

3.3 Variant Power Tariff System Meant to Encourage DSM Is Yet to be Established:

China is still pursuing a power tariff management regime that was developed years ago. The prices of power generation and sell remain being checked and ratified by relevant government bodies, which does not include any necessary flexibility in power pricing or lead to a reasonable variant power tariff system. Because of the lack of pricing temptation, customers are not interested in DSM, and so result in difficulties for DSM implementation.

4. Recommendations

The implementation of DSM in China should be seen as a task of strategic significance.

4.1 To Develop Regulations of DSM to Clarify the Main Policies and Work System of DSM Effort: It is necessary to develop a system of “government taking the lead with participation of all relevant parties,” clarifying that power grid companies, with corresponding incentives, be the main players of DSM implementation after the utilities restructuring.

4.2 To Establish Rational Power Tariff System: It is recommended to pursue time-of-use prices, to increase the volume of customers of load valley and seasonal power prices, to increase the discrepancy of peak/valley load and seasonal prices, to appropriately increase base power tariff, to gradually extend interruptible power price, etc.

4.3 To Develop DSM Public Welfare Fund: Fundraising could be based on the practice of System Benefit Charge exercised in other countries. One to 3 percent of power bills will be pooled for DSM exclusively. In order to avoid the possible increase of a power tariff, a proportion of Urban Surcharge that is levied with the power tariff may be extracted at current stage. Fundraising and spending of DSM public welfare fund should be put under the regulatory supervision of relevant government bodies in terms of fund management, contract management, program planning, evaluation of project outcome, auditing supervision, etc.

4.4 To Make Full Use of Intermediary Bodies: It is recommended that a further role should be given for SETC Energy Conservation Information Dissemination Center and DSM Center of SPC to play in terms of DSM project recommendation, information dissemination, and policy publicity. Necessary funding and policy support should also be provided to these bodies.

4.5 To Develop Quality Standards of Power-Use Equipment. It is also recommended that efforts should be made, through mandatory national standards, to phase out outdated power-use equipment and expedite the extension of energy-efficient and technology-intensive products and equipment.

Announcement of Issuing Management Measures for Electricity Conservation, State Economic and Trade Commission, and State Development and Planning Commission, Joint Circular No. 1256 (2000)

1. Local economic commissions, in collaboration with other relevant government bodies, should utilize various means to promote the healthy development of DSM work in their respective areas, including using industry policies, tax policies, and pricing policies. Through induction, coordination, monitoring, and providing services, they should mobilize various resources, actively develop the market, and encourage stakeholders to participate in and benefit from DSM. Where conditions allow, they should immediately carry out well-coordinated and organized testing and demonstration in order to gain experience before scale up the effort.

2. Each provincial grid operator should systematically study its local situation for DSM and provide timely suggestions to pertinent central government departments. Power DSM should be integrated into grid development plans and be placed at the same importance level as the expansion of generating capacity. DSM can raise grid capacity and generator utilization, thus increasing economic efficiency of system operation.

3. Utilities should strive to implement DSM. Based on electric power resources and demand levels within their respective service regions, utilities should gradually establish information networks on electric power DSM. They should disseminate, advocate, and introduce electric power DSM technology, knowledge, and demonstration projects, through appropriate means, at such places as their custom service centers and exhibition rooms. The aim is to guide end-users to adopt a scientific way of consuming electricity and use advanced electric technologies, appliances, and materials.

4. Electricity users, especially large users, should increase their awareness on resource conservation and environmental protection, and actively seek to use technologies and equipment that are energy-efficient, energy saving, or can store energy for use during peak hours. Through technology upgrading and enhanced management, end-users can optimize their usage patterns, reduce electric consumptions, cut production costs, and raise economic benefits.

5. Local economic commissions should encourage, guide, and support, as appropriate, energy service and conservation institutions and energy dealers to play an active role—using their technological and managerial expertise—in such activities as DSM advocacy, energy audit, energy conservation monitoring, information dissemination, project consultancy, bidding, procurement, technical exchange, training, etc.

6. Technologies and products for power DSM should be able to offer the following: peak shaving to optimize grid operation, improving energy use structure, reducing environmental pollution, and increasing energy use rate.

7. Technologies and products to be immediately promoted include:

- Power load management technologies;
- Heat and cold energy storage technologies;
- Green lighting technologies;
- Energy-efficient home appliances;
- Heat pump and gas and steam combined cycle power generation technologies;
- Ultra-infrared, microwave, or high power/mid frequency inducted heating technologies;
- High power/low frequency electric source metallurgical technologies;
- Speed adjusting operation technology for alternate current electric motors;
- High efficiency fans, water pumps, electric motors, and transmitters;
- Heat treatment, electric plating, molding, and oxygen production technologies;
- Non-power automatic supplement technology;

- High efficiency batteries; and
- Renewable energy power generation technologies.

8. Local economic commissions may develop more detailed implementation plans according to local conditions.

Jiangsu Province Power DSM Implementation Measures (trial), promulgated and effective March 20, 2002

Chapter 1. Summary

1. In order to further carry out the “Saving Electricity Manage Measure,” which is issued by State Economic and Trade Commission and State Planning Commission, strengthen our provincial DSM and improve the efficiency of electricity consumption, balance peak load and valley load, optimize resource configuration, protect environment, ensure the sustainable development of national economy, according to “Law of Electric Power in the People’s Republic of China,” “Law of Energy-Saving in the People’s Republic of China,” and “Several Notions About Enhancing Power DSM Work,” which are issued by National Economic and Trade Commission, we set down the measure.

2. Power DSM, which is named in the measure, means the power demand-side management activities by which improving terminal electricity consumption efficiency and optimizing the consumption mode, decrease electricity consumption and power demand in the fulfillment of same functions, so as to save energy, protect environment, and provide power service in low cost.

3. Power DSM work is involving aspects as law and legislations, standard, finance and tax, price etc., which are relating to the optimal configuration of resources and sustainable development, relating to the economic benefits of power investors, suppliers, and users. Economic and Trade Commission in all levels must enforce the guidance, supervision, and management in power DSM work, and associate with other departments to make full uses of the means of administration, technology, and economy, draw up policies and plans, and implement demonstration projects to promote the healthy and sound development of power DSM work to develop healthy by setting down policy, layout, and carrying out model demonstration.

4. Provincial Economic and Trade Commission administrates the whole provincial power DSM work and is responsible for the organization to draw up power DSM policy, standard, plan and working mechanism, and supervises and instructs the DSM work of the whole province.

Every authority at the prefecture and county level with the duty of power electric regulation takes charge of supervising and instructing implementing power DSM work in their respective areas.

5. Power supply companies are the implementing entity for DSM promotion. They shall establish instruments and mechanisms for DSM promotion according to national related laws and policies. And shall assist government to establish related policy, measure, plans, and standards and implement them.

6. Power consumers, especially highly electric-consuming enterprises, must build up awareness of energy-saving and protecting the environment, and actively adopt DSM technology or equipments, optimize electric-using mode, decrease electric-consuming, reduce production cost, and improve the economic efficiency.

Chapter 2. Publicity and Instruction

7. Economic and Trade Commission at all levels must encourage and back up the research and extending application of DSM technology, and must strengthen the DSM publicity and its training.

A special chapter, which contains publicity contents, methods, capital requested, etc., in the DSM Implementation Scheme must be included.

Actual effects must be fully recognized for DSM publicity activities, and take full advantage of mediums to encourage the customer a more rational power consumption.

8. Power supply companies at all levels shall actively cooperate with government to carry out DSM publicity and hold various activities to provide information and experiences of power DSM technology for the customers.

9. Power consumers shall actively participate those DSM publicity activities sponsored by government.

Chapter 3. Plan and Implementation

10. Economic and Trade Commission at all levels shall fully incorporate decreased power consumption and the reduced electric load and shifted peak load as the results of DSM program into the power industry development plan and annual balance plan respectively.

11. Provincial Power Company must systematically study the situations of provincial DSM work and propose its suggestions on related policies and program advice to the government. It must translate the demand resource into supplier-substituted resource by cutting peak load and filling valley load to improve the equipments and generators efficiency so as to realize the efficient, reasonable, and sufficient use of the existing productivity.

Power supply enterprises at prefecture or county level takes charge of idiographic implementation and report the implementing information to the superior power administration department and power supply enterprises to put on records, according to the power DSM scheme issued by Provincial Economic and Trade Commission and in the instruction of local power administration management department.

12. Economic and Trade Commission at all levels takes charge of supervising and checking the implementation status of the DSM layout and plan.

Chapter 4. Technological Measures

13. The technology and products used in power DSM should meet the following requirements: to cut peak load and fill valley load, to optimize the operation mode of the power system, to realize the economical operation of the power system, to improve the consumption structure and reduce the environment pollution, and increase the energy efficiency.

14. To encourage the following power DSM measures:

a. Popularize the Green-lighting technology and products and cost-efficient electric apparatus;
b. Spread the application of electricity heat-saving and cool-saving technology; Reduce the power plant station service and the power supply line loss and avoid the unknown loss;
c. Encourage the generation by the residual heat, residual pressure, and new energy, support the clear and high-efficiency heat-electricity cogeneration, heat-electricity-cool cogeneration, and all-round utilization power plant.
d. Extend the economical operation mode of electrical apparatus;
e. Expedite the update and reconstruction of low-efficiency fan motors, pumps, motors, and transformers, and increase the operation efficiency of the power system;
f. Spread high-frequency-controlled silicon voltage regulator and energy-saving transformer;
g. Extend AC motor speed regulation and energy-saving technology;
h. Popularize the specialization product in such technology as heat treatment, galvanization, foundry, oxygen-make, and so on.
i. Spread the heat pump, gas-steam jointed circulation generation technology;
j. Extend the infrared ray and microwave heating technology;
k. Spread reactive power automatic compensation technology.

15. The power supply company shall establish the entire power DSM technology and information support system, and enhance the research and promotion of the new

technologies in demand analysis, reasonable power consumption evaluation, power consumption derived service, and load transferring.

16. The new industrial and commercial customer with more than 100KVA power load should be actively encouraged to utilize the load management system.

Chapter 5. Policy Measures

17. In order to carry out the country's energy strategic guideline—put the same emphasis upon the development and the conservation, but place the conservation in priority status, the power DSM special fund should be set up gradually. The special fund will be used in power DSM publicity, training, exhibition and the market investigation, technology research and promotion, typical customer incentive, demonstrative project, project evaluation and consultation service, etc.

18. To mitigate the contradiction of the gap between peak and valley, it should speed the promotion of time-of-use (TOU) tariff policy for peak and valley period, gradually implement the said TOU tariff policy to all large industrial customers, commercial customers, and special industrial customers, and shall successfully implement the experimental projects for those electrical resident regions adopting TOU tariffs.

19. Encourage the power customer, especially the system in which the cool load accounts for a very large proportion, and the heat load is little, and the system in which there isn't urban and region heat source and the oil-fired and coal-fired devices are restricted by environment protection and fire protection, to apply the power energy-saving technology in order to cut peak and fill valley and alleviate the environment pollution.

20. Carry out the interruptible load tariff and enlarge the experimental unit of two-parts tariff in the area that is seriously short of peak load.

21. Electrical power-saving products listed in the high-tech and new product brochure of country and province can enjoy the preferential policy according to the provision.

22. Electrical power-saving technology is listed in the urban environment protection measures to mitigate the air pollution and improve the air quality.

23. Power supply enterprises shall incorporate the research, application, and promotion of the electrical power-saving technology in its technology and science development plan.

Chapter 6. Award and Punishment

24. Economic and Trade Commission at each level shall establish the award and punishment mechanism to award the group and individual with prominent achievements in power DSM.

25. Power supply enterprises and power customers shall also stipulate the awarding methods to award the department and individual with distinct contribution in power DSM.

26. The organization or company whose power consume per product is above the highest permit, which applied the low-efficiency and high power consume technology and device explicitly ordered to be washed out by the country in new or update project, which produced, sold, or transferred the low-efficiency and high power consume technology and device explicitly ordered to be washed out by the country, shall be published and criticized beside the punishment, according to the country's relative provisions.

Chapter 7. Miscellaneous Articles

27. This provision shall be implemented on the same day when it is published.

APPENDIX IV

INTERNATIONAL EXPERIENCE WITH DEMAND-SIDE MANAGEMENT

More than 30 countries around the world have successfully applied DSM to increase energy savings, reduce the need for new power plants, improve economy and reliability in power network operation, control tariff escalation, lower customer electric expenses, save energy resources, and improve environmental quality. DSM has become an important strategy for achieving sustainable energy and electricity development. Specific applications differ in each country according to local conditions.

United States. Energy efficiency has made a tremendous contribution to the economic growth of the United States since the Arab oil embargo of 1973. Total U.S. primary energy use per capita in 2000 was almost identical to that of 1973. Yet over the same time period, economic output (GDP) per capita increased 74 percent (Nadel and Geller 2001). By 2000, reduced "energy intensity" (compared with 1975) was providing 40 percent of all U.S. energy services. This made energy efficiency America's largest and fastest growing energy resource—greater than oil, gas, coal, or nuclear power. Since 1973, the United States has received more than four times as much new energy from savings as from all net expansions of domestic energy supply combined (Lovins 2002).

In 2000, U.S. consumers and businesses spent more than U.S.$600 billion for total energy use. Had the United States not dramatically reduced its energy intensity since 1973, they would have spent at least U.S.$430 per capita more in energy purchases in 2000 (Nadel and Geller 2001).

Over the last two decades in the United States, many states used IRP to compare the benefits and costs of DSM with the costs of additional generation. These IRP programs led states to generate a network of utility DSM programs that together avoided the need for about 100 power plants with 300 MW (Prindle 2001). The average initial cost of efficiency was less than one-half the cost of building new power plants. Utilities report that their average cost of implementing electricity savings of all kinds has been about 2 cents per kWh. In comparison, each kilowatt-hour generated by an existing power plant costs more than 5 cents. Delivered power from a nuclear plant can cost as much as 20 cents per kWh (Lovins 2002).

In the late 1980s, more than 1,300 DSM programs were conducted in the United States, which together curtailed 0.4 to 1.4 percent of peak load, corresponding to a demand growth rate of 20 to 40 percent. Between 1985 and 1995, more than 500 utilities conducted DSM programs, curtailing 29 GW of peak load. Up to the mid 1990s, U.S. utilities increased their investment in DSM each year, from U.S.$900 million in 1990 to U.S.$2,700 million in 1994, corresponding to 0.7 to 1 percent of average sales revenue.

The uncertainty brought on by impending electric industry restructuring caused DSM spending to drop dramatically during the 1990s. Total U.S. utility spending on all DSM programs (*i.e.* energy efficiency and peak load reduction) fell by more than 50 percent. Yet a total of U.S.$1.4 billion was still spent on utility energy efficiency programs in 1999, due primarily to the adoption of system benefit charges (Nadel 2000).

A number of other new approaches to DSM have emerged since restructuring. Texas, for example, is pioneering the idea of an "energy efficiency portfolio standard," analogous to a renewable portfolio standard, whereby utilities are required to derive a certain percentage of their energy from renewable sources, such as solar or wind. Texas requires regulated utilities to acquire energy efficiency equivalent to 10 percent of each year's growth in electricity demand.

Other International Experience (Crossley et al. 1998; World Bank 2000; Eto et al. 1998):

Argentina. Argentina deregulated and substantially privatized its power sector in 1992. Distribution utilities are seen as a natural delivery vehicle for DSM, with direct customer contact, proven skills, and access to financing. However, the revenue structure provides a disincentive to distribution utilities to provide DSM given that profits are linked to revenues. One notable success is public lighting upgrades in Buenos Aires, where a distribution utility operated as an ESCO to provide expansion and enhancements of public lighting without increasing energy use. Argentina is now participating in the ICF/GEF-sponsored multi-country Efficient Lighting Initiative (see below).

Australia. More than half of Australia's electricity comes from cheap domestic coal sources and is being used for large-scale aluminum and other metal refining activities. Energy intensity is high and energy efficiency low due to cheap electricity. Even after restructuring, utility DSM initiatives are leading to the growth of energy service companies. New South Wales, Australia's largest state, has introduced several innovative DSM mechanisms, including licenses for the supply and distribution of electricity. These licenses require the electricity businesses to develop and implement DSM and environmental strategies. New South Wales has also capped revenue from wire transmissions in order to break the link between sales and revenue.

Belgium. A 2002 Flemish decree for the promotion of energy efficiency sets energy efficiency targets for grid managers that must be realized at the customer level. Flanders and Wallonia have introduced certificate markets to support combined heat and power (CHP). Flanders is establishing a quota-based certificate system for the promotion of CHP, with a target to install an additional 1,198 MW by 2005 (IEA 2003).

Brazil. Brazil has restructured its power sector to provide competition for generation and retail supply while regulating the monopoly transmission and distribution functions. Legislation calls for utilities to invest one percent of net revenues in energy efficiency projects. The government established a separate agency to administer DSM programs, including pilot projects with utilities. Total DSM investments in 1998 and 1999 totaled U.S.$112.7 million.

Denmark. Denmark obtains 72 percent of its electricity from coal, and is working to replace coal with natural gas and renewable resources. Distribution companies must conducted Integrated Resource Planning and prepare DSM plans every second year, as well as a 20-year plan on efficient electricity use. Denmark has established an Electricity Savings Fund, which is financed by a small surcharge (DKK 0.006 per kWh) on residential and public service sector tariffs (SBC). The fund, which totals approximately DKK 90 million a year, identifies and supports energy efficiency projects, including conversion from electric heating to combined heat and power (CHP). Today every thermal power plant in Denmark supplies heat, and every industrial boiler generates electricity.

European Union. The Council of the European Union is in the process of drafting a Directive on Energy Efficiency-Demand Side Management. This directive would require each member state to achieve a certain minimum level of energy efficiency improvements through EE-DSM programs. Each state would be free to determine which policy mechanisms to adopt to meet that target. The draft directive recommends a minimum target energy savings level of one percent per year below the consumption in each member state the previous year, expressed in TWh/year per member state. The target also includes a recommended minimum level of investment for EE/DSM programs from each member state of 2 percent of the total net revenue in that member state from electricity and natural gas sales to final customers. The EE-DSM program investments must be additional to energy efficiency activities financed from the state budget at present. The member states should also support the development of a market for EE-DSM services (Wuppertal 2003).

France. France has carried out 19 regional and three national DSM pilot programs to date. The programs promote energy-efficient appliances and compact fluorescent light bulbs, energy efficiency audits in industry, public lighting, and efficient industrial motors. Guadeloupe achieved a 20 percent decrease in peak load through an efficient lighting campaign (IEA 2003).

Greece. Greece obtains 64 percent of its electricity from coal, 12 percent from fuel oil, and 10.5 percent from hydropower. Demand for power is expected to grow almost 3 percent a year over the next 20 years. Greece has a vertically integrated monopoly electricity industry and is using IRP to develop a medium-term, least-cost energy plan that includes all energy sectors and explores the possibilities for exploiting renewable energy resources and DSM.

Hong Kong. The SAR government established a framework for DSM implementation in May 2000 by signing agreements with the two power companies in Hong Kong: the Hong Kong Electric Co. Ltd. and CLP Power Hong Kong Ltd. The purpose of these programs is to influence the level or timing of public demand for electricity and to optimize the use of Hong Kong's power generation facilities. Hong Kong recognizes that reducing peak demand lessens the need for new power plants, lowers tariffs in the long term, and helps to protect the environment.

There are currently three main types of DSM programs in Hong Kong. Energy efficiency programs encourage customers to reduce peak demand and overall electricity consumption through improved consumption patterns and purchase of energy-efficient appliances. Peak shaving programs encourage peak load reduction, and load shifting programs shift consumption from peak periods to off-peak periods. DSM activities include education and information programs and time-of-use tariffs for bulk commercial users. The Electrical and Mechanical Services Department (EMSD), in conjunction with the Economic Development and Labour Bureau, monitors the performance of these programs over the three-year implementation period and coordinates the development of future initiatives (EMSD 2003).

India. India currently faces a peak power capacity shortage of about 13 percent, and approximately 10 percent of the total electricity demand is left unserved. Chronic power shortages have resulted in low voltage supply, involuntary load shedding, and installation of captive generation by consumers. India views DSM as a means of making more existing generation capacity available to connect new customers. Although a few electric utilities in India have begun some DSM activities, the experience and capacity for undertaking DSM is very limited. India's DSM action plan includes near-term capacity building activities and feasibility studies, followed by implementation of identified DSM projects and eventual expansion of DSM coverage to all electric utilities in the country. The expected savings in five years are 955 million kWh/year, equivalent to 160 MW avoided capacity (BEE-India 2003).

Indonesia. Indonesia's DSM program focuses on shaving the peak load, which primarily comes from household lighting, street lighting, and household electric appliances. The government believes that the effective implementation of DSM and labeling will cost less than building and operating new power plants to meet peaks in electricity demand. Although the government recognizes the importance of DSM and labeling, financial constraints have limited the implementation of current programs. The Directorate General of Electricity and Energy Utilization (DGEEU) is now planning/implementing programs to install efficient lamps in homes and street lighting and improve public awareness of DSM. The expected savings in five years are 955 million kWh/year, equivalent to 160 MW avoided capacity.

Ireland. Ireland launched its DSM program in 1991 in order to delay future investment in power generation and reduce environmental emissions. This program achieved 324 GW in energy savings and 250,000 tons of CO_2 emission reductions between 1997 and 2000.

Following market restructuring, in which 40 percent of the Irish electricity market is now open to competition, Ireland modified its DSM program structure. The Commission for Electricity Regulation (CER) agreed to allow ESB Customer Supply funding for ongoing EE programs within ESB's regulated revenue stream as the public electricity supplier. ESB also agreed to report efficiency savings on the basis of lifetime savings rather than for a single year.

Italy. Distribution companies are required to implement end-use efficiency improvement measures in order to reach quantitative energy saving targets. The targets become progressively tighter over a five-year period, ranging from 0.3 Mtoe of energy savings in 2002 to 1.60 Mtoe in 2006. These targets apply to all distribution companies providing electricity to more than 100,000 end-users. The quota of energy savings to be achieved by a single distributor is proportional to the ratio between the electricity it distributes at the local level and the total electricity distributed at the national level. Distributors who do not achieve their assigned energy savings targets must pay fines.

DSM projects designed to comply with these requirements may be implemented by the distributors directly, through companies owned or controlled by the distribution companies, or through ESCOs. Distribution companies can recover the costs of their DSM programs through the national carbon tax and through tariffs paid by all end-users (SBC). Italy expects that by 2006 these DSM programs will achieve a greenhouse gas emission reduction of 7.3 Mtoe (IEA 2003)

Italy is also developing the concept of energy efficiency certificate trading, an emerging market-based mechanism designed to combine the benefits of regulation with the economic efficiency of market-based trading mechanisms. A number of the mechanisms described above, including DSM performance standards and DSM license conditions, may lead to the development of tradable units of energy efficiency, sometimes known as "negawatts," that could be sold into power pools. If this market develops, utilities may be able to trade energy efficiency certificates as a profitable commercial activity (IEA 2002).

Japan. Japan is dependent on fossil fuels (52 percent) and nuclear power (40 percent) for electricity production. At present, the main concerns of the Japanese government are cost reduction and reducing greenhouse gases. The government's efforts to lower the electricity price may lead to electric industry restructuring. Peak load shifting and load management activities are considered essential. Electric utilities often use their own revenues to provide energy efficiency consulting services, lease equipment, and subsidies for investment in energy efficient equipment. The purpose of these activities is to improve both the load factor and the public image of the electricity businesses.

In 1998, Japan selected 800 random households for installation of real-time meters that showed power consumption in terms of both volume and cost. These households reduced their electricity consumption by an average of 20 percent over the previous year. Based on this success, Japan established a Committee on Advanced DSM to study possible measures, particularly in the fast-growing residential/commercial sectors. The committee is investigating measures to encourage users to install more accurate meters, systems to encourage energy conservation, such as time-of use rates policies to promote businesses that support EE activities, and policies to encourage users to invest in energy-saving equipment (IEA 2003).

Malaysia. In Malaysia, utility-sponsored DSM initiatives, particularly tariff incentives, have had an impact on efficient utilization and consumption. Current DSM programs are based on commercial principles emphasizing information services, working with customers, and obtaining profits from DSM services. The national power utility, Tenaga Nasional Berhad (TNB) implements a DSM program, which aims to upgrade economic sectors using state-of-the-art energy-efficient technologies; build public confidence and create a market for energy-efficient products and services; develop small-and medium-scale enterprises to supply new energy-efficient products and services to support and sustain the program; and transfer the benefits of DSM to other relevant sectors.

Major energy efficiency/DSM programs that have been carried out or planned include:

- Pilot DSM marketing of the “Smart Saver” brand;
- Product testing and development for DSM Marketing;
- TNB model buildings (all TNB buildings must undergo energy audits and implement cost-effective measures; all new TNB buildings must incorporate energy efficiency);
- TNB-California Electric Commission Joint DSM Project (preparation of a long-term DSM plan for TNB; implementation of DSM demonstration projects);
- Promote Shared-Saving Programme (promotion of shared-saving schemes in conjunction with energy consultants; assistance will be given by TNB to recover payments through electricity bills);
- Development of direct customer load control system (conduct of pilot project to control air conditioning loads in several TNB buildings in Kuala Lumpur and Petaling Jaya using telecommunications-activated—radio or pager signal—control system);
- Community Outreach Programme (training of local contractors in the installation and maintenance of energy-efficient technologies; competent contractors will become TNB panel contractors);
- Public competition (conduct of energy-efficient appliances competition);
- Energy optimisation scheme in University Malaya;
- EE and demand-side management (DSM) programs by TNB Groups (ASEAN 2003).

Mexico. With support from GEF, the national electric utility of Mexico (Comision Federal de Electricidad, or CFE) executed a successful efficient lighting program. CFE set up an independent trust fund to purchase high quality CFLs at a significant discount and sell them directly to consumers at a reduced price. The utility set specific performance criteria that ensured high-quality lamps at a price comparable to those of lower-quality lamps. Results of this project indicate that DSM programs can deliver a large number of CFLs, distribution through utility officers is feasible, bulk procurement can lower retain costs, and large programs can spur further replication of DSM programs (Martinot 2002).

Netherlands. Gas and electricity distribution companies (grouped together as EnergieNed) are responsible for implementing the national environmental action plans. The latest plans include a carbon dioxide emission reduction target of 17 million tons in 2000. EnergieNed helps small-scale end-users reduce their energy use through advisory services and subsidy schemes. Targeted end-user groups include households, public and office buildings, and industry. These DSM programs are financed by a SBC, called a MAP-levy, of up to 2 percent of the energy tariff (IEA 2003).

New Zealand. New Zealand established an energy saver fund in 1995 as part of restructuring to support residential sector energy efficiency programs. Local utilities, government agencies, and others compete for the funds in a series of bid cycles. The program is funded by a NZ $1.5 to $1.8 million annual appropriation from the central government (IEA 2003).

In 2001 the government proposed a package of electric utility restructuring bills that, among other things, require the new Electricity Governance Board to ensure that its rules promote demand-side participation in the wholesale market. The governance board is moving quickly to establish a real time market so that users can see and respond immediate to changes in price, as well as facilitate demand-side bidding.

Norway. In the mid 1990s, utilities established regional energy efficiency centers in each of the 19 counties in Norway. Utilities could collect a supplementary charge on transmission tariffs at the lowest grid level to finance the EE activities of these centers. In 2002, Norway replaced the regional centers with a single organization, Enova, to coordinate all energy efficiency activities. Funding for Enova DSM activities comes from a SBC fee on the electricity distribution tariffs and from government grants total funding will come to about NKr 5 billion over a 10-year period. The income is collected in a separate energy trust, established on January 1, 2002, which Enova will administer (IEA 2003).

Peru. After restructuring, Peru now has 16 generating companies, six of which are state-owned, and 13 distribution companies, 75 percent of which are private sector owned, with the remainder state-owned. Peru has participated in a Global Environment Facility (GEF) lighting program and a product certification program involving national standards. System load factor has been substantially increased and system losses reduced to approximately 10 percent. Distribution companies are seen as needing to be active entities to help address customer problems and improve their energy utilization.

Philippines. The Philippines is in the process of restructuring its electricity sector, and already has more than 100 distribution companies consisting of cooperatives and private utilities. A government directive requires every electric utility to submit DSM plans to the regulatory agency for approval. Not all of the utilities have complied with this directive, due in part to a lack of incentives and in-house capacity.

There is an ongoing initiative to review, amend, and improve the 1996 DSM Regulatory Framework due to the uncertainties, challenges and opportunities with the liberalization of the power industry. To date, the national DSM program has remained in the pre-implementation stage. By 2011, however, an estimated cumulative potential energy savings of 1.2 MMBFOE will be generated from the DSM program. All the energy efficiency programs in the power sector will defer the construction of 450 MW of additional plant capacity (ASEAN 2003).

Singapore. In addition to a voluntary green labeling scheme, Singapore has launched a one-year accelerated depreciation tax initiative. The focus is on replacing primary building equipment such as cooling systems, boilers, and pumps. Businesses can accelerate the depreciation of this equipment and thus enjoy significant tax savings.

South Korea. South Korea is dependent on fossil fuels (65 percent) and nuclear power (27 percent) for electricity production. The government is emphasizing various kinds of energy conservation policies to improve the country's balance of trade and reduce its reliance on overseas fuel imports. The government is also committed to diversifying its energy resources and balancing supply and demand. Korea is opening some portions of its electric industry to competition. It encourages DSM activities by enabling utilities to include the cost of DSM activities, such as rebates, price reductions, and administration, in the operating expenses account to compensate the utility for part of lost revenue.

The Korea Electric Power Company (KEPCO) has implemented a number of load management programs, including peak dipping, peak shifting, load shaping, and DSM tariff systems. KEPCO recently instituted a successful rebate system for high-efficient appliances. The Korea Energy Management Corporation (KEMCO) also has a variety of programs to encourage end-use efficiency, including financing, incentives audits, information services, basic surveys, analysis, and preparation for climate change. In 2001, KEMCO conducted DSM activities for electricity, gas, and district heating systems. Power DSM projects included Efficiency Optimization with the Operation of Cool Thermal Storage System, End-User's Electric Power Consumption Trend Using Load Curve, "The Application of Capacious Inverter," and the "High Intensity Discharge Demonstration Project (KEMCO 2003).

Spain. Electric industry restructuring is under way. Spain has set forth specific DSM and IRP requirements in its Electricity Act. Under these provisions, distribution companies have conducted at least 10 DSM programs throughout the country, with a focus on residential lighting and appliances and industrial motors and reactive controls. The goals of the programs were energy efficiency and better customer service. Program costs are recovered through an SBC surcharge to the tariff. As of 1998, total benefits were estimated as 35,725 MWh per year in energy savings, 52 MWh in peak reduction, and 21,625 MWh per year in off-peak shifting.

Sri Lanka. The World Bank's International Development Association (IDA) and the Global Environment Facility (GEF) have included a DSM component in the 1997–2001 Sri Lanka Energy Services Delivery Project. The DSM component is aimed at building the capacity of the Ceylon Electricity Board (CEB) through:

- Design and implementation of a code of practice for energy-efficient commercial buildings;
- Development of institutional capacity in the energy-related public and private sectors to incorporate the code of practice into building design and operations and to monitor the energy savings;
- Demonstration of energy efficiency building design through design competition incentives; and
- Support to CEB in implementation of a DSM strategy and load research program.

This project involves load research equipment procurement as well as international and local expertise to advise and train the various stakeholders (government agencies, building associations, owners, and developers) involved in the process (CITE).

Sweden. Sweden obtains 41 percent of its electricity from nuclear power, 37 percent from hydropower, and 19 percent from fossil fuels. As environmental issues become increasingly important, Sweden is working to improve its energy efficiency and increase its use of renewable energy. Utilities are using their own funds to win new customers, particularly larger customers, by providing performance contracting and other energy services.

Taiwan. Taiwan's total installed capacity grew an average of 6.5 percent from 1990 to 2001, while peak load grew by an average of 5.6 percent during that time period. Load management programs enabled Taiwan to reduce its peak load by 4,336 MW in 2000. Taiwan provides a variety of financial incentives for investments in energy conservation equipment, including tax credits, low interest loans, and accelerated depreciation (ITRI 2002).

Thailand. In 1993, the EGAT launched a U.S.$189 million DSM program with partial financing from a tariff adjustment mechanism. The remaining funding came from GEF, Australia, and Japan. From 1993 to 2000, the DSM program succeeded in reducing peak load by an aggregate of 556 MW, or 4 percent of EGAT's total 1999 capacity. Cumulative annual energy savings were 3,140 GWh, representing more than double the original energy savings program targets. The program also reduced carbon dioxide emissions by 2.32 million tons per year (ESMAP 2000).

The Thailand DSM project helped to completely transform the fluorescent light market, increasing its market share from 40 to 100 percent over the course of the project. In addition, the market share of efficient refrigerators went from 12 to 96 percent, and the share of efficient air conditioners went from 19 to 38 percent (Martinot 2002).

In addition to customer-oriented programs, the DSM Office initiated three complementary programs: (1) end-use load research to create end-use profiles, determine future end use priorities and better estimate program impacts; (2) Integrated Resource Planning to catalogue end-uses and DSM measures for each sector and assess expected impacts, costs effectiveness, and technical feasibility, and (3) a DSM management information database (ESMAP 2000).

A detailed ESAMP evaluation revealed a number of lessons learned from Thailand's experience that could prove useful to other countries, including the recommendation that, in those countries that still have vertically integrated utilities, any introduction of DSM efforts should explicitly involve the distribution staff and provide for gradually shifting appropriate DSM program responsibilities to distribution utilities as reforms progress to make use of their established and unique customer relationships (ESMAP 2000). Other lessons learned include:

- The need for a formal process based on market research to identify, select, implement, and evaluate programs;
- The value of proper baseline data and end-use profiles to adequately determine end-use priorities, program selection, and evaluation impacts;
- The fact that DSM program approaches from other countries cannot be implemented without adaptation for Thailand, although alternative approaches should be tested;
- The need for DSM program champions with strong management skills that can market the programs to utility management and to the public in order to gain the necessary support. Utilities should also work to insulate DSM programs from periodic management changes;
- The need for clearly defined DSM objectives and priorities, both long term and short term, which will determine how the program develops;
- The need to consider potential restructuring and tariff issues when designing the DSM program. DSM program financing should be designed to accommodate eventual pricing reforms and include appropriate regulation, oversight, institutional, and incentive mechanisms (ESMAP 2002);
- Clear links should be established between utility DSM programs and other government EE programs and financing efforts to ensure adequate coordination.

United Kingdom. In 1992, following electric sector restructuring, the United Kingdom established an independent, nonprofit Energy Saving Trust (EST) to design and oversee DSM programs. Its primary mandate was to reduce carbon dioxide emissions through energy efficiency. During the first four years of the DSM program, the UK power sector collected U.S.$165 million from a wires surcharge, or system benefit charge, and invested it in more than 500 energy efficiency projects. Estimated electricity savings totaled more than 6,800 GWh, which is equivalent to the annual electricity consumption of 2 million UK households.

Under the UK Utilities Act of 2000, both gas and electricity suppliers are required to meet specific energy efficiency targets and encourage or assist domestic customers to implement energy efficiency measures. The overall energy savings target (known as the Energy Efficiency Commitment) is 62 TWh, with half of the savings targeted at customers receiving benefits or tax credits. The government regulator is responsible for administering the commitment, apportion the overall target to each supplier, determine which EE measures quality, quantify savings, and monitor suppliers' performance against their targets (IEA 2003).

Vietnam. A 1997 study revealed a DSM potential of 1,100 GWh of peak demand and 5,309 GWh of annual savings by the year 2010. The Electricity Agency of Vietnam (EVN) and the International Institute of Energy Conservation launched a DSM program in 1999. Project goals included developing a DSM implementation capability and load research capability, expanding energy efficiency standards, and developing energy-efficient building codes.

The World Bank and GEF have been engaged in a phased, 12-year (1998-2010) DSM program in Vietnam. The goals of the project are to achieve a more than 120 MW reduction in peak electricity demand over three years at a cost of less than one-tenth of the investment required to build a new power plant. EVN is installing 5,600 time-of-use meters in approximately 4,000 large- and medium-sized customers and piloting the use of voluntary direct load control programs to curtail demand from about 2,000 customers. The project also aims to save about 500 GWh by selling 1 million compact fluorescent light bulbs to local households located in areas of high load and network congestion.

EVN expects an almost threefold increase in demand over the next decade, from nearly 26,000 GWh in 2001 to more than 70,000 GWh by 2010, representing an annual demand growth of 13 to 15 percent. EVN believes the DSM program is essential in order to meet the country's growing energy needs and minimize local and global environmental impacts (World Bank 2003).

GEF Multi-country Efficient Lighting Initiative. The International Finance Corporation and GEF launched an Efficient Lighting Initiative in 1999 to promote market expansion for energy-efficient lighting in Argentina, the Czech Republic, Hungary, Latvia, Peru, Philippines, and South Africa. Utilities have been involved in the program in a number of countries, either by selling or leasing CFLs, providing direct loans to ESCOs and manufacturers, or facilitating loans through accredited local banking intermediaries.

The results of this program indicate that utilities in developing countries can be willing and interested partners in market transformation programs. These partnerships appear to be most successful when utilities have sufficient motivation to participate in a DSM program, whether for peak reduction, demand reduction, or public relations reasons. Although utility participation is not essential, utilities can be valuable partners because they can reach end-users in an efficient manner, facilitate consumer education, and provide consumer finance. A decision on whether to include utility partners, however, requires careful consideration of any utility's corporate culture and existing incentive structure in order to avoid slow decision making, political influence, and uncertainties and an emphasis on maximizing electricity sales (Martinot 2002).