Demand-Side Management Strategic Plan for Jiangsu Province, China: Economic, Electric and Environmental Returns from an End-Use Efficiency Investment Portfolio in the Jiangsu Power Sector

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ABSTRACT

Jiangsu's electric system strains to keep up with growing power demand. Reliability has been compromised, consumers have sacrificed, money has been wasted, economic growth has been depressed and the environment has suffered. Jiangsu can reverse these trends by investing in a portfolio of very low cost demand-side management (DSM) opportunities. This paper is based on a report showing how Jiangsu can save electricity for less than half the production cost, resulting in more reliable service, lower costs, an improved economy and a cleaner environment.

This paper demonstrates that sustained investment in the comprehensive demand-side portfolio of end-use energy-efficiency investment throughout Jiangsu's power sector firmly supports national policy. Full portfolio investment would make a major contribution toward China's goal of quadrupling its economy while only doubling electricity supply and would directly support the national government's 10-year plan to bring the energy intensity of China's economy in line with it major trading partners.

Implementing the entire portfolio would reduce China's total coal consumption by 167 million metric tons in 2015, eliminating 613 and 8.6 million metric tons of carbon and sulfur oxides emissions that otherwise would pollute China's environment. Reducing pollution normally comes at a cost: these impressive pollution reductions come at a net cost reduction.

This paper discusses the status of the joint project underway by the Jiangsu Provincial Economic and Trade Commission and the Natiuonal Reform Development Commission (NRDC) to build a policy and regulatory structure that will allow energy efficiency to serve as a fundamental component of DSM, including the potential for Clean Development Mechanism (CDM) funding.

Overview

China continues to experience high growth in electricity demand as its economy continues to expand at roughly 10 percent annually. In its eleventh Five-Year Plan, Jiangsu foresees 7.4% annual growth in electric energy demand, and 8.5% growth in peak power demand. The national government has stated its goal for China to reduce its energy intensity (energy consumption per unit of Gross Domestic Product - GDP) 20 percent by 2010. China has successfully pursued aggressive pricing and load management strategies to offset some of the growth in peak demand. China is just beginning to undertake the planning, regulatory, and administrative steps necessary to procure energy-efficiency savings in sufficient quantities to avoid the additional supply that would otherwise be needed to support its continued economic development and expansion. Jiangsu Province has taken the lead in developing, advancing, and implementing a strategic plan for procuring as much cost-effective energy and peak demand reductions as possible with Efficiency Power Plants (EPP) – large-scale demand-side management programs using financial and technical strategies to knock down barriers to market adoption of energy-efficiency technologies.

Much of the demand growth in Jiangsu Province is driven by new building construction and increased use of residential and commercial air conditioning, as well as high industrial load growth. Heavy industrial electric consumption and China's very successful use of load management have led to very high average load factors on Chinese grids (80-90% compared to 55%-65% in the United States – U.S.). High load factors suggest that, while load management efforts have been aggressive and successful, the potential for additional economic gains from load management is relatively small, and comes with negative effects on economic development. Energy efficiency, by contrast, can reduce both peak demand and long term energy consumption, while avoiding disruptions to economic output.

Long experience with energy efficiency programs in North America and around the world demonstrate that energy efficiency can provide energy and capacity to the electric system in much the same way that a base load power plant does, but at lower cost. Whenever they operate, high efficiency end-use equipment and systems provide benefits in the form of avoided demand and, in this sense, are always available when needed. Because of this, end-use efficiency programs can be designed to deliver the energy equivalent of conventional power plants. DSM is well proven in the U.S. and other nations to significantly reduce electric loads and reduce or reverse electric load growth at costs substantially less than conventional generation. For example, during its energy crisis of 2001 California reduced its peak summer electric usage by about 14% with little lead time.[1]

Increased energy efficiency is a top priority for China. Energy efficiency can be captured at less than half the cost of conventional power generation. In addition, it brings other benefits, including reduced environmental emissions, reduced demand on coal supplies and distribution, increased reliability of transmission and distribution systems and economic development. However, there are many barriers that prevent end users from investing in more efficient lighting, appliances, buildings, motors, and processes. Policies need to be developed and implemented to overcome these barriers.

China has made significant progress using government codes and standards to mandate moderate increases in efficiency of many types of energy-using equipment, including new lighting efficiency standards enacted last year. However, standards tend simply to "bring up the bottom" by ensuring the worst offenders improve efficiency to a moderate level. As a complement to these efforts, this Sino-US project focuses on pushing the market to higher levels of voluntary efficiency through design and delivery of demand-side management DSM) efficiency programs. Our project has assessed efficiency opportunities and programs in multiple markets and all sectors (residential, commercial and industrial) in Jiangsu Province.

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[1] Kushler, M. and Vine, E., (2003), Examining California's Energy Efficiency Policy Response, American Council for an Energy Efficient Economy.

Through cooperative efforts among the Natural Resources Defense Council (NRDC) , the Jiangsu Economic and Trade Commissions, State Power Corporation DSM Instruction Center, Energy Foundation, the China-U.S. Energy Efficiency Alliance and The Regulatory Assistance Project, we are developing a comprehensive inventory of energy efficiency resources and a variety of options to enable these resources to be delivered, beginning in 2006 and into the future. We are in the process of helping Jiangsu prepare first-stage implementation plans for launching two EPP initiatives in 2006 investing 100 million yuan (US $12 million) in funds earmarked by the ETC.

This paper describes the preliminary discussions regarding the organizational structure and funding options, summarizes the initiatives, and provides the anticipated savings, costs and cost-benefit analysis for the demand-side management portfolio based on the 2005 report DSM Strategic Plan for Jiangsu Province. This report was prepared in accordance with a Memorandum of Understanding between the Jiangsu Provincial Economic and Trade Commission and the Natural Resources Defense Council on Cooperation on DSM Strategic Planning. In September 2005, Jiangsu also signed an Agreement on DSM Cooperation with the California Public Utility Commission and the California Energy Commission, which will be implemented by NRDC and the China-U.S. Energy Efficiency Alliance.

The Energy Efficiency Resource

The size of the resource

Large and cost-effective opportunities for electric efficiency improvements exist in all markets in China. While the initial set of recommended programs for Jiangsu may not address all electric efficiency opportunities, it does focus on the biggest and most important. Over time, we envision initiatives could be expanded to more comprehensively address certain areas.

Criteria used to select initial markets included:

- Opportunities that offer the largest potential savings (such as industrial motor systems improvement)
- Opportunities that are particularly time sensitive, and if not captured would be lost for a long time (such as new building construction)
- Markets and end-uses that are driving Eastern China's explosive load growth (such as commercial and residential new construction, and new industrial loads)
- Technologies and markets that have high value in terms of system peak demand reductions (such as commercial and residential cooling and lighting)
- Markets where China has built some momentum and created market transformation opportunities through the use of standards and labeling (such as residential lighting and appliances)
- Markets where DSM experience elsewhere has demonstrated proven strategies for success

The project team analyzed current electric loads, and how they break out by sector and major end use (such as industrial process, cooling, heating, lighting, etc.). While industrial is by far the largest sector in terms of electric use, the rapid growth rates in commercial and residential sectors require attention in those sectors as well. For this paper and the associated study, we define sectors in terms of the ultimate end use of the electricity and the facility it is used in. This diverges from the standard Chinese classification based on ownership. For example, while a hotel owned by a manufacturing company in China would normally be classified as industrial, we have classified it as commercial. Similarly, we classified as residential an apartment building providing housing to industrial workers and owned by the industry. These shifts result in significantly greater electric loads being classified as "commercial" than is typically reported in official sectoral data.

The recommended programs for Jiangsu address the following broad markets:

- Industrial efficiency opportunities (all end-uses including motor-drive systems, non-motor process, and building end uses)
- Industrial and commercial transformers
- Residential and commercial new construction
- Existing residential and commercial building cooling, heating and lighting
- Residential appliances

Programs specific to these markets are described in greater detail follow.

Over the next 10 years, the planned DSM portfolio offers anticipated cumulative annual savings of 30,633 GWh and 12,133 MW in Jiangsu. Detailed program and portfolio savings and economic impacts are shown in the following tables and graph.

Designing DSM programs to tap efficiency resources

Each recommended program uses marketing, delivery and financial strategies that apply the best practices of DSM programs in North America and elsewhere to conditions in China. Together these strategies will increase the adoption of high-efficiency process technologies, lighting, cooling, heating, motor systems, transformers, and appliances by overcoming the many barriers to efficiency.

DSM market barriers in China are similar to those in other countries and together result in a strong bias against considering long-term cost savings at the expense of higher up-front capital costs. Chinese manufacturers of high-efficiency lighting and cooling equipment do not routinely sell these units in China because of low demand for the equipment. Evidence from DSM experience elsewhere demonstrates that marketing, technical assistance and financial strategies directed as end users, equipment vendors, engineers, architects, building owners, and developers can substantially increase the use of high-efficiency equipment. The many barriers to efficiency, such as lack of information, high transaction costs and risk perception, can be overcome with multiple DSM strategies. Provision of a multi-pronged DSM approach including aggressive marketing; detailed and customized analysis; financial strategies, potentially including cash incentives, financing and leasing or alternative purchase arrangements; and project coordination and facilitation services, have been successful and are proposed to be used here.

To capture lasting market changes many different strategies must be deployed, in varying amounts among multiple market actors at different levels (such as designers, developers, builders, contractors, manufacturers, distributors, suppliers, vendors, and end users). Addressing the full market mechanisms throughout the distribution channel will help ensure success influencing these markets. For example, financial assistance to building owners might fail if the efficient products promoted are being manufactured only for export, and not stocked by local distribution units. Similarly, ensuring that efficient products for new construction are commercially available will not matter if architects and engineers are not specifying this equipment.

Our approach to program design is to: 1) address the full market process and barriers; 2) devise strategies based on proven methods used in DSM programs elsewhere; and 3) recognize and respond to important market, financial, technical and cultural differences between China and other countries that may impact transferability. This last point is critical to the success of DSM in China, and requires careful consideration. For example, reliable and consistent efficiency certification and testing standards do not exist for many products, so traditional promotion techniques may not be possible because consumers will not always know when a product qualifies for the program. The personal banking practices in China may create another barrier to residential rebate programs that have been commonly employed in North America and elsewhere. Special attention is being paid to address these and other issues.

In designing the recommended programs we have considered two distinct types of market transactions:

- "Market-driven" investments involve upgrading efficiency choices in transactions already underway as part of normal market events
- Discretionary "retrofits" involving the early retirement of existing equipment and systems before they would otherwise naturally be replaced, purely to capture efficiency benefits

Market-driven opportunities include new building construction, expansion or remodeling of existing facilities, retooling manufacturing processes for new product lines, normal scheduled replacement of existing equipment, and replacement of equipment at the time of natural failure. These events offer the opportunity to improve efficiency and save electricity at modest cost premiums compared to the total costs of building construction and equipment installation. These so-called "lost opportunity" resources require time-sensitive strategies because if not captured at the time of the natural market event they are typically either impossible or prohibitively expensive to capture later. Because of Eastern China's explosive building and industrial growth, as well as large increases in residential living standards and equipment ownership, these market-driven efficiency resources are particularly large and important. Electricity savings from these often low-cost opportunities last the lifetime of the buildings and equipment.[2] While these resources are particularly large in Eastern China, their capture depends on the timing of investments and thus starts out relatively small and grows over time.

Retrofit savings are available at the discretion of existing building and equipment owners, and are not time-sensitive. Because equipment is not being otherwise replaced, the costs of efficiency retrofits include the full equipment and labor costs. As a result, retrofits are typically more expensive than lost-opportunity investments. However, on a cost per kWh saved, efficiency retrofit resources can sometimes be as cheap as or cheaper than lost opportunity resources because the older equipment being replaced is typically significantly less efficient than the typical standard practice new technologies being installed in new buildings or during natural equipment replacements. In addition, the existing building and equipment stock at any given time is much larger than market-driven additions to, and turnover of, the stock. Thus, efficiency retrofit resources are initially much larger, and because they are not time-sensitive, offer the

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[2] Kushler, M. and Vine, E., (2003), Examining California's Energy Efficiency Policy Response, American Council for an Energy Efficient Economy.

ability to ramp up and capture very large efficiency resources soon. Given Eastern China's current power shortages, capturing retrofit resources quickly is important. However, because of China's rapid economic growth it is expected that market-driven efficiency resources will be much more important over the long-term.

Recommended DSM Portfolio Components

The recommended and analyzed DSM programs follow. In actuality, we expect that efficiency services would be provided to end-users seamlessly, and the separations and overlaps between programs would be invisible. However, for analysis and reporting purposes we have grouped them by major market area.

Industrial Motor Drive Systems

The industrial sector consumes by far the largest share of electricity used in Jiangsu.[3] In addition, approximately two thirds of industrial electric use is attributable to motors systems.[4] Estimated cost effective efficiency improvements in these systems with readily available equipment would reduce electric consumption by over 16%.[5] This program would promote improvements in motor systems, including high efficiency motors, fans and pumps, variable frequency drives and other controls, and improved design and equipment sizing and applications. It would offer expert technical assistance, project coordination and financial strategies. This program would encourage direct marketing, delivery and financial packaging by energy service companies (ESCOs). As such, it will contribute substantially to the development of the ESCO industry in China.

Industrial Non-Motor Efficiency

While motors consume the single largest portion of industrial electricity in Jiangsu, non-motor industrial electricity use is still significant. This program would focus initially on selected industries that are large electricity users in Jiangsu, and have significant thermal or other process loads such as steel and other metallurgy and cement. As with the motors program, it would offer expert technical assistance, project coordination and financial strategies, and rely heavily on ESCOs for program delivery.

Transformers

China recently adopted new standards for distribution transformers. While S9 transformers are now required, more efficient S11 transformers are commercially available and offer cost effective savings that will last for the life of the transformers (30 years or more). This program will use upstream marketing and outreach to manufacturers, distributors and vendors, as well as consumer marketing and financial incentives, to leverage the labeling efforts and promote the purchase of high efficiency transformers at the time of natural investment. To the extent the early retirement of old, oversized transformers is cost-effective for selected industries this would be handled in the industrial non-motor efficiency program.

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[3] 2002 industrial electricity consumption represented 76% of total electricity consumption in Jiangsu, based on Jiangsu Provincial Statistics Bureau, "Jiangsu Statistical Yearbook". Based on the sector definitions used in this paper, we estimate the 2005 industrial share of electric load to be 74%.

[4] Motor Project Team, "Energy Efficiency and Market Potential of Motor System in China," China Machine Press, 2002, p.1.

[5] Motor Project Team, "Energy Efficiency and Market Potential of Motor System in China," China Machine Press, 2002, p.2.

Residential and Commercial Market-Driven Cooling and Heating

This program promotes high efficiency air conditioners, heat pumps and chillers at the time of natural investment, and will help to implement China's current standards and labeling programs. Aggressive marketing, technical assistance, project coordination and financial incentives would be used.

Commercial Market-Driven Lighting

This program would focus on enhanced lighting design and systems in new construction, renovations and remodeling activity. Typical current practice for commercial lighting in China is in the range of 15-20 watts/square meter. Lighting in the range of 10 W/m2 or less are readily achievable with existing lighting products available in China and improved design practices. This program would provide training and outreach to lighting designers and engineers, outreach to distributors and contractors, and technical services and financial incentives for building owners to promote optimum lighting systems.

Commercial Comprehensive New Construction

While the above cooling and lighting initiatives would promote efficiency in commercial new construction, efforts will be made to work more comprehensively where possible on new commercial buildings.[6] This initiative would attempt to work closely with building developers and owners, and their design teams early in the design process to capture comprehensive, multiple end-use efficiency recognizing interactions between systems. This program would focus on early identification of construction projects, training to design professionals, efforts to enhance existing building codes and standards, coordination with green building efforts, provision of detailed and customized technical assistance, and financial incentives.

Residential and Commercial Cooling, Heating and Lighting Retrofit

This program targets those existing buildings that have particularly old and inefficient cooling, heat pump and (for commercial only) lighting equipment that can cost-effectively be replaced with new higher efficiency equipment. It is intended to address whole building retrofits, coordinating cooling and lighting activity to capture interactive benefits and capital cost savings from reduced lighting waste heat and smaller properly sized cooling equipment. It would offer technical assistance, project coordination services, and financial incentives. It is envisioned that this program would be delivered and supported by vendors and ESCOs.

Residential Lighting and Appliances

This market-driven program would promote the purchase of compact fluorescent lamps and high efficiency appliances, including refrigerators, freezers, and rice cookers. It will leverage and enhance the standards and labeling progress that has been made in China, and promote the highest labeled efficiency levels (Level 1) with information, retail consumer marketing, upstream outreach to vendors, and financial incentives.

Portfolio Costs and Benefits

The following tables and figure provide greater detail on savings, costs and benefits, by program. As shown in Table 1. Jiangsu Program Impacts and Table 2. Jiangsu Program Cost-

[6] Residential new construction savings are captured in the market-driven cooling and heating program.

Effectiveness, we estimate that after ten years this portfolio of DSM programs would save Jiangsu 30,633 MWh and 12,133 MW every year. And the weighted average life-cycle cost of saved electricity from the initiatives to Jiangsu in the tenth year is only 14 fen/kWh (1.7 US cents/kWh). Figure 1. Jiangsu Portfolio Cumulative Annual Energy and Peak Impact presents cumulative annual energy and demand savings by program. Given current conventional power costs at least three times higher, efficiency offers large benefits.

As indicated in Table 2, in the tenth year, the overall benefit-cost ratio in 2015 is almost 7.0. In otherwords, in the tenth year, every yuan invested in efficiency will return 7 yuan to the Chinese economy. As shown in Table 2, total net economic benefits to Jiangsu are 174.4 Billion RMB ($US 21.2 Billion). In addition, the portfolio will reduce pressure on the coal supply and distribution infrastructure, provide large environmental benefits and allow greater continued economic growth by relieving tight electric supply constraints.

Of course, these benefits do not come for free. As shown in Table 3. Jiangsu Program Costs, we estimate total program delivery costs over ten years to be 27.6 Billion RMB ($US 3.4 Billion) in constant 2006 currency units. While this is cheaper than the long term costs of producing the equivalent power, it does require a substantial investment in efficiency.

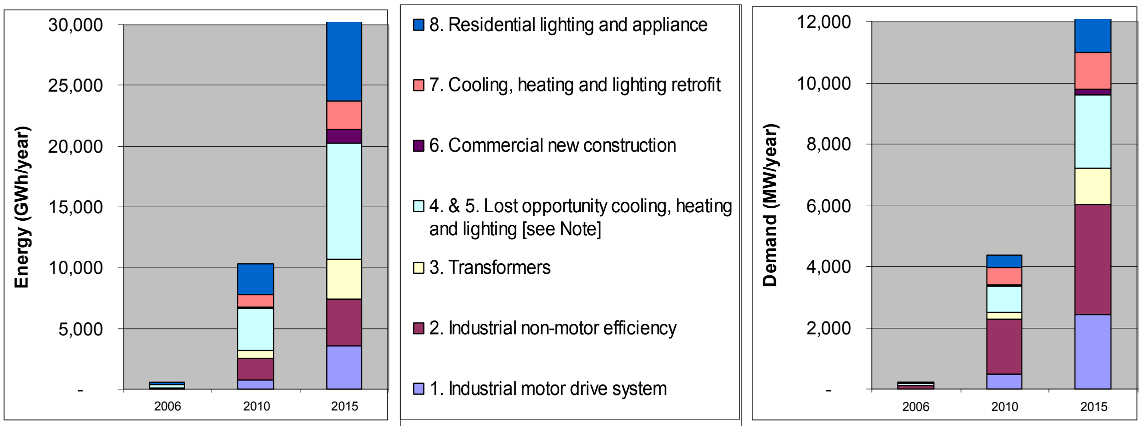
Table 4. Jiangsu Environmental Benefits shows the air emissions reductions from the DSM portfolio. While we have not included a monetized value for them in our cost-effectiveness analysis, we expect that sale of the CO_2 reductions internationally alone could substantially offset the cost of delivering these programs, providing payments of 24.6 Billion RMB ($US 3.0 Billion) for Jiangsu.

Table 1. Jiangsu Program Impacts

JIANGSU						
	Electricity Savings (at Generation Voltage)					
	Energy (GWh/yr)			Peak Demand (MW/yr)		
Cumulative annual	**2006**	**2010**	**2015**	**2006**	**2010**	**2015**
1. Industrial motor drive system	28	707	3,559	17	476	2,412
2. Industrial non-motor efficiency	103	1,831	3,822	101	1,794	3,598
3. Transformers	-	619	3,327	-	225	1,209
4. & 5. Lost opportunity cooling, heating and lighting [see Note]	203	3,453	9,583	51	863	2,396
6. Commercial new construction	0.2	159	1,119	0.04	27	193
7. Cooling, heating and lighting retrofit	73	1,041	2,324	46	574	1,176
8. Residential lighting and appliance	146	2,486	6,900	24	414	1,150
Total Programs	**553**	**10,296**	**30,633**	**240**	**4,374**	**12,133**

Source: DSM Strategic Plan for Jiangsu Province, 2005; Note: two programs (Lost opportunity cooling and heating; and Commercial lost opportunity lighting) were screened together and the quantitative results are presented jointly

Figure 1. Jiangsu Portfolio Cumulative Annual Energy and Peak Impact



Source: DSM Strategic Plan for Jiangsu Province, 2005

Table 2. Jiangsu Program Cost-Effectiveness

Total Economic Benefits					
	Economic Cost Per Saved kWh At Generation		Cumulative net benefits (benefits minus costs, present worth 2005)		Cumulative benefit/cost ratio 2006
	2015		2015		
Program	**RMB (Million)**	**$US (Million)**	**RMB (Million)**	**$US (Million)**	**2015**
1. Industrial motor drive system	0.19	0.023	16,908	2,059	5.48
2. Industrial non-motor efficiency	0.30	0.037	22,101	2,692	3.71
3. Transformers	0.13	0.016	21,768	2,651	8.01
4. & 5. Lost opportunity cooling, heating and lighting [see Note]	0.07	0.009	53,132	6,472	12.60
6. Commercial new construction	0.16	0.020	10,811	1,317	7.33
7. Cooling, heating and lighting retrofit	0.19	0.024	7,990	973	3.48
8. Residential lighting and appliance	0.10	0.012	41,726	5,082	9.40
Total Programs	**0.14**	**0.017**	**174,436**	**21,247**	**6.91**

Source: DSM Strategic Plan for Jiangsu Province, 2005; Note: two programs (Lost opportunity cooling and heating; and Commercial lost opportunity lighting) were screened together and the quantitative results are presented jointly

Table 3. Jiangsu Program Costs

JIANGSU						
	Utility Costs (in constant 2006 currency units)					
	RMB (Million)			$US (Million)		
Cumulative	**2006**	**2010**	**2015**	**2006**	**2010**	**2015**
1. Industrial motor drive system	56.0	1,155.5	4,839.9	6.8	140.7	589.5
2. Industrial non-motor efficiency	266.3	2,432.3	5,539.2	32.4	296.3	674.7
3. Transformers	-	876.8	4,047.9	-	106.8	493.0
4. & 5. Lost opportunity cooling, heating and lighting [see Note]	154.7	1,528.0	3,396.4	18.8	186.1	413.7
6. Commercial new construction	1.2	314.9	1,289.5	0.1	38.4	157.1
7. Cooling, heating and lighting retrofit	231.3	2,491.5	5,099.2	28.2	303.5	621.1
8. Residential lighting and appliance	167.0	1,541.4	3,357.6	20.3	187.7	409.0
Total Programs	**876**	**10,340**	**27,570**	**107**	**1,259**	**3,358**
Total CDM credits	32	589	1,752	4	72	213
Net Program Costs	**845**	**9,751**	**25,817**	**103**	**1,188**	**3,145**

Source: DSM Strategic Plan for Jiangsu Province 2005; Note: two programs (Lost opportunity cooling and heating; and Commercial lost opportunity lighting) were screened together and the quantitative results are presented jointly

Table 4. Jiangsu Environmental Benefits

CUMULATIVE ANNUAL EMISSIONS REDUCTIONS	JIANGSU	
(thousand metric tons)	2015	Lifetime Reductions
CO_2	43,805	**612,908**
SO_2	613	**8,572**
Nox	21	**291**

DSM Strategic Plan for Jiangsu Province, 2005

DSM Implementation

Identifying the energy efficiency potential in Jiangsu, and its costs and benefits, is relatively easy, compared to identifying the best policies and practices to assure the energy efficiency is delivered. The project team is still in the early stages of defining the most effective strategies and systems for organization of a broad-based DSM infrastructure in China. We are drawing on successes and failures elsewhere, particularly in the U.S. While the exact model is not yet clear, we believe that the following elements are essential:

- The DSM mechanism should be an integral part of a power sector reform plan
- The funding mechanism must be sustainable over the long term
- The funding mechanism and level should place efficiency and conventional power supply on an equal footing
- A funding mechanism should remove disincentives for utilities to purchase efficiency
- The DSM organizational structure should develop and enhance natural market mechanisms for efficiency service delivery capability
- The DSM organizational structure should be free of disincentives to the aggressive pursuit of efficiency resources
- The DSM organizational structure should be capable of serving all sectors and markets throughout the province or municipality

Funding

As the list above shows, funding is a critical step. Well-designed DSM can include substantial financial contributions from program participants such as industrial customers. However, experience in the U.S. and elsewhere has shown that to capture aggressive efficiency levels on the order of what is estimated above across a broad spectrum of markets requires some amount of financial contribution from other sources to overcome the substantial barriers that exist to adoption of cost effective efficiency.

Most electric DSM services in North America and elsewhere are funded through electric utility ratepayers. This allows for DSM to be paid for in a similar fashion to conventional power supply, meeting a necessary but not sufficient criteria for treating conventional and efficiency resources equally.

We discuss two different funding models, either of which can be designed to meet these needs.

Energy Efficiency Power Plant (EPP)

The first model is called an Energy Efficiency Power Plant (EPP). The EPP represents a specific bundle of energy efficiency programs designed to deliver a specified amount of capacity and energy savings over a specific time period. Under this model, the grid company would buy (or produce itself) the output (saved kWhs) just as they now buy the output from unaffiliated power plants. As discussed above, our analysis shows, in the tenth year, the weighted average cost of the EPP is 14 fen/kWh, or about a third the cost of new power supply of about 40 fen/kWh.[7]

The Asian Development Bank (ADB) is funding a prefeasibility study concerning the potential for China to "build" an initial EPP financed by an ADB loan, with the loan to be repaid with the funds paid by grid company purchases of the energy efficiency. In the future, utilities could directly raise funds through rates to fund additional EPPs. This option has several advantages. First, needed funds are made available quickly. Second, there is no specific requirement to increase electricity prices. The grid company purchases from the EPP would be treated just like their purchases from conventional power plants. Because the cost of power from new power plants is much higher than the cost of existing sources or the EPP, and because some time of use utility tariffs are currently lower than generation costs, electricity prices may not increase relative to the alternative. Third, grid company purchase requirements could be integrated in new power market rules. Finally, if properly structured, choices about the purchase of efficiency versus conventional power supplies could be made in an integrated, least cost fashion – essentially treating efficiency and traditional supply on an equal footing. While the EPP approach appears to offer some significant benefits, it might be more complex to establish and administer than a fixed public benefit charge dedicated to DSM. In addition, continued funding might be less certain depending on the specific power market rules developed.

Public Benefit Charge

A second DSM funding option is to use a Public Benefit Charge (PBC). This consists of a small dedicated charge (per kilowatt-hour) added to the price of electricity charged to all consumers. This approach has been used successfully in many countries. Benefits of this approach include that by dedicating a fix fund to DSM, spending is made fairly certain and consistent. This can improve long term planning, and may protect DSM funds from being diverted to other uses. This approach can also be simpler to establish and adjust over time. A PBC can also be funded through the government, rather than by ratepayers. However, tying the collection to electric usage provides greater equity by proportioning the costs according to the level of electric usage. A major weakness of the PBC approach is that it is difficult to place efficiency and conventional power supply on an equal footing. This is because the charge level is independent of ongoing resource allocation and purchase decisions. Another important disadvantage is that with a PBC, all DSM is paid for by ratepayers in the year it is purchased. This is different than how power plants are amortized over time, and can result in significant short term rate increases, or alternatively severely limit the amount of DSM completed in early years.

Utility Incentives

Regardless of the source of funding, China's regulatory and pricing system means utilities might lose money when they pursue energy efficiency options. This is not clear, given rapidly growing loads (meaning utilities may still sell all they can even with DSM). In addition, in some cases time of use tariffs result in substantial off peak sales at rates below the market price of new generation. As a result, some DSM may actually save the utilities money, and still

[7] Personal discussions with Jiangsu Economic and Trade Commission personnel.

allow them to sell all power they purchase. Despite this, making utility investment in energy efficiency at least as profitable as utility purchases and resale of power is a critical step to a sustainable energy future.

The project team is exploring these issues, as well as the possibility of incorporation of some funding mechanism in utility tariffs. Careful attention will be given to the objectives above, as well as other political and economic considerations. In addition to utility tariff funding, the project team will seek to leverage international carbon reduction funds -- using the Clean Development Mechanism (CDM) -- available for emissions reductions in China under the Kyoto Protocol. This funding source could be used to supplement other mechanisms, thereby either lowering consumer contributions or expanding the available resource commitment. Based on our estimates of the likely market clearing price for CO_2 emissions reductions, we anticipate the CDM sales could offset approximately 60% of the total program delivery costs over the long term (see the preceding Table 3).

DSM organizational structure and delivery

Regardless where the funds come from, decisions must also be made as to who actually administers and delivers the energy efficiency services. The project team is exploring a number of possible organizational structures for DSM delivery. In the U.S. and elsewhere, most DSM programs are managed or delivered by utilities. For example, California DSM efforts are delivered by independent utilities. However, recently other models have been developed and have had significant success. These include government administration. For example in New York State where the New York State Energy Research and Development Authority (NYSERDA) administers electric DSM programs using ratepayer funds collected by utilities. Under these models, typically the administrator does not directly implement the programs, but rather employs one or more subcontractors to deliver services. In the US states of Oregon, Vermont and Wisconsin, private firms are contracted by the state government to manage and deliver DSM programs directly, again using ratepayer funds provided to them by utilities.

Each of these models has been effective and offers different benefits. It is not clear yet which mechanism would be most effective in Jiangsu. However, whichever model is developed, it is expected that a single organization would retain overall responsibility for administering a portfolio of programs, and for planning and on-going program design and enhancements. This organization would likely sub-contract to a number of different organizations, such as energy service companies (ESCOs), to deliver different programs or parts of programs in different markets, thereby facilitating decentralized development of energy efficiency delivery capability. A separate organization, perhaps governmental, would retain responsibility for verification and evaluation of DSM activities.

ESCOs often structure their services to recoup investments in their customer’s plants through a portion of the customer’s long-term energy savings. In this case, the customers pay for the full cost of the efficiency. This model has worked to a limited extent in the US and Europe. However, experience shows that ESCOs delivered efficiency without additional funding support has a number of limitations to capturing maximum achievable efficiency savings, as characterized above. These include:

- ESCOs outside of China have been most effective, and have focused their business efforts, in those areas where aggressive utility-funded DSM programs operate and can enhance the project economics through leveraging additional DSM funds and services. In fact, the DSM industries have been instrumental in establishing ESCO industries and building ESCO capability that can then offer additional services.

- ESCOs have limited effectiveness in selected markets. ESCOs often have focused almost solely on large early retirement (retrofit) projects, and only among key sectors (in the US, primarily institutional and government, in China primarily industrial). ESCOs tend to promote only the most cost effective technologies, leaving behind numerous additional cost-effective opportunities, and ignoring less lucrative markets such as small residential, and new construction.
- ESCOs do not generally invest in long-term market transformation strategies that would tend to enhance overall societal cost-effectiveness by permanently changing practices and behavior. For example, ESCOs would be unlikely to invest private funds in working with government and manufacturers to advance product certification, testing, labeling and standards that might be critical to long term DSM success.

As a result, we believe that any DSM effort should work with and enhance the emerging ESCO industry in China, and rely heavily on ESCOs to deliver efficiency services in certain markets, with some support through the portfolio funding mechanism. In other areas, we believe that traditional ESCOs funding approaches may not be as effective. ESCOs alone will not capture maximum cost-effective efficiency resources. We envision that one or more ESCOs would be likely to implement the industrial efficiency services, as well as the retrofit (early retirement) cooling, heating and lighting program for residential and commercial facilities. This will help build market capability for energy efficiency service delivery. We anticipate that the residential lighting and appliances, new construction and market-driven non-industrial programs would rely on entities that do not use a performance contracting model. In these instances, reliance on a greater level of DSM funding and an entity (either private or public) to deliver under a more traditional DSM model may be necessary.

Summary and Future Prospects

DSM in China is still in its infancy. This project seeks to establish, above all, a sustainable model for funding and delivering DSM services that can be expanded upon in Jiangsu, and replicated throughout China. DSM efforts in North America and other countries have shown that substantial reductions in electric load are achievable, with the best regions offsetting roughly half their long term load growth through DSM. Given Eastern China's high economic growth expected over the next decade, effective and aggressive DSM initiatives are critical to avoid locking in inefficient building and industrial systems that will persist for decades. If this challenge is not met, these inefficient systems will hamper China's opportunities for economic expansion and environmental improvements.

The above evidence shows that these efficiency resources are large and much cheaper and cleaner than conventional electric supply. However, to fully be effective, a number of things must happen:

- Electric power sector reform that allows for appropriate economic choices between efficiency and conventional electric supply
- A permanent and adequate efficiency services funding mechanism
- The development and expansion of an energy service infrastructure

This last item is essential to long-term success of efficiency efforts, and just beginning to be developed. While there are a number of ESCOs and other efficiency service delivery organizations in China, the developed systems and capability still need improvement. Existing and available data on equipment and system performance, as well as efficiency service delivery is also beginning to become available. However, the ease with planners and program designers can ascertain likely equipment, system and program performance and identify the optimal planning solutions is still limited. These infrastructure problems will diminish naturally as DSM gets started and progresses. In addition, by using the lessons learned over two decades of DSM efforts in North America and elsewhere, China will likely find this progression much more rapid than has been experienced elsewhere.

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