



*THE REGULATORY ASSISTANCE PROJECT*

**The Guangdong Efficiency Power Plant**  
**An Assessment of Progress**

March 2010

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# The Guangdong Efficiency Power Plant An Assessment of Progress<sup>1</sup>

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## I. Introduction

Energy efficiency is a relatively inexpensive and plentiful resource – in China and around the world. Exploiting energy efficiency opportunities is at the top of the agenda in the struggle against climate change. This means overcoming economic and behavioral barriers which prevent firms and households from taking advantage of efficiency opportunities – even those that would bring lower costs, increased profit, and net private gains. The efficiency power plant (EPP) concept is intended to help (and encourage) planners and policymakers to mobilize investment toward energy efficiency resources in the same ways that they channel investment to conventional power plants (coal, hydro, wind, etc).

An EPP is a virtual power plant consisting of a bundle of energy efficiency investments that provide predictable load-carrying capacity, in much the same way that a conventional generating unit does. Compared to conventional plants, EPPs are inexpensive, clean and easy to plan. Moreover, they can be “constructed” and financed in much the same way as a conventional unit. Ultimately, it should be possible to seamlessly integrate EPPs into the routine planning of the power sector – providing a big boost to the exploitation of energy efficiency opportunities. However, in order for this to happen, a number of policy and financial arrangements must first be in place.

The EPP concept was first advanced by RAP in 2004, in recognition of the fact that conventional power plants have well-defined planning and investment frameworks that efficiency does not – and as a challenge to institutions that fund conventional generation in China. In that year, the Guangdong provincial government and the ADB began discussing developing an EPP in that province. A major consultants’ study – one of its two parts led by RAP – was completed in late 2007.<sup>2</sup> It addressed both policy and technical aspects of EPP construction. The present report provides background on EPPs and evaluates the Guangdong EPP from operational, design, and

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<sup>1</sup> We would like to thank the Center for Industrial and Energy Efficiency in Beijing as well as the Asian Development Bank for assistance collecting information for this report. We would also like to thank our partners LBNL and WRI for valuable input.

<sup>2</sup> Parts A and B of the consultants’ report are available here:

[http://www.raponline.org/docs/RAP\\_ADB\\_EPP\\_PartAFinalReport\\_2007\\_07\\_01.pdf](http://www.raponline.org/docs/RAP_ADB_EPP_PartAFinalReport_2007_07_01.pdf)

<http://www.adb.org/documents/Reports/Consultant/39020-PRC/39020-PRC-TACR.pdf>

(in particular) policy perspectives. A chief goal here is to compare the EPP as it currently exists to the recommendations in the 2007 consultants' report.

In summary, this paper makes several points:

- The Guangdong EPP is a pioneering effort and lays the groundwork for future EPPs. It is perhaps best viewed as a test case and capacity building exercise.
- The Guangdong authorities successfully organized a project management office (PMO) that is operating well as an administrative center. The PMO and other responsible provincial authorities are successfully demonstrating ability to manage economic, technical and financial aspects of delivering energy efficiency. The EPP is achieving real energy savings and emission reductions.
- The Guangdong EPP is based on commercial loans for efficiency projects. There are no subsidies and borrowing firms are responsible for full loan repayment. The 2007 consultants' report warned that this would be a weak model.
- Lessons from the Guangdong experience – and other pilot EPPs currently supported by the Energy Foundation – can contribute to policy reforms from Beijing to support more robust EPPs in the future. Indeed, EPPs may receive a further boost from an anticipated National Development and Reform Commission ruling on demand-side management and energy efficiency, which could be issued as soon as April of this year.
- Our recommendations for future EPPs include: 1) involving grid companies; 2) moving away from commercial loans and toward subsidized projects; and 3) models that reach beyond large facility retrofit projects.

Today, the Guangdong EPP is less of an EPP as originally conceived (a set of programs whose savings resemble the output of a typical coal-fired generator) than it is a system of accounting for the savings produced by discrete and unrelated energy efficiency projects. The savings can be identified and catalogued, but they have not been acquired as part of an integrated resource strategy to meet China's overall energy needs. This is not so much a criticism than it is recognition that the Guangdong project is a good first step to a stronger model.

## **II. Guangdong EPP Background**

The Guangdong EPP plan calls for investment of \$269 million, of which \$100 million is financed by a 12-year loan from the ADB. The remainder is self-financed by the implementing firms (also known as the sub-project borrowers).

The Chinese government approved the project in early 2008, followed by the ADB Board in June of that year. The loan agreement was signed in September 2008 and the project went into effect in January 2009. The implementation stage finally began in February 2009 with the launch of the first batch of sub-project agreements. The second batch of sub-project loans was signed in November 2009.

When completed, the EPP is designed to be the equivalent of a 154 MW conventional power plant, saving 810 GWh annually. In the context of Guangdong this is a relatively small project, roughly equal to about 0.2% of total 2008 electricity consumption in the province. One estimate of potential exploitable energy efficiency in Guangdong is 1541 MW or 9286 GWh in retrofits alone. However, despite its fairly small size, the EPP is intended as an experiment and offers potentially valuable lessons for future EPP projects around China and in other countries.

The organizational structure of the Guangdong EPP features a Project Management Office (PMO) that administers and coordinates the EPP. The PMO includes representatives from the Guangdong Development and Reform Commission (DRC), the Guangdong Financial Bureau and the Guangdong Energy Conservation and Monitoring Center, among other provincial bodies. The PMO answers to an EPP Steering Committee of senior provincial officials.

The PMO decided to employ an external financial firm, Guangdong Yuecai Financial Trust, to handle management of the sub-project loans – including facilitation of disbursements and collections. This financial firm also takes the lead with evaluation of projects.

In order to get moving quickly, the Guangdong authorities began by targeting projects where borrowers had already identified and begun buying equipment. However, these were limited: only candidate projects that followed the ADB's strict equipment acquisition guidelines qualified.

The first tranche consists of eight sub-projects (see Table 1), representing a total investment of 607 million RMB (\$89 million), of which nearly 40% is ADB financing (with the remainder self-financed by the borrowers). The largest sub-project, representing almost half of the total first tranche investment, is a waste-heat recovery project, which captures heat from industrial processes and uses it to produce electricity for other uses. The other projects in the tranche are largely industrial. Together, the first tranche was estimated (at time of contracting) to be equivalent to a 60 MW generating unit, with associated electricity savings of almost 300,000MWh annually.

**Table 1: Guangdong EPP - First Tranche Projects**

	Project focus	Financing (RMB mn)		Savings			USD per KW
		ADB	Self	MWh (annual)	MW	CO <sub>2</sub> tons (annual)	
1	Variable speed drives	50	44	51975	10	40541	1377
2	Reactive power	20	55	63042	13	49173	845
3	HVAC	20	5	12595	3	9824	1221
4	Transformers	10	3	2397	1	1870	1905
5	Steam recovery	10	3	6706	1	5231	1905
6	Monitoring systems	20	32	22058	4	17205	1905
7	Waste heat recovery	78	194	126770	25	98881	1594
8	Transformers	30	33	12739	3	9936	3077
	<b>Total</b>	<b>238</b>	<b>369</b>	<b>298282</b>	<b>60</b>	<b>232661</b>	<b>1482</b>

Source: Guangdong EPP PMO and RAP calculations.

The sub-projects in the second tranche have now been identified and preliminary work is moving ahead. There are six agreements awaiting approval for about \$60 million of investment, including \$22 million from the ADB. Unlike the first tranche, the second tranche includes substantial non-industrial sub-projects, including an LED street lighting project (\$15 million) and a solar project (\$6 million).

Sub-project borrowers must provide substantial amounts of self financing. The ADB project agreement states that ADB must provide no more than 70% of financing for any one given sub-project; the overall project calls for 37% ADB financing. The repayment period must not exceed five years. Borrowing firms can be end-users or ESCOs. Firms that have any history of tax problems, credit problems or documented history of failure to punctually meet payroll are excluded from consideration. Applicant firms must also have debt to equity ratio lower than 75%.

The Guangdong EPP's process for sub-project application, review, approval, and evaluation is as follows:

- The application prepared by prospective sub-project borrowers must include a project brief, including description of technologies, implementation methods, projected energy savings, estimated investment costs and a plan for partial self financing.

- After receipt of the application, the PMO prepares an initial technical review while financial intermediary (Yuecai Financial Trust) assesses the sub-project from a financial perspective (including borrower creditworthiness).
- Once this preliminary review is completed, the implementer hires an engineering agency to prepare a feasibility study.
- The Guangdong Development and Reform Commission (DRC) reviews the sub-project.
- The National Development and Reform Commission and Finance Ministry then review the sub-project before the contract can finally be signed.
- The intermediate financial agency (Yuecai) monitors disbursements and repayments, with regular reports to the PMO and provincial DRC.
- Equipment acquisition by sub-project borrowers must comply with strict ADB regulations.<sup>3</sup> For each batch of equipment purchase, the sub-project borrower must obtain a no-objection letter from the PMO (stating that the acquisition methods are acceptable) in order to draw down from Yuecai.
- Evaluation must be done by third party organization.

**Table 2: Guangdong EPP - Second Tranche Projects (provisional)**

	Project focus	Financing (RMB mn)		Savings			USD per KW
		ADB	Self	MWh (annual)	MW	CO <sub>2</sub> tons (annual)	
1	Electric steam	15	35	67534	14	52676	544
2	Micro-grid	13	11	2008	<1	1566	8825
3	Solar	2	2	174	<1	136	19667
4	Solar	20	20	916	<1	714	32667
5	Transformer	10	20	6235	1	4863	3528
6	Furnace (aluminum)	20	20	14509	3	11317	2026
7	Converting station	10	28	6307	1	4920	4413
8	Monitoring system	10	80	33600	7	26208	1969
9	Street lighting	50	50	6775	1	5285	10816
		<b>150</b>	<b>266</b>	<b>138058</b>	<b>28</b>	<b>107685</b>	<b>2214</b>

Source: Guangdong EPP PMO and RAP calculations.

<sup>3</sup> See <http://www.adb.org/documents/guidelines/procurement/default.asp?p=prcrmnt>

### **III. EPP Models: Variations in Funding and Delivery**

This section provides essential context for assessing the Guangdong experience by describing conceptual options for EPP design. The original prospectus on EPPs, which was released in July 2007 and served as the groundwork for the Guangdong project, was funded by a technical assistance grant from the ADB. It describes four approaches, for delivering EPP investments. The approaches differ primarily in the means by which efficiency measures are funded and their costs recovered from customers. These differences can meaningfully affect the range and magnitude of investment in efficiency.

An EPP can be partly explained by contrasting it to a conventional power plant (CPP) and by comparing it to ordinary DSM.

#### **A. EPPs versus CPPs**

A typical CPP in China is a 300 MW coal-fired power plant that operates for approximately 6000 hours a year. Its cost and emissions characteristics are set out in the table below, where they are compared to those of an EPP that yields savings equivalent to the CPP's output. The EPP performs significantly better than the CPP, economically and environmentally.

	<b>CPP</b>	<b>EPP</b>
<b>Capacity</b>	300 MW	300 MW
<b>Annual MWh produced/saved</b>	1.5 million	1.5 million
<b>Fuel Use/kWh</b>	340 grams coal	0 grams
<b>SO2 emissions/kWh</b>	4 grams	0 grams
<b>Levelized cost/kWh</b>	35-40 fen	15 fen

Like a CCP, an EPP must be planned, financed, built, and operated, and its performance (producing or saving kilowatt-hours, kWhs) must be measured and verified. Refer to the table below. With the right policies and actions by the government, an EPP can be financed and paid for in the same way as a CPP. With a CPP, the capital and operating cost is paid over time as the power plant produces electricity. Similarly, the cost of the EPP is paid over time by paying for the kWhs the EPP saves.

	CPP	EPP
<b>Planning</b>	China's planning process identifies best type, size and location of power plant	Scientific planning process identifies best types, size and location of energy efficiency programs
<b>Approval</b>	CPP approval and licensing is performed by NDRC and SERC	EPPs could be subject to review and approval by NDRC, SERC, or both
<b>Financing</b>	Capital construction cost financed using debt, equity, or other sources of capital.	Capital cost including cost of rebates and other incentives financed using debt, equity, or other sources of capital. Initial EPP financed by loans from ADB
<b>Building</b>	CPPs must be designed and engineered. Major components must be ordered. Skilled contractors of all types must be hired and deployed	EPPs energy efficiency program designed to deliver the desired savings at a reasonable cost. Efficient products may have to be ordered. Skilled contractors of all types must be hired and deployed
<b>Operation</b>	Operating cost depends on type of power plant. Some, such as coal and natural gas have high operating costs, others such as hydro-electric and wind have low operating cost	Energy efficiency programs have no significant operating cost.
<b>Performance</b>	Power plant performance (and operating cost) is an ongoing risk. Actual power plant output is metered	Energy saving performance is reasonable predictable. Actual kWh savings measured by well established measurement protocols
<b>Cost Recovery</b>	Power plant's recover capital and operating cost through kWh prices paid over the life of the plant	EPPs are designed to recover cost thru payments for energy savings over the life of the energy efficiency investments. The source of funds vary depending on the EPP model selected

## **B. EPPs and DSM**

An EPP can also be understood by seeing how it compares to demand-side management (DSM) generally. DSM refers to measures sponsored, funded, and implemented by electric utilities (or other entities) that modify end-use electrical energy consumption through "energy efficiency" or "load management." In China, until recently, most DSM was limited to load management. Recently, several provinces have begun to focus on energy efficiency.

An EPP is a collection of DSM programs designed to produce energy and capacity savings of a specified size and with specified characteristics. An EPP that emphasizes load management will produce electricity savings that resemble the output of a conventional peaking power plant. An EPP that makes use of energy efficiency will produce electricity savings that resemble the output of a base-load power plant.

Although EPPs and DSM have much in common, ordinary DSM programs are not EPPs. The EPP concept adds additional important characteristics to China's usual approach to DSM. The most important differences relate to aggregation, financing, and repayment.



- EPPs aggregate DSM programs a large number of energy efficiency options into a single EPP. Aggregation makes large-scale, low-cost external financing possible and reducing financial risk and administration and transaction costs.
- The aggregation of efficiency programs into large EPPs allows for integration of energy efficiency into the new power markets. The new markets can be designed so that EPPs can compete against conventional power plants.
- EPPs simplify comparisons of supply- and demand-side options and, in so doing, allow policymakers to more clearly see the role and capability of energy efficiency, which in turn should lead to an improvement in China's planning and investment processes.
- The need for, and approach to, cost recovery is simplified by amortizing the cost of the EPP's aggregation of energy efficiency activities in the same fashion as the cost of a conventional power plant.

### **C. Models of EPP Implementation**

We have identified four general approaches for implementing EPPs:

- *Model 1:* Comprehensive integration with power sector reform and funding directly through electricity prices;
- *Model 2:* Funding via a small uniform charge (approximately 1 fen/kWh) on all kWh sales;
- *Model 3:* Government funding, perhaps through pollution or energy taxes; and
- *Model 4:* Direct funding by participating consumers.

All of the models share certain features:

- Energy efficiency opportunities are identified and evaluated. Energy efficiency options are selected and aggregated into a single EPP of substantial size.
- Investment capital to fund the energy efficiency is identified and loans or other capital sources are obtained by a responsible, competent, and credit-worthy entity that can oversee the design and delivery of the programs and manage the loan repayment process.
- Energy efficiency programs are delivered by a mix of Energy Service Companies (ESCOs), customers, contractors, and others under the supervision of a competent entity.

- Actual energy savings performance is measured and verified by one or more responsible government agencies.
- The loan is repaid over the life of the aggregate energy efficiency investment.
- The entire process is subject to government oversight and approval.

	<b>Model 1 Comprehensive Integration With Power Sector Reform</b>	<b>Model 2 SBC/PBF Funded</b>	<b>Model 3 Government Financed</b>	<b>Model 4 Participation Consumer Funded</b>
<b>Planning and investment</b>	Energy efficiency is treated as a resource in power sector planning and investment process. Amount of energy efficiency is determined by studies identifying all cost-effective energy efficiency.	Energy efficiency may or may not be analyzed as part of the planning process. Level of energy efficiency funding determined by government and collected by utility through SBC	Energy efficiency may or may not be analyzed as part of the planning process. Level of energy efficiency funding determined by government	Level of energy efficiency funding determined the number and size of energy efficiency opportunities consumers are willing to implement using this approach.
<b>Grid company role</b>	Grid company is fully involved in assessing potential for energy efficiency and suggesting program design and funding level	Grid company collects PBF and forwards funds to administrator of energy efficiency programs	Grid company has no role significant role	Grid company may collect ESF from participants
<b>Source of funds for repayment</b>	Electricity prices, preferably though modified prices that reinforce consumer incentives to investment in energy efficiency such as inclined block prices and new construction hookup fees	Small uniform SBC added to electricity prices of all consumers	Government energy efficiency funding, possibly through increased taxes or fees on energy or pollution	ESF added to electric bills of participating customers
<b>Major policy reforms needed in China</b>	Requires reform of electricity pricing policies and pricing method	Requires a Adoption of SBC policies and identification of administrator or energy efficiency programs	Requires government decision to fund energy efficiency and identification of administrator or energy efficiency programs	Requires identification of administrator or energy efficiency programs
<b>Best international example</b>	California	Vermont	South Korea	Loan or PAYS® programs in several states in the US

Because these elements are common to all four models, they do not influence the choice of which model to use.

In three very important ways, however, the models differ. These have to do with (1) how the EPP relates to power sector planning and investment, (2) how the EPP relates to the grid company and power sector reform; and (3) how the capital that financed the EPP is repaid.

These different approaches to funding and administration will affect the magnitude of the efficiency resource (the savings) that they will acquire. It happens, however, that the models that are likely to achieve more substantial results also require significant policy reform at the central level.

The following table summarizes the four models and the major distinguishing features. The table also summarizes the major policy reforms needed to implement each model and the best international example of the model.

### **1. Model 1 – Comprehensive Integration with Power Sector Reform**

Model 1 is the most comprehensive and powerful model. It places high priority on energy efficiency and treats energy efficiency as a full alternative to generation. The high priority China places on energy efficiency and environment and the fact that power sector reform in China is in its early stages mean this model should receive very serious consideration. This model is used in several states in the US and other countries. California's is one of the most comprehensive examples of this approach.

Cost recovery has been the single largest barrier to full, productive grid company support for energy efficiency in general and EPPs in particular. One of the key features of this option is that it aims to treat EPPs and conventional supply-side investments equally. The manner in which grid companies have recovered supply costs has been evolving since major power sector reforms began. The clear trend has been to allow easier, faster, more automatic recovery of such costs in prices or surcharges linked to prices. However, there is still no mechanism to allow grid company recovery of EPP costs. Moreover, because energy efficiency causes grid companies to lose money, regulatory reforms are needed to support large-scale investment. The basic features of Model 1 are:

- *Reformed Planning and Investment.* Energy planning and investment policies in the electric utility sector are reformed and based on a least-cost scientific planning process where the costs (including environmental costs and other social costs) of all power supply options and energy efficiency options (EPPs) are considered on an equivalent basis. Energy efficiency options are bundled into EPPs.
- *Grid Company Purchase of EPP Output.* Grid companies buy the output of the least-cost mix of conventional power plants and EPPs. Grid company involvement in EPP planning, administration, delivery, and evaluation can vary from full involvement to very little.
- *EPP Integration into Wholesale Markets.* Where there are competitive wholesale generation markets, EPPs can be an integrated part of the demand response programs built into the markets. In this case, the market operator is essentially the purchaser of the EPP output and the cost of the purchases is included in the generation prices buyers in the market pay.

- *Tariff-setting practices that reward grid companies for least-cost performance.* Pricing methods are reformed so that grid companies are encouraged to support EPPs.
- *EPP Costs Recovered in Retail Prices.* EPP-related costs are included in electricity prices, ideally in concert with specific price reforms that are designed to encourage energy efficiency.
- *Delivery of energy efficiency programs.* Energy efficiency programs are delivered to consumers using a mix of energy service companies (ESCOs), government agencies, contractors, grid company personnel, consumers, and others.
- *Measurement and verification.* Measurement and verification of actual energy savings is performed by the government or qualified independent experts.
- *Loan repayment.* The cost of the EPP is treated in the same manner as the costs of CPPs. Thus, EPP costs are included in electricity prices, preferably in ways that reinforce consumer incentives to invest in energy efficiency.

Three aspects of Model 1 deserve special comment. First, it is fully integrated with power sector reform. Second, it incorporates improved retail pricing, and, third, it reforms electricity pricing methods to harmonize grid company profitability with China's national efficiency and environmental goals.

**Model 1 is fully integrated with Power Sector Reform.** Integration of energy efficiency with power sector reform makes sense for many reasons. It was a strong recommendation of the International Energy Agency in its recent review of China's power sector.<sup>4</sup> IEA recognized that utility DSM programs can add substantially to China's energy conservation efforts if energy conservation policies are integrated with power sector reform. Unfortunately, China's initial power sector reforms are making energy efficiency more difficult rather than easier.

Recent reforms make the grid company's recovery of power supply cost easier and faster. If a grid company buys power from a conventional power plant (CPP) for, say, 40 fen/kWh, it is allowed to include the cost of that power in prices it charges retail consumers for electricity. But, if the same grid company wants to buy efficiency from an EPP for 15 fen/kWh, there are no established policies allowing the company to recover the costs. This gives the grid company no

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<sup>4</sup> "China needs to devote effort now to reform activities that can yield positive near term benefits while also helping to lay the groundwork for fully competitive markets. These include: strengthening the institutional framework; integrating energy efficiency and environmental objectives more firmly into current regulation and future reform plans; and implementing pricing reforms to support improved economic and energy efficiency. See *China's Power Sector Reforms: Where to next?* IEA, 2006 <http://www.iea.org/w/bookshop/add.aspx?id=288?>.

reasonable financial choice except to meet demand with the more expensive, more polluting CPP option.

Power markets are being designed and will soon be implemented, but these markets do not incorporate EPPs. Markets are designed by people and markets deliver what they are designed to deliver. Design electricity markets to deliver energy efficiency and they will. So far, electricity markets in China have been designed to exclude energy efficiency, even though detailed studies by Chinese experts show that energy efficiency can save a kWh at 1/3 the cost of producing one.

**Model 1 combines EPP cost recovery with improved retail prices.** Under Model 1, EPP costs are incorporated in electricity prices. This can be accomplished in many different ways. The best option is to reflect EPP costs in prices in ways that reduce existing barriers to energy efficiency and reinforce the incentives consumers have to invest in energy efficiency on their own. Some pricing reforms that would achieve these ends and facilitate EPP cost recovery include the following:

- *Residential and Small Commercial Customers - Inclining Block Prices.* “Inclining Block” prices are used widely around the world. With inclining block prices, the prices for incremental blocks of consumption increase as usage increases. Inclining block prices have several advantages. Higher levels of consumption can be priced at marginal cost without increasing average power prices. They also establish an initial low-priced block serving social development and universal service goals, without creating an inefficient subsidy for all consumption by customers in an entire rate class.
- *Industrial prices – Expand Linkage of Electricity Prices to Efficiency.* The electricity prices some energy-intensive industries pay differ depending on which category of overall energy efficiency they qualify for. This pricing option can be expanded to other customers and the price differentials can be increased.
- *New Construction – Adopt Hook-Up Fees to Address Split-Incentives.* The problem of “split incentives” arises in those situations in which the person or entity that determines what kinds of energy-consuming equipment will be purchased is not the same person or entity that pays the operating costs of that equipment. In such circumstances, the purchaser has an incentive to minimize the cost of the capital investment, which is not the same as minimizing the total life-cycle costs—capital and operating—of the energy end-use. This is typical of rental housing and new construction, since the landlord or developer is not the one paying the electricity bills—and it’s a particular problem in China, where the stock of new and energy-inefficient buildings is growing rapidly. Hook-up fees charge builders a one-time fee to connect to the grid. The fee is related to the building’s efficiency and is designed to give builders price signals to construct efficient buildings.

To the degree that price structures such as these collect revenues in excess of the grid company's needs, those monies can be invested directly into EPPs. But, even without these reforms, the costs of EPPs should be included in the company's overall prices, in the same way that all other legitimate costs of service are covered.

**Model 1 harmonizes Energy Efficiency Utilities and Utility Profitability.** Utility involvement in EPPs is useful but not vital. However, either way, the utility's role in energy production, environmental protection, and society in general makes it imperative that utility profit motives be harmonized with China's national energy efficiency and environmental goals. Current practices and planned reforms are completely opposed increased end-use energy efficiency and clean power. This is a serious problem that should be fixed regardless of the EPP Model selected.<sup>5</sup>

**Strengths and Weaknesses:** This model has two major strengths: (1) it is explicitly designed to integrate EPPs and power sector reform and (2) it is designed to deliver all of the cost-effective energy efficiency. The greatest weaknesses of this model is it requires significant central level policy reform (1) to integrate energy efficiency in the planning and investment process and (2) to reform electricity pricing methods to both allow EPP cost recovery and to make grid company profits consistent with energy efficiency. The needed reforms are important but they will take time to fully evaluate and implements. It is for these reasons that the first EPPs are not based on this model.

## **2. Model 2 - System Benefit Charge (SBC)**

Model 2 differs from Model 1 in two significant ways. First, the grid company role is substantially reduced. It is limited to collecting the funds needed to repay the EPP financing. Second, EPP costs are included in electricity prices in a different way. Under Model 1, electricity prices are adjusted to both collect EPP-related costs and to give consumers increased incentives to investment in energy efficiency. Under Model 2, EPP costs are recovered through a separate, small, uniform surcharge on electricity prices or electricity generators, referred to generically as a system benefits charge, or SBC.

This approach has been taken in many states and countries. Vermont is one of the best examples of it. The basic features of Model 2 are:

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<sup>5</sup> We agree with the IEA's 2006 review of China's power sector which concluded: "The reforms still lack a broad and sustained commitment to energy efficiency through demand-side management (DSM) and demand participation (i.e., responsiveness of customers through operation of a price mechanism). There is a major opportunity to integrate DSM and demand participation into the regulatory framework for competitive markets and into investment planning. This should, at the least, remove barriers and disincentives to energy efficiency and demand response. Going further, efficiency programs could be strengthened by encouraging power companies to make it their business to provide not just electricity, but electricity services."

- *Planning and Investment.* Model 2 does not require reformed energy planning and investment policies. The level of EPP investment is determined mostly by the government's willingness to set the SBC at a reasonable level. Preferably, analysis and planning would identify the size and cost of the EPP potential, but, practically speaking, it is rare that the SBC is set at a level high enough to build all of the cost-effective EPPs.
- *Grid Company Role.* The grid company role is limited to collecting the SBC from consumers and remitting the collected funds to the entity responsible for loan repayment.
- *Delivery of energy efficiency programs.* Energy efficiency programs are delivered to consumers through a mix of ESCOs, government agencies, contractors, consumers, and others.
- *Measurement and verification.* Measurement and verification of actual energy savings is performed by the government or qualified independent experts.
- *Loan repayment.* The cost of the EPP is included in electricity prices as a small uniform charge per kWh.

**Strengths and Weaknesses:** The main strengths of this model are (1) that it is well tested and established in many countries, (2) that it has demonstrated the ability to deliver adequate and stable funding for significant energy efficiency investment, and (3) that its diminished role for the utility makes it easier to implement the EPP in China in the near term.

The model has two main weaknesses. First, it does little to integrate energy efficiency in power sector planning, investment, or power sector reform and regulation and, second, total EPP funding is likely to fall short of the level justified by economic and environmental goals.

### **3. Model 3 - Government Funding**

The main distinction of Model 3 is the source of funding. Under this model repayment of EPP financing comes directly from the government. Government revenue can come from existing revenue sources or from new sources designed to encourage energy efficiency, for instance, energy or pollution taxes. Key features of the model are:

- *Planning and Investment.* Like Model 2, Model 3 also does not require reformed energy planning and investment policies. The level of EPP investment is determined mostly by the government's willingness to fund it. Preferably, analysis and planning would identify the size and cost of the EPP potential, but experience suggests that government funding will fall short of cost-effective needs.

- *Grid Company Role.* The grid company role is essentially eliminated. Energy efficiency is taken on as a government responsibility. South Korea is the best international example of this approach.
- *Delivery of energy efficiency programs.* Energy efficiency programs are delivered to consumers through a mix of ESCOs, government agencies, contractors, consumers, and others.
- *Measurement and verification.* Measurement and verification of actual energy savings is performed by the government or qualified independent experts.
- *Loan repayment.* The cost of the EPP is covered by government sources of revenue.

**Strengths and Weaknesses:** The major strength of Model 3 is that it fits well with existing and planned fiscal and tax policies, including pollution fees. The main weaknesses are (1) that it does little to integrate energy efficiency into power sector planning, investment, and power sector reform and regulation and (2) that total EPP funding is likely to fall short of the level justified by economic and environmental goals.

#### **4. Model 4 - Direct Participant Funding**

The last model combines traditional loan or ESCO approaches (in which consumers who choose to invest in energy efficiency pay for the investment over time) with the EPP's ability to aggregate activities. This is the approach being pursued in Guangdong.

- *Planning and Investment.* Model 4 also does not require reformed energy planning and investment policies. Under this model, industrial and other consumers with energy efficiency investment opportunities are identified. Proposed projects are evaluated for technical, economic, and financial merit. Accepted proposals are aggregated to form an EPP with the size and characteristics desired. The size and number of EPPs may be limited more by available funding than by the available cost-effective energy efficiency options.
- *Grid Company Role.* The grid company's role is either eliminated entirely or it is limited to collecting the loan repayments from consumers and then remitting the collected funds to the entity responsible for loan repayment.
- *Delivery of energy efficiency programs.* Energy efficiency programs are delivered to consumers through a mix of ESCOs, government agencies, contractors, consumers, and others.



- *Measurement and verification.* Measurement and verification of actual energy savings is performed by the government or qualified independent experts.
- *Loan repayment.* The cost and expected energy savings of the projects are summed to derive the total size and cost of the EPP. Individual loans are made to the participants but, for purposes of risk management and repayment, the participants are treated as a group. Loan repayment is structured as an “energy saving fee” (ESF) equal to the average cost per kWh-saved for the aggregated EPP (or greater if one wants the EPP loan repaid in a time that is shorter than the average life of the energy efficiency measures). Each participant pays the same ESF for the kWh savings estimated for its particular project. Ideally, the ESF is included in the power bills of the participating customers; however, it is a separate charge and is not part of the electricity price.

**Strengths and Weaknesses:** The major strength of Model 4 is that it requires very little if any policy reform. The main weaknesses are (1) that the approach is mostly limited to large customers and energy efficiency retrofit applications, (2) that the model does little to integrate energy efficiency in power sector planning, investment, and power sector reform and regulation, and (3) that total EPP funding will fall short of the level justified by economic and environmental goals.

#### **IV. Guangdong EPP: Evaluation, Lessons, and Opportunities**

This section evaluates Guangdong’s EPP, identifies lessons learned from Guangdong’s EPP, and discusses opportunities for scaling up energy efficiency in China through the implementation of more robust EPPs.

##### **A. Financing**

Improving on Guangdong’s financing model will require new policies at the central government level. In the best of the EPP models (Model 1), grid companies take charge of financing EPPs, with funds ultimately derived from the electricity fees paid by consumers (ratepayer funds). In the second- and third-best models, government authorities finance – or at least subsidize – EPPs with ratepayer or taxpayer funds. However, the Guangdong EPP is operated on a commercial basis, with little injection of taxpayer or ratepayer funds to subsidize energy efficiency projects.

Implementing EPP Model 1 – featuring grid company financing – would have required changes to the way grid companies are regulated. However, there is currently no system in place for China Southern Grid (or for State Grid, the other major grid company in China) to make money from providing energy efficiency services. To the contrary, currently grid companies make money from throughput; increased efficiency hurts profits.

Ideally, in order to support grid company financing of EPPs, certain policy reforms would be implemented. First, the grid company would be given responsibility for provision of energy efficiency services as well as the supply of electricity. Second, these responsibilities would be institutionalized under a “revenue-cap regime” – that is, an approach to ratemaking that breaks the link between sales volumes and revenue levels and thus renders the company indifferent to changes in sales (referred to as “decoupling”). The regulated grid company no longer has a financial incentive to increase sales; nor is it harmed by reduced sales (a consequence of successful investment in end-use efficiency). The company then has a very strong incentive to lower its costs (and thus boost efficiency and profits) over the period, before the next review. Third, overlaid on the revenue cap would be various incentive mechanisms that allow for defined increases in the overall revenues of the firm, depending on how well the firm meets specified objectives. These could include a mechanism that rewards (or penalizes) the firm for provision of targeted amounts of energy services (e.g., an annual EPP construction target, in MW and MWhs, subject to regulator verification). The first of these three features may soon come into being with the adoption of the central government’s DSM directive (mentioned above). However, the second and third are currently far from realization.

Implementation of a system benefit charge (Model 2 EPP financing) also requires central government approval. Ultimately, in the absence of supporting policies, Guangdong opted for a Model 4 financing scheme, under which electricity consumers borrow to finance projects and are directly responsible for repaying loans.<sup>6</sup> As noted earlier, the key problem with this financing approach is that it operates on a largely commercial basis – that is, there is no payment provided to “sweeten the deal” and promote efficiency. The sub-project loans are offered at an interest rate close to that to which large firms could obtain from Chinese commercial banks (for projects other than energy efficiency). The scope for scaling up this type of EPP to exploit potential energy efficiency resources is limited.

There are several opportunities for improving on the Guangdong experience in the area of financing:

- The current Guangdong model addresses repayment risk by limiting loans to only the most credit worthy enterprises. There are a limited number of firms meeting the credit standards – just the enterprises that have the least need for external financing. Ideally, EPPs should be able to shift the focus of risk management from the credit worthiness of the enterprise to the portfolio. At this level, risk can be managed by having a large assemblage of diverse projects. Moreover, to the extent that efficiency investments improve a firm’s cash flow – i.e., reduce its energy costs by more than the loan repayment expense – the risk of non-repayment is reduced.

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<sup>6</sup> The Guangdong authorities may have had scope to mobilize provincial public funding resources in order to subsidize efficiency projects (Model 3).

- Repayment risk and transaction costs can be further reduced by on-bill collection (discussed further, below).
- More efficiency opportunities can be targeted and exploited by moving away from the loan-based model in which 100% of the funds are repaid by the participating consumer.

By moving to a model that includes other sources of revenue, the EPP can more easily expand into energy efficiency opportunities that do not lend themselves to loan-based programs. In addition, the portion of the EPP that is loan-based can be made far more attractive to customers. For example, China has two national energy efficiency programs – one providing subsidies for energy efficient lights and the other for energy efficient air conditioners – that cannot be fit into a conventional loan-based model. Both could be integrated into an EPP. Guangdong’s large and rapidly growing air conditioning load makes it a prime candidate for an EPP tailored to meet local conditions.

### **B. On-Bill Collection of Loan Repayments**

A major recommendation in the 2007 consultants’ report was “on-bill collection” of loan repayments from sub-project borrowers. The idea is to take advantage of the existing electricity billing system in order to collect repayments and associated fees. These would simply appear as line items on routine electricity bills. On-bill collection has several advantages:

- It avoids the costly and complex effort of setting up from scratch a billing and collection system dedicated to the sub-project loans. This consideration becomes particularly important if the EPP is intended to expand and cover large numbers of customers, each of whom would be responsible for small periodic repayments. (Although the Guangdong EPP currently comprises a fairly small number of sub-projects, this would have been an ideal time to set the groundwork for expansion to exploit energy efficiency potential in China.) In addition, reducing the cost and complexity of billing operations can support the development of ESCOs.
- The electricity bill can become an effective marketing tool for energy efficiency, most importantly by facilitating easy comparisons by consumers and highlighting the savings associated with energy efficiency.
- On-bill collection is convenient for sub-project borrowers, who only have to deal with a single bill. (The relatively large firms currently executing sub-projects under the Guangdong EPP have significant administrative resources and are not heavily burdened by separate bills. However, as noted above, this is a missed opportunity to set the stage for expanded EPPs targeting residential consumers and a larger number of smaller firms.)

- Implementing on-bill collection can help lay the groundwork for greater grid-company participation in energy efficiency at a later date. In other words, on-bill collection is a way of luring a grid company to “put a toe in the water.”

Regulators in the US and Canada have growing interest in – and experience with – on-bill collection of the costs of energy efficiency, under programs for a range of customer classes (residential, government, and industrial). Some of these regional programs in North America have been in place for two decades. Sri Lanka launched a successful on-bill collection system in the 1990s.

The Guangdong decision not to implement on-bill collection appears to have been based partly on grid company reluctance and partly on a set of concerns heard in other countries:

- Grid companies in China, like many of their counterparts elsewhere, have little incentive to get involved with on-bill collection – or any part of energy efficiency – because energy efficiency cuts into their profits. Grid companies that make money based on how much electricity they move – on their throughput – are naturally reluctant to see efficiency measures cut into customer demand. The broader solution to this problem is to implement performance-based regulation that breaks the link between sales and revenues, wherein grid company profit is a function of operational efficiency and not of the number of kWhs delivered, and that also allows grid companies to profit from selling energy efficiency services.
- Grid companies naturally dislike incurring the cost of adjusting existing billing systems to accommodate on-bill collection for efficiency projects.
- Grid companies are sometimes concerned about being exposed to the risk of default by project borrowers. The dynamics of this vary by country and jurisdiction, but the problem centers on legal and political constraints to the grid company’s ability to disconnect consumers who fall into arrears. These considerations are difficult to assess in Guangdong because the constraints are somewhat indeterminate – the grid company may be concerned about the political difficulties associated with disconnecting a large industrial consumer should the consumer default on a sub-project loan.

Each of these problems can be alleviated – at least partially – through artful program design and the implementation of supporting policies.<sup>7</sup> In an encouraging development for the future of EPPs in China, it appears the central government is planning to announce a new DSM framework this year that will likely require that grid companies provide energy efficiency

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<sup>7</sup> For example, pilot projects for the PAYS (“Pay As You Save”) approach in New Hampshire during the mid-2000s showed that customers whose energy efficiency investments produced immediate bill reductions were far less likely to default on their electric bills than the average customer. So long as the loan repayments are less than the bill savings, the default risk remains low.

services to their customers. This policy breakthrough would pave the way for on-bill collection (and should also encourage grid company financing of EPPs, as discussed below).

In deciding not to implement on-bill collection, Guangdong opted to appoint a third-party financial institution, Yuecai Financial Trust, to manage the EPP loan portfolio. Yuecai seems to be functioning well in this role. But this is undoubtedly adding a layer of costs that could have been reduced or avoided with on-bill collection.

### **C. Retrofits and Lost Opportunities**

The Guangdong EPP is largely limited to retrofits for relatively large electricity consumers. To date, the Guangdong EPP sub-projects have targeted retrofits, as opposed to “lost opportunities” – that is, the EPP focuses on upgrades or replacements of equipment in existing installations, as opposed to addressing efficiency issues during the design and construction of new buildings and factories. The Chinese economy is growing very quickly – particularly in terms of investment in heavy industrial capacity. The Chinese government has the power and political leeway to simply close down inefficient facilities. As a result, the average age of the industrial capital stock is much younger than that in the developed world. Plants that were in existence five years ago may now only comprise as little as half of the capacity in some sectors. Failure to address energy efficiency in new construction is a much bigger loss in China than in most of the rest of the world. Despite the difficulties of addressing these opportunities – there is a narrow time window to affect planning and difficulties with marketing to firms focused on development – it is important for future EPPs to adopt methods for doing so.

One quick way to integrate lost opportunities would be to adapt two of China’s national energy efficiency programs – subsidies for energy efficient lights and subsidies for energy efficient air conditioners. Guangdong’s large and rapidly growing air conditioning load makes it a prime candidate.

### **D. Energy Saving Fee**

On-bill collection supports an additional recommendation of the 2007 consultants’ report: implementation of an energy savings fee (ESF), a fee per kWh-saved that is uniform across sub-project borrowers, regardless of size or cost of project.<sup>8</sup> An ESF is both a marketing tool that helps break down informational barriers to investment in energy efficiency and a mechanism that can easily be combined with other sources to attract participants.

The ESF communicates important information clearly and simply. Customers know how much they pay for a kWh they consume. The ESF allows them to easily see the cost of a kWh saved.

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<sup>8</sup> While the fee, denominated in RMB per kWh saved, is the same for all borrowers, the terms of each loan would differ in the length of time it takes each customer to pay it off, given that the amount of investment and savings would differ customer by customer. If the ESF is collected through customers’ utility bills, the risks of default would be reduced.

In Guangdong, as the EPP currently works, the terms of the sub-project EPP loans are not particularly attractive when compared to the alternative – i.e., simply paying for electricity at the going rate. This is because the EPP loan terms requires the borrower to pay for the savings in a relatively short period of time. (In contrast, CPPs are financed over a much longer period of time. If customers had to pay for the cost of power plants in a short period of time, the per kWh price of electricity would be very high.)

Problems with attracting customers to a loan-based model are partly a function of information and communication but mostly a function of the economics. A loan that is subsidized or that requires only partial repayment will attract many more customers than a loan that must be fully repaid on conventional terms. An ESF-based approach to financing efficiency can be easily combined with other sources of investment funds (including government subsidies) to reduce the costs of loans and expand the pool of participants.

It is not clear at this time why Guangdong did not seriously consider the ESF as a component of its pilot EPP. It seems likely that it was rejected for the same reasons that on-bill collection was rejected, as the fee makes sense only if it is collected through the utility billing apparatus.

By moving to an ESF-approach Guangdong can improve the communication of the fundamental point that saving electricity costs less than buying electricity.

### **E. Other Issues**

As previously noted, the Guangdong EPP has not been operating for very long. Overall, the organizational structure is working and the PMO is functioning well as an administrator. Interagency cooperation among Guangdong's various provincial government bodies clearly gives a major boost to the EPP effort. However, several operational problems seem to have developed since the first projects were launched a year ago:

- There appears to be a shortage of applicants for sub-project loans. This strongly suggests that the terms of the loans may simply not be sufficient to attract large numbers of borrowers. As discussed earlier in this paper, a model featuring commercial loans (that is, without some other kind of additional funding from ratepayers or taxpayers) is typically not able to overcome barriers to exploitation of existing energy efficiency opportunities. In addition, the strength and approach of the EPP marketing effort may be a problem. It is possible that, once the EPP becomes more widely known – and understood – in Guangdong, then more potential borrowers will materialize.
- In particular, potential applicants may be discouraged by onerous procedures, requirements and associated transaction costs.<sup>9</sup>

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<sup>9</sup> Reducing transaction costs (broadly defined) is one of the main targets of the EPP concept. From this point of view, our analysis of EPP models is essentially an effort to identify ways to minimize the transaction costs associated with

- Applicant firms must have debt to equity ratio lower than 75%, which is fairly restrictive by international standards.
- As mentioned above, firms must have excellent records in terms of credit history, labor relations, etc.
- The intensive application, equipment acquisition, monitoring and reporting processes present considerable barriers, particularly to smaller, less sophisticated firms.
- In reaction to the global financial crisis, the central government encouraged state-owned banks to rapidly expand credit in China. This led to a substantial easing of access to commercial loans for potential sub-project borrowers. Despite the fact that EPP project loan interest rates are still lower than those available to firms from commercial banks, the spread has narrowed and many firms may now balk at the relatively difficult administrative requirements associated with borrowing under the EPP. In response, the PMO has begun easing some of these requirements – in particular, eliminating the need for the borrower to obtain a costly financial guarantee from a third party.
- Weak economic conditions last year may also be contributing to emerging loan recovery problems. Some borrowing firms have already requested adjustments to loan terms. Others are not withdrawing on schedule. Out of the eight projects in the first tranche, three had not begun to draw on available funds as of the end of 2009.
- Some sub-project borrowers have failed to comply with the ADB's equipment procurement guidelines, resulting in further disbursement delays.

## **V. Concluding Comments**

The EPP is a new approach to energy efficiency, designed to meet many of the special conditions faced in China, but also drawing on international best practice. EPPs provide the opportunity to significantly change the financial, economic, and organizational aspects of energy efficiency delivery.

The concept fits well with China's current national energy efficiency goals and priorities. The State Council's Decision No. 28, Article XXVI (issued in 2007), specifically states that "China will strengthen management of the power demand side and of power scheduling; give full play to

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exploiting energy efficiency opportunities.

the comprehensive advantages of power demand-side management; optimize the use of power schemes for cities and enterprises; promote the use of high-efficiency energy conservation technologies; push forward the construction of EPPs; and increase the efficiency of power use.”

Guangdong has good reason to celebrate early successes of its new EPP. In addition, Guangdong’s experience will be very fruitful for other efforts currently under way. The Energy Foundation is currently supporting EPP pilots in Sichuan, Jiangsu, Beijing, Shanghai, and Hebei. The ADB is also in discussions with Hebei Province about supporting an EPP, and is moving ahead with preliminary work for an EPP in Shandong Province. New policies in support of EPPs may be announced in Beijing this year. There will be valuable opportunities to integrate the lessons from Guangdong in the near future.

There is ample room to build on Guangdong’s approach. In particular, Guangdong’s model may be feasible for an EPP comprised of a few large projects; however, if EPPs are to be scaled up and broadened in scope, they will need to target larger numbers of smaller, more disbursed projects. Alternative approaches will be necessary. Application, procurement, and assessment procedures will have to be simplified and made routine, with the administrative authorities (whether the government or grid company) taking on a more centralized role. Together with our partner organizations, we will follow up on these ideas in future reports.