Meeting China's Energy Efficiency and Environmental Goals with Efficiency Power Plants (EPPs)

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June 2007

1) Introduction

A little more than a year ago China's leaders recognized that current energy and environmental trends are not sustainable and not consistent with China's long-term interests. They set ambitious goals to reduce the country's energy use per dollar of GDP by 20% and reduce emissions of certain major pollutants by 10% by 2010. Increased energy efficiency is now a top priority for China. But, during the past year while researchers and government officials have been hard at work discussing how to meet the goals, energy intensity and pollution increased. Failing to make progress in the first year makes it especially important to find new and more effective policies.

This paper provides a brief overview of a new concept called the "Efficiency Power Plant" (EPP). The EPP bundles efficiency programs so that the resulting savings are as predictable and substantial as the output of a power plant. This concept provides a way to address barriers to energy efficiency, integrate energy efficiency in power sector reform, and make substantial progress in meeting China's 20% efficiency improvement goal.[1]

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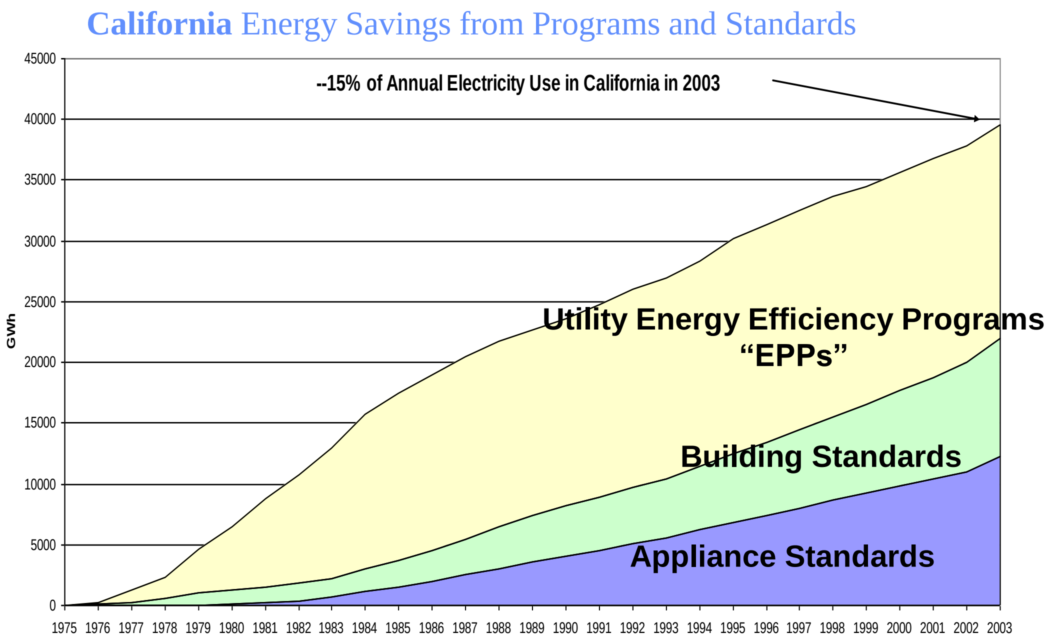
International and Chinese experience shows that improving energy efficiency in the use of electricity is highly cost-effective. But there are many barriers to energy efficiency. Some discourage residential, commercial, and industrial customers from investing in more efficient appliances, buildings, motors, and processes. Other barriers inhibit utility support for efficiency, and still others impede needed policy reforms.

One of China's greatest policy barriers to energy efficiency is the widely held misconception by policy makers that energy efficiency goals can be met by standards, labeling, education, and

[1] Much of our initial work on this was in connection with an Asian Development Bank project to develop the concept in China, and to finance a pilot EPP in Guangdong. The ADB effort had two parts: Our focus was on Part A, which identified the full range of EPP options and central level policy issues. Part B focused on a pilot EPP in Guangdong. This paper provides a brief overview of the policy options and needed reforms to make EPPs a major part of China's energy efficiency effort. Our conclusions are EPPs provide a very powerful and practical way to increase China's investment in energy efficiency and to integrate energy efficiency in China's power sector reform. Our conclusions are also very consistent with those of a team of experts that visited the US to gain first hand experience with EPPs. More details on the policy options or the Guangdong pilot are available.

more economically efficient energy prices. All of these steps are important and contribute to addressing the energy efficiency problem, but many years of international experience have proven that a very large reservoir of low-cost energy efficiency potential will remain untapped even if these steps are taken. The market barriers to energy efficiency are too significant and varied in nature to be solved only by standards, education, and information.

The following figure makes the point graphically. It shows the sources of energy efficiency savings in California. California has the most stringent building and appliance standards in the US. Energy and electricity prices in California are very high and well-designed to encourage energy efficiency. Still, as the graph shows, more than 50% of the electricity savings achieved are through government-mandated, ratepayer-funded, demand-side management (DSM) programs. The consistent savings from these efficiency programs can be thought of as a virtual power plant, the EPP, meeting consumer demand while reducing energy use and pollution.



2) The EPP Concept

The EPP combines many of the best features of international energy efficiency experience. An EPP can be partly explained by contrasting it with a conventional power plant (CPP).

a)

A typical conventional power plant (CPP) in China is a 300 MW coal-fired power plant that operates for approximately 6000 hours a year. The table below reveals several differences between a CPP and an EPP for each kilowatt-hour (kWh) delivered.

Table 1 CPP and EPP Fuel Use, Emissions and Cost/kWh

	CPP	**EPP**
Capacity	300 MW	300 MW
Annual MWh produced/saved	1.5 million	1.5 million

Fuel Use/kWh	340 grams coal	0 grams
SO2 emissions/kWh	4 grams	0 grams
Average cost/kWh	35-40 fen	15 fen

Like a CPP, an EPP must be planned, financed, built, and operated, and its performance (producing or saving kWhs) must be measured and verified. See Table 2, 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 costs are paid over time as the power plant produces electricity. Similarly, the cost of the EPP is paid over time as the EPP saves kWhs.

Table 2 Comparison of CPP and EPP Processes

	CPPs – Present Process	EPPs – Proposed Process
Planning	China's planning process is not transparent. Proposed power plants are screened for compliance with government policies and regulations.	Scientific planning process would identify best types, size and location of EPPs' energy efficiency programs.
Financing	Capital construction cost financed using debt, equity, or other sources of capital.	Capital cost including cost of rebates and other incentives can be financed using debt, equity, or other sources of capital. The Pilot EPP was financed by loans from ADB.
Building	CPPs must be designed and engineered. Major components must be ordered. Skilled contractors of all types must be hired and deployed.	EPPs' energy efficiency programs must be designed to deliver the desired savings at a reasonable cost. Efficient products must be ordered for some programs. Skilled contractors of all types must be hired and deployed.
Operation	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 costs.	EPPs' energy efficiency programs have no significant operating cost.
Performance	Power plant performance (and operating cost) is an ongoing risk. Actual power plant output is metered.	Energy saving performance is reasonably predictable and risk-free. Actual kWh savings are determined by well-established measurement and verification protocols.
Cost Recovery	CPPs recover capital and operating costs through kWh prices paid over the life of the plants.	EPPs are designed to recover costs through payments for energy savings over the life of the energy efficiency investments. The sources of funds vary depending on the EPP model selected.

3) Models of EPP Implementation

We have identified four general options for implementing EPPs. All of the models share certain common features:

1. Energy efficiency opportunities are identified and evaluated. Energy efficiency options are selected and aggregated into a single EPP of substantial size (on the order of 300 MW).
2. Investment capital to fund the energy efficiency is identified, and loans or other capital resources are obtained by a responsible, competent, and credit-worthy entity that can oversee the design and delivery of energy efficiency programs and manage the loan repayment process. For the project we have been involved with, the ADB is prepared to loan the necessary funds.
3. Energy efficiency programs are delivered by a mix of energy service companies (ESCOs), customers, contractors, and others under the supervision of a competent entity.
4. Actual energy savings performance is measured and verified by one or more responsible government agencies.
5. The loan is repaid over the life of the energy efficiency investment.
6. The entire process from beginning to end is subject to government oversight and approval.

The main differences between the models relate to the source of funding, the grid company role, and the degree of integration with power sector reform. All of the models are practical and effective but most of the models require central level policy reforms. Even those that do not require central level reform would benefit from the reforms to produce substantial results.

a) Model 1: Comprehensive integration of EPPs 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. It also harmonizes national goals and utility profitability. Under this model, grid companies have the obligation to meet customer needs using the least-cost mix of CPPs and EPPs. Because EPPs are much less expensive than CPPs this model results in substantially increased use of EPPs. Electricity pricing is reformed so the costs of CPPs and EPPs are treated equally. Currently, grid companies can include the cost of CPPs in prices but there is no opportunity to recover the cost of EPPs.

Model 1 is also 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.[2] IEA recognized that utility DSM programs can add substantially to China's energy efficiency efforts if energy

[2] "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: IEA. 2006. *China's Power Sector Reforms: Where to next?* http://www.iea.org/w/bookshop/add.aspx?id=288?

efficiency policies are integrated with power sector reform. Unfortunately, China's initial power sector reforms are making energy efficiency more difficult rather than easier.

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 that this model should receive very serious consideration. This approach is used in a number of states in the US and other countries. California provides one of the most comprehensive examples of this approach.

b) Model 2: System benefit charge (SBC) collected by a small uniform charge on all kWh sales

Model 2 differs from Model 1 in two significant ways. First, the grid company role is substantially reduced. The grid company's role 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 give consumers and developers increased incentives to invest in energy efficiency. Under Model 2, EPP costs are recovered as a separate small uniform surcharge on electricity prices or electricity generators. Scientific energy planning can be used with Model 2 to identify the size and cost of EPP potential, but it is rare that the SBC is set at a level high enough to build all of the cost-effective EPPs. This approach has been taken in many states and countries. Vermont is one of the best examples of this approach.

c) Model 3: Government funding

The main distinction of Model 3 from Model 2 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 taxes designed to encourage energy efficiency such as energy or pollution taxes.

d) Model 4: Direct funding by participating consumers[3]

The last approach combines the EPP's aggregation approach with traditional loan or ESCO approaches in which consumers who choose to invest in energy efficiency pay for the investment over time. This model has received a great deal of attention and innovation because it is the basic model being pursued in Guangdong.

Individual participants (or ESCOs) propose energy efficiency projects. The projects are reviewed for technical, economic, and financial viability. The projects that pass the tests are aggregated into an EPP and loans for individual projects are approved.

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. Each participant pays the same ESF for the kWh savings estimated for its particular project.
There are several useful versions of this option. Under the best versions, the ESF is included on the power bills of the participating customers; however, it is a separate charge and is not part of the electricity price. The grid company merely collects the ESF and forwards the collected

[3] Model 4 is further distinguished from the other options because it has been designed to require no central government policy reform.

funds to the actual borrower (a government-designated entity), which will then recycle or repay the loan.

Table 3, below, 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.

Table 3 Distinguishing Characteristics of EPP Models

	Model 1 Comprehensive Integration With Power Sector Reform; Costs Recovered in Rates	**Model 2 SBC Funded**	**Model 3 Government Financed**	**Model 4 Participating Consumer Funded**
Planning and investment	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 though 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 determines the number and size of energy efficiency opportunities consumers are willing to implement using this approach.
Grid Company role	Grid Company is fully involved in assessing potential for energy efficiency and suggesting program design and funding level.	Grid Company collects SBC and forwards funds to administrator of energy efficiency programs.	Grid Company has no significant role.	Grid Company may collect ESF (loan repayment) from participants.
Source of funds for repayment	Electricity prices, preferably through pricing policies that reinforce consumer incentives to invest in energy efficiency such as inclined block prices and differential new construction hookup fees	Small uniform SBC added to electricity prices of all consumers.	Government energy efficiency funding, possibly though increased taxes or fees on energy or pollution.	Energy Saving Fee (ESF) added to electric bills of participating customers, based on kWh saved and original loan amount.
Major policy reforms needed in China	Requires reform of planning, investment, market and electricity pricing policies and pricing methods.	Requires adoption of SBC policies and identification of administrator for energy efficiency programs. Planning reforms would improve results.	Requires government decision to fund energy efficiency and identification of administrator for energy efficiency programs	Requires identification of administrator for energy efficiency programs
Best international example	California	Vermont	South Korea	Loan or PAYS® programs in several states in the US

4) Supporting Provincial Policies

Although EPPs benefit most from central government policy reforms, there are policy reforms available at the provincial level that could dramatically enhance any of the four EPP models.

The best option builds on recent experience in Shandong province. Shandong has implemented an energy quota system covering 20 industries and 52 products manufactured in the province.[4] The provincial government has set energy use (electricity and other fuels) quota levels. Consumers who exceed the quota level pay a substantial surcharge, as much as 400% of the energy price. The surcharge is paid to the Shandong Energy Conservation Supervision Center and is deposited in a special fund to be used for energy efficiency.

Other provinces including Guangdong are currently in the process of designing similar energy quota systems. Coordinating the design of the quota system with EPPs will provide multiple synergistic benefits for the electric system, for the environment, for EPP participants and other consumers. The quota system can set realistic efficiency goals, provide financial "carrot and stick" incentives to achieve those goals by participating in the EPP, and create a revenue stream to support efficiency investments.[5]

In particular, we suggest coordinating the quota system and EPPs by setting the quota level at a relatively low level so all but the most efficient consumers will exceed the quota. This means that candidates for participation in the EPP will be subject to surcharges. For example,

- 10% surcharge for exceeding the quota by 10% or less, (Shandong's surcharge is 100%);
- 20% surcharge for exceeding the quota by 10% to 20%;
- 30% surcharge for exceeding the quota by 20% to 30%; and so on. (Note that the surcharges are applied to energy use in excess of the quota.)

Funds collected by the surcharge should be used to help fund EPPs and reduce the ESF payment collected directly from the participating customer. This creates a powerful incentive for consumers to participate in the EPP.

5) Conclusions

A large team of international and domestic experts have examined the EPP concept and options in great depth. Our conclusions are summarized as follows:

- China has a great need for EPPs.
- EPPs can contribute substantially to China's 20% energy efficiency goal.
- China's electric sector has many barriers to energy efficiency and EPPs and current power sector reform plans tend to increase the barriers.
- All of the four EPP models identified are financially viable, although some are much more effective than others.
- Any of the four EPP models identified can be implemented in China, although some will require more central level policy reform than others.
- There are very powerful provincial level policies available to support EPPs.

4 The eight industries covered in the central government's differential pricing policy are excluded.

5 Funding energy efficiency with surcharges on excessive use was common in China before 2000. It has also been used with success in Brazil. See Demand-Side Management in China's Restructured Power Industry: How Regulation and Policy Can Deliver Demand-Side Management Benefits to a Growing Economy and a Changing Power System, Report 314/05, December 2005. Available at http://wbln0018.worldbank.org/esmap/site.nsf/files/314-05+ChinaDSM+FINAL_For_Web.pdf/$FILE/314-05+ChinaDSM+FINAL_For_Web.pdf

The most important near-term steps to support EPPs are as follows:

1. EPPs need central level policy reforms. To assure the reforms receive high priority, the EPP concept and related reforms should be included in the Energy Conservation Law, Electricity Law, and Energy Law.
2. EPPs should be considered a resource that is equal to, or better than, CPPs. EPPs need a stable and adequate source of funds beyond funding directly from participating customers. The funding may be through tariffs, local construction fees, quota surcharges or other sources. China needs to create special funds to support EPPs within the power sector, perhaps as a percentage of the overall power rates.
3. China needs to go further with pricing reforms. Experience in China and elsewhere has demonstrated that consumers will modify their consumption in response to price signals. Inclining block rates, hook-up fees for new construction linked to building energy efficiency, and increased use of higher electricity fees for inefficient industrial technologies are some of the most important reforms.
4. China needs to build EPPs into the power sector market structure. One of the main lessons from the California electricity crisis was the importance of designing competitive markets to allow full participation by demand-side options. The importance of demand-side participation in these markets has now been widely accepted internationally.
5. It is necessary to remove financial disincentives that discourage utilities from investing in EPPs. It is important to adopt tariff methods that align grid company financial incentives with investment in low-cost EPPs. This has two parts: (a) recovery of EPP-related costs and (b) the adoption of tariff methods that do not reward increased sales.