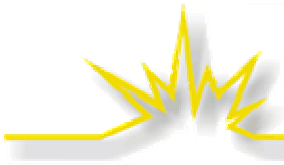

The Regulatory Assistance Project

The Role of Electric Power Sector Reform in China's Sustainable Development

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Electricity and electric power sector reform will play a central role in China's development. Whether the industry grows and reforms in ways that produce sustainable or unsustainable development depends entirely on decisions that will be made by China's policymakers in the next year or two.

My message today is straightforward – there is no doubt that the use of electricity will grow rapidly as China's economy grows. Lessons learned from experience in the US and other countries shows that there are a handful of policy options which can assure that China expands and reforms this sector and the economy it fuels in a sustainable fashion. Because of the shortness of time I will only touch upon some of the more important issues. Thanks to the China Sustainable Energy Program sponsored by the Energy Foundation and the Packard Foundation, Chinese versions of papers covering many of the topics I will discuss are available on our web site www.rapmaine.org

National Perspective

For national and provincial policy makers two facts about electricity explain the important connection between the electric industry and sustainable development. First, electricity is an input to a productive economy, not an output. Second, the environmental impact of the industry is very large in absolute terms and in relation to the industry's position in the economy. Let me explain these two points more fully.

Electricity is an Input

The Chinese economy uses electricity and other inputs to produce goods and services to meet the demand of domestic and international consumers. Using more electricity than necessary to produce a given amount of goods and services is just as wasteful and uneconomic as using too much steel to build a car, too much cement to build a dam, or too much fabric to make a shirt. The economy is improved if China expands its production and sales of cellular telephones, but producing and selling more electricity than needed to make cellular phones and all of China's other goods and services would be inefficient and polluting.

Consider the issue from several different perspectives. From a national perspective, the Chinese economy is best served by making more and more products with fewer and fewer inputs. If viewed from the much narrower perspective of a coal supplier or a profit-making electric company the result is very different. The coal supplier's first interest is in selling more coal and the electric company's first interest is in selling more electricity. This means that, if coal suppliers and electric companies are put in charge of reforming the electric sector, the outcome will be influenced by a set of interests that may differ from the national interest.

The guiding principle that should govern reform of the electricity sector is to provide energy services in the least-cost manner. This also happens to be the guiding principle of Integrated Resource Planning, IRP. This principle distinguishes between electricity, kilowatts, kilowatt-hours, and energy services such as heat, light, motor drives, etc. This energy service perspective recognizes that electricity is an input which, when combined with a light bulb, produces light and, when combined with a motor, produces motor drive. The cost of the energy service is the combination of the price of kWhs that provide light, drive a motor, or operate a refrigerator and the number of kWhs needed to produce the desired light, motor drive, or cooling. This means that how efficiently the motor or refrigerator converts kWhs to mechanical energy or cooling is important. Thus, if the energy service needed is refrigeration, the goal of IRP is to find the least-costly mix of investments to make refrigerators more efficient and to provide the electricity to operate the refrigerator.

Our experience with energy efficiency is compelling. We have learned that the potential for cost_effective savings from accelerated investments in energy efficiency is very large. Individual demand-side management programs (DSM) vary in their size and cost_effectiveness, but the overall results of US utility DSM programs over the past decade have been remarkable. Even in a period of start_up, experimentation, and institutional development, utility_sponsored DSM programs quickly lowered the nation's summer peak load by more than 25,000 MW, and delivered energy savings to utility systems at a cost to the utilities of about 2.1 cents per kWh. And the national potential for efficiency savings is by no means exhausted. Moderate estimates by experts at the nation's energy laboratories forecast that by 2010, efficiency programs could reduce the nation's overall electric consumption by 15%, saving more than $23 Billion in the process.

Large Environmental Impact

The second fact is that there is an inescapable linkage between energy use and the environment. Pollution from electric power plants affects the air, lakes and streams, agricultural crops, land, animal habitat, and human health. The environmental impacts of electricity production are large and they are experienced locally, nationally, and globally. For most countries, the environmental harm caused by producing electricity is rivaled only by that of the rapidly growing transportation sector. Electricity production is almost always the single largest stationary source of air pollution. In the United States the electricity production sector is about 2% of the overall economy, yet it causes more than one-third of all air pollution.

While many governments wish to create abundant low-cost electricity for their citizens and economy, to do so by ignoring the environmental consequences only creates other large costs for society such as higher health costs and reduced agricultural production. It is far more efficient to take environmental impacts into account at the time an electricity system is planned, expanded, and reformed rather than after the fact when the environmental harm has occurred and large vested financial interests resist change.

Market economics teaches us that resources of all kinds are allocated most efficiently when their full costs are included in prices and distributed in a competitive market. This is as true for electricity as it is for other products and services. To avoid unnecessary damage to the environment, to people's health, and to the productivity of other segments of a nation's economy, the actual cost of environmental harm for each potential electricity resource should be factored as completely as possible into the resource selection process. Where competitive markets are used, the best option is to reflect environmental damages in the competitive price. Where government regulators have the responsibility of selecting electricity resources, they should take environmental costs directly and fully into account when comparing the cost of one resource with another. If the cost of environmental harm is not internalized to electricity production, a competitive advantage is created which favors those resources, however dirty, that are most successful in transferring environmental costs to the rest of society.Market economics teaches us that resources of all kinds are allocated most efficiently when their full costs are included in prices and distributed in a competitive market. This is as true for electricity as it is for other products and services. To avoid unnecessary damage to the environment, to people's health, and to the productivity of other segments of a nation's economy, the actual cost of environmental harm for each potential electricity resource should be factored as completely as possible into the

With these two basic facts in mind we can turn briefly to the five most important policies to consider while restructuring the industry. These policies represent my view of the best international practices.

1) Be sure sustainability is a clearly stated goal of restructuring

Electric utility restructuring means different things to different people and different countries. No one model of restructuring fits all countries. The most important step in any electric utility restructuring is to clearly understand and articulate the country's goals and constraints. Typical goals may be:

Reducing electric costs;
Attracting private capital;
Maximizing public revenues from the sale of government owned assets; and
Creating an environmentally sustainable electricity sector.

Constraints are equally important to understand and may typically include the following.

Existing prices are subsidized for some customers and others are overcharged;
National security or economic conditions may force the use of local resources; and
Rapid reductions in the workforce may not be possible. Current employment levels may be well above the level that a competitive sector would support.

A full and complete understanding of a country's goals and constraints will dictate the shape and pace of industry restructuring. The lesson from other countries is clear. If electricity sector reform is to be done in a way that produces sustainable outcomes, the process must begin with high-level officials making it clear that this is a goal to be achieved.

The reform process in China is in the very early stages. Now is the time for policymakers at the highest levels to make it clear that the reform of the industry should be a driver and a model of sustainability.

2) Incorporate environmental costs

As the electric industry is reformed and relies increasingly on markets and competition, sustainability may be best achieved by including the full cost of pollution in the cost of electricity. There are many ways to accomplish this and China's "polluter pays" policy provides an excellent starting point. If sustainability is to be achieved, the "polluter pays" policy must have three essential characteristics. First, the fees must apply to all major pollutants. Second the fees must be high enough to reflect the full damage cost imposed by pollution. Third, revenues from the fees may be used to redress or prevent pollution, but they cannot be returned to the polluter in direct proportion to the fee paid by the polluter.

Until the "polluter pays" policy fully meets these three requirements other steps must be taken. Experience in the US and elsewhere provides other options. A number of states in the US have required the use of "adders" when planning how to make investments in the electric system. During the planning process, or in some states the competitive bidding process, the cost of each option would be increased to include the full environmental cost. Next the planning process would identify the least-cost mix of options and then those options would be built or purchased.

For example, suppose there were two competing coal-fired plants that bid to supply power to China. Plant A bids 3 cents per kWh and emits 10 grams of SO2 per kWh and Plant B bids 3.5 cents and emits 2 grams per kWh. If emissions are not taken into account Plant A would win the bid. But suppose the damage caused by SO2 were worth 0.5 cents per kWh. Plant A now costs 8 cents and Plant B costs only 4.5 cents. Taking the environmental costs into account Plant B wins the bid.

Notice however that Plant B would be paid 3.5 cents, not 4.5 cents. The adders are not included in the costs passed on to customers, but rather are used only in the selection process. This approach has the effect of passing less than full environmental cost on to customers.

3) Reform environmental regulation to conform with new industry structures

The approach taken to environmental regulation will influence the environmental performance of the power sector as well as the cost of meeting environmental goals. As the power sector is reformed to include more and more

competition it is important to simultaneously reform environmental regulation to match the more competitive model. Experience in the US points to three policy options to consider.

In the U.S. many states, eager to embrace electric utility restructuring as a means of increasing efficiency and reducing costs, have also been eager to ensure that competition is introduced in a manner that preserves environmental quality. Recognizing the wide disparities in emissions levels that characterize existing power plants throughout the U.S., regulators became concerned that, in the absence of comparable environmental requirements for all suppliers, restructuring could lead to greater reliance on lower cost but more polluting resources. These concerns are particularly acute in the northeastern United States, where serious air pollution problems are compounded by pollution that are blown by the winds from regions with less stringent environmental regulation.

Two options or issues top the list: Generation Performance Standards Cap and Trade .

Generation Performance Standards

Power plant emissions in the US and most other countries have traditionally been regulated on the basis of pounds of emissions per unit of fuel burned (e.g., lb./mBtu). Historically, this input-based regulatory option was adopted because it could be applied to all sectors being regulated, not just power plants but industrial and commercial sectors. This method was also consistent with the U.S. practice of setting different standards for power plants depending on plant age and fuel use. However, using non-uniform, fuel input-based standards has led to unintended negative consequences. It encourages the construction and operation of plants with higher emissions and lower efficiency, encourages less efficient plants to continue operating, fails to provide incentives for pollution prevention, and is not compatible with competitive markets for generation.

To address these shortcomings the US is increasingly turning its attention to output-based standards. Instead of specifying the amount of pollution per unit of fuel or heat input, output-based standards specify a given amount of emissions per kWh produced. Ideally, the output standards would be uniform for all plants and trading would be used to reduce the cost of compliance. Output-based standards encourage greater thermal efficiency in the generation of electric power regardless of plant age or historic fuel use. Using uniform output-based emission standards is important for electricity markets in the process of evolving to competitive markets since they reward facilities that are efficient in production and promote the development of new and cleaner facilities.

Output-based performance standards prevent utility restructuring from resulting in a degradation of air quality by providing a mechanism to ensure that disparities in environmental regulation do not create a competitive advantage for more polluting resources. This approach improves economic efficiency by allowing generators to optimize the choice between fuel source and control technology. Setting the standard low enough can improve air quality and reduce the adverse impacts of electricity generation on public health and the environment.

Cap and Trade

Cap and trade approaches to minimizing pollution can be very effective especially when combined with output-based standards. A typical cap and trade approach sets an overall cap on the level of permitted pollution (set on a local, national, or even international geographical basis) and then encourages affected parties to trade among themselves to most efficiently achieve the required cap. The trades are accomplished through the creation of pollution credits, one credit for each permitted ton of pollution (e.g., SO_2), with auctions or other allocation methods used to distribute the credits initially. Those businesses which can lower their pollution outputs less expensively than by purchasing a needed credit at auction will do so. In fact, some businesses will find that it is most economical to reduce pollution output below required levels and then sell their unused pollution credits at auction to the highest bidder.

Our experience with cap and trade teaches two lessons. First, the approach can substantially reduce the cost of pollution reduction. Second, the approach works best for pollutants that affect large geographic areas such as sulphur dioxide and carbon dioxide. Pollutants with predominantly local impacts must be addressed locally.

Two related aspects of US environmental regulation have been caused problems and hopefully China will not repeat our mistakes. First, older power plants have historically been allowed to produce more emissions than newer plants. Although setting lower standards for plants that are nearing retirement has some logical appeal, it has had unintended consequences that become especially troubling in light of our rapid transition to competitive markets for generation. The older and more polluting plants were expected to be retired but the advantage of being allowed to emit more pollution than newer plants has provided a strong incentive to keep these plants running, and consequently polluting. The faster China moves to uniform output-based standards the better.

Second, the US has tended to focus too much on one pollutant at a time. First we regulated particulate matter and dust. Next our attention turned to SO2, and then to NOx. Now the focus will be on CO2, fine particulates, or mercury. Dealing with one pollutant at a time is not very efficient. This approach has been expensive because a control option targeting one pollutant has resulted in higher emissions of the next pollutant to be regulated. Minimizing the cost of pollution control and the environmental damage caused by electricity production requires consideration of all of the major pollutants at the same time.

4) New Regulatory Approaches Send the Right Incentives

Every reform will create a new set of incentives, some of which will be intended and some unintended. The question utility managers will ask is "How do we make money under the new set of rules and requirements?" Our experience shows that there are two basic options: organize and regulate the industry so it makes more money by selling more electricity or organize it so it makes money by becoming more efficient.

Prior to 1990 regulation in the US rewarded increased sales. When regulators became aware of these perverse incentives, especially the strong disincentives for utility investment in end-use energy efficiency, they began to develop and adopt reforms. The goal of the reforms was to make utility investment in energy efficiency more profitable than investment in more costly power supply options. The theory was that the least costly option should be the most profitable option.

The results of these regulatory reforms have been very positive. Utility investment in cost-effective energy efficiency increased dramatically.

Most recently US regulators have addressed the question of how regulation encourages or discourages distributed generation. Distributed generation are very small-scale technologies, 1 kW to 1 MW. The plants, which include microturbines, fuel cells, and photovoltaics, have developed rapidly as a result of developments in the aerospace, defense and automotive industries.

However, unlike large power plants which are constructed on site, usually over a period of years, the small power stations are manufactured at a factory and shipped out for installation, a process that may take only months or even days. These mass manufacturing economies have the potential to bring unit costs down quickly, thus presenting the possibility that on-site generation will become as common as air conditioners, clothes washers, and lawn mowers.

In the US, utility regulators have now begun to adopt reforms that assure that distribution company profits are not hurt by the deployment of these new low cost and relatively clean sources of power. Based on our experience I suggest that China take special care to assure that reforms create strong financial incentives for utility investment in end-use energy efficiency, distributed resources, and increased use of clean and renewable energy supplies.

5) Sustainability Require a Steady Stream of Funding for Efficiency and Renewable Options.

Across the globe, and over many years, electric utilities, governments, and utility regulators have explored numerous mechanisms to assure that cost-effective energy efficiency and renewables are delivered to consumers. Many successful examples exist. Some, such as the practice of Integrated Resource Planning, were developed in the context of vertically-integrated electric systems, and have greatest applicability in any type of single-buyer industry structure. Others have been developed in connection with emerging retail competitive models. Leading examples include:

Energy Efficiency Programs*Energy Efficiency Programs*

a. Comprehensive energy efficiency and load management programs have been developed and widely implemented as part of utilities' Integrated Resource Plans;

- Jurisdiction-wide programs have been funded through wires or system uplift charges, and administered through public efficiency agencies (e.g., the UK's Energy Savings Trust, California's Energy Commission, and the new Energy Efficiency Utility franchise set up in Vermont);
- Efficiency measures have been promoted through voluntary programs (e.g., the EPA's *Green Lights* and *Energy Star* programs) and mandatory building and appliance efficiency programs;
- Some jurisdictions have simple mandatory spending guidelines (e.g., Texas under restructuring and Brazil's 1% spending mandate);

b. In some regions the focus is on Market Transformation activities (e.g., the U.S. Pacific Northwest and New England).

Renewable Electricity Generation*Renewable Electricity Generation*

- Mandatory purchase requirement at avoided cost (e.g., PURPA in the U.S. and feed laws in Germany and elsewhere);
- Support for renewable energy research and development through research consortia (e.g., the Electric Power Research Institute and several state-level programs);
- Creation of a renewable energy fund to support new renewable energy production in response to a public bid offering;
- Establishment of a Renewable Energy Portfolio Standard applicable to all generators or retail electric sellers in a competitive electric market.

Research and Development

There are other benefits that have been part of the regulated electric industry in the US which are at risk as a result of reforms. The industry has historically cooperated on funding research and development. With increased competition policy makers and others fear that investment in R&D will suffer. To address this concern a number of policies have been adopted. These include the following:

- Pooled funding, either voluntarily (e.g., Electric Power Research Institute) or through a mandate (e.g., a wires charge), to support public-purpose research and development;
- Tax credits for qualified R &D;
- Public expenditures through government agencies, universities, and grants to utilities and equipment manufacturers.

Universal Service Mechanisms

Finally, with more emphasis on competitive markets, governments have been concerned about universal service and expansion of service to unserved areas. The following options have been adopted to address these concerns:

- Traditional franchise: obligation to serve all customers within the franchise territory;
- Rural build-out requirements as part of franchise awards in urban areas;
- Geographically-averaged distribution rates which provide support for service at average rates in high-cost portions of the service territory;
- Affordability subsidies for low-income households (lifeline rates, low-income discounts, bill arrearage forgiveness programs, disconnection moratoria);
- Rural electrification subsidies (both grid and off-grid options);
- Rural electric cooperatives;
- Efficiency programs targeted to low-income households.

Conclusion

The electricity industry is key to the sustainability of China's economic and environmental development. Increased availability of electricity energy services at reasonable prices and with less pollution is possible if the right policy options are selected. The reform of China's electricity industry is still in the very early stages and making sustainability a goal of the reforms is the first and most important step.