*The Regulatory Assistance Project*

# Climate Policy Options for China's Power Sector

## Discussion Draft

October 2008

# 1. Introduction and Summary

Electricity generation is the single largest source of greenhouse gas emissions worldwide, and China's share is growing fast. China's power sector is responsible for approximately 50 percent of the country's greenhouse gas emissions, XX percent of 2007's increase in emissions, and in projected scenarios it accounts for anywhere from X to X percent of the incremental increase over the 2050 horizon. A plan to contain China's rapid growth in greenhouse gas emissions will have at its core the power sector.

Policy makers concerned about the environmental footprint of the power sector should ask two questions:

1) What can be done in the power sector address climate change? and,
2) How much will it reduce GHGs and at what cost?

The first question should be considered in the broadest possible terms, and our answers should not be constrained by current power sector structure and law or by the existing organization of government agencies. The first question is the focus of this paper.[1] The second question will be addressed by the second phase of this study. With this two-part analysis in hand, policy makers and advocates can determine the best possible path forward.

***Approaching a Sustainable Energy System***

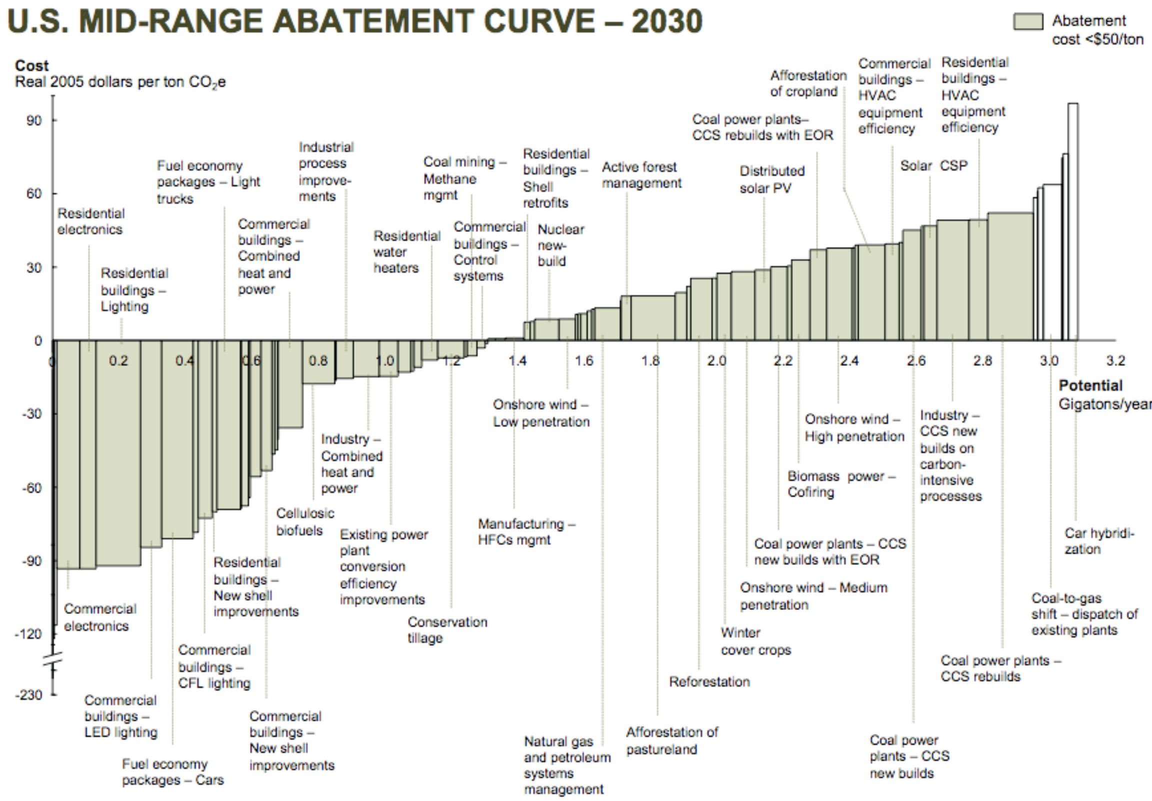
Analysis of the costs of emission abatement measures across the U.S. economy indicates that enormous promise for emission reductions resides. The following graph, Figure A, summarizes the results of a detailed assessment of the opportunities and cost of carbon abatement measures across all sectors in the U.S.

There are two key points to be drawn from the figure. First pertains to improved energy efficiency in buildings, appliances, and industry. The large majority of these measures will have negative marginal costs, such that they will generate economic returns through energy savings that will more than offset the capital investment over their lifetimes. There are significant market barriers to acquiring the energy efficiency savings that will require concerted and creative public and private effort to overcome.

The second opportunity for substantial abatement lies in measures that reduce the carbon intensity of power generation. Part of the challenge is to shift the overall energy mix, dramatically increasing the share of renewable energy resources and low-carbon generation, and planning for the future deployment of carbon capture and sequestration technology. This follows the course of market and policy trends around the world.

[1] While the focus is on climate change, all of the policy options also apply to reduction of $SO_X$, $NO_X$, particulates, mercury, and other pollutants associated with power generation.

**Figure A**




Source: McKinsey analysis

The mitigation of greenhouse gases and other harmful emissions is especially difficult because of the widely held misconception that investment in emissions reduction comes at the expense of economic growth. But as the abatement curve above demonstrates for the United States, many emissions reduction practices come at a negative cost, before even accounting for the very real benefits of improved public health and reduced damage to agriculture and building stock. What this means is that substantial reductions in greenhouse gases and other emissions can be achieved at negligible incremental cost to the power sector.

Specifically with respect to the power sector, China has several conditions that improve its chances of achieving large carbon reductions. First, the power sector is highly concentrated, with ownership dominated by a few large state-owned companies. Second, China has strong central government control with a commitment to energy efficiency and environmental improvement. Third, China is in the early stages of restructuring its power sector, so many irreversible decisions, which will have pervasive implications for energy efficiency and environmental regulation, have not yet been made.

### 1.1. Summary of Policy Options

The power sector climate policy options are divided into three parts: 1) revisions to existing policies, 2) policies in use internationally but not in China, and 3) innovative reforms that fit China's conditions.

1) We have identified nine policies that build upon the best policies China has already adopted.
    i. Continue China's recent practice of setting energy efficiency and environmental goals with clear assignment of responsibility;
    ii. Implement the new power plant dispatch rules and expand it by giving high-priority dispatch to other low-carbon options including capture-ready IGCC and polygeneration meeting specified carbon emissions standards. Also, where generation markets exist adopt steps to preserve benefits of the new dispatch rule;
    iii. Expand the existing pollution levy system to the full range of power sector air emissions, including greenhouse gases and direct funds collected to energy efficiency and low-carbon options;
    iv. Improve current technology-based generation pricing practices to include low-carbon generation including IGCC, capture ready IGCC, polygeneration, and high efficiency CHP. Also, extend the policy of a price premium for FGD carbon capture and sequestration or polygeneration with specified levels of carbon removal;
    v. Strengthen and expand the current differential pricing policies used for energy intensive industries;
    vi. Adopt stronger more effective steps to allow EPPs and DSM to be integrated in the power sector and power markets;
    vii. Strengthen the renewable mandatory market share policies and extend the policies Agreement to low carbon options;
    viii. Transform the existing small power plant closing policy to be a energy efficiency
    ix. Transform the existing small power plant closing policy into an efficiency standard for power plants and gradually increase the standard; and
    x. Expand the existing government reward scheme for energy efficiency improvements to cover more industries and more energy efficiency options.
2) Policies proven work in other countries but that have not yet been adopted in China. There are five policies in this category. These policies are:
    i. Adopt Scientific Energy Planning
    ii. Adopt a carbon cap or carbon "path" for the power sector;
    iii. Adopt a UK style Climate Change Levy and Climate Change Agreement;
    iv. Adopt carbon taxes or carbon fees
    v. Adopt an Emission Performance Standard for new power plants.
3) Innovative, new policies that hold promise given China's unique circumstances. These policies are:
    i. Revise power sector reform plans to reflect high priority energy efficiency and environmental goals;
    ii. Add a clear sustainability mandate to each of China's energy and environmental agencies;
    iii. Adopt industrial policies to encourage more efficient use of coal in the industrial sector by encouraging CHP and polygeneration; and

iv. Increase integration of energy and environmental policies.

## 2. Expanding Existing Climate-Related Policies in the Power Sector

Although China is presently not bound by international commitments to control its greenhouse gas emissions, China does have in place numerous innovative and effective policies and practices that have the effect of mitigating emissions. These policies were driven by efforts to bolster energy security, increase energy efficiency, and reduce local pollution. Whether intended or not, they are also an effective first suite of climate policies.

This section describes nine current power sector policies that offer a sound foundation for significant **additional** reductions in greenhouse gas emissions. For each policy we start with a brief description of the current policy and end with a ***"next steps"*** section that explores how the policy could be modified and improved.

Several policies, for example the small power plant closing and differential pricing, and are now generally viewed as being temporary policies with limited or no long-term value. Each however has substantial opportunity to be the foundation of an ongoing policy with continuing ability to reduce GHG emissions.

### 1.2. National Energy Efficiency and Environmental Goals

China's 11th Five-Year Plan formally announced the goals of reducing energy intensity by 20 percent and emissions by 10 percent by 2010. These goals were quickly followed by an allocation of the goal to the provincial level and, in the case of the Top-1000 industries, energy efficiency goals were allocated to individual firms. The seriousness the government attaches to these goals is demonstrated by the fact that meeting the goals is now a specific measure of the performance evaluation of government officials.

The goals have led to the adoption of many innovative policies. One weakness is that while most key power sector entities are in the Top 1000, the energy efficiency goals are limited to supply-side and grid company transmission and distribution upgrades. Energy efficiency goals do not extend to customer end-use energy efficiency or demand side management DSM, which is broadly recognized as a large potential source of energy efficiency gains and GHG reductions. More than 17 states and three countries have adopted specific DSM goals or targets.[2]

***Next Steps***

- Make it clear that aggressive and specific energy efficiency and environmental goals will be part of every future five-year plan.

[2] American Council for an Energy Efficient Economy, "Energy Efficiency Resources Around the U.S. and the World, September 2007, available at http://www.aceee.org/energy/state/6pgEERS.pdf.

- Energy efficiency and environmental goals should be disaggregated and allocated in three ways: by sector, by political level, and by time. This three-dimensional disaggregation will allow for greater accountability and hence better performance.
- Energy efficiency goals should include specific energy efficiency, or DSM targets for power sector.

### 1.3. Environmental Dispatch Rule

China's current power plant dispatch policies are highly inefficient, resulting in more coal being burnt and more emissions than necessary. To address this problem, one of the most impressive policy innovations in the Chinese power sector is the recent adoption of an environmental dispatch rule. Formalized by the 2007 Energy Conservation Law and detailed in an NDRC circular issued in August 2007, the implementation details of the rule are now being finalized.

What the new rule will do is convert the current inefficient dispatch practice, which is based on plant average (rather than marginal) cost, to one that is based on thermal efficiency and environmental emissions. It requires that the dispatch, or loading, order of power plants be determined according to a new ranking system. The result will be that the cleaner, more efficient plants will be brought on line before others, significantly improving dispatch as it reduces coal-use and emissions, even more effectively than a simple bid-based approach to dispatch would. In turn, the dispatch rule will drive new investment to low-carbon and thermally efficient generation that receives preferential treatment.

The order calls for the operation of non-emitting resources first, then low-emissions resources, and, lastly, the higher emitting units. Specifically, power plants will be scheduled to meet hourly demand according to this dispatch sequence:

1. Non-dispatchable renewable energy generating units, such as wind, solar, ocean, and run-of-river (i.e., non-storage) hydropower facilities;
2. Dispatchable renewable energy facilities, such as hydropower with storage, biomass, and geothermal units;
3. Nuclear facilities;
4. Combined-heat-and-power units that meet specified thermal efficiency criteria and whose operations are determined by thermal energy demand;
5. Natural gas, coal-bed gas, and coal-gasification generating units;
6. Coal-fired generating units, including combined-heat-and-power generating units not meeting minimum thermal efficiency requirements; within this category, power plants with the same heat rates (thermal efficiency) will be ranked according to their emissions of air pollutants (per unit of electrical output); and, lastly,
7. Oil-fired generating units.

An added benefit is that the rule, to be implemented effectively, requires that all thermal power generating units be outfitted with continuous emissions monitoring devices, or CEMs. The data generated by these monitors will greatly enhance the potential for enforcing emissions and efficiency standards in the future. More importantly, because this policy requires the immediate and full sharing of information among governmental agencies, it will foster the sort of energy and environmental policy coordination needed to address climate change.

For now, the rule does not affect the prices generators receive for their output. Consequently, the generators that are dispatched more experience a windfall and those dispatched less experience losses. A generation rights trading scheme is used to address this problem. Generators dispatched more essentially buy the rights to generate more from generators that are dispatched less.

***Next Steps***

The environmental dispatch policy is simple and can be used easily where there is no generation market. It could be made a more effective climate policy in several ways.

First, to better integrate power sector regulation with environmental regulation, implementation and enforcement of the dispatch rule can be improved by:

- Transitioning the generation rights trading scheme to a two-part capacity/energy pricing scheme. This will simplify the system and improve compliance.
- Requiring CEMs or other means of monitoring plant heat rates as well as the output of other key pollutants.
- Incorporating CEM data directly into power plant dispatch operations.
- Modifying dispatch rules to clarify that power plants that do not meet specified minimum pollution output or efficiency standards (i.e., they emit more than is allowed) will not be dispatched at all.

Second, giving high-priority dispatch to several other promising low-carbon options will encourage investment in new technologies, such as:

- Capture-ready IGCC;
- Polygeneration meeting specified carbon emissions standards; and
- Generation that has funded EPPs.

Where generation markets exist, the current rule will be superseded by new bidding rules. This means China will need a policy that affects bidding practices is a way that achieves the efficiency and environmental objectives now met by the new dispatch rule. One of the best options would be a two-part pollution levy scheme, recently designed by Chinese researchers. The two-part levy would cause generators to recognize environmental costs in their bid prices, while minimizing the impact on end-user electricity prices. The two-part levy, which is simply an expansion of the current pollution levy policy, is described in the following section.

## 1.4. Pollution Levy

China's pollution levy system was first implemented in 1978. It covers an extensive range of water and air pollutants, and was structurally revised in 2003 from a levy that applied to discharges in excess of specified allowable levels to one that applies to all pollution emissions. Rates are determined by the central government's Ministry of Environment (MEP) and are enforced by the local Environmental Protection Bureaus (EPB). Regional EPBs are also charged with administering the funds generated from the tax revenue, which are designated for environmental projects, such as pollution control technology.

In 2004, the levy for $SO_2$ emissions from electric power plants was raised from $24 per ton (200 RMB per metric ton) to $76 per ton (630 RMB per metric ton). The levy was increased again in 2007 to $152 per ton (1260 RMB per metric ton) and is now slightly higher than the average cost to control emissions.

The system still has weaknesses including (1) failures of local enforcement, and (2) the failure to apply it to carbon dioxide, nitrous oxide, or methane emissions, chief among the greenhouse gases. Despite these shortcomings, the pollution levy provides an important regulatory platform that can be used to address climate change.

***Next Steps***

There are five improvements in the near term.

- Expand the levy system to the full range of power sector air emissions, including greenhouse gases.
- Set the level of the fees to encourage investment in low-carbon power options and announce in advance how the fees will increase over time.
- Direct a substantial portion of the pollution levy to investment in end-use energy efficiency.[3]
- Improve implementation and enforcement of the levy by better integration with power sector regulation, by:
    - Requiring CEMs capable of monitoring heat rate (carbon emissions) as well as other key pollutants;
    - Basing dispatch decisions directly on CEM data;
    - Modifying regulation to clarify that power plants emitting more than specified levels of air pollutants will be not dispatched;
    - Transferring the responsibility for collecting the levy to the grid operator;
    - Clarifying that non-payment of fees will also disqualify a power plant for dispatch.
- Where competitive wholesale generation markets exist, modify the levy (as described in the following paragraphs) to effect the same system dispatch that the new environmental dispatch rule produces in fully regulated markets.

As noted earlier, environmental dispatch can be undertaken easily where there are no competitive generation markets. However, where generation markets exist, an approach that affects the bidding practices of competitors, and thus dispatch, will be needed. For this, the pollution levy

---

[3] As discussed more in the section on carbon cap and trade the reduction in energy use (and the related environmental benefits) due to direct investment in energy efficiency is 7 to 13 times greater than the effect of raising prices to create the energy efficiency fund.

should be expanded into two parts. A two-part levy will cause generators to recognize environmental costs in their bid prices, thus improving the environmental profile of the overall system dispatch and guiding new plant investment. Furthermore, by being imposed in two parts, the levy can minimize the impact on end-user electricity prices.

It is straightforward and easy to implement. Under the two-part system, the first part is simply the existing pollution levy on emissions. The second part is the difference between the existing levy and the estimated full environmental cost of the generating unit, or, alternatively, the amount needed to affect bid prices (i.e., the variable operating costs) so as to alter the sequence of dispatch to match that of the new environmental loading order. Imposing both parts of the levy on generators participating in competitive generation markets assures that their bid prices and resulting dispatch reflects China's efficiency and environmental goals.

To address concerns about the effect of the policy on retail electricity prices, funds from the second levy can be used to lower electricity prices in ways that do not undermine the effect of the combined levy on generators. For example, the part-two funds could be used to lower the transmission and distribution portion of electricity prices. Funds from part-one would continue to be used as they are now, that is, to fund environmental programs. This approach allows for the rapid inclusion of environmental costs at the generation level, while protecting rate-payers from bearing the brunt of those costs.

Having two rate "levers" will afford SERC and MEP together the flexibility to more finely tune pricing mechanisms to: (1) steadily inure rate-payers into higher rates over a period of time; and (2) gradually increase the fees to full cost of the environmental externalities.

### 1.5. Generation Pricing

Two aspects of China's existing pricing policies encourage clean generation. First, the prices paid to new generators are set on a technology basis in each province. For example, within a province all new hydro-electric generation is paid the same price and that price is different from the price paid to other technologies such as coal-fired generation. Each price is based on the current estimated provincial-specific construction and operating costs of the various technologies. This is, in effect, a kind of "standard offer" pricing, similar to approaches taken in some U.S. states and other countries to promote renewable energy resources, except that in China the published prices are not limited renewables and the prices may be adjusted periodically by NDRC to reflect, for instance, changes in fuel prices.

Second, in 2004 when China first pilot tested competitive generation markets, China introduced price premiums for electricity generated by coal-fired power plants with FGD equipment. The price premium of $0.002 (0.015 RMB) per kWh is meant to pay for the operating cost of the FGD equipment. This was done to assure clean plants were not disadvantaged relative to dirty plants in the competitive market.

In 2006, the policy was modified to improve performance. Under the new approach, the price premium is granted for electricity produced only when FGD equipment is in operation. If the equipment is in operation less than specified levels, fines are imposed. The fines are increased as FGD equipment becomes more widely available.

***Next Steps***

These pricing policies provide a solid foundation for several next steps:

- The technology-based pricing can be extended to further encourage low-carbon generation. Generation pricing for conventional plants are well known in China. Prices for newer technologies such as IGCC, capture ready IGCC, and polygeneration are not known. Setting generation prices for these technologies would encourage investment.
- Price premiums for high efficiency CHP should be adopted.
- The policy of a price premium for FGD can be extended to carbon capture and sequestration or polygeneration with specified levels of carbon removal.

### 1.6. Differential Retail Pricing Based on Energy Efficiency for Industry

China has adopted very innovative and effective pricing reforms, which seek to link prices for large industrial consumers to the efficiency of their production. The National Development and Reform Commission began implementing a trial phase of the "differential electricity price" policy for energy intensive industries as early as June 2004 and later codified it in a NDRC circular issued in March, 2005.

The program applies to eight industries that are some of the largest energy consumers in China: electrolytic aluminum, ferroalloy, calcium carbide, caustic soda, cement, steel, and, recently included in 2007, phosphorous and zinc smelting. It grades consumers in these industries by four classes based on their relative energy efficiency: those enterprises to be *encouraged, permitted, restricted, and eliminated*. Electricity prices vary for the four categories and are designed to phase out the least efficient enterprises and encourage the most efficient.

Enterprises in the well-performing "encouraged" and "permitted" categories pay the standard regional prices for electricity without penalty. Consumers in the poor performance classes, "restricted" and "eliminated", originally paid surcharges of 2 fen and 5 fen per kWh, respectively ($0.0025/kWh and $0.0063/kWh). Those surcharges have been gradually ratcheted up following to a public schedule of planned price increases, and today pay 5 fen and 20 fen per kWh ($0.0063/kWh and $0.025/kWh). Advance notice of the planned increases is an especially effective feature because it gives industry time to plan and invest in better equipment and processes.

**Figure 1. NDRC's electricity price increases for eight heavy energy-consuming industries**

| Project type | Current price difference | Price difference from Oct. 1 2006 | Price difference from Jan. 1 2007 | Price difference from Jan. 1 2008 |
|---|---|---|---|---|
| Projects to be eliminated | RMB 0.05/KWh (USD 0.0063/KWh) | RMB 0.10/KWh (USD 0.0013/KWh) | RMB 0.15/KWh (USD 0.019/KWh) | RMB 0.20/KWh (USD 0.025/KWh) |

| Project type | Current price difference | Price difference from Oct. 1 2006 | Price difference from Jan. 1 2007 | Price difference from Jan. 1 2008 |
|---|---|---|---|---|
| Projects to be restricted | RMB 0.02/KWh (USD 0.0025/KWh) | RMB 0.03/KWh (USD 0.0038/KWh) | RMB 0.04/KWh (USD 0.0051/KWh) | RMB 0.05/KWh (USD 0.0063/KWh) |

Source: National Development and Reform Commission

Marked progress has been seen with the industrial differential pricing. In 2004, 30 provinces (including autonomous regions and municipalities, excluding Tibet) had implemented the policy, covering approximately 8,000 enterprises. Of those, nearly 2,500 enterprises had been ranked as poor performers, with some 2,000 firms set in the “eliminated” category and 500 in the “restricted” category. By May 2006, there were only 1,100 firms in the “eliminated” category and 120 in “restricted.” Those numbers imply that about 1,200 enterprises had either shut down, suspended operations, modified production processes or invested in energy efficiency. The industries covered by the policy have recently expanded to eight and implementation continues to grow across the country.

In addition to making headway towards its original objective of retarding runaway growth in heavy energy-consuming industries, the differential pricing policy has had a number of advantageous side-effects. Of those is the beginning of a shift in attitudes toward energy efficiency, positioning it as a tool to enhance an enterprise’s competitive edge within an industry class.

Different regions have implemented the policy to varying degrees. A minor yet significant adjustment, issued in the summer of 2007 from the central government, will permit local provincial authorities to retain revenue collected through the differential pricing policy, as opposed to the central government, as the policy had originally been designed. The expectation is that this will provide due incentive for provinces to become aggressive about implementation, despite the negative impact it may have on locally-owned, inefficient industries.

***Next Steps***

This pricing policy is both innovative and effective, yet it is presently considered a temporary measure designed to encourage a one-time shift in the industrial structure away from inefficient processes toward more efficient options. However, the existing policy provides a strong foundation for a permanent measure with continuing value. In particular, the policy can be viewed as an approach to setting tiered energy efficiency standards for industrial production.

Rather than operating as a strict single standard (by requiring plant shutdowns if standards are exceeded), the new policy would operate as a series of soft energy efficiency standards linked to a penalty, or fine system. Meeting an energy efficiency standard means there is no fine. Exceed the energy intensity standard by no more than a specified level and you pay a fine. Exceed it by more and pay a higher fine, and so on. The fact that China chose to implement it through electricity prices rather than taxes or fines, simplifies administration and probably improves enforcement.

The opportunities to expand and improve the system are:

- Expand the system to cover more industries and products. The practice of announcing a multi-year schedule of steadily increasing price differentials should be retained.
- Apply the pricing concept to new construction through the use of efficiency based hook-up fees.

Each of these modifications is discussed below.

### *Expanded Use of Differential Pricing*

A recent Asian Development Bank project relating to Efficiency Power Plants, or EPPs, in Guangdong examined Shandong's experience with a provincial level variation of differential pricing and how it could be used to strengthen an EPP-related program.

Shandong has implemented an energy quota system covering 20 industries and 52 products manufactured in the province.[4] Provincial authorities have set quota levels for energy use, including electricity and other fuels. Consumers whose usage exceeds the quota levels pay a substantial surcharge – in certain cases, as much as 400 percent of the energy price (see Figure 2 below). The surcharge is paid to the Shandong Energy Conservation Supervision Center and is deposited into a special fund to be used for energy efficiency investments.[5] Shandong's policy affects only about 11 percent of customers, but those that do exceed the quota will pay very high surcharges ranging from 200 percent of the electricity price for those that exceed the quota by 10 percent or less, to 400 percent for those that exceed the quota by more than 20 percent.

A modified approach would integrate the Efficiency Power Plant concept. Most customers have cost-effective energy efficiency opportunities, so the quota level should be set low enough to encourage almost all consumers to save energy. The fines could be graduated, but should be set at a much lower level. For example, 10 percent surcharge for exceeding the quota by 10 percent or less, 20 percent surcharge for exceeding the quota by 10 to 20 percent, and so on. The funds collected by the surcharge can be used to fund energy efficiency investments, such as Efficiency Power Plants (more on EPPs below).

### *Differential Pricing for New Construction: Hook-up Fees*

Residential and commercial buildings are responsible for more than a quarter of China's total electricity consumption, and China builds an estimated 2 billion square meters of floor space annually. Energy standards for new construction are being phased in but compliance is very poor. Under current electricity pricing practices, developers see little incentive to construct energy-efficient buildings or install energy-efficient end-use equipment, because less efficient materials, methods, and machinery have lower capital costs. Developers generally focus on

---

[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 World Bank, Energy Sector Management Assistance Program, *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://www.raponline.org/Pubs/China/Dec05ChinaDSM.pdf.

competing construction quickly, minimizing investment, selling the units, and moving on to the next project. Energy efficiency is not a priority for them, and even significant increases in electricity prices would have little effect on building practices.

Differential pricing can be modified to overcome the barrier to energy efficiency known as "split incentives" that characterize the building and construction sector. One way to reduce this market barrier is through a modified approach to differential pricing known as hook-up fees. The fee would operate in two steps. First when construction begins the developer would pay a very substantial fee, or deposit, related to the building's estimated peak connected load. Second, when the building is completed it would be tested and a portion of the fee would be returned. The more efficient the building the more of the fee would be refunded. The best buildings could even get a net payment. Buildings that fail to meet standards would receive no refund.

### 1.7. Efficiency Power Plants and Demand-Side Management

Energy conservation is a top government priority and China has adopted many effective energy efficiency policies. One very large energy efficiency opportunity has been neglected: power sector DSM. There has been substantial use of load management options but relatively little focus on energy efficiency.

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

In order to institutionalize demand-side management, the power sector policies must do two things: one, it must allow cost recovery of grid company energy efficiency whether through pricing methods or otherwise; and two, it must permit demand-side measures to compete against supply side resources.

China's Efficiency Power Plant (EPP) policy can resolve both of these issues, and certain regions, including Guangzhou, Hebei, and Jiangsu among them, have already started to take the initial steps to invest in EPPs.

An EPP is essentially a bundle of DSM or energy efficiency programs designed to save as much electricity as a conventional power plant (CPP) produces. The resulting energy savings are as predictable and substantial as the output of a conventional power plant. The EPP concept was developed partly to help convey the idea that energy efficiency is a resource comparable to conventional power plants. By packaging energy efficiency program into large blocks, greater or equal to 300 MW, planners and policy makers more readily see the advantages of incorporating EPPs in power sector planning and investment.

The EPP can be a powerful communication tool especially important in China's case, where one of the greatest challenges is getting policy makers from various agencies to share the same vision. The EPP concept also 1) helps demonstrate how current pricing methods support the development of conventional power plants but discourage the development of lower-cost and cleaner efficiency measures, 2) allows EPPs to more easily be integrated in power sector planning, and 3) simplifies the financing options for energy efficiency. All of this is aimed at allowing energy efficiency to be comparable in every significant way to power supply options – and hugely preferable in terms of cost, over-all system efficiency, and greenhouse gas emissions.

There are four general EPP models. The main differences between them 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. Described below at the two most optimal designs, as they are those which will ensure ongoing emissions reduction potential in the power sector.

Model 1 is the most comprehensive and powerful model through which EPPs are fully integrated into the power sector reform process. Under this model, grid companies have the obligation to meet customer needs using the least-cost mix of both conventional power plants and Efficiency Power Plants. Because EPPs are much less expensive than CPPs, this model results in substantially increased use of EPPs. Model 1 also requires that electricity pricing is reformed so the costs of CPPs and EPPs are treated equally. That is, as it currently stands, grid companies are permitted to recover the capital costs of conventional power resources through rates, but there is no such opportunity for cost-recovery for Efficiency Power Plants or demand-side management more generally. Consequently, Model 1 places high priority on energy efficiency and treats energy efficiency as a full alternative to generation. It also harmonizes national goals and utility profitability, and ultimately will bring about significant reductions in $CO_2$ and other pollutants through reduced power generation.

Model 1 is also fully integrated with power sector reform, such that it provides for continuous investment opportunities in demand-side resources over the long term. Integration of energy efficiency with power sector reform makes sense for many reasons and was a strong recommendation of the International Energy Agency in its recent review of China's power sector.[6] The IEA recognized that utility DSM programs can add substantially to China's energy efficiency efforts if energy efficiency policies are integrated with power sector reform. Unfortunately, China's initial power sector reforms have so far discouraged energy efficiency.

The high priority China places on energy efficiency and environment, the superior role energy efficiency can play in an emissions reduction strategy, and the fact that power sector reform in

---

[6] "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: International Energy Agency, *China's Power Sector Reforms: Where to next?* 2006, available at http://www.iea.org/w/bookshop/add.aspx?id=288?.

China is in its early stages, mean that this model is of utmost importance for China. This approach is used in a number of states in the United States and other countries. California provides one of the most comprehensive examples of this approach.

Model 2 would provide for a system benefit charge to be collected through a small uniform charge on all kilowatt hour sales. Model 2 differs from Model 1 in two significant ways. Firstly, the grid company role is substantially reduced; it is limited to collecting the funds needed to repay the EPP financing. Secondly, 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 system benefit charge 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.[7]

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.

Model 4 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 that is being used in Guangdong.

***Next Steps***

Several provinces are moving forward with variations of Model 4. As described in other reports, Model 4 is the weakest of the options. Its chief appeal is that it can be pursued at the provincial level without any new central policy reform. Major increases in energy efficiency would flow from two improvements in the existing EPP policies.

- Adopt the needed central level reforms to allow the policy basis of the EPP to shift to either Model 1 or Model 2.
- Build EPPs into power market is ways that EPPs approved by responsible government agencies would be paid for by the market and costs recovered through charges to the market participants.
- At a minimum, improve Model 4 by requiring grid companies to lend consumers funds to invest in energy efficiency and pay the loan back to the company through the savings on the customers power bill.

[7] For more on Efficiency Power Plants in China, see Asian Development Bank, *TA 4706-PRC: Energy Conservation and Resource Management Project*, July 2007.

## 1.8. Renewable Mandatory Market Share

China has established a renewable energy goal and a Mandatory Market Share policy (comparable to a Renewable Portfolio Standard). The 2005 Renewable Energy Law required grid companies to buy all certified renewable energy within their service areas, and in September 2007, the government announced a "15 percent by 2020" target. The renewable goal thus became a floor, establishing the minimum amount of renewables in the planning process, which then in turn will drive the investment approval and licensing process. Renewables in China's energy mix will be further encouraged by the environmental dispatch rule, discussed above, which requires that all energy from renewables be used before coal power.

Recent analysis concluded that China is in fact on track to surpass its 15-percent target. The goal for wind was set at 5 GW by 2010 but that target will be surpassed in 2008. The RPS policy has already demonstrated its ability to drive investment and innovation. At least two policies can build on China's early successful experience.

***Next Steps***

- Longer-term and more aggressive renewable energy standards should be established to guarantee investment in these resources across diverse regions.
- Coordinate renewable planning with transmission planning to assure major supplies of renewable power can be integrated in the grid.
- Extend the basic RPS policy approach to other low-carbon, high-efficiency options such as high efficiency, CHP, low-carbon polygeneration, or IGCC with at least limited carbon sequestration.

## 1.9. Small Plant Closing Policy

Small and old coal plants are the most inefficient and polluting, both in terms of greenhouse gases and particulate matter. By some estimates 50 MW plants may use as much as 200 grams more per unit of electricity output than a plant larger than 300 MW plant, and generators of 100 MW or less make up an approximate 30 percent of China's coal-fired capacity.

Consequently, China's recent enactment of a policy to close small power plants has already yielded significant energy savings and emissions reductions. Initiated in January 2007 through trial programs in various regions across the country, the policy aims to phase out approximately 50 GW of small inefficient, coal-fired power plants nationwide, 7 to 10 GW of small natural gas units, and halt construction on new small power plants.

The policy is being affected by three different means: the direct rescission of operating permits; the transfer of generation rights; and tariff reductions.

Under the rescission of operating permits, SERC requires that permits be withdrawn by the dates originally specified for small plants, prohibits permits for new small generators not stipulated in development plans, and publishes specific guidelines for permit application approval. Plants can prolong operation if they are retrofitted to improve efficiency. In addition, power companies that close small units are given priority in receiving permits to build new power plants.

The government is encouraging the transfer of generation rights through bilateral agreements between small and large generators, such that small generators sell the right to generate to larger, cleaner and lower-cost facilities. Small plants that are designated for shutdown under the 11th Five-Year Plan period and those that are scheduled to shut down according to their original expected life span are given generation allowances to sell to larger generating units.

SERC oversees the transactions, and the cost paid to small generators for these allowances should be roughly equal to the original tariffs they would have received, thereby reducing the adverse financial impacts of retirement, in some cases, early retirement.

In addition, there is a special provision for companies that own small coal generation which are proposing to develop new capacity. This allows that 60 percent of the capacity of a closed small plant can be directly substituted by new capacity from a larger plant within the same company. For example, a company that shuts down 100 MW of small plant capacity is eligible to build 60 MW of new, large-scale generation units.

A number of provinces are piloting generation rights transfer. From 1997 to 2006, Sichuan's implementation of this policy resulted in total savings of 8.16 billion kWh, 3.26 million tce, 60,000 tons of carbon dioxide emissions, and 2.22 million tons of particulate matter. Henan and Jiangsu provinces initiated trading in May and September 2006, respectively. In one year, Henan saved 1.58 billion kWh, 330,000 tce, and 5000 tons of carbon dioxide emissions. By the end of 2006, Jiangsu saved 6.2 billion kWh, 300,000 tce, and 6000 tons of carbon dioxide emissions.

As of June 2007, 15 provinces had begun implementing these transfers, including Shaanxi, Liaoning, Shandong, Jilin, Hebei, Henan, Jiangsu and Fujian. In addition, five provinces were preparing to begin, and two provinces had acknowledged generation rights-trading in their provincial plans.

With respects to the tariff reductions, the small plant closing policy generally targets units with installed capacity of less than 50 MW, units with installed capacity of less than 100 MW that have been in operation for at least 20 years, and units with less than 200 MW of installed capacity that have been in operation for longer than their estimated life-spans.

In April 2007, the NDRC announced that tariffs for these small generating units were to be reduced until they reach the "local base tariff." The local base tariff refers to regionally specified tariffs set by the government. To attract investment in the 1980s and 1990s, small plants were granted tariffs higher than the local base rate.

In August, NDRC announced the scheme for the first wave of tariff reductions, covering 32 units and 1.17 million kW of installed capacity in Beijing, Henan, Jiangxi, Hunan, Yunnan, Guangxi, and other provinces. NDRC also specified that the revenues generated by grid companies as a result of reduced tariffs for small units are to be put towards absorbing other fuel price increases.

Reductions will be phased in over two to four years, depending on the initial difference between a unit's current tariff and the base. Specific measures for the tariff reductions are devised by local pricing bureaus and SERC departments, which report to NDRC on progress at the provincial level.

In January 2007, thirty provinces, five major power companies, and two major grid companies signed on to the policy. By the end of the year, China had shut down a total of 14.39 GW of generation capacity, 40 percent greater than the national target of 10 GW for that year. The closures led to annual savings of 13.6 million tce, 27 million tons of carbon dioxide emissions, and 230,000 tons of sulfur dioxide emissions, an improved China's average coal consumption per kilowatt hour of generation by 10 grams. While similar policies have been enacted in the past to close small coal generation, gains were rescinded when the plants were brought back online under the pressure of power shortages, such as those in 2002. In the case of this recent effort, however, the majority of plants shut down have been dismantled. The risk of temporary shut-down is also decreased by the environmental dispatching policy, which forbids such inefficient plants from re-connecting to the power grid.

***Next Steps***

Like the differential pricing policy, the small plant policy is now viewed as being a temporary one-time policy aimed at closing a fixed number of power plants. The current policy could be modified to have continuing value in terms of energy efficiency and environmental gains. Specifically, the small plant policy should be viewed as being the equivalent of an energy efficiency standard for existing power plants that is combined the supportive pricing and investment approval incentives. Viewing the policy as an efficiency standard has the advantage of shifting the focus of the policy to efficiency rather than size, and a common aspect of standards is that the level of the standard can be steadily raised over time.

The following steps are needed:

- Express the existing policy as an energy efficiency standard for existing power plants. Create a phased schedule that raises the standard to remove the least efficient power plants. Also adopt a complementary, phased, multi-year policy to encourage increased energy efficiency, more efficient CHP, lower carbon polygeneration, and carbon capture.
- Expand coordination with the project approval process. The aspect of the small plant policy that involves the project approval process presents a valuable policy option for demand-side management and EPPs. New supply-side resources can be required to submit plans for an Efficiency Power Plant equal to or greater than, for example, 60 percent of the proposed new capacity. A demand-side resource option would afford generators greater flexibility and provides a way to transition the policy mechanism from a temporary to permanent status, even as small, inefficient plants are being phased out.

## 1.10. Central Government Energy Efficiency Incentives

The central government has launched a variety financial incentives programs for the promotion of energy efficiency. A state bond of 5.4 billion yuan was issued and provided to enterprises at low interest rate loan to support energy efficiency and emission reduction projects. Furthermore, the domestic banks have been encouraged to increase their financial support to energy efficiency and emission reduction projects. The guidance was provided in a People's Bank of China document "Guiding Opinion for improving and strengthening Financial Services to Energy Saving and Emission Reduction Activities" issued on June 26, 2007. A number of documents were issued to require the banks to tighten control of money supply to projects in the key energy intensive sectors like steel, cement and aluminum.

An award fund for energy saving technology transformation, also referred to as the "Energy Efficiency Award", was launched jointly by NDRC and MOF in 2006 as a system by which to financially award enterprises that undertake the energy-saving technology retrofits. Qualifying retrofits are specified in "Suggestions on Implementing 10 Major Energy Saving Projects during the Eleventh Five-Year Plan Period (FGHZ [2006] No.1457)."

Projects must generate at least 10,000 tce of energy savings to be eligible for funds and can include:

- Retrofitting of industrial boilers,
- Utilization of waste heat and residual pressure,
- Saving or substitution of oil
- Motor energy savings, and
- Energy system optimization.

In the eastern and western regions of China, enterprises are given RMB 200 and 250, respectively, per ton of coal equivalent saved by technology changes. Application procedures are as follows:

- *Enterprise reporting.* The enterprise reports its energy-saving retrofits, benchmarking tools, and pre-retrofit energy consumption to local energy management institutions (the local Development and Reform Commission, Ministry of Finance, Economics and Trade Commission, etc.). Projects must include the required energy accounting, statistics, and management systems.
- *Third-party verification.* Government-designated energy auditing organizations (provincial energy conservation management organizations, approved by NDRC and MOF) verify the enterprise-reported energy savings and report to NDRC and MOF. Central-level enterprises report directly to NDRC and MOF. NDRC and MOF then organize experts to evaluate the energy savings report.
- *Government approval.* NDRC approves the award, and MOF allocates 60 percent of the approved award in the initial payment. Award funds are treated as capital accumulation. Enterprises' energy savings award information is made public.

***Next Steps***

The reward system provides a policy framework that could easily be expanded in several ways.

- Expand the system to cover more industries by lowering the savings threshold. (It is now limited to very large industries.)
- Expand by increasing to funding. Seven billion RMB, even if it were all concentrated in electricity savings, would be less than .04 percent of power sector revenues. This compares to the best U.S. states that invest about 4 percent of power sector revenues in energy efficiency.
- Coordinate with other policies such as differential pricing to increase funds and EPP programs to increase the effectiveness of both programs.

# 3. 2. Applying International Lessons in Climate Policy for the Power Sector

## 2.1. Scientific Energy Planning

Scientific Energy Planning (OR Integrated Resource Planning) is a methodology for planning and implementing investment options to meet users' needs for electricity services in a way that satisfies multiple objectives. It is the basic tool used to optimize a country's resource mix.

It first came into popular practice among electric utilities in the 1980s and 1990s as a simple process for evaluating supply-side resource options (power plants) to meet forecasted demand. Modern Scientific Energy Planning has since evolved into a more complex, economic analysis that integrates all resources and technologies available on the supply-side and the demand-side, to provide energy services at minimum total cost—including environmental and social costs. It is currently applied in as many as 23 stares, including California, Vermont, Oregon and Minnesota.

By evaluating the broadest reasonable range of options to meet future demand – including technologies for energy efficiency, load control on the demand-side, as well as decentralized and non-utility generating sources – planners can select technologies and programs to minimize the total cost of electric service. And by including environmental and social costs in the cost criteria, Scientific Energy Planning makes it possible to design a portfolio of electric supply and demand-side options to meet electricity demands without wasting economic or natural resources.

In simple terms, Scientific Energy Planning makes it possible to compare options that have very different cost and operating characteristics. How does one accurately compare a coal power plant with a wind farm? How does one compare a gas-fired plant with a hydro-electric plant, and how does one compare a clean coal-fired power plant with energy efficiency? It is relatively easy to calculate the cost of power from each option, but a simple comparison of the cost per kilowatt or kilowatt hour is not possible. Scientific Energy Planning is necessary to determine how each option fits into the overall system; how it affects reliability, risks, the environment, and other important considerations like greenhouse gas emissions.

The details of Scientific Energy Planning are discussed in other papers. For the purpose of understanding its role as a climate option it is enough to know that Scientific Energy Planning is an overarching planning process that can incorporate meeting climate goals in a least-cost manner.

A recent study in the U.S. has examined how Scientific Energy Planning is used in the U.S. to address climate change. The study examined the resource plans of 15 investor-owned and publicly-owned utilities in the Western United States. Together, these utilities account for approximately 60 percent of retail electricity sales in the West, and cover nine of eleven Western states.[8] The following summary is drawn from that report.

Fourteen of the 15 utilities examined investment plans that assumed a future carbon tax or carbon allowance price relating to cap-and-trade system. Eleven utilities included carbon regulations in their base-case portfolio analysis, assuming levelized carbon emission prices, over the 2010-2030 timeframe, ranging from $4 to $20 per short ton of $CO_2$ (2007$).

Eleven utilities conducted scenario analyses to evaluate portfolio costs under alternate carbon emission price projections to their base-case. Most considered a reasonably broad range of scenarios (i.e., levelized prices exceeding $30-40/ton).

Of the 15 utilities, nine included the "maximum achievable" energy efficiency program savings, with incremental annual energy savings ranging from 0.6 percent to 1.3 percent of total retail sales and cumulative savings ranging from 30 percent to 73 percent of projected retail sales growth over their planning periods.

All 15 utilities evaluated candidate portfolios with new renewables, and most evaluated one or more candidate portfolio in which renewables constitute at least 50 percent of all new supply-side resources in the portfolio and 10 percent of the utility's total retail sales. Thirteen of the utilities are subject to a renewables portfolio standard (RPS), but most of these utilities evaluated candidate portfolios with new renewables above and beyond the level strictly needed for RPS compliance.

Six utilities evaluated candidate portfolios containing coal-fired integrated gasification combined cycle (IGCC) generation with carbon capture and storage (CCS). One utility also evaluated CCS in combination with pulverized coal and natural gas fired CCGT generation.

As a result of Scientific Energy Planning that included specific consideration of carbon, the study found:

- All utilities selected preferred portfolios that include an expansion of existing energy efficiency programs and new renewables, and more than half of the utilities selected

[8] Reading the Tea Leaves: How Utilities in the West Are Managing Carbon Regulatory Risk in their resource Plans, Galen Barbose, Ryan Wiser, Amol Phadke, and Charles Goldman , Lawrence Berkeley National Laboratory, Environmental Energy Technologies Division, March 2008. See, *http://eetd.lbl.gov/ea/EMS/EMS_pubs.html*.

portfolios in which energy efficiency and renewables together constitute at least 50 percent of all new energy resources.

- Twelve utilities' preferred portfolios include natural gas-fired generation, representing 30 percent or more of new investment.
- Ten utilities whose preferred portfolios contain no new coal without CCS, the composite $CO_2$ emission rates (focusing just on new supply- and demand side in the portfolio) range from zero to approximately 475 lbs/MWh. The five utilities that included new coal without CCS in their preferred portfolios have composite emission rates ranging from approximately 700-1,600 lbs/MWh, depending on the relative contribution from coal.

***Application in China***

China has not adopted Scientific Energy Planning, even though it has adopted many innovative policies that are consistent with Scientific Energy Planning. Obstacles to the adoption of Scientific Energy Planning are partly organizational, because planning and other energy regulatory authorities are dispersed too widely in government. But obstacles are also partly ideological, because many people believe that planning and markets are incompatible.

The view that competitive energy markets alone will lead to least-cost solutions and meet China's energy and environmental goals is incorrect. Counter to a common misconception, planning and competition are in fact compatible. Indeed, they work together throughout market economies and daily life. On the one hand, markets give you the widest range of options possible at the lowest cost. While, on the other, planning is how businesses and individuals decide what mix of goods and services available to them best meets their needs. Planning is especially important when there are many very different options to meet a particular need.

The relationship between planning and markets is experienced everyday by small and large consumers alike. Here are some examples in other sectors of a modern economy. Farmers rely on information, experience, and market conditions to plan their planting and rely on markets to buy their inputs and sell their outputs most efficiently.
Urban dwellers plan their housing needs or transportation needs by learning what options exist in the market. Cars, for example, come in a wide range of sizes, prices, features, and efficiency levels. Consumers decide what car best meets their needs and the market is where they go to buy. Corporate planning can be much more complex and sophisticated. Sinopec, for example, plans where to deploy its substantial capital and other resources to best meet its long-term objectives and then uses markets to implement its plans.

In each case, private business decisions are made using a mix of planning and markets. The same is true for the power sector. Generation companies and grid companies engage in serious and sophisticated planning but, like the examples above, their planning will take their business interests into account. A government role in Scientific Energy Planning is needed to take account of a broader range of interests and weigh risks and rewards from a societal perspective.

***Next Steps***

- Adopt Scientific Energy Planning and be sure the planning process incorporates all environmental costs.
- Link the planning process to the investment approval process.

### 2.2. Power Sector Carbon Caps

Globally, there is great interest in cap-and-trade systems to control GHG emissions, especially from the power sector. Support for this approach is based on the experience of the U.S. Acid Rain program, viewed as a success in reducing $SO_2$ emissions at lower costs than those expected under historic technology-based regulatory models. In the United States, approximately 40 percent of the power sector is covered under three regional programs implemented at the state level. Federal level initiatives are pending and may be adopted in the next year or two.

Recent experience in Europe and design studies in the United States now reveal that the cap-and-trade architecture used for the U.S. Acid Rain program, and copied in other systems such as the European carbon trading system, is not optimal for carbon management in the power sector, especially where there are competitive generation markets.

There have been three problems with these cap-and-trade efforts:

- By taking a "generator-down" approach instead of focusing on the portfolio management activities of distribution utilities and other load-serving entities (LSEs), they cost consumers more than other models that take an "efficiency and portfolio-up" approach to GHG reduction.
- By awarding carbon allowances to emitters on the basis of their historic pollution, they provide a windfall to generators far in excess of their cost of program compliance[9] and charge consumers more than needed to achieve a given level of reduction (up to 3 or 4 times more).
- In addition, both Phase I of the European Trading System, and the leading U.S. system (the Regional Greenhouse Gas Initiative, or RGGI) are *"over-allocated"* – that is, they mistakenly set the caps too high, and awarded too many allowances, undercutting the price of allowances and, more importantly, the actual effects of the control programs.

Program designers are now learning from these early efforts. The simplest matter to fix is the over-supply of allowances. Phase II of the ETS will attempt to reduce the cap to a more meaningful level.[10]

As for the structural problem, a variety of techniques are being used. Most importantly, GHG regulators in the U.S. now recognize that most of the actual reductions are going to come as a result of deliberate portfolio management decisions, especially the use of Renewable Portfolio

---

[9] Recent studies by Resources for the Future (for RGGI); the U.S. GAO (for the U.S.) and the House of Commons Environmental Audit Committee (for the UK trading system) have all documented this problem.

[10] RGGI has not yet dealt with the over-allocation problem. The other major effort in the U.S. is in California, which appears to be taking a strict approach to historic baselines and is less likely to have this problem.

Standards (or feed-in tariffs) and utility-sector energy efficiency programs. Extensive modeling has shown that most of the reductions that will occur in the RGGI region and in California are going to come from these so-called "parallel" policies.

In addition, cap and trade program designers are working on two other design options that promote portfolio-based approaches, especially energy efficiency investments. Those options are:

1) Some US states have studied the benefits of a "load-side" cap-and-trade system, which gives responsibility for carbon reduction to the distribution companies that choose and buy power supplies, rather than to the generators who sell power. A chief benefit of this system is that the carbon value of efficiency is automatically conferred on the entity (the distribution utility, not the generator) that is in the best position to help lower customer load. While this approach has attracted strong interest, it now appears that these states will adopt a "hybrid" type cap and trade with both generator-side and load-side elements.
2) In the eastern United States, RGGI will use a generator cap, but with a positive twist – a substantial "consumer allocation" of carbon credits will be given to distribution companies or other consumer trustees, who can then sell the credits to generators who will need them to operate. Those consumer trustees can then use the carbon credit revenues to invest in low-carbon resources, particularly energy efficiency. Depending on program details and the price of allowances, these mechanisms could provide enough revenue to double or triple total spending on utility-sector energy efficiency – which is the lowest-cost method to avoid carbon emissions.

***Cap and Trade Basics – Why Carbon is Different***

The U.S. Acid Rain program is widely regarded as successfully demonstrating the advantages of cap-and-trade programs for environmental improvement.[11] Most observers conclude that the incentives created by the program and emitters' ability to trade allowances have led to less expensive attainment of the program's goals. The success of this model has led many decision-makers to conclude that carbon cap-and-trade programs should be built on the same basic structure. Unfortunately, it is not so easy, especially considering the crucial role of energy efficiency to program success. At the outset, it is necessary to dispel three very misleading assumptions that often seem to waylay cap-and-trade analysts.

The first wrong assumption is that a carbon tax or its equivalent, such as an auction of pollution credits[12], will inspire a conservation response among consumers that will deliver the socially-optimal level of investment in end-use efficiency. Cap-and-trade architects expect that lowering carbon emissions from power plants will raise the cost of electricity. Influenced by economic theory on internalized external costs, they often view increased power prices as *desirable*, and

---

[11] See, e.g., http://www.whitehouse.gov/news/releases/2002/02/clearskies.html.

[12] Or even the free allocation of credits under a cap-and-trade system. As will be discussed below, most economists agree that once credits are made tradable through a cap and trade system, they will have the same upward pressure on power prices regardless of whether they were initially sold to emitters or distributed for free.

any resulting demand reductions as merely a *consequence* of the program. A better approach is to view avoidable increased costs as *undesirable*, and efficiency as an *integral component* of the cap-and-trade program.

More than two decades of experience with utility DSM programs has demonstrated in practice that price increases alone will not deliver anything close to the societally cost-effective level of investments in efficiency. On the one hand, the price-elasticity of demand for electricity is quite low (about -.32 in the U.S. in recent decades, and the effect is lowered as incomes rise). In addition, there are numerous, well-documented market barriers to cost-effective efficiency investments, and they will continue to block needed improvements even after whatever rate increases could possibly be expected to flow from a carbon cap-and-trade program.[13]

On the other hand, there is widespread experience with utility-sector DSM programs, and with codes and standards, revealing a huge untapped reservoir of energy efficiency potential at the cost of three cents per kWh – much lower than the marginal cost of supply. For these reasons, the power system will realize about 7 to 13 times more savings from each dollar spent in a well-managed efficiency program, than it will through a generalized, across the board price increase.

***Lessons Being Learned:***

- Policies such as renewable standards, environmental dispatch, and Efficiency Power Plants, will provide most carbon savings and lower the cost of any power sector the cap-and-trade system.
- A carbon program that directly mobilizes end-use efficiency will cost less and achieve more than one that focuses only on generators.
- Free allocation of carbon credits to generators based on historic emissions can lead to substantial windfall gains to generators with only small reductions in GHG emissions.
- Merely increasing the price of fossil power through carbon taxes or credit auctions will not reduce demand very much, and will thus be an expensive path to GHG reductions.
- A load-side cap or "carbon budget" for distribution utilities and other load-serving entities gives carbon responsibility to portfolio managers and customer-serving enterprises, creating a direct link between GHG pollution and those in a position to make pollution-lowering decisions.
- An auction of emissions allowances, with revenues devoted to energy efficiency is a positive way to use the "polluter pays" principle and to fund low-cost GHG reductions at the same time.

***Application in China:***

In addition to the detailed lessons of cap and trade experience, it is also clear that many governments, including the U.S. federal government, have difficulty accepting the concept of a "cap". It is understandable that this would even more so be the case in China. China is an emerging economy, without the long history of industrial emissions that have contributed to

[13] There is an extensive literature detailing these market barriers, including access to information, high first-cost problems, consumers' high discount rates, unpriced externalities, the landlord-tenant problem, and others.

climate change over the course of the last century, and where economic growth is reducing poverty at an unprecedented rate.

A better option for China, perhaps, would be to adopt a "carbon path". Chinese researchers have produced many recent studies of China's energy future. These studies, such as *** , show that China can significantly reduce GHG emissions relative to a business as usual case. These studies provide a practical carbon "path" for C. This path provides a trajectory of national greenhouse gas emissions out to 2050, which incorporates disaggregated growth and emission projections across sectors, taking into account influential trade, economic and climate action policies, to determine a long term horizon and incremental goals for China's emissions levels. Adopting a path with annual targets and detail allocation to regions and sectors will help policymakers to adopt and adjust policies over time to assure actual emissions stay below the national carbon path.

## 2.3. Climate Change Levy & Climate Change Agreements

The UK has had significant experience with a range of policy options aimed at addressing climate change. The four primary policy elements are:

1. The Climate Change Levy (CCL), a tax charged on the energy used. The Levy charges appear on consumers' fuel bills, with the revenue collected and passed on to the government by energy companies.[14]
2. Climate Change Agreements (CCA), which give large industrial customers the ability to receive an 80 percent discount on the Levy in return for agreeing to meet agreed upon energy efficiency targets.
3. The Carbon Trust, which is funded by a portion of the CCL revenues. These monies are used to accelerate energy efficiency.
4. Exemptions from paying the CCL on alternative energy sources, including renewables and CHP.

This system has been effective in reducing GHG emissions and increasing energy efficiency.

## 2.4. Carbon Tax

Carbon taxes are widely seen as a means of changing behavior to address climate change. But actual experience with carbon taxes is limited. Carbon taxes currently aimed at the power sector are summarized in the following Table.[15]

---

[14] The CCL charges are: Electricity, at 0.441 penny/kilowatt hour (kWh); Gas, at 0.154 p/kWh; Coal and coke, at 1.201 p/kilogram (kg); and Liquefied Petroleum Gas, at 0.985 p/kg. Note: From 1 April 2008, all rates will be increased in line with inflation. *Source: HM Treasury, Budget 2007, Pre-Budget Report 2007.*

[15] See U.S. Environmental Protection Agency, National Center for Environmental Economics, available at http://yosemite.epa.gov/EE/Epalib/incent.nsf/c7950cb0634d42808525634e00438a4a/032bb32faab7e7a3852564f7005e325a!OpenDocument.

**ENERGY/CARBON TAXES** (IN $ PER TON OF $CO_2$ UNLESS OTHERWISE STATED)

| Country | Year Adopted | Rate | Annual Revenue | Observations |
|---|---|---|---|---|
| Denmark | 1992 | $9-$18 | $560 million (1993) | Gasoline, natural gas, and biofuels exempt. Aviation, shipping, and refinery gas exempt. 50% rebate for larger businesses. |
| Finland | 1990 | $8 + 21¢/ gigajoule | $314 million (1994) | Industry raw materials and fuel for planes and certain vessels exempt. 60/40 carbon/energy content. |
| Netherlands | 1990 | $16.4 + 91¢/gigajoule | $850 million (1995) | Full rate not phased in until 1998. 50/50 carbon/energy content. |

In addition, the Canadian province British Columbia recently adopted an economy-wide carbon tax that becomes effective in July 2008. It has been designed to be revenue neutral. Other taxes in the province have been lowered to offset the effect of the carbon tax. In addition all BC residents are receiving a one-time $100 tax refund "to invest in energy saving devices" as a way on gaining acceptance of the tax.

Closely related to carbon taxes is the use of carbon adders in the planning and investment process. This option is essentially used to guide new investment decisions as if there were carbon taxes, but no actual tax is charged. The effect on new power sector investment is similar to a carbon tax but the effect on electricity prices is much lower. The adder approach was described in the discussion of Scientific Energy Planning.

There is a large body of research on the use of carbon taxes versus cap-and-trade programs.[16] The basic arguments can be summarized as follows:

1. Both can achieve the same result.
2. Cap-and-trade programs set the level of emissions and allow the price of carbon allowance to fluctuate.
3. Carbon taxes set the tax rate and the level of emissions is variable.
4. Carbon taxes are simpler and more cost effective.
5. Cap-and-trades are politically more popular.

### 2.5. Emissions Performance Standard

An Emissions Performance Standard (EPS) is a minimum performance standard for electric generating facilities, set in terms of a maximum amount of greenhouse gases or other pollutant emissions per unit of output. In California, the EPS is expressed in pounds $CO_2$ equivalent per megawatt-hour; in the EU, it is expressed in grams of $CO_2$ equivalent per kilowatt-hour. GHG

[16] See http://www.carbontax.org/, http://www.cbo.gov/ftpdocs/89xx/doc8934/02-12-Carbon.pdf

emissions performance standards have been used in several states in the U.S., including Oregon, Connecticut and Massachusetts. In January 2007 California adopted a very strict EPS for all new electricity contracts. Subsequently, Washington state and the European Union, the latter as recently as October 2008, have followed suit.

The numerical standards established by California and the European Parliament are approximately the same, using the emissions of a combined-cycle gas turbine as the threshold for performance, or 1,100 lb per MWh and 500 grams per kWh. However the California and EU models vary significantly in their administrative approaches. There are advantages and disadvantages to both methods that would have implications for an emissions performance standard in China.

The California EPS, already in effect, requires that all new long-term commitments involving base load generation facilities must meet the standard of 1,100 lb per MWh. This affects all long-term contracts pertaining to new plant construction and new investments to existing facilities, for new and renewed contracts both in and out of state. By applying regulatory leverage at the point of long-term contracts, those five years or longer, the California Public Utilities Commission expects it will capture approximately 78 percent of all new utility transactions.

By way of comparison, convention coal-fired power plants generally have an emissions rate ranging from 2000-2500 lb/MWh. An integrated gasification combined cycle plants can have an emissions rate ranging from 1600-2000 lb/MWh. Therefore, the EPS virtually puts a freeze on all new coal generation, because no coal-fired plant can meet the standard without carbon capture and storage (CCS) technology to dramatically reduce emissions. There is a caveat, however, in the California ruling, which allows the standard to be met over the lifecycle of the plant. This forces new proposals to include viable plans *now* for retrofitting facilities with CCS *later* once the technology comes on-line, such that the facility's average emissions rate meets the standard over the course of its lifetime.

The EU Parliament has taken an alternative approach. It mandates that all new plants with a capacity greater than 300 MW meet the EPS, but will not come into effect until 2015, once, it is presumed, CCS technology will be feasible. One the one hand, the EU model is more straightforward than the California model, which requires compliance from every facility associated with every long-term contract. While the permit-approach may demand greater administrative burden for the utilities and the regulatory bodies, it prevents potential leakage, whether through the construction of dirty plants out-of-state or the purchase of power from dirty sources out-of-state. It also provides broader coverage, applying to not only new plants, but also additions to existing plants. Another weakness of the EU standard is the deferred implementation, which threatens to have the adverse impact of encouraging the construction of dirty coal plants in advance of the emissions constraint. For its complexity, the California model is more comprehensive.

An important aspect of both EPS models is how they are linked to provisions for CCS retrofits. The California model requires all utilities, generators and developers to plan ahead for carbon capture, and it provides assurance that the future costs associated with this technology will be included in the rate base. The EU scheme is timed to come into effect only once CCS is operational, and public financing will be provided to support 12 large scale commercial CCS demonstration projects by awarding developers with carbon allowances which they can sell on the carbon market, the EU Emission Trading Scheme.

***Application in China***

California's permit-approach may not transfer well to China's circumstances where procurement is not commonly negotiated through long-term commitments vetted by regulatory processes. A variation on the EU model would be a better fit: a ratcheting emissions performance standard that comes into effect by a certain date.

# 4. 3. Innovative Reforms

## 3.1. Alternative Power Sector Reforms

China's plans for power sector reform were developed more than 10 years ago. Some of the planned reforms have been implemented. Other reforms have not yet been implemented. The original pace of reform has slowed for a variety of reasons, but planned power sector reforms are still essentially the same as they were a decade ago.

In the last decade, two things have changed that justify a review of power sector reform plans.

- First, China's priorities have changed since the reform plans were first designed. Today, energy efficiency and environment are top priorities. Projections of future energy needs by Chinese and international experts suggest that these new priorities will intensify over time.

- Second, international experience with power sector reform shows the process has been much more complex and difficult than expected, and that some of the hoped for benefits have been achieved, but many problems and issues remain. One conclusion that is clear is that power sector reform generally, and competitive markets in particular, have been detrimental to energy efficiency efforts and environmental improvement.

The question now is what policy changes and revisions to power sector reform plans are will address the experience and changed conditions. What changes would allow China to better address the current and future challenges of energy efficiency, the environment, and climate change.

Is the objective to create a reliable power sector that is low-cost and whose investment decisions are in some way marked by environmental considerations? Or is the goal to create an environmentally sustainable power sector that is both reliable and least-cost? While it might appear that these are two ways of framing the same question, in fact they are not. In the first, cost is the central criterion, whereas environmental protection is valued secondly. It is critically important that policymakers understand that, in the long run, there will be very little difference in the costs of the two strategies, but that there will be a very great difference in their environmental consequences.

Power sector reformers generally call for increased reliance on electricity markets without detail about what kind of electricity market. What kind of competitive electricity market makes sense for China? There are no simple answers. Competitive electricity markets come in many forms.

Well-functioning, organized markets are not natural things like plants and animals. If one plants a flower seed in good soil and gives it sun and water, it will grow into a predictable and complete thing. Markets, in contrast, are like machines: one must thoughtfully design and build them to do a desired job. And then they need to be carefully maintained and constantly overseen and, when necessary, modified and improved, because sometimes even well-built machines fail to do what one expects. *China needs to design and build its electric market to achieve specified objectives, and then it should be prepared to watch it closely, manage it carefully, and, when necessary, fix it.*

Appendix 2 describes practice on how to use a practical blend of improved planning and better markets to achieve China's energy and environmental goals.

There are two market reform options based on real world experience. The first will likely be most effective. Under either option, China would substantially increase energy efficiency and investment in clean generation.

#### 3.1..1. Option 1: Integrate energy efficiency and environment in power sector reform and design markets to deliver energy efficiency and renewable energy, combining better planning and better markets.

1) Increase and expand use of competitive wholesale generation markets. Wholesale markets will be a mix of long-medium and short-term contracts plus a competitive spot market to balance supply and demand and improve efficiency of generation and transmission. Competitive wholesale generation markets are compatible with the integration of energy efficiency and environment. Increased reliance on market forces is a sound policy that should remain, but international experience makes it clear that some ordinary power sector market reforms and China's original power sector reform plans will not deliver end-use energy efficiency or environmental improvement.
2) Defer retail competition. The benefits of retail competition are small or negative and an industry structure with retail competition eliminates many proven energy efficiency policies.
3) Redefine the obligations of grid companies, distribution companies, and market operator. The most important obligation (this could be at the grid level or at a lower distribution company level) is to assemble a portfolio of

resources using Scientific Energy Planning principles to meet environmental goals at the least-cost.

4) Reform regulation, pricing methods, and market rules so incentives are aligned with obligations. Markets work because they create a powerful set of incentives. The aim of market reforms must be to make energy efficiency and environment profitable to as many market participants as possible. Thus regulatory practices should be revised to allow grid company investment or purchases of energy efficiency to be at least as profitable as buying power.
5) Create greater opportunities for ESCOs to deliver energy efficiency.
6) Make markets fully incorporate energy efficiency in every way practical. One way would be through having the market operator "buy" savings from approved EPPs.
7) Make transmission planning and investment aimed at integrating new renewables.
8) Replace environmental dispatch policy with a two-part pollution levy.

#### 3.1..2. Option 2: Efficiency Utility Model

1) Permit market reform to continue as planned, including retail access.
2) Make markets fully incorporate environmental costs.
3) Create a fully funded and staffed efficiency utility or similar entity.
4) Increase funding through a Public Benefit Fund.
5) Design markets to fully incorporate energy efficiency in every way practical.

### 3.2. Add a Sustainability Mandate to Regulatory Agencies

The Sustainable Development Commission (SDC) is the UK Government's independent advisor on sustainable development. It conducted a review of Ofgem, the national gas and electricity regulatory body, and analyzed how Ofgem could take a more active role in helping the UK meet climate goals. The SDC reached two especially important conclusions.[17] The first relates to the role and organization of the regulatory agency. The second relates to the need to organize markets and regulation to make energy efficiency profitable to key power sector entities discussed above.

1. **The fundamental question is should Ofgem be making a low-cost system as sustainable as possible, or should it be making a sustainable energy system at the lowest possible cost? The SDC believes the latter is essential.**
2. **The current policy and regulatory framework undermines climate efforts. The business model for utilities is driven by the need to sell more electricity and increase market share, rather than provide energy services that reduce consumption.**

---

[17] Lost in Transmission? The Role of Ofgem in a Changing Climate, 19 September 2007, available at http://www.sd-commission.org.uk/publications/downloads/SDC_ofgem_report%20(2).pdf.

Aligning the interests of the utilities and the mandate of the regulatory agencies with government policies were especially important to the SDC. The SDC concluded that, as there was an "overwhelming need for better alignment of the government's energy goals through the delivery and regulatory bodies . . . fundamental changes are needed. There is an opportunity to bring energy and environment policy together under one Secretary of State."

A second very recent and substantial study examined several countries to see what features of power sector regulation and regulatory bodies either support or impede sustainability issues.[18] The study examined a wide range of policy and institutional structures in three relatively successful places: California, The Netherlands, and Holland. The conclusions point to four key ingredients for success:

1) Political leadership;
2) Regulatory bodies with broad powers, including the power needed to design and implement energy efficiency and clean energy policies;
3) A legislative mandate to the regulatory agency to pursue sustainability goals;
4) Use of practical and effective options to support energy efficiency and clean energy.

### 3.3. Options to Promote Use of New Technologies, including Clean Distributed Generation, and CCS Combined with IGCC or Polygeneration Technologies

Coal will be a major part of China's energy future for many decades. This makes it critically important to provide a policy foundation that begins a transition to low-carbon output uses of coal. The discussion above describes several specific policies to support IGCC, polygeneration, and carbon sequestration. These measures included:

1) Carbon taxes and cap-and-trade policies that encourage low-carbon use of coal;
2) Extending and expanding environmental dispatch rules;
3) Extending the small plant policy to be a carbon-based energy efficiency standard and offsets want to build a coal plant; and
4) Expanding renewable portfolio standard type mandate, starting with a modest baseline.

In addition, China's heavy use of coal in and out of the power sector suggests the possibility of a power sector and industrial policy aimed more broadly at reducing GHGs.

***Maximize the efficient use of coal***

In China, the power sector represents only about ½ of total coal use. The remainder is used in industrial boilers and increasingly as a feedstock for a wide array of chemical, fertilizer, and other industrial products. In many cases total efficiency of coal use, thermal, electrical, industrial, and chemical use of coal can be greatly increased. This can be accomplished through a combination of power sector and industrial policies.

---

[18] Dr. Catherine Mitchell, *Political Economy of Sustainable Energy*, MacMillan Publishers, December 2007.

One of the best attributes of power sector reform and competition in generation is the opening of power generation to new entrants. This has encouraged new and more efficient technologies and greater use of CHP. For low-carbon coal-based generation competitive generation markets offer special promise in China. China already is a world leader in coal gasification and use of coal as a feedstock for other products. Many of these industrial uses of coal do not generate electricity. Competitive generation creates policy and market reforms aimed specifically at encouraging this sector to move to polygeneration. Encouraging these industrial coal users to enter the generation market may be more promising than trying to encourage a generation company to enter the chemical or other industrial product business.[19]

### 3.4. Greater Integration of Energy and Environmental Regulation

Energy and environment are inextricably linked and the way government goes about regulating energy and environment need to be linked as well. Failing to coordinate the energy and environment policies fully and completely will create unnecessary costs and poor environmental performance.

Numerous energy and environmental policies in practice in China today demonstrate this principle of policy integration. Some of them have been described above, such as the environmental dispatch rule, by which electricity is dispatched according to relative environmental impacts. Another example is the sharing of emissions data, as stipulated in the details of the environmental dispatch rule, between MEP, SERC, NDRC and the grid companies. Fostering this sort of information flow, transparency and communication channels will be critical to building an accountability system with regard to environmental law.

These are examples of policies that successfully align energy and environmental goals. As an underlying principle governing both spheres of policy-making strategy, however, greater integration of the two stands to bring about significant improvements in energy efficiency and environmental performance.

Restructuring will affect the environment in many significant and long-term ways. Having MEP's full engagement in the power sector reform process is vital. Failure to reflect environmental concerns in the restructuring process will make it harder to correct problems later. Once restructuring is complete, new generating companies will be competitive businesses. These companies will make every effort to increase profits, and companies will strongly resist more stringent emission requirements. It will be much easier and fairer to impose more stringent requirements before restructuring is complete.

Power sector reform means that MEP's environmental regulations should reflect and work in conjunction with the new market realities. For example, power sector reforms will affect power plant economics that should cause MEP to modify its approach to power sector environmental regulation. Environmental regulators generally refrain from imposing stringent environmental

[19] This option will require coordination with China industrial policy.

controls on existing power plants because retrofitting is relatively expensive and existing plants are assumed to retire within a reasonable period of time.

Power sector reform can change these assumptions dramatically. With competitive generation markets planned for China, old polluting plants are likely to be paid far more than their costs. The increased profits for these plants are likely much larger than the cost of adding pollution control equipment. In this situation, requiring added pollution control equipment may be very fair and equitable.

Additional opportunities for improved integration of energy and environmental policies include:

- Design environmental policies such as use of multi-pollutant (SOx, NOx, particulates, and mercury) to drive investment in gasification and cleaner technologies.
- Design environmental rules for coal-based chemical, fertilizer, or other non-electricity generation to encourage electricity generation and polygeneration.
- Design environmental rules to encourage CHP.
- Use of output-based standards.

# 5. APPENDIX 1

## Current U.S. State GHG Reduction and CCS Deployment Initiatives

A number of states are using their numerous relevant authorities to reduce greenhouse gas emissions or to encourage CCS demonstrations. These initiatives are briefly reviewed by topic below. Further details of state initiatives are provided on a state-by-state basis in the appendices.

1. Key efforts to reduce GHG emissions include:
   - Under the northeast Regional Greenhouse Gas Initiative (RGGI) ten states – Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont – have agreed to reduce $CO_2$ emissions from power plants in the region. Using a cap-and-trade system, the states have agreed to return emissions to current levels by 2009 and to reduce emissions 10 percent by 2016. The states are in the state-by-state process of adopting an agreed-upon model rule for implementing the program. In the absence of federal policy, such a regional approach is relatively more efficient and effective than a single-state effort.
   - California's AB 32, The Global Warming Solutions Act of 2006, sets a greenhouse gas target for the state that reaches 1990 levels by 2020. The state will need to address emissions from the power sector, including imports, in order to meet the law's requirements. The California Public Utilities Commission (CPUC) and the California Energy commissions jointly initiated proceedings to consider a "load-based" cap on greenhouse gas emissions from investor owned utilities. This proceeding is also considering a "first deliverer" approach in which the generator is responsible for the emissions from power produced in-state and the importer is responsible for the emissions associated with the generation of the power they import.
   - The Western Climate Initiative was established in February 2007 by the governors of Arizona, California, New Mexico, Oregon, and Washington as a joint effort to reduce greenhouse gas emissions and address climate change. The states of Montana and Utah, as well as the Canadian Provinces of British Columbia and Manitoba, joined the initiative later in 2007. The member states and provinces set a regional emissions target of 15 percent below 2005 emissions levels by 2020 and have committed to design a market-based system by August 2008 – such as a cap-and-trade program covering multiple economic sectors – to aid in meeting the target. Members will also set up an emissions registry and tracking system. The initiative builds on work already undertaken individually by several of the participating states.
   - In November 2007, six states and one Canadian Province established the Midwestern Regional Greenhouse Gas Reduction Accord. Under the Accord, members agree to establish regional greenhouse gas reduction targets, including a long-term target of 60 to 80 percent below current emissions levels, and develop a multi-sector cap-and-trade system to help meet the targets. Participants will also establish a greenhouse gas emissions reductions tracking system and implement other policies, such as a low-carbon fuel standard, to aid in reducing emissions. The Governors of Illinois, Iowa, Kansas, Michigan, Minnesota, and Wisconsin, as well as the Premier of the Canadian Province of Manitoba, signed the Accord as full participants, while the Governors of Indiana, Ohio,

and South Dakota joined the agreement as observers. According to the agreement, the Accord will be fully implemented by mid-2010.

- Both Oregon and Washington have carbon offset requirements for new power plants.20 Oregon requires new power plants to offset approximately 17 percent of anticipated $CO_2$ emissions or pay an up-front, one-time fee per ton of carbon dioxide emitted, while Washington requires new power plants to offset approximately 20 percent of anticipated $CO_2$ emissions through third-party mitigation, carbon credit purchase, or investment in mitigation projects such as cogeneration.

2. Key efforts to require, or provide incentives, for CCS include:

- California is pursuing a number of policies that may drive low-carbon coal power investments in neighboring states that export coal power to California. California law SB 1368 sets a GHG emissions performance standard at the $CO_2$/kWh emission rate typical of natural gas combined cycle plants for all new long-term electricity contracts. This standard has the effect of requiring coal-fired power generators in, or exporting into, the state to capture and sequester approximately 40 percent of their carbon dioxide emissions. While California imports less than 20 percent of its electricity from out-of-state, 50 percent of the state's GHG emissions associated with electricity are from imports, mostly from coal-fueled plants. The state's imported electricity comes from western states where a number of new coal power plants are scheduled for construction. Thus SB 1368 provides an incentive to design and equip these new plants with CCS.
- In November 2007 the governors of eight Midwestern states and one Canadian province agreed to a regional Energy Security and Climate Stewardship Platform.[21] By endorsing the platform, members agree to specific objectives and measurable goals for energy production and use in the region, and to work towards these goals by implementing a mix of policy recommendations included in the Platform. In addition to goals related to energy efficiency, renewables, and biofuel production, the Platform lays out explicit objectives with respect to carbon capture and storage. Members agree to have in place a regional regulatory framework for CCS by 2010, and by 2012, to have sited and permitted a multi-jurisdiction $CO_2$ transport pipeline and have in operation at least one commercial-scale coal-powered IGCC power plant with CCS, with additional plants to follow in succeeding years.
- In May 2007 Montana adopted a $CO_2$ emissions performance standard for electric generating units in the state with the enactment of HB 25. The law prohibits the state Public Utility Commission from approving electric generating units primarily fueled by coal unless a minimum of 50 percent of the $CO_2$ produced by the facility is captured and permanently geologically sequestered. The standard applies only to electric generating units constructed after January 1, 2007.
- In 2006, Colorado adopted legislation providing incentives for IGCC power plants of 350 MW or less that use Colorado or other western coal to generate electricity and that

---

[20] See Oregon Revised Statutes 469.503; Revised Code of Washington 80-70-010 et seq.

[21] Members include Indiana, Iowa, Kansas, Michigan, Minnesota, Ohio, South Dakota, Wisconsin, and Manitoba. The full Energy Security and Climate Stewardship Platform, and accompanying agreements, are available online at http://www.midwesterngovernors.org/resolutions/MGA%20Platform1_Layout%201Right.pdf. Accessed December 6, 2007.

demonstrate the capture and sequestration of a portion of the project's $CO_2$ emissions. Incentives for projects meeting these criteria include mechanisms for cost recovery (including full life-cycle capital and operating costs); financial support for study, engineering, and development from a clean energy development fund; and support in obtaining federal funding, among others.

- Wyoming and California are working together to develop an IGCC/CCS project and jointly seek federal funds for it.
- Several states are allowing or considering eminent domain for $CO_2$ pipelines and storage. For example, a bill has been introduced in the Montana Legislature to allow the inclusion of pipelines and storage in the state's eminent domain powers.[22] Minnesota provides an innovative energy project with the power of eminent domain, enabling it to acquire the property for its facility and transmission infrastructure.[23] Mississippi may include carbon dioxide pipelines within the class of common carriers eligible for eminent domain proceedings.[24]
- Texas has enacted legislation that would relieve companies from liability associated with the escape or migration of captured and stored carbon dioxide, and Illinois has twice considered similar legislation.[25]
- Colorado has pledged to support a utility's efforts to seek federal funding, and West Virginia may follow suit.[26]

3. Closely Related IGCC Initiatives:

Although some states are pursuing CCS incentives, many more states are providing incentives for IGCC. The following state-level IGCC incentives could be extended to CCS:

- Pennsylvania includes IGCC and waste coal in its Alternative Energy Performance Standard and is buying power under long-term contract with a coal gasification plant.
- Illinois is assisting with front-end engineering design (FEED) costs for three coal gasification projects at a cost of a few million dollars per project. FEED includes many of the major upfront tasks for a project, such as planning documents, requests for proposals, and cost estimates. By paying for upfront FEED costs, which are difficult for companies to finance through other means, the state avoids one of the major hurdles to undertaking a project and provides an early demonstration of support for a project.
- Indiana provides a tax credit to newly constructed IGCC plants that serve Indiana customers. The Indiana PUC also provides financial incentives to low-carbon coal technology in general, including cost recovery and an increase in shareholder returns while allowing rate changes to be made without a full rate case (see section IV, B).
- Idaho has adopted a moratorium on coal plants other than IGCC.

---

[22] Montana HB 24, 60th Legislature, Regular Session (MT 2007).
[23] 216B.1694(2)(a)(3), Minnesota Statutes 2006.
[24] Mississippi SB 2152, 122nd Legislature, Regular Session (MS 2007); *see also* H.B. 300, 122nd Leg. Sess. (MS 2007)(in the Senate as S.C.R. 509).
[25] Texas Natural Resources Code Ann. § 119 (2006) (H.B. 3110, 80th Leg. Sess., Reg. Sess. (TX 2007) would amend this statute to require the attorney general to defend any claim of liability against an owner or operator of a sequestration project and indemnification); Illinois HB 1135, 95 General Assembly, Regular Session (IlL 2007); H.B. 5825, 94th Gen. Assem., Reg. Sess. (IL 2006).
[26] Colorado Revised Statutes § 40-2-123(2)(j) (2006); West Virginia SB 631, 78th Leg., Regular Session (WV 2007).

# 6. APPENDIX 2

## Electricity Markets:
## The Roles of Integrated Resource Planning and Competition in Meeting China's Power Needs

October 2008

### I. INTRODUCTION

What does it mean to have a competitive electricity market? What kind of competitive electricity market makes sense for China? There are no simple answers. Competitive electricity markets come in many forms.

Well-functioning, organized markets are not natural things like plants and animals. If one plants a flower seed in good soil and gives it sun and water, it will grow into a predictable and complete thing. Markets, in contrast, are like machines: one must thoughtfully design and build them to do a desired job. And then they need to be carefully maintained and constantly overseen and, when necessary, modified and improved, because sometimes even well-built machines fail to do what one expects. One need look no further than the current financial crisis gripping Wall Street and Washington to find proof of these characteristics of markets. The lesson applies generally to all sectors of an economy, but even more so with respect to essential infrastructure and energy services: *China needs to design and build its electric market to achieve specified objectives, and then it should be prepared to watch it closely, manage it carefully, and, when necessary, fix it.*

International experience can help identify the best option for China. The United States provides many useful examples because it has so many types of competitive electricity markets. In the U.S., the particular form of a competitive market is decided partly by the Federal Energy Regulatory Commission (FERC) and partly by the states. This division of responsibility may be cumbersome, but it provides China with some very useful models.

A good example is New England, the six-state region in the northeastern part of the U.S., where there is a single regional wholesale market regulated by FERC, managed by an independent system operator called ISO New England (ISO-NE). Five of the six participating states have restructured their retail electric market, though each in a way that differs in important respects from others'. The sixth state, Vermont, has retained the vertically integrated monopoly structure. There are now six different types of electricity markets in New England, and they all operate within a single, regional wholesale market.

Implicit in these different approaches to industry structure are different goals, priorities, objectives, and choices about reliance on planning and markets. If the overall public policy objective is to minimize the long-term economic and environmental costs of meeting demand for electric service, then we find that those states that have been most pragmatic, that have recognized that neither planning nor markets can alone achieve the best outcomes, have been most successful in meeting their goals. They have found an effective balance between planning and markets that allows them to reap the benefits of wholesale markets – economic efficiency, innovation, and choice – while reducing their attendant risks – price volatility and uncertainty of supply. They have done this by limiting their exposure to short-term market fluctuations and avoiding heavy reliance on particular energy sources and fuels: market strategies that, in fact, have been greatly advanced by other government policies relating to end-use energy efficiency, renewables, and environmental protection.

> **MARKETS AND REGULATION**
>
> Markets are tools. We use them to produce and deliver goods and services in the most efficient ways possible, to spur innovation, and to put our scarce resources to their most highly valued uses. But we also know that markets are, at best, imperfect tools, that they are not in all cases the best means for achieving an end, that without vigilant oversight and management they can be destructive of the greater public good.
>
> The 2008 financial crisis in the United States is a case in point, and it offers important lessons for China as it considers how best to reform its electric sector. The evidence is quite clear that the crisis was the result of a lack of regulatory oversight. Key failures were:
>
> - The Federal Reserve's unwillingness to enforce a 1994 law that required it to prevent banks and other creditors from engaging in unfair, deceptive, and predatory lending; this led directly to the practice of sub-prime mortgage lending and the overvalued housing market, whose collapse is a central cause of the crisis;
> - The passage, in 1995, of a law that restricted the ability of investors to sue companies, securities firms and accounting firms for misstatements and misleading financial projections; it insulated management from the consequences of their actions and encouraged excessive risk-taking, and the massive bankruptcies of Enron, WorldCom, Global Crossing, and Tyco followed;
> - The repeal, in 1999, of crucial features the Glass-Steagall Act, passed in 1933 to separate commercial and investment banking; by allowing commercial banks to invest directly in the wide range of securities, it greatly increased bank depositors' vulnerability to collapses of the stock market; and
> - The enactment of the 2000 law that explicitly excluded derivatives, including credit default swaps, from regulation under the Commodity Exchange Act of 1936;
>
> The causes of the financial crisis demonstrate unequivocally the need for strong, fair, and decisive regulation. The lesson is especially important because creating and overseeing an electricity market is much more difficult and risky than a financial market.

Vermont provides an especially useful example. The five other New England states have required their utilities to divest generation and open their markets to retail competition to one degree or another. Vermont, by contrast, has retained a vertically integrated utility structure. Vermont utilities are legally responsible for meeting the need for present and future demand for service.

Unlike the distribution-only utilities in the other states, Vermont's electric companies manage their own resource portfolios using a variety of market mechanisms, such as:

1. A mix of their own generation units that were built using competitive construction practices;
2. Long-, medium-, and short-term power purchases from inside or outside the region, using competitive procurement practices;
3. Demand-side resources, using a wide range of market-based practices; and
4. Full participation in the ISO-NE regional wholesale regional market as both buyers and sellers is one means by which the utilities meet their obligation to serve.

In essence, the Vermont model relies on traditional planning tools and processes to determine what resources (demand and supply-side) will minimize Vermont consumer costs and risks, and then uses the market to deliver the desired resources in the most efficient manner possible.

This paper explains how the state's utilities make complementary use of markets and the integrated resource planning (IRP) process to meet their needs, and describes the benefits of both. In summary, IRP provides utilities the framework within which to consider the broadest range of resources to meet energy service needs; and the regional competitive wholesale market (through bilateral contracts and short-term energy trading) expands the pool of resource choices and ensures that the portfolio of resources assembled by an IRP is as inexpensive and diverse as possible.

## II. Competitive Wholesale Markets

In most of the United States, wholesale sales of electricity are considered transactions in interstate commerce and are regulated by the federal government, under exclusive authority granted to it by the US Constitution.[27] The Congress delegated that power to FERC under the Federal Power Act. Individual state utility commissions regulate utilities within their own state and decide many issues relating to the relationship of the utilities to the wholesale market.

The degree of wholesale competition in the United States varies from region to region. Commodity markets have not been developed in all regions, and those that have been created differ somewhat in the ways they are operated and in the electricity products they trade.

[27] Article 1, Section 8, Clause 3 states that "The Congress shall have power . . . To regulate commerce . . . among the several states, . . ." Even wholesale sales of electricity within a state are regulated by FERC, because, given the multi-state nature of the grid, they are effectively indistinguishable from, and can have direct impacts on, interstate commerce. The only exception to this is Texas, whose network is not interconnected with those other states.

A. The New England Wholesale Market

In the northeastern United States, there is a competitive market for wholesale electricity. ISO-NE serves a six-state region consisting of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont.

ISO-NE currently operates under a service agreement with the New England Power Pool (NEPOOL), the voluntary organization whose over 200 members are engaged in the electric power business.[28] The two organizations work together to develop the market rules and operating procedures and the transmission tariffs for New England's wholesale market. NEPOOL members make up virtually all of the participants in the market.

The New England wholesale market is really three markets, one each for energy,[29] capacity,[30] and ancillary services.[31] ISO-NE serves as the market "clearinghouse." Like any commodity market, these markets establish prices by matching supply and demand. The "clearing price" (i.e., the price at which the commodity is sold) is derived by matching suppliers' bids (ranked in ascending order by quantity and price to yield a "supply curve") with buyers' offers to purchase (ranked in descending order by quantity and price, to produce a "demand curve"). The point where supply equals demand determines the market-clearing price for a given period.

The energy, or "spot," market operates in the short-term, from the day before to real time. In the day-ahead" market, suppliers offer energy in defined quantities and prices, in specified hours. At the same time, buyers, primarily local distribution utilities and other load-serving entities, but also large industrial customers, may bid to purchase these products, also in defined amounts and prices in specified hours. These bids to supply and purchase are matched until the market clears. The clearing price is paid to all suppliers whose bids are less

---

[28] Members include not only utilities, but also independent generators, competitive retail suppliers, providers of end-use energy efficiency and short-term demand response, end-users, and transmission owners. NEPOOL was created in 1971, as a means of addressing the regional reliability challenges that were exposed by the October 1965 blackout in the eastern US.

[29] "Energy" is the generation or use of electric power over a period, typically expressed in kilowatt-hours or megawatt-hours.

[30] "Capacity" is the instantaneous measure of a generating unit's maximum output or of a transmission line's maximum ability to deliver power (usually expressed in kilowatts or megawatts).

[31] "Ancillary services" support the reliable operation of the transmission system as it moves electricity from generating sources to retail customers. The ancillary services market is the least-developed on the three New England markets.

than or equal to that price, and it is paid by all purchasers whose bid are greater than or equal to it. This price provides the basis for further trading and competition among participants in the wholesale market: the commitments that the participants make in the "day-ahead" market are binding – the seller must supply and the buyer must purchase – but these commitments can be resold in secondary trading up until the time of the transaction the next day. The market works generally as expected. Supply and demand fluctuate in response to changing prices When supplies are tight, prices increase, making it economical for the more costly generation and more valuable alternative resources, such as demand response, to operate. Where there are retail pricing mechanisms that reveal these changes in wholesale prices directly to end-users, consumers often respond by decreasing their usage. And the converse is true. When supplies are plentiful, prices decrease, production falls, and consumption increases.[32]

The New England capacity market works in a similar fashion, expect that it is not intended to provide capacity in the short term, but instead to assure that the system has sufficient resources to assure reliability over the long term. It is called the Forward Capacity Market (FCM). The ISO forecasts the system's peak demand for power three years ahead. Suppliers of capacity – which includes not only generation but end-use energy efficiency, short-term demand response, and customer-sited generation – bid the price at which they are willing to provide capacity three years later. The bids are accepted in ascending order of price, and the marginal bid (i.e., the final bid that brings the aggregate amount of capacity to the level projected) determines the clearing price, which all cleared bidders will be paid *if, and only if, their capacity is on line and operable three years later*, and for as long thereafter as it continues to serve capacity needs. All buyers in the market will be charged for the capacity, in proportion to their total demands for capacity at times of system peak.

Most electricity in the region is traded is through bilateral contracts, typically direct transactions between wholesale buyers and sellers for market products over specified time periods and at set prices. Bilateral transactions can provide price certainty because the risks of spot-market volatility are reduced or mitigated in the negotiation of contract terms. However, the "price" for this reduced risk is the longer-term commitment that the parties make to each other, which typically will not allow either of them to effect unilateral changes the terms of the contract in response to changing market conditions.

---

[32] But, again, only to the extent that customers see the changes in prices and that the change is sufficient to render increased consumption valuable to them. This is called "price elasticity" and it describes customers' willingness to purchase more or less as price falls or rises. Short-run price elasticities for electricity are typically quite low, which is to say that a price change must be fairly significant to induce a change in consumption. Longer-run elasticities are slightly higher, because customers can make investments that increase the efficiency of their end-uses. But even then there remain very substantial market barriers to customer investment in end-use efficiency that justify alternative, administratively overseen means for providing those resources.

Short-term trading in the day-ahead and real-time markets allows participants to balance their loads and generation resources. Electricity supply and demand can be unpredictable, owing to diverse factors such as weather and the unexpected failures (forced outages) of generators. Generators and consumers can buy and sell in the spot market to manage risk and to account for any differences between their bilateral and day-ahead entitlements, on the one hand, and their real-time needs on the other. Nevertheless, the spot market poses the most risk for participants because prices can change dramatically in very little time. As a consequence, new, short-term financial agreements have been developed to hedge against price volatility in the real-time spot market.

## III. The Retail Market in Vermont

Increasing competition in US wholesale electric markets during the early 1990s was accompanied – indeed, partly the cause of calls for the opening of retail markets to competition as well. By mid-decade, Vermont and many other states were considering restructuring their electric industries to allow for retail choice. Since then some seventeen states have opened their markets to some form of retail choice. Vermont, after in-depth regulatory and legislative investigation, decided not to restructure but rather to keep its electric companies vertically-integrated and to continue to regulate all aspects of their monopoly operations.

But this does not mean that Vermont cannot participate in the greater regional market. To the contrary: its utilities participate actively in the market as both buyers and sellers and, as a consequence, the state has a wider range of resource options from which to choose – constrained only by the types of generation available and the transmission paths over which electricity may be delivered. New England's energy supply is comprised of resources fueled by natural gas, oil, nuclear, coal, hydro, pumped storage, and other renewables.[33] Vermont is also interconnected with and receives power from Canada (Hydro-Quebec). Furthermore, the state has indigenous renewable resources, one of the nation's most aggressive energy efficiency programs, and modest development in distributed generation and short-term demand response. Retail customers do not have direct access to competitive generation; instead, resource decisions are made through a planning process that fully reflects the state's goals and policies.

### A. Integrated Resource Planning

Vermont's utilities are responsible for acquiring power and delivering it reliably to their customers. This requires utilities to participate in, among other things, the regulatory process known as integrated resource planning (IRP). Under Vermont law, each regulated electric or gas company is required to prepare and

[33] ISO-NE, *2006 Regional System Plan*, October 26, 2006, at 53.

implement a "least-cost integrated plan" for provision of energy services to its Vermont customers.[34] Orders of the Public Service Board (the state's regulatory agency) have further defined the requirements that a utility's IRP should meet in order to be approved and implemented.

The objective of the IRP process is to ensure that utility customers are provided with safe, adequate, and reliable service while reasonably balancing the costs and benefits of providing this service. The cost factors to be considered are both direct dollar costs and those indirect costs that are hard to quantify in dollar terms, such as environmental and societal impacts, which are referred to as "externalities."

After its IRP is approved, a utility is responsible for administering approved projects, evaluating and reporting on progress, and updating its IRP as required. Projects should be carried out in accordance with deadlines specified in a utility's implementation plan.

## IV. IRP AND THE WHOLESALE MARKET

As explained above, the central principle of IRP is to identify, analyze, and acquire the least-cost, long-term portfolio of resources sufficient to meet demand for energy services. However, this is not a matter of simply comparing prices and choosing the lowest one. While prices show what a resource costs, prices do not show what it is worth.

Consider, for example, a photovoltaic (PV) system that produces power at the cost of 8¢ per kWh and a coal-fired plant that produces power for 4¢ per kWh. Which is the preferred resource? Despite the disparity in prices, the answer is requires knowing the operating characteristics of the two resources and the

[34] 30 V.S.A. § 218c. Least cost integrated planning:

> (a)(1) A "least cost integrated plan" for a regulated electric or gas utility is a plan for meeting the public's need for energy services, after safety concerns are addressed, at the lowest present value life cycle cost, including environmental and economic costs, through a strategy combining investments and expenditures on energy supply, transmission and distribution capacity, transmission and distribution efficiency, and comprehensive energy efficiency programs. (2) "Comprehensive energy efficiency programs" shall mean a coordinated set of investments or program expenditures made by a regulated electric or gas utility or other entity as approved by the board pursuant to subsection 209(d) of this title to meet the public's need for energy services through efficiency, conservation or load management in all customer classes and areas of opportunity which is designed to acquire the full amount of cost effective savings from such investments or programs.
>
> (b) Each regulated electric or gas company shall prepare and implement a least cost integrated plan for the provision of energy services to its Vermont customers. Proposed plans shall be submitted to the DPS and the PSB. The PSB, after notice and opportunity for hearing, may approve a company's least cost integrated plan if it determines that the company's plan complies with the requirements of subdivision (a)(1) of this section.

nature of the demands that the resource will service. It may in fact be the case that the 8¢ per kWh PV is more valuable to the utility than the 4¢ per kWh coal plant. This could occur if the PV's output were largely on-peak or if installation of the PV reduced transmission and distribution costs. IRP is the analytical tool by which we can determine whether the advantages of the PV facility are sufficient to overcome its 4¢ price premium over the competing resource. In this way, planning and markets are reconciled.

In sum:

- **Competition reveals what a resource costs.[35]**
- **IRP identifies what a resource is worth given the resource's operating characteristics and how it integrates with the existing power system, and**
- **Ultimately, IRP reveals whether any particular resource is worth more to the system than it costs. Resources should be acquired (built or bought) whenever they cost less than they are worth.**

The benefit of IRP is that it allows very different resources – e.g., lighting retrofits, photovoltaic units, a utility-owned and operated gas-fired turbine, a non-utility biomass facility – to be compared in order to determine which is the most cost-effective for a given utility at a given time. Because the available resources may be very different, as illustrated above, an analysis must include all related costs for each potential alternative. When conducted in this manner, an IRP analysis identifies the resources that offer the greatest value, net of costs, to a utility and its customers.

The evaluation of competing resources is at the heart of the IRP process. IRP is a very effective tool, even in the absence of broader market competition, but it will be improved by access to a competitive wholesale market, which can greatly expand the pool of resource choices. In this way, competition is entirely compatible with planning. It enables the utility to test whether the marketplace—through competitive bidding, negotiation, or some combination of the two – can provide resources at a lower cost than the utility itself can. If the answer is yes, then total costs will be lower than otherwise, and consumers will benefit.

## V. The Role of the State Regulator in Regional Market Transactions

The electric sector in Vermont remains vertically-integrated, and the therefore utilities retain the obligation to meet demand for service at the lowest total

[35] Competition may take the form of competitive bidding for construction of power plants, competitive bidding for long- or medium-term demand or supply resources, and bid-based short-term markets.

societal cost over the long run. As such, resources choices are in the hand of the electric companies, with review and oversight by the regulators.

Prior to acquiring most resources, whether through construction or purchase (including some on the spot market), a utility company must receive regulatory approval. When determining whether to grant approval, the regulator reviews environmental effects, system reliability, and economics. The regulator must also find that the proposal is "consistent with the principles for resource selection expressed in that company's approved least cost integrated plan."

## V. Conclusion

Discussion of competitive markets often focuses on the distinction between wholesale and retail competition. This may oversimplify the issues and options. Vermont is just one example of states that have made important restructuring decisions to combine the best of markets and planning. China's emphasis on energy efficiency, environmental improvement, and renewables suggests that lessons from states like Vermont, Minnesota, and California can be especially useful.

These states have found that IRP gives utilities the framework within which to consider the broadest range of resource alternatives to meet energy service needs. The competitive wholesale market for electricity products increases the number and types of resources from which to choose and ensures that the various options reviewed in an IRP are as inexpensive and diverse as possible. This can yield benefits such as lower utility and consumer costs, greater system reliability, reduced consumer risk, and less environmental damage.