

Scientific Energy Planning in China

April 19, 2006

Abstract

China needs “Scientific Energy Planning” to meet its energy, environmental, and power sector reform challenges.

In the power sector, Scientific Energy Planning means planning that relies on sound economic and analytical methods to identify how to meet China’s rapidly increasing power needs at the least total social cost. Achieving the least total social cost requires identifying and implementing a portfolio of supply-side and demand side resource options that meet China’s power needs at the lowest total long-term capital, operating, environmental, and other social costs imposed by the power sector.

China’s current planning process is inconsistent with Scientific Energy Planning in many important respects. In addition, ongoing market reforms in the generation sector will not lead to efficient investment and cannot substitute for better planning. China needs both: more and better planning to identify the desired energy future, and better markets where competition is likely to achieve those objectives most efficiently. China also needs better integration of energy and environmental policies and regulation.

China has a successful track record in learning from pilot programs. These three energy and environmental agencies (NDRC, SERC, and SEPA) should join in a regional pilot where close cooperation on energy planning, power market design and environmental regulation can be integrated to demonstrate the value of Scientific Energy Planning.

1. China’s Energy Challenges

China’s energy challenges are well known. The primary challenge is how to meet the energy needs of a very rapidly growing economy while protecting the environment. This and a host of related challenges have led to the adoption of many goals, policies, and laws such as:

- Meeting the rapidly growing power demand without costly boom/bust cycles;

- Reducing China's energy intensity by 20% by 2010;
- Meeting the renewable energy law's goal of using renewable energy to supply 15% of China's energy needs by 2020;
- Increasing reliance on natural gas and LNG for power production;
- Building as many as 40 GW of new nuclear generation by 2020; and
- Reforming the power sector to allow market forces and prices to guide power sector investment.

The NDRC Minister and other leaders have called for Scientific Energy Planning as the way forward.¹

China's energy sector reform has been criticized as being stuck part way between a planned and a market-based power sector. This suggests it is necessary, or better, to have either a planned power sector or a market-based power sector. In fact, China needs both: more and better planning to identify the desired energy future and better markets where competition is likely to achieve those objectives most efficiently. We believe Scientific Energy Planning reflects this reality.

Scientific Energy Planning provides a way to improve planning, and to harmonize planning with market reforms and China's economic, environmental, and social goals. This paper focuses on Scientific Energy Planning and addresses four main questions:

- What does Scientific Energy Planning mean in the power sector?
- Is China's current planning process consistent with Scientific Energy Planning?
- Why is it that the competitive generation market alone will not deliver Scientific Energy Planning's desired results?

¹ For example, see "Scientific energy planning leads way to sustainable growth" at downloaded on April 18, 2006 http://english.people.com.cn/200504/25/eng20050425_182603.html

- What do China and its energy-related government agencies need to do to adopt and implement Scientific Energy Planning in a manner that is consistent with its market-oriented power sector reform?

2. Scientific Energy Planning and the Power Sector

Scientific Energy Planning combines several concepts: it is scientific, so it is rational, logical, and based on facts and analysis. It is holistic and economic, so it considers the supply side and the demand side. It is sustainable, so it considers environmental and social costs. Finally, to be meaningful and effective, Scientific Energy Planning is connected to China's energy investment and regulatory practices.

In the power sector, Scientific Energy Planning means planning that relies on sound economic and analytical methods to identify how to meet all of China's power needs at the least total social cost. Achieving the least total social cost requires identifying a portfolio of supply-side and demand-side resource options that meet China's power needs at the lowest total long-term capital, operating, environmental, and other social costs imposed by the power sector. The economic foundation of Scientific Energy Planning is described below in more detail.

Scientific Energy Planning is not just a planning exercise. Scientific Energy Planning needs to be connected to the investment approval process, the licensing process, the design and operation of competitive generation markets, environmental regulation, and every other aspect of the government's oversight and regulatory functions.

The Basic Economic Foundation Of Power Planning

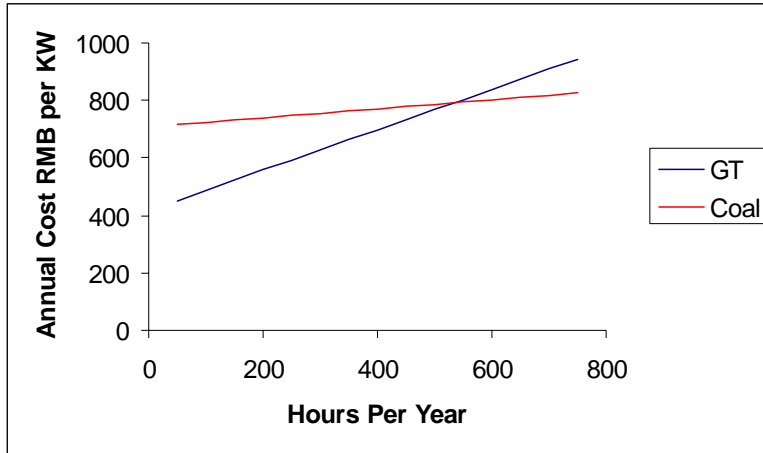
Power system economics is at the heart of Scientific Energy Planning. The most basic power sector planning question is how to meet demand in the most economical manner. Or stated another way, what kind of power plant will most economically meet the load given the relevant costs of each option and the extent and nature of power demand?

How basic power planning answers these questions can be illustrated with the use of power plant cost curves showing the combined capital and operating cost characteristics of various types of power plants and a load duration curve showing the key characteristics of the demand to be met.

Figure 1 shows the total cost for two types of power plants in China, a conventional coal-fired power plant and a gas-fired combustion turbine. The figure shows total annual cost (capital plus operating cost) as a function of how many hours the plant is required to operate. Figure 1 shows that the line representing the gas turbine ("GT") is below the line representing the coal plant until about 600 hours. This means that if a power plant is needed fewer than about 600 hours per year the gas turbine is the

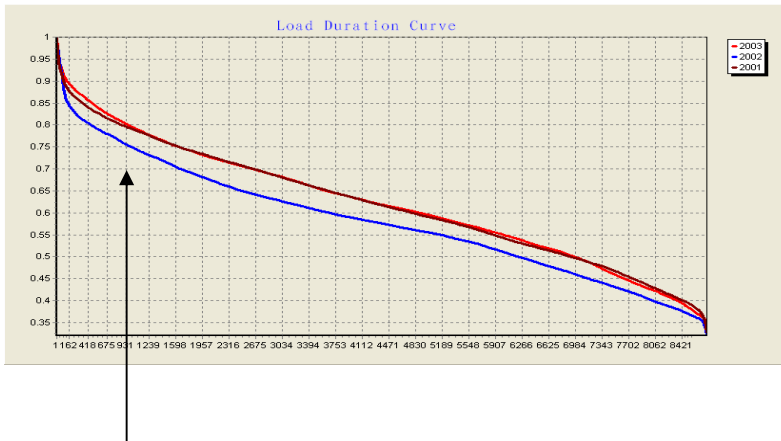
lower-cost choice.

Figure 1 Total Annual Cost of Two Types of Generation



With the information from Figure 1, one can turn to a load duration curve to see how much peaking capacity makes economic sense. Figure 2 shows the load duration curve for Beijing for three years beginning in 2001. The figure shows that for these years the demand was more than 78% to 85% of the peak demand for about 600 hours or less. Peak demand in Beijing is about 10,000 MW. Thus, between 1500 and 2200 MW of supply is needed for 600 or fewer hours per year. If the coal plant and the gas turbine “peaker” were the only two options, having about 2000 MWs of gas-fired peakers would be the least-cost way to meet this load in Beijing. Currently there are no gas-fired peakers in Beijing and plans call for none to be added.

Figure 2 Beijing Load Duration Curve 2001-2003



Economics can determine the least-cost mix of capital and operating cost to meet a specific load profile. If the load profile changes, the least-cost mix will change. If a new technology becomes available, its unique mix of capital and operating cost will determine how it can contribute to a least-cost mix.

How Scientific Energy Planning Differs from Basic Power Planning

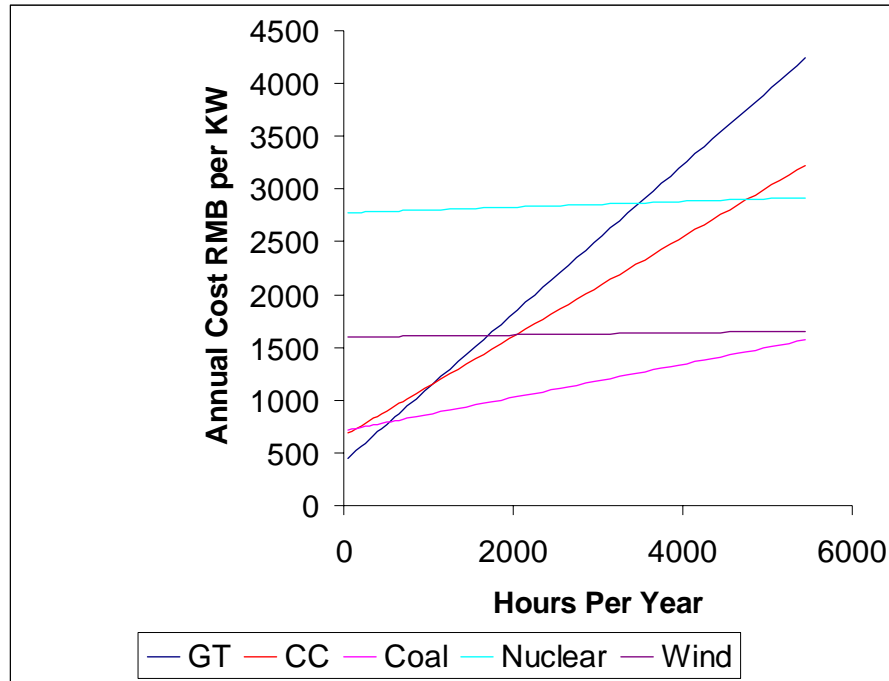
Scientific Energy Planning starts with the analytical approach described above and adds five key features:

Scientific Energy Planning Considers All Power Plant Options.

Every type of power plant can be added to Figure 1. For initial analysis it may suffice to use estimates for generic types of plants. For some plants, such as hydro-electric plants, each unit's cost and operating characteristics are so different that every plant will need to be treated individually.

For example, Figure 3 adds data for combined cycle gas or LNG fueled plants ("CC"), nuclear plants, and wind plants. Notice that these lines are always above and never cross the line for coal plants. This means, these plants are not as cost-effective without consideration of environmental costs or other social costs.

Figure 3 Total Annual Costs of 5 Types of Generation



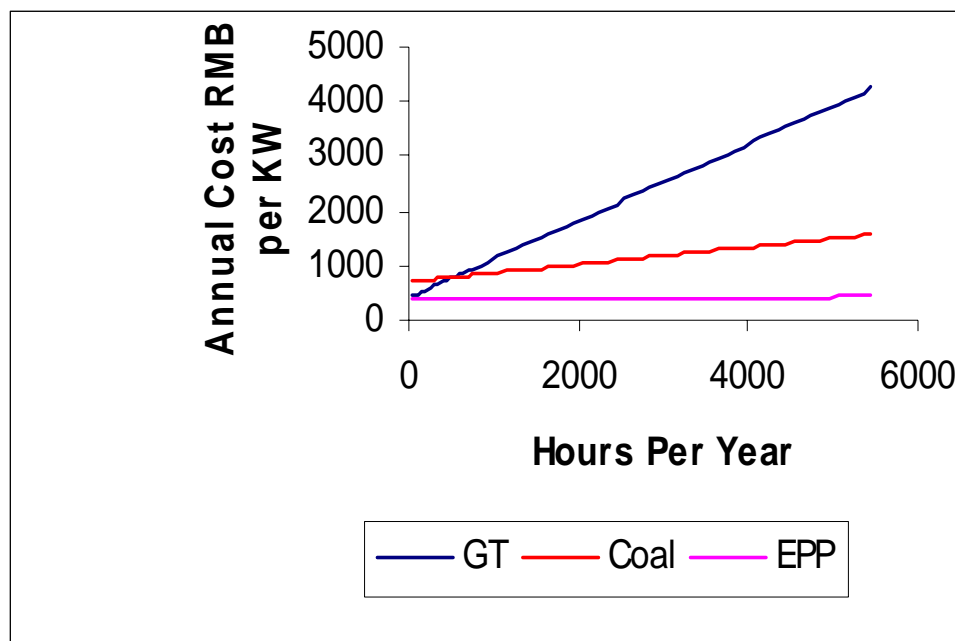
Scientific Energy Planning Considers All Demand-Side Options.

Scientific Energy Planning considers demand-side options equally with supply-side options. To simplify the consideration of these energy efficiency options we will use the “Energy Efficiency Power Plant” (EPP) concept and data developed in Jiangsu.²

Figure 4 shows the original cost curves for coal and gas-fired combustion turbines. We have added a line representing the Jiangsu EPP. The EPP cost curve looks very much like the curve for a hydro-electric plant; a plant with high capital cost and very little operating cost. But the more important observation is that the EPP curve is well below those of the coal plant and the combustion turbine. This means the EPP is always cost-effective and should be added to the energy supply mix to produce a least-cost result.

² The “Energy Efficiency Power Plant” (EPP) concept is discussed more fully later in this paper. Basically, an EPP is a virtual power plant consisting of a bundle of energy efficiency, also known as demand-side management (DSM) programs, designed to produce energy savings equivalent to the electricity output of a large conventional power plant.

Figure 4 Total Annual Costs of EPP and Two Types of Generators



Scientific Energy Planning Considers Environmental Costs.

Reducing pollution is a high priority for China. Indeed, pollution reduction is a primary reason China is adding gas-fired plants, nuclear plants, and renewables, even though Figure 3 showed these options are not cost-effective when comparing them to coal units simply on the basis of their capital and operating costs.

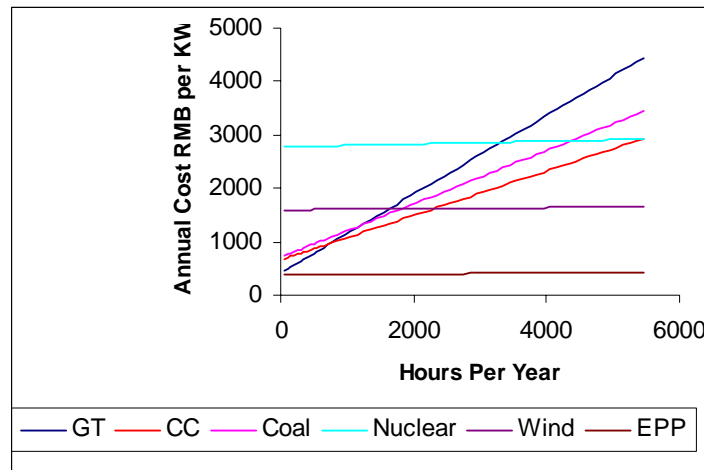
Figure 5 shows how the analysis changes when air emissions costs are included. The cost for each type of plant has been adjusted upward to reflect the cost of emissions associated with the plant. Coal plants have the greatest emissions per kWh so its costs have been raised the most. Gas is relatively clean so its costs have not been increased as much. The costs for the EPP, wind, and nuclear have not been raised at all because these options have no air emissions.

The results of including the cost of air emissions now show that gas-fired plants, EPPs, wind and nuclear are all far more competitive with coal.³ This

³ Scientific Energy Planning would consider other environmental costs including the costs of water pollution, solid waste disposal, and disposal and storage of radioactive material. This would change the outcome of the economic analysis, but our purpose here is to illustrate the methods, not to show which resources are least-cost.

also shows how a scientific and economic analysis would rationalize and quantify the contribution different resources would make to China's energy needs. This is the essence of Scientific Energy Planning.

Figure 5 Total Annual Costs of Generator Types and EPP, Including Emissions-related Costs



Scientific Energy Planning Performs The Analysis Over A Multi-Year Time Horizon.

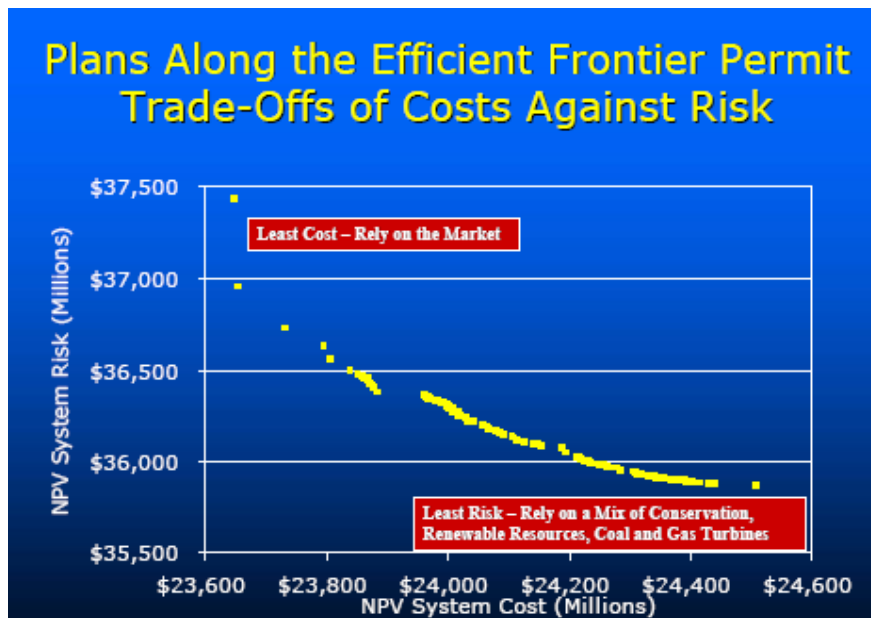
All of the discussion and figures above show a static, one-year picture. A complete Scientific Energy Planning analysis would repeat the effort for many years to capture the effects over time of changes in demand and changes in many costs, such as fuel costs, construction costs, and financing costs. The results of a multiyear analysis would show the least-cost investment path for China given a certain set of input assumptions.

Scientific Energy Planning Considers Multiple Scenarios To Test For Risk.

The final step in Scientific Energy Planning is to test the least-cost plan for risk. How would the outcome change if different assumptions are used for fuel prices, capital costs, and other major variables? It is possible that a plan that was least cost under a base-case set of assumptions was, in fact, very risky. The objective is to create a plan that will meet China's power needs in a least-cost, low-risk scientific manner. Figure 6 shows the graphical results from Scientific Energy Planning conducted by the Northwest Power and Conservation Council in the US. Their studies examined hundreds of scenarios, each of which is represented by a single point. As the figure shows, some scenarios had lower expected costs than the preferred option, but

they carried much higher risk. The scenarios with the most energy efficiency were both low-cost and low-risk.⁴

Figure 6 Cost – Risk Tradeoff



3. Is China’s Current Planning Process Consistent with Scientific Energy Planning?

China’s current power sector planning process uses some sound long-term planning methods but it falls short of Scientific Energy Planning in five significant ways:

China’s Current Power Sector Planning Process Does Not Fully Consider Demand-Side Energy Efficiency Options As An Alternative To Supply Options.

Every relevant Chinese and international study consistently identifies vast amounts of energy efficiency potential in China. A few demand-side options are funded and pursued, but these options are not given the same level of

⁴ <http://www.raonline.org/Conferences/Minnesota/Presentations/EckmanMNPUC120605.pdf>

importance and consideration as supply options, (although there are indications this may change with the 11th 5-year plan). Supply and demand-side options are under the supervision of different agencies or divisions. Coordination and integration of plans is lacking. With Scientific Energy Planning, all energy options would be evaluated, prioritized, and funded in a sound, logical, least-cost manner.

Jiangsu's proposal to build an "Energy Efficiency Power Plant" (EPP) can help make this last point clear. An EPP is a virtual power plant. Detailed analysis in Jiangsu has led to the design of an EPP, a bundle of energy efficiency, also known as demand-side management (DSM) programs, designed to produce energy savings equivalent to the electricity output of a 300MW conventional power plant.

The Jiangsu analysis is the most recent and thorough study of energy efficiency potential in China.⁵ The study concluded Jiangsu can achieve 30,633 GWh and 12,133 MW in cumulative annual electricity savings by implementing a portfolio of eight demand-side initiatives investing in energy efficiency improvements throughout the province's industrial, commercial/institutional and residential markets. Total electric energy savings represent the generation output (in GWh) equivalent of 58 new 300 MW coal-fired plants over the next decade. The total 2006 net present worth economic benefits of these energy efficiency savings to Jiangsu is RMB 174.4 billion (\$21.2 billion US).

Best estimates show Jiangsu's first 300 MW EPP can be built in less time than a conventional power plant, it produces no pollution, it consumes no water, and its average cost is about 15 fen/kWh, or less than ½ the cost of a conventional power plant. But this large, low-cost, and clean option faces many barriers while much more costly and polluting projects move ahead. Moving ahead with more costly, less benign resources is not consistent with Scientific Energy Planning.

Scientific Energy Planning uses proven planning and economic analysis to meet electricity demand with the least-cost mix of EPPs and conventional power plants. The existing planning methods essentially ignore EPPs and the

⁵ See, DSM Strategic Plan For Jiangsu Province: Economic, Electric And Environmental Returns From An End-Use Efficiency Investment Portfolio In The Jiangsu Power Sector: Joint Report Prepared In Accordance With the Memorandum of Understanding Between the Jiangsu Provincial Economic and Trade Commission and the Natural Resources Defense Council (USA) on Cooperation in DSM Strategic Planning, Optimal Energy, Inc., Green Energy Economics Group, and the State Grid Corporation DSM Instruction Center. Updated Report, January 20, 2006.

contribution energy efficiency can make to meeting China's energy needs in a least-cost manner.

China's Current Power Sector Planning Process Does Not Adequately Consider Environmental Costs.

China has made substantial efforts to address its environmental problems. More restrictive environment regulations, higher pollution fees, and better enforcement have all been significant accomplishments, but more needs to be done. China's environmental problems are still very serious and they are getting worse. The rapid growth of energy use has caused China's environmental goals to be missed by a wide mark. The 10th five year plan called for SO₂ emissions in 2005 to be 10% **lower** than they were in 2000. Instead, 2005 SO₂ emissions were more than 27% **higher**.

In the real world, energy decisions and environmental outcomes are inextricably linked. But energy and environmental decisions and policies do not seem to be linked in China.

China has prepared many energy studies that include the environmental consequences of different energy choices, but the environmental impact is never treated as a constraint or input to the study. The studies consistently forecast alarming levels of emissions, well above sustainable levels. These studies and the nation's environmental goals do not seem to be linked to the government's day-to-day decisions relating to power plant investment and approval processes.

For example, in 2003 the Energy Foundation funded Chinese experts from ten well-respected institutions to prepare a comprehensive analysis of China's energy future. They developed three energy scenarios: a business-as-usual case, a case in which energy efficiency and pollution-reducing policies are adopted, and a case in which stronger policies are adopted earlier. Next, the researchers estimated the emissions of SO₂ and NO_x under each scenario. Alarming, even under the most aggressive scenario, SO₂ and NO_x emissions increased 40% and 52% respectively above 2005 levels, and 2005 levels are already well above acceptable levels.⁶

With Scientific Energy Planning environmental constraints and environmental costs would be an explicit part of the planning process. Options for meeting

⁶ See, "China: Energy Sustainability; The Shrinking Window Of Opportunity," World Bank Discussion Draft, June 1, 2006.

the environmental goals in a least-cost manner would be identified and costs, benefits, and risks of the preferred plan would be clear.

China's Current Power Sector Planning Process Does Not Consider Other Social Goals.

There are many other social and national goals that factor into China's energy planning, including the desire to diversify resources, to minimize supply and price risks, to promote economic development of particular areas or regions, to improve national security, and to reduce health care costs, coal mining related injuries and deaths, water use and water pollution control costs. These goals manifest themselves in specific projects or goals approved by the government, but there is no transparent scientific basis indicating that the projects selected meet the goals in a least-cost manner, or that they are integrated into the power sector planning process.

With Scientific Energy Planning, the value of these other social goals would either be quantified in economic terms or treated as a constraint in the analysis. Least-cost ways of meeting these objectives would be identified.

China's Current Power Sector Planning Process Is Not Well-Connected To Investment Decisions.

China's power plant approval process is not described in any formal document. The process appears to be a fluid one that changes to meet current conditions. At the peak of the power shortage most proposed projects were quickly approved. Many projects began construction before approval was received.

NDRC has developed a multi-attribute ranking system. The rankings are mostly qualitative. NDRC relies on outside power sector experts to rank projects. Specific projects or types of projects that are preferred in the Five-year Plan move to the top of the ranking.

Attributes used in the ranking process include:

- Industrial policy
- Resource diversity
- Public resources
- Environment

Projects that lack one or more of these attributes, such as failing to meet environmental regulations or being located in an area with serious water shortage problems, are unlikely to be approved. But, the process is neither

open nor transparent. As a result, political and other non-objective considerations can move projects up or down in the ranking.

Several aspects of the approval process are at odds with Scientific Energy Planning. The ranking appears to be on a pass/fail system. No apparent mechanism allows an alternative proposal to improve its ranking by offering a lower price or by improving environmental performance.

With Scientific Energy Planning, each of these issues would be explicitly addressed.

China's Current Power Sector Planning Process Is Not Well-Connected To Regulatory Decisions Relating To Power Sector Markets.

Power sector reform and generation market design also do not appear to incorporate the principles of Scientific Energy Planning. There are many market design options to choose from. Some market options incorporate Scientific Energy Planning principles and others do not. Markets that ignore environmental costs or exclude participation by EPPs and energy efficiency will not yield results that are consistent with Scientific Energy Planning. Appendix A describes these issues and options in more detail.

4. China's Existing and Planned Generation Market Reforms In The Power Sector Will Not Deliver Scientific Energy Planning

Scientific Energy Planning can clearly be used to find the least-cost path to China's energy needs. The next question is whether competitive generation markets will deliver the desired results. The short answer is NO, at least not without substantial changes to the markets China is designing.

Many people believe that competitive generation markets will produce generation prices that lead to the optimal levels and types of generation. This is not true.⁷

⁷ For an excellent discussion of why generation markets fail to guide efficient generation investment see, "The Convergence of Market Designs for Adequate Generating Capacity with Special Attention to the CAISO's Resource Adequacy Problem: A White Paper for the Electricity Oversight Board," Peter Cramton and Steven Stoft, 25 April 2006, available at http://www.ksg.harvard.edu/hepg/Papers/Cramton_Stoft_0406.pdf.

Generation markets will produce prices and these prices will influence investment decisions, but the design of the markets will determine the level and distribution of prices. Competitive generation markets have many positive attributes and they should be developed, but these markets on their own will NOT deliver the optimal energy resource mix that results from Scientific Energy Planning. This is the case for many reasons, the most important of which are:

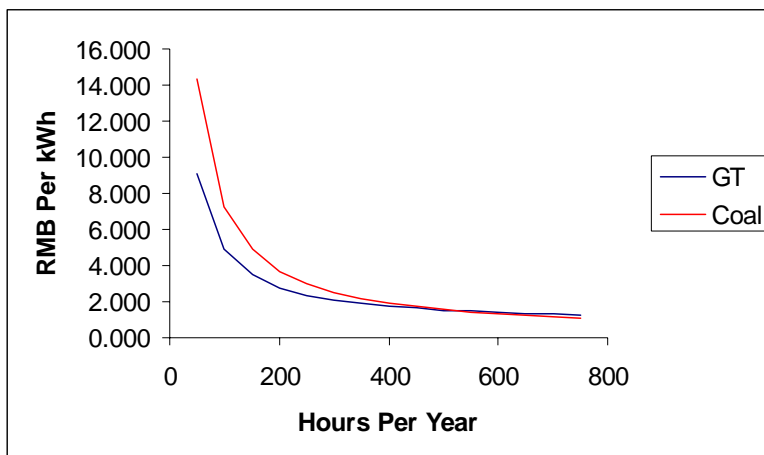
- **China's generation markets are not designed to produce the necessary prices**

Every power market is different. Each has its own set of rules and practices, and it is the combination of market rules and resulting prices that will influence the kinds of generation capacity that investors will build. Internationally, competitive generation markets are rarely designed to produce prices that are the sole driver of generation investment decisions. Figure 7 helps explain why this is the case.

Figure 7 shows the same data as shown in Figure 1, except that the costs of the gas peaker and coal plant are shown on a per-kWh basis. As expected, Figure 7 still shows that the peaker is least-cost if used for fewer than about 600 hours, but the cost per kWh is very high, above 2 RMB/kWh and as high as 10 RMB/kWh. Competitive generation markets would have to consistently produce market prices averaging about 3 or 4 RMB/ kWh for 600 hours a year before private investors would invest in peaking plants. Yet for plants needed for only 600 hours per year, considering only operating and capital costs, this is the least costly option.

Most markets have not been designed to yield these prices. Price caps are used to protect against market power abuse or prevent excessive price volatility. Other mechanisms such as capacity or reserve obligations are used to guide new plant investment. China's generation markets, like markets in most countries, are too constrained by market design and price caps to guide efficient investment.

Figure 7 Gas Turbine Peaker and Coal Plant Cost per kWh



Thus in China, the prices resulting from competitive generation markets can not guide efficient investment in new generation.⁸

- **Energy efficiency is not included in existing markets**

Energy efficiency is not integrated in China's existing markets even though it is by far the cheapest and cleanest option. Investors would invest in EPPs in Jiangsu if EPPs could participate in the market, but today there is no opportunity for an EPP to do so. Current market rules do not recognize the value of the EPP resource and, as a result, significant cost-effective and environmentally benign savings are lost. Planned market rules give an additional advantage to supply-side resources. They will allow grid companies to pass the cost of power purchases on to consumers. However, they don't allow grid companies to recover lower-cost energy efficiency purchases or investments.

- **Environmental externalities are ignored in existing markets**

As we illustrated with the power plant cost curves, one result is achieved if environmental externalities are ignored and another, very different, result is

⁸ Where markets do not yet exist, China sets generation prices administratively. Generation prices are set using a single kWh-based price for output that includes capital and operating costs. This pricing practice favors the choice of base load generation, particularly coal. It discourages the choice of clean technologies such as hydropower and gas-fired generation, and peaking power plants that are capable of providing system flexibility and more valuable, least-cost, peak hour electricity.

achieved if environmental costs are considered. Scientific Energy Planning includes full consideration of the environment. As currently implemented and planned, China's generation markets do not consider environmental externalities so they cannot be expected to deliver the desired results of Scientific Energy Planning without the help of other mechanisms.

- **Markets provide inadequate consideration of risk**

Private investors will consider the full range of risks when they make generation investments, but these risks are considered from their own perspectives and with particular attention to the risks created by the particular market structure selected. International experience shows that investors' assessment of risk and means of limiting risk can be very different than the risks that consumers or countries experience.

5. What China And China's Energy-Related Government Agencies Need To Do To Adopt And Implement SEP In A Manner That Is Consistent With Its Market Oriented Power Sector Reform

For the reasons given above, China's planning process has not yet incorporated the principles and methods of scientific energy planning. Moreover, it is clear that the country's generation markets will not produce the least-cost outcomes that Scientific Energy Planning would identify. Implementing Scientific Energy Planning in China will take both more and improved planning and more market reforms.

Here are the practical steps China can take to make Scientific Energy Planning a reality.

Improve The Planning Process Technically And Administratively.

Technically, there are improvements to the planning process that have been proven in many countries. These include among other things:

1. Use improved end-use and econometric methods of forecasting electrical load;
2. Broaden the range of resource options considered and explicitly include demand-side options;
3. Incorporate environmental externalities in the planning process; and,

4. Incorporate uncertainty in fuel prices and other risk factors.

From an administrative perspective there are two improvements to be made:

1. Consolidate supply- and demand-side planning in one entity. Having separate power and energy conservation divisions is not, by itself, a problem. However, if overall power sector planning is the responsibility of the power division, one should not be surprised that energy efficiency and other DSM options are not properly integrated in the plan.
2. Link environmental considerations in a more direct and transparent way to the approval process. Appendix A describes many ways power sector reform and market design affects the environment. NDRC and SERC need to have environmental divisions to assure all key power sector decisions fully consider the environmental effects of each option considered.

Connect The Planning Process To The Investment And Power Plant Approval Process.

For Scientific Energy Planning to be of value to China it has to be more than only a plan. The plan must lead to investment in identified resources. The steps to achieve this are:

1. Publish the results of the Scientific Energy Plan, so all investors know what resources are wanted, when they are wanted, and, if location is important, where they are wanted.
2. License or approve only projects that comply with the plan. Proposals should be ranked based on some combination of price, load shape, reliability, environmental performance, and other key attributes. The ranking should make it clear how improved environmental performance is measured. For example, if a gram of SO₂ per kWh is worth 2 fen, make it clear that a project that costs 50 fen/kWh and has no pollution will beat a project that costs 45 fen/kWh and emits 3 grams of SO₂ per kWh.

SERC Should Fully Integrate The Principles Of Scientific Energy Planning Into The Design Of Power Sector Reform And The Markets That Are Being Created.

Scientific Energy Planning is essential to identify the resources China needs to meet energy demand in a least-cost way. Once preferred resources are identified,

generation markets can be used to acquire those resources in an efficient manner.⁹ But, to make markets work for China rather than against it, SERC will have to design the markets to be consistent with the principles of Scientific Energy Planning.

There are many changes to market design that will be needed. The most important are:

1. The incorporation of environmental costs into market design. The very first step in this direction is to assure the necessary data are available to be used in the dispatch of power plants. This means generation data on emissions need to be collected and dispatch software needs to be able to use these data. The next step is to adopt practical options to incorporate environmental costs in markets now without major effects on electricity price. A promising option is included in Appendix A.
2. The modification of markets to enable energy efficiency to participate. Studies in Jiangsu demonstrate that more than 50 cost-effective 300 MW EPPs could be built. The environmental and cost savings would be enormous, yet, as things currently stand, there are no means of capturing those savings.
3. The differentiation among types of generation for the purposes of setting capacity obligations or reserve requirements. Markets are much better at efficiently acquiring and operating resources than they are at determining the kinds of resources needed.

NDRC, SERC, and SEPA should undertake a joint Scientific Energy Planning Pilot.

As explained in Appendix A, energy and environmental issues are inextricably linked. Energy agencies need to learn more about how their decisions affect the environment, and environmental regulators need to learn more about how their decisions relate to reformed power markets.

China has a successful track record in learning from pilot programs. These three energy and environmental agencies should join in a regional pilot where close

⁹ Generation markets are best at using, or dispatching, existing resources in an efficient manner. They are weakest at producing prices that assure the right amount and mix of generation is created.

cooperation on energy planning, power market design and environmental regulation can be integrated to demonstrate the value of SEP.

Appendix A - Integrating Energy and Environmental Issues

Energy issues are environmental issues. The linkage is inescapable. Energy agencies, such as SERC and NDRC, make many decisions that may not seem to be environmental decisions but do have significant environmental effects. The only question is whether the agencies are aware of the environmental consequences of their choices. Unfortunately in most cases, decisions made without deliberate consideration of the environment will result in environmental harm.

Similarly, decisions made by China's environmental regulator, SEPA, without knowledge of the implications of power sector reform and other energy sector reforms means its policy judgments, choice of implementation and enforcement mechanisms, and forecasted environmental effects, will be based on faulty assumptions.

Institutional structure is one reason for the lack of policy integration. Energy agencies assume SEPA will deal with environmental issues, and SEPA assumes they have no purpose in being engaged in energy issues. Adding an environmental bureau at SERC and NDRC with the specific role of integrating environmental goals in agency decisions would lead to better decisions. Likewise SEPA should have a bureau that assesses reform efforts in energy and other sectors for their environmental consequences and participates in shaping the reform plans.

China's Power Sector Reform Needs Better Integration of Energy and Environmental Issues.

The power sector is China's largest stationary source of air pollution and it is growing very rapidly. The power sector is at the earliest stages of being restructured. A key aspect of the restructuring is that generation will be made a competitive business. The new markets will determine which power plants run and which do not. The new market will also determine what kinds of power plants are built.

The exact form of restructuring and rules of the new markets have not yet been established. International experience shows that the restructuring and market rule decisions will determine whether the environmental performance of the

power sector improves or degrades. There are many specific restructuring decisions that have environmental implications. **Failure to include environmental concerns in the restructuring process now 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. Companies will strongly resist more stringent emission requirements. It will be much easier and fairer to impose more stringent requirements before restructuring is complete.

How power sector reform is implemented will affect the environment. A few of the most immediate and important issues are described below.

- a. **Restructuring will affect dispatch order.**
One of the main goals of China's power sector reform is to improve power plant dispatch and inter-provincial trading. Competitive generation markets will clearly change how much each power plant is operated. But, without specific consideration of environmental issues, the result will be increased pollution. Plants with low operating costs will run more and plants with high operating costs will run less. In China, coal plants without flue gas desulphurization (FGD) will run more and plants with FGD will be run less. Natural gas-fueled plants have higher operating costs and as a result these plants will run less despite their lower emissions.
- b. **Restructuring will affect power plant investment.**
The rules to be established for the new market will determine what kinds of plants are built. Markets designed for coal plants will lead to prices that encourage coal plants to be built, even when other plants are lower cost and cleaner. The market rules will also determine whether demand-side options are allowed to compete.
- c. **Restructuring will affect power plant lifespan.**
International experience shows that restructuring may cause generators to extend the life of the oldest and most polluting plants. This is because older plants without FGD have low operating costs and fully recovered capital costs. Power plants that were expected to retire after 25 or 30 years may go on operating for 40 or more years.
- d. **Restructuring will affect investment in end-use energy efficiency.**
The cleanest and lowest cost way to meet customer energy needs is to reduce demand by investment in more efficient motors, appliances, and other energy consuming equipment. How restructuring is implemented will determine whether the market and regulation will provide incentives for investment in energy efficiency. Detailed studies in Jiangsu show more than 12 GW of energy efficiency savings available at costs well below 1/2 the cost of conventional supplies. Market rules are planned to allow grid companies to pass the cost of power purchases through to consumers. Yet there is no provision allowing the recovery of much lower cost energy efficiency purchases.
- e. **Decisions regarding market infrastructure (computer hardware and software) will determine if electricity markets will have the ability to track emissions and other attributes of power generation.**

China plans to allow direct retail access by power consumers. One of the promises of retail competition is that consumers will have the option of buying green, or clean, or renewable power. International experience shows this is possible, but tracking systems need to be incorporated in generation markets at the outset or the ability to use markets to improve the environment will be difficult or impossible. These same tracking systems can be used to improve environmental monitoring, enforcement, or taxation.

f. **Retail electricity price levels and structures can encourage or discourage energy efficiency.**

China has very large opportunities to improve end-use energy efficiency. Price levels and price structures can have a significant effect on consumers' decisions to invest in more efficient equipment and appliances.

g. **Incorporate environmental costs in market design**

Economists and policymakers agree that there is a need to incorporate environmental costs in energy decisions. The problem is to find practical options that are politically and publicly acceptable.

Adding full environmental costs to retail electricity or other energy prices is unlikely in the near-term. But, most of the benefits of reflecting environmental costs in prices can be achieved by targeting areas where large gains can be had at small cost. In the power sector, incorporating environmental costs at the generation level can have significant effects on dispatch and generation investment decisions without imposing significant burdens on end-users.

CRAES's "Environmentally Friendly Electricity Pricing" research provides a solid foundation for an integrated 2-part pollution levy system. The approach is as follows:

- Part 1 is the existing levy. Part 2 is the difference between the existing levy and the estimated full environmental cost. As part 1 increases part 2 decreases. The sum of parts 1 and 2 reflects the full environmental cost.
- Both parts 1 and 2 are assessed on generation. The effect of imposing full environmental costs on generation will be:
 - To raise the generation cost for polluting plants;
 - To dispatch cleaner plants more and polluting plants less, and
 - To encourage investment in new cleaner and more efficient plants.
- Funds from the part 1 levy will continue to be used as they are now. Funds from the part 2 levy can be used to lower the transmission and distribution portion of electricity prices or to lower electricity prices in other ways that do not undermine the effect on generation of the increased levy.
- This 2-part approach allows for the rapid implementation of environmental costs at the generation level (where it does a great

deal of good) and slower phased approach at the retail price level. The 2-part approach is also a good way to incorporate gas-fired plants in the market. China plans to add substantial amounts of new gas-fired power generation to address environmental issues and the desire for greater resource diversity. The question is, how to integrate these plants in generation markets in ways that achieve the desired result?

Chinese researchers have examined the question and their initial recommendation is to rely on options like Take-or-Pay contracts or setting higher on-grid prices for gas-fired power plants, with the government paying the above-market price. These options imply China is willing to pay a certain above-market cost for power from gas plants. By definition, this cost premium, or penalty, is considered reasonable considering the environmental and other benefits of gas power plants.¹⁰

Incorporating environmental costs in the market, such as through the 2-part pollution levy, is a much better option. The cost to China is lower than the cost premium options mentioned above, the environmental results will be better, and the integration with the market will provide better investment incentives for other clean energy options.

Power sector reform also means that SEPA's environmental rules should reflect the new market realities. For example:

- a. **Power sector reforms will affect power plant economics that should cause SEPA to modify its approach to power sector environmental regulation.** Environmental regulators generally refrain from imposing stringent environmental 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.

¹⁰ Given a competitive generation market, these recommended cost premium options will not yield the expected environmental benefits. With the competitive generation market, the most expensive plants will be forced off-line to make room for the gas plant output. The plants forced off are likely to be relatively clean plants with FGD.

- b. **Most cap and trade programs were developed before power sector reform and did not consider competitive generation markets.** The cap and trade program in the US was designed more than 20 years ago when the US had a vertically-integrated regulated power sector. The question of how to allocate the pollution allowances was not a serious issue. The same approach used in the US then is not well-suited to the unbundled competitive generation markets planned for China. A much better option for a restructured power sector is referred to as “load side allocation.” This approach would allocate allowances to China's grid companies instead of electricity generators. Grid companies will be buying power from competing generators. When the grid company chooses to buy from a heavy polluting generator they must use many allowances. When they buy from clean generators they use few if any allowances. This approach has very favorable features and in many cases fits the conditions in China.
- c. **Output-based generation performance standards (GPS) make sense with competitive generation markets.** China has accepted the fact that output-based emission regulation is superior to input-based options. Thus far however, GPS methods have been applied in just a few limited situations. Full adoption of GPS approaches to emission allocations and emission limits is well-suited to the power sector reforms planned in China.
- d. **Power sector reform provides opportunities to improve the collection and beneficial results of pollution fees.** In 2005, China expects to collect about 12 billion RMB for all air, water, solid waste, and noise pollution. Air pollution levies now account for about 50% of the total collections. Yet if the levy were effectively collected from just the emitters of SO₂, collections should be over 15 billion RMB (25 million tons x .63RMB/kg). (We do not know how much of the shortfall in collection relates to the power sector.) Power sector reform provides opportunities to integrate pollution fee collection as part of the market design. For example, levies could be collected from the grid companies based on the environmental characteristics of the power they buy. They are well-positioned to collect the fees from their suppliers, and it provides incentives for the grid company to buy from clean power sources.