Integrated Resource Planning in the Context of China's Electricity Situation[1]

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The resource choices made by vertically integrated utilities and by unconstrained markets have generally not protected the environmental and societal values woven into the electric sector or the broader energy sector. Decisions to build and to buy have emphasized the lowest price and have rarely been made in a context that compared the real costs of all technically feasible alternatives in a manner that included environmental impacts and the value of other societal goals. As the importance of wise electricity policy to the wellbeing of nations becomes increasingly clear, the principles of integrated resources planning (IRP) become uniquely important.

Under conventional processes by which electric utilities and governments decide what to build, proponents of each project and each technology praise its benefits in the language of societal benefit. It will have the lowest costs. It will clean the skies. It will free the nation from import dependence. It will diversify supply and reduce risk. It will achieve regional economic goals. But rarely do the developers of any one project show convincingly that their project achieves these goals in a manner superior to other combinations of alternatives. Only through integrated resource planning can a nation or a region choose the combination of investments that will achieve these benefits at the lowest total cost to customers and to the nation.

IRP supplements conventional power supply planning in three important ways. It considers demand-side options on equal terms and in direct competition with investments in expanding the power generation and delivery systems. It includes consideration of societal objectives such as environmental enhancement, national security or regional economic development. And it considers the risks and uncertainties associated with each potential decision. Done well, IRP provides decisionmakers with a ranking of the real value and of the real costs of different possible courses of action in a variety of possible scenarios some years into the future. The country can then chose the path whose value most exceeds its cost.

For a nation with the growth expectations of China, the difference between making energy policy choices wisely and making them in a haphazard fashion are immense. According to one estimate,[2] China will spend nearly $2 trillion on its electric power system between 2001 and 2030, which equates to annual expenditures of more than $60 billion per year (as compared to about $20 billion per year spent in the Chinese electric sector between 1996 and 2000). China's tenth Five Year Plan as amended contemplates adding 110GW in the three year period between

[1] This paper was prepared by the Regulatory Assistance Project for the China Sustainable Energy Program and for the China Development Forum in June 2005.
[2] "World Energy Investment Outlook", International Energy Agency 2003. See for example, "World Energy Investment Outlook: 2003 Insights" presentation of Huriyaki Kato, Beijing, October 2003. http://www.iea.org/textbase/work/2003/beijing/6WEIO.pdf.

2003 and 2005, which is consistent with expenditures of at least $40 billion per year. Current nuclear power goals include spending $30 billion to add some 30 GW of nuclear capacity in the next 15 years, or $2 billion per year on nuclear power alone.

These capital requirements are very significant. Total foreign investment in China in 2003 was slightly more than $50 billion, which was some 8% of total investment in that year. So the $2 trillion estimate for the electric sector between now and 2030 seems to contemplate that between five and ten percent of the total investment in China during that period will go into providing electric power. If the penalty for poor power supply planning is assumed to be a 10% increase in the investment required to provide electricity (a conservative assumption by the standards of the California crisis or the U.S. experience with nuclear power), then the savings in investment to China from planning wisely (and blending that planning with market principles where desirable) will be on the order of $200 billion by 2030, or $6 billion per year, or one percent of China's total capital requirements during that period. Of course, this does not include savings in operating costs.

Integrated resource planning can be a fundamental tool for achieving these savings.

This paper first discusses the circumstances that gave rise to IRP. It then considers current electric sector resource selection in China followed by consideration of some relevant IRP experience in other regions. It concludes with a discussion of some IRP principles particularly applicable to China.

Background

Integrated resource planning in the U.S. developed out of widespread public dissatisfaction with the power supply planning experience of the 1970s. That experience is worth attention because it has substantial elements in common with the circumstances faced by China today. The elements fueling public discontent in the U.S. included the following:

1) Belief that rapidly increasing demand for electricity continuing at historic rates would justify the construction of almost any available electricity resource.
2) Rapid and large electricity price increases resulting from the combination of increasing dependence on foreign oil (which itself increased tenfold in price during the 1970s), unexpectedly high costs of nuclear construction, and very high rates of inflation.[3]
3) Increasing dependence on imported fossil fuels at a time when world market conditions were creating a high degree of volatility (mostly upward) in fossil fuel prices;
4) Resort to nuclear power as an alternative to continuing fossil fuel dependence, including advocacy of a rapid increase rate of nuclear construction beyond anything in previous national experience;
5) Increasing environmental constraints on the construction of additional generation due to rising awareness of the health consequences of the air emissions from the existing plants as well as concerns about nuclear safety;

[3] In fact, the price of electricity doubled in some parts of the U.S between 1968 and 1980. It tripled in others.

6) Underestimation of the potential of energy efficiency and load management to offset the high costs of new construction, with a consequent tendency to overestimate the need for power plant construction;
7) Constraints on the availability of capital at reasonable costs;
8) The introduction of wholesale competition into electric systems, challenging the role and nature of planning itself, raising new questions about how best to reconcile public sector energy planning techniques with the role of competitive markets; and
9) Concerns that the public was not being effectively consulted before major resource commitment decisions were made.

Among these elements, only the second is not yet either occurring or planned in China. Of course, there are also important differences in the situations of the U.S. in the 1970s compared to China today:

1. China's high growth rates and present power shortages are real, whereas those in the U.S. were merely projected, and erroneously so in hindsight.
2. China has the benefit of thirty years of international experience and can avoid many of the mistakes made by countries whose energy systems developed sooner.
3. China's experience makes clear that economic growth need not be closely linked to a fixed quantity of energy per unit of gross national product, as was widely asserted in the U.S. during the 1970s.
4. Climate change is now an acknowledged reality, so reduction in carbon emissions is a likely goal of a sophisticated planning process.
5. Renewable and distributed generation technologies, as well as energy efficiency, have advanced greatly in the last three decades, so that pursuit of these goals can no longer be said to be a high risk approach to power supply planning.
6. The U.S. had considerably more natural gas than had been believed in the 1970s and was therefore able to draw on a domestic (and relatively clean) fuel source to extricate itself from the prospect of power supply shortages and environmental degradation when oil and nuclear power proved unable to play the role expected by the utility planners of the early 1970s.
7. China still has substantial potential to develop large hydroelectric projects; and
8. The viability of competition in wholesale power supply procurement – merely an academic theory in the 1970s – has now been conclusively demonstrated in many countries.

From the discontent with power procurement experience in the U.S. in the 1970s, two approaches emerged. The first depended on improving the regulatory process, deepening the regulator's involvement in power supply planning and procurement and assuring that demand side management was treated as a resource equal to new investment in utility infrastructure in meeting customer needs. This approach derived in part from the insight that customers needed energy services – heat, light, and the ability to accomplish work – rather than kilowatt-hours. It also rested on the realization that a lower total energy bill – for an individual, a factory or a nation – could be a more desirable result than a lower per kWh price, and could be attained through lower usage as well as through lower prices.

The second approach involved ending the treatment of electric generation as part of the "natural monopoly" framework that had characterized the U.S. electric industry throughout the 20th century. This approach treated generation as a potentially competitive business. At first, it relied on improved regulation to calculate the price to be paid to independent power producers, but the introduction of competition, notably competitive bidding, into power supply planning soon began to reduce the role of regulation. Some theorists, especially in California, concluded that competition and customer choice might ultimately displace the role of regulation altogether.

Integrated resource planning was a natural outgrowth of the first approach. Regulators realized that many of the problems of the 1970s were traceable to a procurement process that relied too heavily on the ability of a few people to predict the future under a system of rate-setting and taxation that rewarded new construction even when wise power purchases or energy efficiency would have led to lower bills for customers. In response, regulators sought to assure both that the planning process included all options and that it compared them equally as to their risks and likely impacts on electric rates and bills. As the IRP processes became more sophisticated, they often also encompassed achieving societal goals not directly reflected in the price of power, goals such as reducing environmental harms or enhancing economic development or diversifying sources of fuel.

To reflect the value of these goals, IRP processes had to give economic weight to considerations that were not directly reflected in the price of electricity or of the fuels that went into electric power generation. Such considerations included environmental impacts, fuel import dependency and regional economic development.[4] Methodologies have been developed to quantify some of these considerations, especially environmental impacts. Some of these methodologies achieved the quantification in monetary terms. Others involved scoring systems that gave nonmonetary weight to different types of impacts. Still other approaches used the avoidance of these impacts as constraints on the planning model.

Regardless of the method used, these "externalities" had to be recognized if IRP was to achieve the goal of lowering the societal costs of electric power production. Otherwise, these impacts were given an implicit value of zero, which was often more clearly incorrect than even the most imprecise values chosen through the planning process. Indeed, the incorporation of externalities in the IRP process is one of the factors that distinguishes IRP from conventional power supply planning.

Integrated Resource Planning and the Current Electricity Situation in China

Of course, China has vastly more experience with economic planning and with energy sector planning than does the United States. Indeed, the government ownership and state planning that have long characterized the Chinese electric system were anathema to leaders in the U.S. electric

[4] Of course, such considerations had often been part of power supply planning long before the development of IRP. However, they were rarely quantified in monetary terms. Thus, many decisions were issued in the 1970s justifying a nuclear power plant as a way to reduce dependence on imported oil, but these decisions never put a value on the reduction of that dependency and therefore could never conclude either that nuclear power was a cost-effective way to achieve it or that other goals might not have been equally important.

power industry for most of the 20th century. In the U.S. the planning initiatives have largely been with the utility industry, reviewed by the state governments. In China, the responsibility has always been primarily with the national government.

The pillar of energy planning in China is the five-year planning process. As China has moved toward a more market-based economy, the five-year plans (FYP) have evolved from prescriptive pronouncements on investments and projects to something more like targets and objectives. China is now well into its Tenth Five-year Plan, published in 2001.[5] Work on the Eleventh Five-year Plan has begun.

The five year plan is a pyramid of plans. At the top is The Five-year Plan for the National Economy and Social Development. Beneath it are many sector or industry plans of which energy is one. Below these are a series of special plans for each sector. In the energy sector for example there are separate plans for renewable energy and for energy conservation.

The National Development and Reform Commission (NDRC) is responsible for developing the overarching "Plan for the National Economy and Social Development." The final Five-year Plan for the National Economy and Social Development, approved by the National Peoples Congress, is a comprehensive integration of economic, social, and environmental considerations. The inputs to the plan use sophisticated modeling. The effort is remarkable in its scope and in the fact that it is repeated every five years.

In theory, the energy-related dimension of the Plan guides all power and other energy sector development. In practice, however, the Plan sets the tone and agenda for the five year period and has only indirect effect on many individual energy-related decisions.

The five year planning process has many positive attributes.

- The Plan gives the government the vehicle to evaluate and harmonize energy development, national security, the environment, and regional and provincial economic development.
- Energy planning is coordinated and integrated with China's social and economic development plans.
- The Plan benefits from sophisticated scenario modeling that examines a wide range of possible policy choices.
- The Plan sets forth many specific and positive objectives. If these objectives were derived from an IRP process, they would represent achievable and measurable milestones against which energy and environmental progress could be measured.

[5] See http://www.chinacp.com/eng/cppolicystrategy/10th_5_intro.htm

For a number of reasons, the Five Year Planning process does not presently achieve all that it might.

- Despite sophisticated modeling and scenario analysis, the outcome is a top-down plan driven by macroeconomic goals. Once overall economic growth goals are articulated, the energy sector planning focuses on meeting the broader national goals without meaningful evaluation of the various options within the energy sector for meeting those goals. The World Resources Institute has pointed out the importance of bottom-up modeling for energy planning, "In contrast to top-down models, in which the scope for technological substitution is extrapolated from past experience, bottom-up analyses estimate possibilities by considering explicitly the actual technologies that firms could profitably adopt at various energy price levels. Bottom-up analyses tend to be more optimistic about the scope for cost-effective energy savings".[6]

- Neither individual projects nor broader strategies ever undergo a least-cost analysis that considers all demand and supply side options, to say nothing of their societal costs and their life cycle costs.

- The plan is not updated to reflect rapidly changing conditions. The Tenth FYP, published in 2001, did not foresee the rapid electricity demand growth or the severe power shortages experienced in 2003.

- The Five-year Plan itself is a short pronouncement with no discussion or analysis of why particular options were chosen, how the information was analyzed, or how tradeoffs were made. As a result, it does not provide extensive guidance either when circumstances change or when the next plan must be prepared.

The Relationship Between Planning and Investment

Because China seeks the introduction of competition into its power supply markets, the role of planning in power supply decisions may become less clear. Projects may be initiated by independent power producers, some of whom are truly independent and some of whom are really state-owned successors to the generation assets of the former vertically integrated monopoly. Nuclear power projects and large hydro-electric projects are initiated within the government. All projects still require governmental approval to go forward. Neither the approval processes nor the process by which capital is allocated to particular projects is transparent, but it seems safe to say that Integrated Resource Planning principles do not figure deeply in these decisions.

Project proposals over 200MW are submitted to the NDRC for review and approval. NDRC performs this task reactively, responding to power projects placed before it. Power projects over 200MW also require approval from the Premier's office. The NDRC review and approval process is not directly linked to the Five-year Plan or to any other ongoing planning process.

Projects under 200MW are approved at the provincial level. Because smaller projects do not require NDRC approval and because provincial governments directly and indirectly invest in the

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[6] Robert Repetto and Austin Duncan, "The Cost of Climate Protection: A Guide for the Perplexed" (World Resources Institute, 1997),

projects, there are many small power projects that are also approved outside of any coherent planning regimen.

NDRC's Approval Process

The 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 almost every proposed project was quickly approved. Many projects began construction before approval was received. At times, the number and size of approved projects for a particular year is hard to ascertain.

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 are located in an area with serious water shortage problems, are unlikely to be approved.

Because the process is neither open nor transparent, political considerations can move projects up or down in the ranking.

Several aspects of the approval process are at odds with IRP:

- **Cost.** No apparent mechanism allows an alternative proposal to improve its ranking by offering a lower price.
- **Environment.** Limited environmental review means that alternative proposals cannot improve their ranking on the basis of environmental improvement.
- **Demand-Side Considerations.** Potential of DSM to meet needs in a less costly, less polluting, or quicker way than the proposed project is not analyzed.
- **Forecasting inputs.** Near-term demand forecasting and resource adequacy assessments are done but the accuracy of these efforts is questionable. Forecasting energy needs and planning least-cost solutions requires timely and reliable data. However, detailed end-use energy data such as the number and efficiency of new buildings, appliances, and factories is either not available or incomplete. The same is true on the supply-side. Data obtained

from different sources as to installed generating capacity in 2004 varied by 13 GW. Estimates of construction period and completion dates were also incomplete or inconsistent.

> The responsibility for resource adequacy in China is not clear. Planning and investment responsibility is now with NDRC. SERC, however, is responsible for the reliable operation of the power sector.

Integrated Resource Planning in the U.S. and Elsewhere

U.S. law has required all states to use integrated resource planning since 1992, and many have done so, at least for a time. However, electric restructuring has caused many changes in the way that IRP is practiced, and has resulted in its abandonment in some states. In other states, where customer choice and other aspects of restructuring have fundamentally changed the shape of the industry, many of the concepts of integrated resource planning are now covered under the term "portfolio management".[7]

Since the California crisis in 2000-2001, there has been a general recognition that restructured electric utilities will not protect societal values and that the state must assert these values at the point in the process at which resource acquisition decisions are being made. Several states have suspended their restructuring proceedings in part because of this concern. Others have taken an active role with regard to portfolio management.

Two regions of a size and diversity to be relevant to China are discussed below. Each has begun to reflect the environmental implications of new resource decisions in its selection process.

California

California responded to its energy crisis in part by enacting a law requiring utilities to "seek to exploit all practicable and cost effective conservation and improvements in the efficiency of energy use and distribution".[8] The California regulatory commission then ordered the utilities to submit plans to achieve this goal and set out also to devise ratemaking plans that provided clear incentives to do so. In addition, the state developed its own "Energy Action Plan" incorporating a priority for energy efficiency followed by renewable energy in meeting the state's future needs. Building on this plan, the utility commission has set quantifiable annual minimum efficiency and renewable energy goals for each investor-owned utility.[9] The commission adopted the targets

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[7] Portfolio management differs from IRP in that it assumes that the distribution function will be performed by an entity that is buying rather than building a large part of its power supply and is therefore managing a portfolio of different supply and demand options. However, the basic concepts are not different.
[8] Ca. Assembly Bill 57 (Ch. 85, Statutes of 2002. California Public Utilities Code §701.1(a) and (c).
[9] The efficiency goals will more than double the level of efficiency savings obtained over the next decade, compared to recent efforts. The renewable goals require that 20% of the electricity supply portfolio be from renewable sources by 2010.

based on reviewing the remaining energy efficiency potential in the state determined through energy efficiency potential studies. The regulators will update the targets every three years[10].

Every two years, each utility must submit a 10-year procurement plan detailing its demand forecasts and showing how it will meet that demand. The plans must show adequate, reliable supply including reserves of 15-17%, as well as compliance with California's goals for efficiency and renewables. Each plan must also show compliance with the Energy Action Plan's priorities, which guide all new energy procurement. The utilities must do more than meet the minimum efficiency and renewable goals. The priorities require that they show that all cost-effective energy efficiency, distributed generation, and renewable sources have been acquired before procurement of fossil fuel powered generation will be approved.

After public comment, the utility commission analyzes the plans. Risk is addressed at this point in the process by requiring the utilities to devise low, medium, and high resource scenarios, and by regulatory instructions that investor-owned utilities enter contracts of varying lengths and with staggered expiration dates. If a plan is found deficient, the utility will be required to modify and resubmit it.

Once the plans are approved, they guide each utility's procurement activities. Each utility files monthly risk assessments and issues requests for offers of power as needed in an open, transparent process. These requests are used when the utility anticipates needing fossil fuel sources and are designed to insure comparison between energy efficiency, renewable and fossil fuel energy sources in a competitive process. Recognizing that fossil fuels impose costs and risks on California customers, a greenhouse gas charge is added to the price of any fossil fuel-fired generation. This additional charge is not actually paid, but is used to more accurately compare total societal costs for decision-making purposes. The same approach was used by the New York regulatory commission between 1990 and 1995.

Quarterly reports to the California Public Utilities Commission document each procurement transaction. Cost recovery will be denied for any transaction not in compliance with the ten year plan. If circumstances warrant a departure from the plan, the utility must file a separate application with the regulators; all such applications must be approved before costs may be recovered.

The ten-year planning process began in 2004. On May 5, 2005, the utility commission reasserted its planning priorities in approving an additional $38 million in efficiency programs at one large utility's request, to meet an anticipated energy shortfall during the coming summer.

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[10] Pacific Gas & Electric (California's second largest power company) has a total portfolio budget for years 2006 – 2008 of $936 million. The energy savings that it must achieve for 2006 – 2008 are:

Energy Savings	**2006**	**2007**	**2008**
Total Annual Electric Savings (GWh/yr)	829	944	1,053
Total Cumulative Savings (GWh)	2,317	3,260	4,313
Total Peak Savings (MW)	503	708	936
Total Annual Natural Gas Savings (MMTh/yr)	12.6	14.9	17.4
Total Cumulative Natural Gas Savings (MMTh)	32.1	47.0	64.4

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The Pacific Northwest

The Pacific Northwest region of the United States has evolved a unique interplay between state-level and regional power planning and implementation. Integrated resource planning is done at the regional, state and utility level. Resource procurement decisions are made by various entities including the federal power supplier, investor-owned state-regulated utilities, local public utilities and independent power producers.

The four states of the Pacific Northwest (Idaho, Montana, Oregon and Washington) are united by the Columbia River basin and its system of hydroelectric dams. This power system is administered by the federal Bonneville Power Administration (BPA).

During the 1960s, the region's hydro resources could not meet forecasted demand. Without the benefit of a comprehensive planning process, the BPA as well as government and investor-owned utilities invested in new, non-hydro generating plants. A major nuclear power project undertaken in the 1970s proved too costly. Several plants were cancelled, though many of the costs are still being paid by customers. The resulting price increases depressed demand.

Congress enacted the 1980 Pacific Northwest Electric Power Planning and Conservation Act, which authorized the four states to form the Northwest Power and Conservation Council. The Council is required to develop a 20-year power plan, which must be reviewed for possible updating at least every five years, "to assure the region of an adequate, efficient, economical, and reliable power system, and to develop a fish and wildlife program to protect, mitigate and enhance fish and wildlife affected by the dams."[11]

The Council has produced five power plans. The most recent planning process included the BPA, municipally-owned utilities, investor-owned utilities, state governments, environmental organizations, large customers, consumer groups, and efficiency and renewable energy experts. The resulting Fifth Power Plan covers the years 2005-2024.[12]

All four states have required their regulated utilities to undertake IRP. The investor-owned utilities and most of the large municipal utilities engage in IRP in Idaho, Oregon and Washington, with planning horizons generally in the 20-year range. The largest utility in Montana has undergone restructuring, no longer owns generation assets and is no longer subject to IRP rules. However, legislation passed following major restructuring disappointments in 2003 requires utilities in Montana to undertake long-term electricity supply resource planning and procurement, looking ahead at least ten years.[13]

Over the past 25 years a certain amount of coherence has developed in the region's complex power planning processes. The Council is an interstate compact. By law it provides guidance to

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[11] http://www.nwcouncil.org/energy/powerplan/draftplan/(000)%20Executive%20Summary.pdf.
[12] http://www.nwcouncil.org/energy/powerplan/draftplan/default.htm.
[13] For details on state resource planning processes, see http://www.nwcouncil.org/energy/powersupply/adequacyforum/Default.htm.

the administrator of the BPA, but it cannot order the administrator to follow the Plan. Although the Council represents the four States, it cannot tell state regulators how to direct the regulated utilities. The municipally-owned utilities purchase much of their power from BPA under terms that may be guided by the Plan, but they are responsible ultimately to the municipalities or consumers they represent.

Nevertheless, the development of sophisticated analysis processes and the inclusiveness of the Council's planning process have given the Council's Plan some weight and legitimacy. PacifiCorp, a multi-state investor-owned utility, now develops comprehensive integrated resource plans for the states it serves, including three of the four Northwest states.[14] At the same time, utility and state regulatory staffs have become more skilled at long-term planning and have developed policies that are somewhat parallel with each other and with the Council. Demand side efforts are considered resources in all four states and by the BPA. The Council's estimates of achievable energy efficiency, which include consideration of the extent to which efficiency reduces exposure to the possible costs of future environmental regulation, are often used as benchmarks by utilities, states regulators, state energy offices and/or advocates.[15] The Council's estimates of renewable energy contributions are influenced by the goals the states set through their IRP processes.

The Council's recent Fifth Energy Plan proposes reliance on energy efficiency, demand response, cogeneration and wind power to meet load growth in the next five years, and proposes a schedule for considering and optioning various new energy sources after that (e.g. more wind and coal-gasification). During June, after consulting with BPA, regulators, utilities and others, technical committees will be formed to propose specific targets and a policy committee will propose ways to reach the targets (e.g. reaching 95% of commercial retrofit lighting efficiency through rebates and technical assistance).

Applicability of IRP Principles to China's Energy Situation

For all of the sophistication of China's comprehensive national planning process, integrated resource planning offers considerable potential to lower the nation's future energy bill and to harmonize energy sector goals with broader economic and environmental concerns. China's present power shortage and its historic oscillations between surplus and shortage suggest the need for a more flexible resource selection process.

As China moves cautiously toward opening its electric system to increased private participation and competition, it faces the temptation to repeat errors made in the U.S. and elsewhere, to trust to what a principal architect of California's restructuring called "the genius of the marketplace" to provide societal benefits that markets have never provided effectively. Indeed, failure to adopt IRP principles in a time of high growth in a system that is likely to blend government and private ownership for a substantial number of years raises the possibility of unfortunate surprises and considerable social harm.

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[14] See PacifiCorp's 2004 IRP at http://www.pacificorp.com/File/File47422.pdf

[15] A comparison of the Council's EE targets for 2005 with the top 15 utilities' plans show the utilities on track to acquire 88% of their prorated target, with IRP proceedings expected to increase the compliance.

In times of high growth, policymakers are always tempted to believe that they need every possible resource, that the worst mistake that they can make is to move too slowly to approve major power plant construction regardless of cost. And, of course, power plant construction is essential if China is to meet its growth targets.

Nevertheless, western experience shows case after case of great harm done by a rush toward supply-side solutions regardless of cost. As noted earlier, parts of the U.S. continue to pay large sums for nuclear plants that seemed urgently needed decades ago but that were later cancelled as unnecessary when demand declined in the face of higher prices and cheaper solutions. More recently, California signed too many long-term contracts at too high a price during its crisis and will be paying for them for several more years, even after renegotiations.

In today's China, IRP would be useful both for overall planning and to inform the specific resource approval decisions that government officials must make as often as three or four times per month. It would also provide guidance as to the importance of related decisions on building and appliance efficiency standards, decisions beyond the reach of those whose primary responsibility is in the power sector.

As China's power sector evolves toward a market basis, IRP remains an important tool for managing such concerns as environmental impacts, price stability and regional economic development. The IRP process as now used (often under the term "portfolio management") in California, the Pacific Northwest and other parts of the U.S. is helpful in revealing the real value of various options in circumstances in which bid prices alone do not capture significant differences in societal impact. Used effectively, it is also essential to various types of risk management and consumer protection from risks not always revealed by more traditional analysis.

If China actually does quadruple its 2000 economy by 2020, one of the largest economies on earth will produce three more economies of almost the same size within the same geographic area over a very short time. This presents an immense economic, environmental and national security challenge.

China's electric energy system cannot continue to grow according to current patterns without substantial risk of:

- Major increases in capital spending needs, straining the availability of capital for other purposes;
- Possibilities of substantial rate increases to reflect higher capital and fuel costs;
- Severe additional public health and environmental damage that will have very large economic consequences;
- Being unable to meet the emerging challenges and economic opportunities of limiting greenhouse gas pollution as global warming impacts become increasingly apparent; and

- Having limitations in the energy system become a constraint on economic growth, especially if advanced technology projects do not come on line sufficiently quickly.

This challenge is well understood in China. However, the opportunity to resolve it constructively will only be realized if the energy system options are carefully analyzed in an integrated fashion. Such work is already underway. It needs to be expanded into more fully integrated supply-demand scenario generation, expanding on the options and exploring the implications in terms of cost, emissions and imports for various alternative futures, employing various levels of advanced technologies, and exploring what these would require in terms of institutional and policy change.

Such an approach would require an understanding in quantitative terms of where China desires to be in 2020 in terms of such goals as 1) growth and composition of the economy, 2) energy costs, 3) regional development, 4) level of oil and gas imports, 5) expanding access to electricity, and 6) controlling air emissions. Modeling could then identify alternative options and paths to get there as well as the institutional and policy changes that best support these changes. The options that would be most compatible with future decisions to limit greenhouse gas and other pollutants at least cost could also be identified.

Work done by the Energy Research Institute of the NDRC and other modeling analyses[16] suggest that the desired economic growth can be attained with a much lower growth in energy consumption and at lower cost if an optimal strategy and mixture of policies are chosen. Additional end use efficiency should be explored, using advanced technologies. This will leave coal and renewables - and gas in some areas - as the major domestic energy resources. Credible modeling shows advanced technologies and aggressive energy efficiency allowing China to achieve significant developmental, security, and environmental benefits *at lower cost* than under any scenarios that delay efficiency and advanced technology implementation.

To quadruple its economy by 2020, China will need a much-increased level of energy services. The extent to which this translates into growth in primary energy demand depends on the level of energy efficiency that is built into society. The most important factor, however, is energy efficiency of new investments in such areas as buildings, appliances, transportation and industrial equipment. There is a window of opportunity to become much more energy efficient through maximum emphasis on that goal in building the new China. Already, remarkable results have been achieved in this direction; however, the technical and economic opportunities remain very large, and opportunities are being lost every day.

These findings strongly suggest a basic approach not only to efficiency but to import reduction through acceptable use of coal. With aggressive deployment of advanced technology and of energy efficiency, coal has the long-term potential to meet all China's need for clean fuels and environmental protection. However, not all technologies now labeled "clean coal" can achieve

[16] For example, Ni Weidou and Thomas B Johansson, *Energy for Sustainable Development in China,* Energy Policy, vol 32, 2004, 1225-1229, and Special Issues of Energy for Sustainable Development, available at www.ieiglobal.org:

a. *On coal gasification for China*, Vol. VII, No. 4, December 2003.
b. *On energy for sustainable development in China,* Vol. V, No. 4, December 2001.

this. Coal can be used (if the CO_2 pollution is sequestered) in ways that are compatible with sustainable development requirements, through, for example, oxygen-blown gasification to produce clean liquid and gaseous fuels as well as electricity and heat. Such facilities must be assured access to the grid for electricity sales and payments based on a market situation that either eliminates or charges for environmental and health impacts.[17] IRP is far more likely than conventional planning to reveal the need and the benefits of accelerated introduction of such technological advance.

Here are some additional energy strategy considerations concerning IRP in China:

1) The objectives and principles underlying an IRP plan must be articulated very clearly, as must conflicts among the constraints. For example, regional development, holding down China's total energy bill and protecting the environment will inevitably be goals of high importance. Nevertheless, a scenario in which a constraint against increasing China's total energy bill is more important than the other two may produce quite a different result than a scenario in which the highest priority is that the environmental burden must be stabilized or reduced. And this in turn would be quite different from a scenario in which the highest priority went to developing the West and extending service to all unserved areas. If a preferred future scenario is chosen, it should indicate the priority among the major constraints. Too many energy plans – including the current U.S. national plan – do not do this.

2) The challenge of integrating the work on different aspects of the Chinese energy system is immense. These aspects include energy efficiency in the building, transport, and industry end-use sectors, agriculture and forestry, power system design and operation as well as policies providing incentives for sustainable development in all sectors. Without such integration, any plan risks becoming a list of desirable items – of limited use in guiding government officials through the inevitable conflicts and competing resource claims that will arise.

3) With regard to electric sector IRP, the roles of NDRC, SERC and the new state energy office attached to NDRC will need to be defined at the national level and integrated with provincial IRP initiatives. As the U.S, experience in the Pacific Northwest shows, IRP at a regional or national level can be used to provide guidance for local IRP processes even when there is no close legal nexus between the two layers of government. The important principle is that IRP be used to part of all major planning initiatives and that decisions to buy or build new plants be part of an IRP process.

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[17] The health and environmental impacts of burning coal in the Chinese electric sector are apparently very large, estimated at up to 7% of total GDP at present and likely to increase in the short term. Another study estimates the health impacts of coal burning at as much as 1.5 cents/kWh, see "Air Pollution in China: Health Damages and Policy Options", report by the Harvard Center for the Environment, China Project and the Tsinghua University Institute for Environmental Science and Engineering, 2003. The external costs for air pollution from coal-fired power stations in Europe have been estimated by the European Commission to be on the same order of magnitude as the private cost for power generation, which is € 0.04-0.05 per kWh, a subsidy of 50 percent of the total cost. External costs from carbon dioxide emissions may be much larger, however. See the EU project ExternE website, http://externe.jrc.es/.

U.S. experience suggests that IRP is most effective when linked to tariff-setting, so that the incentives woven into the tariffs are fully consistent with the IRP conclusions. As long as both licensing and tariff-setting remain at NDRC, it seems desirable that the IRP process be developed under the leadership of the new State Energy Office, which is also to be affiliated with NDRC. Adjustments can, of course, be made as responsibilities shift in the future.

4) China's extraordinary growth rate compels the inclusion of scenarios based on the employment of best available technologies and standards at least by 2010. In a country that is doubling its economy every decade, the use of such technologies and standards in all fields – conventional supply, renewables and energy efficiency – can make a much greater difference than would be the case in societies growing more slowly. The retrofitting and reconfiguration of existing facilities that will occur in industrialized countries will be of relatively little significance in China, which has more to gain from implementing the best proven technologies quickly. Of course, China also has much to lose with each year that goes by, because the added stock of buildings and equipment will exist for decades. Every year's failure to use ambitious energy efficiency building standards (both for installations and equipment and for the building shell) represents a commitment to build more power plants and to consume more fuel.

5) Once the scenarios are developed, the policies necessary to create the desired outcomes must be clearly stated from the beginning of their implementation, and they must be adhered to and consistently enforced as long as they remain productive. Companies, investors and customers must be able to count on policy continuity and fair treatment for purposes of their own planning and investment decisions. When policies are set in this way, they will have great effect, but if they are frequently changed or abandoned, investment will be discouraged and results will be disappointing.

6) Whatever policies are chosen, substantial interests will quickly grow up around them and develop considerable governmental influence in ways that will make future change difficult. Such stagnation – especially if it is reinforced by corruption – has been one of the greatest obstacles to sustainable development all over the world. This is another reason for the urgency of wise and vigorous energy policymaking in China at this vital time.

7) A policy favoring full-scale, simultaneous pursuit of all options is likely to be expensive and self-defeating. Once plants and transmission lines are built, they must be used fully to pay for themselves. Efficiency options that might have been cheaper at the outset will not look as desirable if they are conserving away the consumption necessary to pay for a completed program of massive investments. If aggressive efficiency commitments are designed in from the outset, this problem is less likely to arise.

8) China's institutional and policy changes will take place in an environment that is moving towards increased market orientation and full enforcement of World Trade Organization obligations. The market mechanisms that China is embracing will continue to be a powerful source of enhanced productivity throughout its energy sector. However, market mechanisms will *always* drive prices toward marginal costs and will favor the producers with the lowest marginal costs. These marginal costs will not include environmental, social, reliability or national security impacts unless China takes steps to assure that they do so. This can be done

by regulations that require elimination or mitigation of these impacts. It can sometimes be done by cap-and-trade mechanisms that enlist the market on the side of abatement. It can also be done by tax policies that impose a charge on the undesirable impacts or that reward the output of more desirable technologies. The important point is that if it is not done, powerful market forces – far from improving the adverse social impacts of energy consumption – will in many respects make them worse, as competing companies seek to lower costs in every way possible.

IRP can inform these steps in crucial ways. Indeed, as China introduces more competitive power market characteristics, IRP can play a crucial role in evaluating the risks and benefits of various types of contractual arrangements that distribution utilities may enter into. If the planning process sets forth clear objectives to be pursued by contracting distribution companies, there are many different types of contracts available to attain these objectives. But without a government requirement that such contracting be done pursuant to an IRP process, the criteria likely to dominate the selection process are no more likely to be socially beneficial than a conventional power plant procurement process.

9) The same point made in #7 with regard to energy market forces is also true for tariffs that continue to be set by government. All regulatory tariff-setting methodologies contain incentives. Wise regulation seeks to understand these incentives and to shape them to support national policies. The financial incentives that are built into the tariffs will determine the behavior of the regulated entities and their customers at least as powerfully as regulatory mandates. Even if energy firms are assumed to comply fully with regulatory mandates, their environmental and social performance will be much stronger if their financial interests are consistent with such conduct. If the tariffs only reward increasing sales and cutting costs, then utilities will be converted into powerful opponents of public benefits, energy efficiency and environmental improvement. Even reliability investment may suffer.

   In choosing pricing rules, China might benefit from the principle that companies whose performance is most beneficial to China and to their customers should be the ones that make the highest profits. Such a principle rewards efficient and clean performance more than it will reward efforts to pass on increasing costs, to engage in accounting gimmicks, or to skimp on environmental performance. The U.S. National Association of Regulatory Utility Commissioners endorsed a similar principle some 15 years ago, and it remains fundamental to the California IRP process today.

   IRP is thus an important component of a wise tariff-setting process, because the incentives built into the tariffs will be the primary determinant of future utility conduct. Incentives can be given to reward utilities that plan effectively (and that penalize those that do not). Further incentives can assure that the course shown by IRP to be preferable are the ones actually followed.

10) In analyzing what can be expected from each energy source, it is important to include an estimate of the uncertainties involved. If two different electricity sources are each expected to cost $1000/kW but the possibility of a 100% cost overrun or a large fuel price increase or major new environmental requirements is 5% for one source and 50% for the other, they do not really have the same value. U.S. and British utilities wasted a lot of money by

overlooking this principle in the 1970s and 1980s. In general, when uncertainties are taken into account, investment in energy efficiency looks more favorable because it does not take long to "build", and once in place its performance is quite predictable. Efficiency is followed by renewables (which have little or no fuel risk) and proven fossil technologies. Nuclear power has tended to rank lower when uncertainties are taken into account.

The history of energy policy is characterized by unrealized opportunities - opportunities that were well understood at the time but that seemed less urgent than other national priorities or political considerations. China too has such opportunities, but it also has such competing considerations. Given the importance of reliable and clean energy to China's continuing growth and wellbeing, the nation does not have large margins for error. Fortunately, it does have lessons of experience from many nations to draw upon.

Combining the lessons with the unique Chinese power supply situation and structure will not be easy, but some fundamental principles seem clear:

1) Top level government support will be necessary on an ongoing basis.
2) The national IRP process will have to be housed at the center of the national government's electricity policy setting apparatus;
3) Coordination among the agencies involved in the power sector must assure that they each participate cooperatively in the IRP process;
4) The IRP process is critically dependent on the gathering of high quality and the use of end use forecasting as well as the more traditional econometric forecasts;
5) The national objectives to be reflected in the IRP must be clearly articulated and carefully prioritized;
6) National objectives such as air emission reduction should be given specific value in he planning process to assure that they receive priority in the final plan;
7) Compliance with the IRP process should be a condition of approval for future substantial investments in generation and transmission;
8) Tariff setting should assure recovery of the costs of all projects built in conformity with IRP and should provide incentives (and penalties) to further the process;
9) China's experience with using pilot projects to test concepts can be of value in getting a regional or a provincial IRP process underway in order to demonstrate the feasibility and the benefits;

If these steps are taken, China's electricity future will be less expensive and more environmentally benign than will be case if the nation does not systematically reconcile the important goals that are in play and in conflict as it confronts the challenges of its current situation.

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