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US-China Collaboration

Signs of Hope for the New Century: US-China Cooperation on Environment and Energy

Changhua Wu[1]

If you only follow the mainstream media on Sino-US relations here in the US, your heart might be aching now. The historic visit by Chinese Premier Zhu Rongji to the US has been painted gray. The deal of China's entry to the World Trade Organization disappeared at Zhu's fingertips. Issues of espionage on nuclear technology, human rights, Chinese contributions to US Congressional campaigns, and Taiwan have clouded the political scene. "Worrisome" appears a rather weak word to depict the relationships between the world's two powerhouses. On the other hand, a huge Chinese delegation met with their US counterparts to discuss cooperation on environment, energy, and sustainability issues. The US-China Forum on Environment and Sustainable Development, co-chaired by VP Gore and Premier Zhu, was barely noticed given the other contentious issues. Aching or not, your heart shall be enlightened a little bit when it comes to the bilateral cooperation on those crucial issues.

Ten cooperative agreements were signed at the Forum. They cover issues from air quality monitoring, SO_2 trading, natural gas policy, air pollution and public health, energy efficiency in buildings, air quality and children's lung functions, coal-bed methane, and energy efficiency and conservation. Though limited in scale and funding, those agreements have sent a positive signal that there are at least some channels still open for the two to work with each other.

The groundwork for such progress shall mostly be attributed to USEPA Administrator Carol Browner. Her visit to China in March has been regarded as historic – as the first USEPA Administrator to visit China in more than a decade. The trip was made right before Premier Zhu's visit to the US. Partly as a messenger for VP Al Gore, Administrator Browner brought with her a letter from the Vice President to the Premier and nearly a dozen projects to negotiate with the Chinese side.

Besides the historic significance, the trip was also successful in the following aspects: Administrator Browner has carried a message that the US is willing to and could work with China on such crucial issues as environment, energy, and sustainability. This cooperation could be based on better mutual understanding and conducted in ways of research, capacity building, and technology transfer.

The US lagged far behind Japan and some European countries in supporting China's environmental protection. Japan is now the largest donor to China, followed by several EU countries. Though still limited in funding, this trip has been seen as a positive signal that a much more and better bilateral cooperation on environment and energy between the two is possible into the new century.

China's SEPA and SDPC responded positively to the projects initiated by Administrator Browner. Her trip also opened eyes. By visiting Beijing, Xi'an, Suzhou and Shanghai, Browner and her colleagues have gained a deeper understanding of the increasing commitments to environmental protection from the China side and the tough environmental and economic challenges China faces today.

China has established a comprehensive environmental legislative system, with hundreds of laws, regulations and standards in place. Environmental protection has been adopted as one of two basic national policies. Environmental spending last year in China exceeded one percent of the country's GNP, the most in Chinese history.

Sharing her experience and lessons in the US has been very educational to her Chinese counterparts. She tried to drive home the point that it is crucial to have at least three legs – government, business and NGOs – in order to achieve the environmental goals.

The composition of the US delegation is also illustrated this way. In addition to EPA delegates, WRI and NRDC staff represented NGOs while the Clean Energy Group, the US-China Business Council, and the Metal Finishing Association represented private businesses on the delegation.

When touting the success, I have to admit that the two countries still need a better dialogue. Inadequate understanding has been and will continue to be a barrier for the two to overcome. This has been illustrated clearly in bilateral talk on climate change-issues. Political sensitivity in international arenas is hard to ignore at this

[1] Changhua Wu traveled with the US delegation to China. The opinions here are her own and do not represent the World Resources Institute.

stage, but a better understanding of each other and a sincere attitude of cooperation would help tremendously.

The doors are definitely not closed, even to such sensitive issues as CDM. Better understanding, sincerity and fairness shall and will paint a brighter future for the world' two largest powerhouses to work with each other into the new century. Let's keep hoping and also join hands to work towards that future.

Opportunities for Partnerships between the United States and China in Energy Efficiency Research, Development, Demonstration and Deployment[2]

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Director of Environmental Energy Technologies Division of Lawrence Berkeley National Laboratory

Abstract

Because of its dynamic economy and huge population, China will experience the greatest growth in energy demand of any nation in the world. As such, China represents the largest future source of energy-related pollution, including CO_2 emissions. At the same time, China is the leading developing country in its efforts to reduce energy growth. Since 1980, energy demand in China has grown only half as fast as GDP. Had energy and GDP in China grown at the same rates, at today's GDP China would produce CO_2 emissions at twice the current level and account for about one quarter of world emissions instead of the 13% it actually contributes.

This paper describes the research, development, demonstration, and deployment (RD3) China has undertaken to promote energy efficiency, since the major reforms in energy carried out early in Deng Xiaoping's regime. Most of the attention is given to deployment, in terms of policies and programs that China has carried out, because much of the effort has focused in this area. However, China has also had important RD&D activities as well, and these are described. Some of the major uncertainties facing the future of energy efficiency in China include

- the continuation and reformulation of energy efficiency RD3 under a new national energy conservation law;
- the maintenance of government investment in energy efficiency demonstrations in the face of sweeping reforms of the banking system;
- the inadequacy of existing regulations and standards for co-generation systems; and
- the design and application of new deployment approaches to energy efficiency technology (market transformation programs) consistent with market reforms.

The paper recommends that a U.S. government program be initiated at a level of at least $10M per year to further the energy efficiency RD3 collaboration between China and the United States.[3] The U.S. Department of Energy (DOE) should lead the program. Its design and execution should rely on the active efforts of the Sino-U.S. Working Group on Energy Efficiency and its ten teams created jointly by the government of China and the U.S. DOE. Such a program has the potential to produce benefits to the United States, to China, and to the global environment that are vastly greater than its costs.

Introduction

Key Issues

For almost two decades, China has put enormous efforts into controlling energy growth, with significant success. Since 1980, energy demand has grown at half the rate of economic growth. This is an extraordinary achievement for a developing country. In the rest of the developing world most countries have seen energy demand grow faster than GDP (Levine, et. al. 1992).

In coming years and decades, the largest growth in energy consumption – and associated local and global environmental emissions – will come from the developing

[2] Editor's note: This article was taken from an unfinished draft the author had prepared for the President's Council of Advisors on Science and Technology (PCAST). We reprint it here with his permission but apologize for not having the associated references.

[3] This is a component of $60M per year program for environmental energy technology RD3 with developing countries recommended in a companion paper by Fulkerson, Levine, Schock, and Wilbanks.

world. As described in the companion paper to this one (Fulkerson, et. al., 1999), the largest portion of the growth in global energy demand is in the developing world (EIA, 1998; Nakicenovic et. al. 1998; IPCC 1996; WEC 1992). Energy demand in the developing world has grown from less than 22% of that in industrialized countries in 1971 to more 55% in 1995 (Price et. al. 1999). It will likely overtake energy demand in the industrialized world by 2020.

In spite of the significant emphasis on energy efficiency, China will nonetheless account for a greater energy demand growth than any other country in the world by virtue of its size and the dynamism of its economy. Under "business as usual" forecasts, China will grow from 13% of world CO_2 emissions today to 25% over the next two to three decades (IPCC 1996; Nakicenovic et. al. 1998; Fridley et. al., 1998).

Just as there are considerable benefits to collaborations between the United States and developing countries on energy research, development, demonstration, and deployment of better energy technology (Fulkerson, et. al. 1998), so are there benefits to an expanded United States-China collaboration on energy efficiency RD3. The Chinese are well aware that their continued efforts in energy efficiency depend on advanced energy efficiency technology. Close and much enhanced collaboration between the United States and China will enable China to continue and expand its energy efficiency activities. The result will benefit China, in reductions in energy costs and environmental costs. It will benefit the United States in energy product trade and reduction of global carbon emissions. It will demonstrate to the rest of the developing world the opportunities for energy efficiency to substantially reduce local and global pollution while producing economic benefits. In short, a meaningful program between China and the United States on energy efficiency technology RD3 could be an important step in creating a global sustainable energy system.

Scope of Paper

This paper addresses energy efficiency RD3 for China. It describes the experiences of energy efficiency in China. Similar papers on renewable energy, cleaner coal technology, coal-bed methane recovery, and other energy technologies and resources could be written that would make a compelling case for collaboration with China in these areas. As proposed in the companion paper by Fulkerson, et. al., broad-based collaborative programs with key developing countries addressing the range of environmental energy technologies are needed. This paper will demonstrate that collaboration on energy efficiency between China and the United States would be a very important part of such a broader program.

Energy efficiency deserves attention because of its large near-term impacts, the high interest of China's policy community, China's past successes and its existing infrastructure for delivering energy efficiency services, and its current need to assure the continuation of energy efficiency under in an economic system that is changing rapidly.

Rationale for U.S./China Partnership

Fulkerson, et. al., provide a rational for U.S. government partnerships on environmental energy technology RD3 with developing countries. They note that

- current global energy demands, largely driven by energy growth in the developing world, will lead to severe environmental problems if conventional technologies are used;
- the choices by developing countries will determine whether or not CO_2 levels in the atmosphere can be stabilized at any reasonable level;
- there is a high potential for the introduction of advanced technologies if they can be made and demonstrated to be economic and effective;
- collaborative RD3 is can play an important role in creating a sustainable energy future by hastening deployment of much improved energy technologies.

As a result of these considerations, Fulkerson, et. al., recommend the initiation of a "program of RD3 partnerships between the United States and developing countries . . .,(b)eginning at a modest level with several key countries. . ."

China deserves special consideration. No country plays a more important role in climate change. A strengthening of China's commitment to reducing the growth of energy-related CO_2 emissions is critical because of the magnitude of its emissions and as an example for the developing world.

At the same time, China's market for energy technology – both supply and efficiency – is the largest in the world. The possibilities for expanding business opportunities in energy efficiency – e.g., joint ventures or other business relations in the manufacture of energy-efficient refrigerators, efficient amorphous core transformers, controls for energy-using equipment, efficient lighting systems, insulation, advanced motor systems, advanced

turbine generators – is enormous. In these technologies and many others, United States manufacturers maintain strong capabilities and/or competitive advantages over companies in other countries. R&D, demonstration, and deployment programs in collaboration with Chinese counterparts can lead to very desirable business outcomes for both parties.

Energy Efficiency RD3 in China: Historical Perspective

The Early Years: 1949-1980

In 1949, when the Communists gained control of China almost all energy came from non-commercial sources (dung, agricultural waste, forest waste, etc.) Energy use per capita – in which only commercial energy forms are included – has increased by a factor of 40 since 1949 in China. That is to say, essentially the entire energy system of China has been created since 1949.

Unfortunately, the energy system created by the Chinese regime, while very beneficial in bringing modern forms of energy – first coal and later oil – to industry and the population, emulated the Soviet system in its structure and performance. Energy, as a necessity of economic well being, was highly subsidized. No attention was paid to the environment. As a result, the Chinese system produced, converted, and used energy in exceptionally inefficient ways. During the thirty years between 1949 and 1979, energy demand grew on average more rapidly than the economy.

Deng Xiaoping's Energy Reforms and Their Aftermath: 1981-early 1990s

In 1980, Deng Xiaoping proclaimed that China's economy would quadruple over the next twenty years. A group of astute Chinese energy researchers recognized that China could little sustain a growth in energy demand over twenty years by a factor four. This would mean an increase in raw coal production from 450 million tonnes to almost 2 billion tonnes, more than 50% greater than any country in the world today! Such growth in energy demand would have required a capital investment far beyond China's means. Such an investment level would have required either by selling major Chinese assets (e.g., power plants, transmission lines, industrial facilities) to the West or taking investment from other economic sectors, thus making a fourfold increase in the economy impossible.

As these options were not acceptable to Deng, the Chinese chose a new approach – the aggressive pursuit of energy efficiency – an approach never previously pursued by a developing country. The program was designed very quickly, and described in detail in the sixth five-year plan in 1981. It included:

- creating a national fund to invest in energy efficiency (initially 10 to 12% of total energy investment);
- creating a comprehensive energy consumption monitoring system for all large industrial facilities;
- establishing regulations to promote or require reductions in energy consumption (through quotas on industry and requirements for discarding antiquated and purchasing more efficient equipment);
- creating and supporting a capability within the country of performing applied energy efficiency research, development, and demonstration; and
- establishing organizations within the State Planning Commission – the Bureau of Comprehensive Resource Utilization and the forerunner to the China Energy Conservation Investment Corporation – with responsibility for overseeing and promoting energy efficiency policy and programs.

All of these activities were pursued with great enthusiasm. The investment program was set up and operating effectively within one year. It was largely operational by the second year of operation (1982). Virtually all of the investments produced energy savings at a cost considerably lower than the (subsidized) cost of energy (Levine, et. al. 1990).

The result of this activity was quickly felt. China was able to clearly demonstrate an ability to reduce energy growth through policies and investment that encouraged the deployment of energy efficiency technologies and practices broadly throughout urban China: energy demand growth from 1981 to 1986 (the period of the sixth five-year plan) fell to half that of economic growth! The program was clearly successful.

Additional features were created and implemented to assure continued efforts in energy efficiency from program inception through the middle 1990s (Sinton, et. al. 1998). These included:

- promotion of co-generation for electricity and heat (1981, 1989);

- additional regulations to promote energy efficiency (e.g., favorable treatment of energy-efficient enterprises (1985); energy intensity standards for industrial boilers and kilns and penalties for use of obsolete equipment [1982; 1987, 1989]);

- establishing energy conservation service centers in major urban areas throughout the country to provide engineering, policy development, and training expertise in energy efficiency at the provincial and local level (1986);

- allowing firms to retain financial benefits of energy savings from internal energy efficiency investments (1985); granting conservation awards of 8 to 15% of the value of conserved energy for coal and electricity (1986);

- promoting use of briquettes for coal-burning in urban areas (1987);

- providing lower interest rates and extended payment periods for energy conservation loans (1985, 1986);

- supporting research, development, and demonstration programs in energy conservation techniques and technologies (1986). Major demonstration projects over subsequent years include efficient motors and adjustable speed drives for fans and pumps, efficient heat exchangers, efficient lighting systems, improved insulation for kilns, precision metal casting; heat pumps, coal briquetting, and efficient gas turbines (Wang, 1999)

In short, throughout the 1980s and 1990s the Chinese established a comprehensive system of RD3 in energy efficiency, with particular emphasis on deployment. The program was – and remains – highly successful. Energy demand growth was cut to half that of economic growth through the 1980s and 1990s, with energy growth reduced to even lower levels in the late 1990s. Figure 1 shows the dramatic increase in energy demand (and CO_2 emissions that would have taken place in China without the program.

The Future of Energy Efficiency in China

China is at an important moment in the evolution of its energy conservation programs and policy. Key reforms – both those promoting a much stronger market economy and the recent reforms limiting governmental authority – will affect energy efficiency. Some factors will encourage energy efficiency: especially higher energy prices, continued commitment of the government at high levels to energy efficiency, and the expected increase in attention to environmental concerns (of which energy production and use are by far the largest contributors). Some factors will discourage energy efficiency in the future: the primacy of economic growth in much economic planning; the unrestricted/uncontrolled growth of township and village enterprises; the decline of some of the traditional governmental institutions for reducing energy growth (e.g., quota systems, energy conservation service centers). The greatest danger may be the perception that institutions for energy efficiency may not be important in a market system. This perception has diminished somewhat, in part because of the frequent contact with U.S. energy efficiency researchers, who have often emphasized that markets alone will not ensure cost-effective levels of energy efficiency, and that energy efficiency RD3 and associated policies, programs, and institutions are essential.

But mostly the future of energy efficiency in China depends on many factors that cannot be known very well at present. These include:

- the design and implementation of the energy conservation law (passed after a decade of effort in November, 1997;

- the seriousness of the commitment to increasing attention to environmental issues in the development of the energy system;

- the fate of the large and effective energy conservation loan program in China, which may be sacrificed or cut back as part of much larger reforms of the banking system;

- new regulations to assure the continued large-scale use of co-generation for electricity supply; and

- the commitment of a government that has diminished resources to support of energy efficiency research, development and demonstration programs as they have in the past.

Recognition of these uncertainties helps define ways in which collaborative programs have the potential to provide impetus to energy efficiency in China.

Key Opportunities for Influencing the Future of Energy Efficiency in China

The Energy Conservation Law

First and foremost is the opportunity to influence the design and implementation of the Energy Conservation

Law. This law, and its various means of being applied, will have a profound impact on the way that the institutions for energy efficiency RD3 evolve in China over the next years and decades.[4]

The Law will provide the SDPC and the SETC[5] the opportunity to revamp the entire government energy-efficiency apparatus. The many-year delay in getting it out of the Peoples' Congress was a result of a basic disagreement between different parties on the degree of specificity about the new energy conservation organization and associated regulations. The winning side was the group that favored a general law, with the specifics to be ironed out in two ways: through decisions of the federal government and by experience in pilot programs at the provincial level.

The law expands activities in several areas: key energy-using industries are required to maintain an energy management staff and an energy-monitoring capability; data-gathering on energy use is to be resumed; labels for energy-using products will be required; standard-setting for energy-using products and building energy standards are to be strengthened; rules to encourage co-generation will be promulgated. In addition, the law gives the government authority for creating new mechanisms to finance and tax energy efficiency (The Law on Energy Conservation of the Peoples Republic of China, Presidential Mandate No. 19, November 1, 1997).

Thus, the law provides a strong foundation for the maintenance and strengthening of energy efficiency in China. Its success, however, is far from assured. It depends on the ways in which the implementing regulations are designed and carried out, as well as the response of the emerging private sector parties to the regulations.

[4] Based on previous experience, it is likely to be a decade or longer before another energy conservation law is passed by the Peoples Congress. Because of the general nature of the existing law – which serves primarily as a framework and legitimization for government energy efficiency policy and programs – it may be longer before a new law is needed.

[5] The State Development Planning Commission (SDPC) and the State Economic and Trade Commission (SETC) are the two super-agencies in the Chinese government in terms of authority over planning, policy, program development and implementation, and budgets. The fact that both agencies have retained energy efficiency in their portfolios in the aftermath of the recent governmental reorganization indicates that the area continues to be of importance.

The Buildings Sector

The residential building sector will be privatized over the coming years. Because owners of private houses will for the first time have to pay their energy bills, they will have an incentive to invest in energy efficiency. At the same time, the government, through the Ministry of Construction, is now also willing to pursue more actively efforts to assist homeowners in energy efficiency. These include a variety of RD3 programs affecting the heating, lighting, and thermal integrity of buildings (see later discussion).

Construction of commercial buildings in China has been at the highest volume the world has ever known.[6] Construction activity will probably slow down for a few years, but may well begin anew. Few of the new buildings are well constructed and virtually none of them are energy-efficient. As the Chinese survey the fruits of their vast building activity, there is increasing recognition that systems must be created to improve the quality and the energy efficiency of these commercial buildings. Unfortunately, there is not an existing institutional structure (like the MOC for residential buildings) that can lead the effort nationally. Municipal government in key cities (e.g., Shanghai) can, however, play very important roles.

There are policies and programs to support energy efficiency RD3. Many of them lend themselves well to collaborations. These include:

Energy standards for residential buildings

China has existing standards in the heating zone (north) of the country. At present, they are implemented only in three cities. The standards are weak. Even more problematic, they are based on the building design and do not involve controls of heating equipment. The government has made a commitment to greatly strengthen the standards, both in stringency and in effectiveness of implementation. China is also interested in developing residential standards for the transition zone (middle region) of the country, in which both heating and cooling occurs.

Heat metering and tariffs for heating in residential buildings

Technology is essential to permit individual apartment-dwellers to control indoor temperatures. This, combined

[6] 25% of the world's cement is manufactured and consumed in China, in support of the vast construction enterprises.

with metering and billing of apartments, will provide substantial energy savings.

R, D, and D

The areas of R, D, &D in building energy efficiency currently pursued in China include: multiple glazings and window coatings; weather-stripping for doors and windows; heating meters and temperature control systems (see above); solar design; external insulation for walls; building materials; and computer simulation (Ministry of Construction 1997). Information to support these programs, including exchanges with U.S. researchers, would strengthen the projects.

Institutional development

Unlike industry, the building area has seen only limited commitments to energy efficiency in China.[7] This appears to be changing somewhat, as evidenced by (1) the inclusion of building energy standards in the National Energy Conservation Law, (2) the increased involvement of foreign bilateral programs in building energy efficiency (Canada, Denmark, and Great Britain, for example), and (3) greater involvement of the Ministry of Construction in energy efficiency. A collaborative program can strengthen the institutional commitment in a number of ways (e.g., technical support for building standards, technical support for ongoing demonstration programs, collaboration in RD&D projects).

Private Energy Conservation Service Providers

There is a major experiment underway to create private energy service providers as delivery systems for energy efficiency in the market. A multi-year project of the Global Environmental Facility (GEF) that provides funding for the initial creation and operation of three such centers support this experiment. A second round may produce additional energy management companies.

The basic idea is to establish an industry that can make a profit from energy conservation services, as energy service companies (ESCOs) in the United States have done. Such an enterprise would take over many of the responsibilities of the existing network of energy conservation service centers, some of whose staff might be absorbed by the new organizations. Residual services, not easily privatized, might be retained by the existing energy conservation service centers.

The success of this experiment is far from assured. Creation of a private enterprise system for energy efficiency has been very difficult in industrialized countries, in part because of the complexity of establishing contractual mechanisms for sharing energy savings and/or the high transaction costs of carrying out the contracts. There are, however, some reasons for optimism, not the least is the ability of the Chinese to develop innovative institutions that fit their own economic and cultural system. It is worth noting that the Chinese created a shared savings program with industry (retention of 8 to 15% of savings from energy efficiency investments) as early as 1985.

Efficiency Standards for Energy-Intensive Products and Equipment

The State Bureau of Quality and Technical Supervision (SBQTS) is responsible for the development and implementation of product standards. In the last several years, SBQTS has become involved in energy efficiency standards. With training from the United States, SBQTS has developed efficiency standards for refrigerators. It is likely that most manufacturers will adhere to these standards. The standards will be updated and made more stringent periodically (every three to five years).

SBQTS is prepared to move aggressively on standards for additional products (e.g., lighting equipment, air conditioners, motors, and pumps). They lack adequate staff to move quickly on multiple products. There is a need for test procedures to be developed and evaluated. Many products need to be labeled for energy efficiency. Means need to be developed to improve implementation of the standards. All of these areas would benefit from collaborations with and technical support from the United States.

Market Transformation Projects and Programs: (1) lighting products, (2) refrigerators, and (3) air conditioners

[7] Major institutional barriers to energy efficiency in buildings include lack of (1) a governmental institution responsible for energy efficiency in commercial buildings, (2) a structure for effectively implementing a building code for energy efficiency, if such a code is widely promulgated, and (3) advocacy for energy efficiency in buildings at high levels of the Chinese government. As noted, the Ministry of Construction is beginning to address the third deficiency. A related problem is the difficulty in obtaining materials (insulation, efficient windows, etc.) and equipment in the market for energy-efficient building construction. However, much progress has been made (and will continue) as houses and markets are privatized.

The Chinese are presently pursuing very actively three major market transformation programs. These are briefly discussed below. These, as well as other transformation programs not yet in the works, can yield very large and cost-effective savings.

The Chinese "Green Lights" program is primarily of their own design and has had substantial funding from the Chinese government to improve lighting product quality – higher efficacy, increased lifetime and reliability, and higher-quality light output. The UNDP has provided support for training of Chinese participants in the Green Lights program. There remains a critical need for test procedures and reliable test laboratories for a variety of lighting equipment.

The GEF has recently approved a major $32M program to support the transformation of the Chinese refrigerator industry to one that produces a large volume of energy-efficient refrigerators. This, combined with continued updates of minimum efficiency standards for refrigerators, represents a significant opportunity for improving the energy efficiency of the 10 million refrigerators built each year in China (the most of any nation in the world).

The Chinese are now the largest producers of air conditioners, with sales approaching 10 million per year and a growth rate that has been 35% per year for the past decade! The Chinese have only recently begun to pay attention to increasing efficiency of these products. Collaborations with United States counterparts could provide important technical assistance in these undertakings.

Guidelines and Standards for New Industrial Facilities

The Chinese already have very extensive programs for renovating and improving existing energy-intensive industries. Much work remains to be done in these areas. Two types of technical assistance are in order: (1) new and acceptable sources of finance for energy efficiency upgrades and (2) support for advanced technologies and techniques in which the Chinese are not knowledgeable.

However, the economy is growing so rapidly that more than half of all energy in industry will be consumed in new facilities after a decade, and more than three-quarters after two decades. Thus, attention needs to be paid to new industrial facilities.

The critical need is to determine cost-effective state-of-the-art industrial facilities suitable for China. This is not an easy task. Such "benchmarking" activities (involving evaluations of industrial processes in multiple countries) need to be done carefully, they need to be fully documented, and they must be credible enough to support large investments. Such a task is beyond the resources of the program we are proposing. Indeed, it will need resources from a variety of sources and should make its results known to many different countries.

Financing Reform

As noted, the continued financing of energy efficiency projects in China is uncertain because of broader reforms designed to eliminate subsidies in the banking system. After initial indications that the Chinese government might treat energy conservation loans like other subsidized loans, it now appears that there is a recognition of the benefits of this loan fund to the nation. However, it is essential that the loan conform to standard, international banking practices, and it is desirable that additional leveraging of the loan be sought.

A second financing problem relates to the limited ability of most Chinese institutions to prepare business plans that will support the raising of capital for projects. In a time when the major new sources of capital will go to private or privatizing companies, ability to obtain capital is critical to success of ventures. As such, strengthening organizations involved in promoting energy efficiency in their ability to prepare business plans will attract more capital to energy conservation investments.

Guidelines and Standards for Co-generation

Co-generation has been on the order of 10% of new electricity generating capacity for many years. This has been a major asset to China, as its higher energy efficiency has reduced energy demand growth substantially. Unfortunately, new barriers to co-generation (even though it is highly cost-effective) have arisen in the past few years. The first is that utilities, now required to earn a return on their capital without support from government subsidies, are leery of co-generators that supply power to the grid. Such co-generators do not contribute to utility profits, may destabilize the power system, and may require the utility to provide additional (high-cost) peak power to customers. The situation is made worse by the fact that the Chinese continue to subsidize the heat produced by co-generators. A third difficulty – some Chinese maintain this is the most serious problem – is that the previous standards for the technical performance of co-generation are outdated and a new guidebook for evaluation of co-generations is sorely needed. Thus, there are two critical items to maintain China's active co-generation programs: support for (1) development of new policies (perhaps along the lines that

PURPA established in the United States and (2) a new technical guidebook.

Recommendations for Collaboration with China on Energy Conservation RD3

The examples described above demonstrate a large number of opportunities in which collaboration with China could yield very significant impacts, in terms of promoting sound approaches to energy efficiency in China, reducing energy-related CO_2 emissions, and increasing business, trade, and joint ventures in energy-efficiency products and services. In the previous section, we noted very significant opportunities to work with the Chinese in the design of their energy conservation law, research, development, and demonstration of a wide variety of energy end-use technologies, the creation of privatized firms to deliver energy services, standards and broader market transformation programs refrigerators, lighting equipment, air conditioners, guidelines for new industrial facilities, finance reform for energy efficiency, and new rules and regulations for co-generation.

There exist tremendous opportunities to collaborate with China on energy efficiency.

The companion paper by Fulkerson, et. al., recommends an initial program addressing three countries and a range of environmental energy technologies that starts at $60M per year (i.e., $20M/year for each of three countries). It suggests that a reasonable breakdown of the funds is $5 to $10M for research and development, $5 to $10 million for demonstration, and $5M for market transformation and policy development (leading directly to deployment). It identifies the United States Department of Energy as the lead agency for such a program. It indicates that the RD3 activities – with the exception of sensitive policy collaborations – involve private firms as well as research providers. The relatively small funding for such activities requires that the funds be invested so that they can leverage much larger investments, either from the private sector or from institutions such as the Global Environmental Facility or the World Bank.

This approach can be applied directly to energy efficiency in China. Assuming that about half of the program in environmental energy technologies in China were energy efficiency, this would lead to an initial program of at least $10M/year for energy efficiency.

There are particular advantages to the U.S. Department of Energy (DOE) taking the lead in this program. DOE, in concert with the Government of China, has created the Sino-U.S. Working Group on Energy Efficiency.[8] This Working Group consists of ten teams that have been constituted to address opportunities and barriers in the following areas: energy policy, information exchange and business outreach, district heating, co-generation, energy-efficient buildings, energy-efficient motors systems, industrial process controls, lighting, amorphous core transformers, and finance. The U.S. teams consist of representatives of industry, state agencies, energy associations, DOE national laboratories, and other interested parties. The Chinese have appointed representatives to each of the ten teams. These groups have met actively since they were constituted in 1995, have developed work plans, and have pursued joint projects. The activities have been carried out actively in spite of limited funding.

The Sino-U.S. Working Group provides an ideal vehicle for initiating the recommended program. The team leaders are respected individuals in their fields in China and the United States. They, and many of the team members, have been working together for several years. Working relations are generally excellent between the two sides. Almost all of the teams have been able to create new collaborations between the two countries. Priorities have been established for collaborations for each of the ten areas. DOE has viewed its role as facilitating interactions, allowing the teams to work out their plans through meetings, information gathering, and joint efforts to obtain funding.

In short, the China program on energy efficiency is a natural for DOE to manage, using the Sino-U.S. Working Group that it created as a major vehicle for deciding on program priorities and carrying them out.

Conclusion

There exists outstanding opportunities to further collaboration between the United States and China in promoting energy efficiency in China. Such an opportunity involves all aspects of energy efficiency research, development, demonstration, and deployment. An existing structure – the Sino-U.S. Working Group on Energy Efficiency, created by the U.S. Department of Energy and the Government of China – provides an excellent vehicle for carrying out the program. An initial program of at least $10M per year would have many

[8] Go to http://www.oit.doe.gov/international/china.shtml to learn more about the activities of the Sino-U.S. Working Group on Energy Efficiency.

options to choose from in creating successful activities. Such a program can serve as a seed for major advances in energy efficiency in China, with substantial benefits to the global environment. It can also provide expanded opportunities for trade, investment, joint ventures, and other business activities in a large energy efficiency product market in China.

Painting China Green: The Next Sino-American Tussle

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When Chinese Premier Zhu Rongji meets President Bill Clinton and Vice President Al Gore in Washington in April, the political climate is unlikely to be auspicious. The United States and China have reached a virtual stalemate on each of their traditional agenda items. Negotiations over China's entry into the World Trade Organization have stalled; China's continued drive for reunification with Taiwan offers little potential for fruitful dialogue; and human rights remains an elusive area for compromise. Yet the Sino-American relationship may well define global prosperity and military security in the 21st century. Allowing it to deteriorate risks a future punctuated by frequent military and economic conflicts and global instability. Both sides are eager to sustain the illusion of progress produced by the recent presidential summits. Hence, a centerpiece of the talks will likely be a subject viewed by both as uncontroversial-environmental cooperation.

Chinese and American leaders believe that the environment is a low priority issue with plenty of common ground. This is a big mistake. The environment is as complex as other key diplomatic issues, featuring differing interests and priorities, weak Chinese institutions, Chinese defiance of international agreements, and conflict between Congress and the White House over how to achieve U.S. aims.

Moreover, environmental issues have direct and serious implications for other U.S. foreign policy objectives. A warmer Sino-American relationship is stymied by China's reluctance to seek any middle ground with the United States until it is in firm control domestically. But the environmental problems created by China's recent economic boom now threaten the country's fragile social, political, and economic infrastructure. This is a momentous issue, and the question is: Is China's economic growth sustainable? Progress in bilateral discussions rests on China's resolution of it. Fleeing to the environment as a short-term foreign policy sanctuary will be treacherous if these complications are ignored. If fully understood and thoughtfully addressed, however, China's environmental problems offer a unique opportunity for the United States to cooperate with China on a vital issue.

It's not easy being green

At first glance, the connection between China's environment and U.S. interests may appear tenuous. China is halfway around the world and unlikely to affect American air and water quality. But China's impact on the global environment should not be underestimated. China is one of the world's largest contributors to both global climate change (albeit a distant second to the United States) and ozone depletion. Its environmental practices affect Americans, from the rate of skin cancer to agricultural productivity to the frequency and scale of natural disasters. Moreover, China's need for grain has a direct and growing impact on U.S. farmers' interests. Beyond these direct effects, however, China's environmental policy influences the full range of U.S. interests in China: stability and security, human rights, democracy, and trade.

The environment is beginning to shape China's economic and political choices in important ways. The government reports large internal migrations due to scarcities, particularly of water. These migrants will complicate Beijing's efforts to manage the overpopulated coastal cities, with their millions of unemployed workers. Moreover, political conflict over land and water resources has become endemic, occasionally erupting into wide-scale violence. Over the past few years, for example, farmers from the Ningxia Autonomous Region have raided the more fertile land in Inner Mongolia for a favored plant. Thousands of police and local officials have been injured by the incursions. China's environmental practices alone may not challenge economic growth, but when combined with other trends, their consequences for social stability are magnified. A China in political and economic disarray cannot be a stabilizing force in the region or the world.

Regarding human rights, China's environment causes both concern and hope. China's environmental problems encroach on the most basic necessities of life: clean air and safe drinking water. Every year, 300,000 Chinese citizens die prematurely from air pollution-related diseases. In 1996, 50,000 people were affected by water pollution-related diseases. Sixty million people cannot get enough clean water for their daily needs. But U.S.

politicians should also recognize environmental action's potential to propel political change. In the environment, perhaps more than in any other area, the Chinese government has opened the political space for dissent. Rather than devote signiþcant financial resources to environmental protection (it spends slightly under one percent of GDP), the government has permitted the emergence of genuine nongovernmental organizations (NGOs) devoted to the environment. Helped by the media and the general public, which also discuss environmental policy with unusual openness, these NGOs criticize and expose the weaknesses of local environmental protection efforts. Grassroots environmental organizations have blossomed, many of them dominated by politically reform-minded Chinese intellectuals.

Finally, as the United States attempts to reduce its growing trade imbalance with China, it should not overlook the sale of technologies and products protecting the environment. The World Bank estimates that between 1995 and 2004, China will require about $100 billion of infrastructural investment in water conservation, treatment, and sanitation. The market for environmental goods and services, already estimated at around $4 billion, is growing rapidly. American companies, however, still lag far behind their Japanese competitors in market share.

China's Faustian Bargain

Chinese leaders know they have a problem. They also realize that it is not just an environmental issue but an economic and political one. They have gambled that the rate of economic growth will outpace the rate of environmental degradation and resource scarcity. But their development practices have produced a costly environmental disaster; it is clear to anyone living in China that economic growth has come at the expense of the environment. The country's overwhelming reliance on coal has resulted in some of the world's worst air quality and acid rain that is damaging one-third of Chinese agricultural land. Eighty percent of wastewater and sewage is dumped untreated into rivers and lakes; in 1997, China's Environmental Protection Agency announced that water quality had deteriorated in every single major river system during the previous year. Fully 86 percent of the water in rivers flowing through China's cities is considered unsuitable for drinking or fishing.

This damage is haunting China's economic growth. Economists estimate the cost of environmental degradation and resource scarcity to be 8 to 12 percent of China's GDP. According to the World Bank, water scarcity and pollution alone annually cost China about $14 billion in lost industrial output and about $24 billion in crop loss. The health costs of air pollution will skyrocket-reaching $98 billion by 2020.

Perhaps the most dramatic example of the costs of China's decision to trade the environment for economic growth was 1998's flooding of the Yangtze River. Official indifference and decades of poor environmental choices-failing to protect wetlands and clear-cutting forests for timber, farmland, and industrial development-contributed to the unrelenting floods, which killed more than 3,000 people, destroyed 5 million homes, and inundated 52 million acres of land. The economic losses are estimated at more than $20 billion.

In the race between development and the environment, Chinese leaders have bet on development. Either because it had no choice-since the regime's legitimacy is predicated on continued rapid economic growth-or because it has decided to see who will blink first, China has placed the burden of global environmental problems on the rest of the world. Issues such as global climate change and ozone depletion are more diffuse and long-term than China's current woes. Chinese officials have resisted devoting financial resources to problems that they could blame on industrialized countries, a philosophy best summed up as "For China to play, the world must pay."

The silver lining

Despite these obstacles, the silver lining of the April summit is that the environment may finally receive the attention it deserves. The danger lies in assuming that environmental discussions should provide no more than an easy photo opportunity for Gore and Zhu. The Clinton administration tends to settle for nonsubstantive policy "wins"-in the words of one official, "finding the low hanging fruit"-rather than þghting for difficult new programs. Congress, in turn, blocks substantive initiatives by withholding funding without offering constructive alternatives. The United States cannot afford this repeat performance. China now stands on a precipice of change as steep as that in 1979, when the leadership launched its economic reform program. Since then, China has embarked on wholesale economic restructuring, including a national infrastructure program, that will not only determine its own economic and environmental future but will also affect the world's. Washington must acknowledge that changing Beijing's environmental performance will take several decades. As with other contentious issues in the Sino-American relationship, from intellectual property rights to control over weapons technology transfers, China's capacity to enforce its environmental agreements is constrained by bureaucratic and regional conflicts. The United States must act quickly if it is to influence China's choices.

First, Gore needs to incorporate businesses, foundations, and NGOs from both countries into the U.S.-China Forum on Environment and Development. The forum, which Gore inaugurated in April 1996, serves as the umbrella for cooperation between both countries' bureaucracies. The low level of funding to date-less than $10 million in 1997-has limited joint ventures to small-scale workshops on topics such as natural disaster relief, water usage, and energy efficiency. Introducing new actors into the forum will provide fresh sources of funding and expertise, organize the disparate efforts of environmental organizations in China, advance U.S. trade interests, and nonthreateningly support Chinese NGOs. Forum-sponsored projects should address both U.S. priorities like global climate change and Chinese domestic needs. Ventures could involve reforestation, energy efficiency, and renewable energy.

Second, the United States urgently needs to soften China's recalcitrance on global climate change. Chinese leaders resist even minimal voluntary limits on greenhouse gas emissions for fear that more significant future commitments will slow China's economic development. Since Congress is withholding funding for domestic global warming initiatives until it sees China and other developing countries move on this issue, the White House is desperate for progress. Yet it should resist the temptation to oversell any summit agreement. China's compliance will be weak because it lacks the will and capacity to address climate change, and the United States is bound to be disappointed. Instead, Washington should proceed along the two tracks that offer the best hopes for improving Beijing's performance. The bill proposed by Senators John Chafee (R-R.I.), Joseph Lieberman (D-Conn.), and Connie Mack (R-Fla.), which grants early action credit to companies that reduce greenhouse gas emissions, should be expanded to include actions undertaken in other countries. The administration should also refrain from high-profile demonstration projects unless they are funded by those whose business interests will profit. U.S. efforts should focus on activities with a long-term payoff, such as training Chinese officials and researchers in environmental planning and enforcement, rather than on projects with limited application elsewhere in China.

Third, it is time for Congress to clear the way for lifting sanctions on U.S. assistance programs to China imposed after Tiananmen Square. The U.S.-Asia Environmental Partnership, the Trade and Development Agency, and the Overseas Private Investment Corporation could all facilitate exports of environmental goods and services to China. For U.S. firms to compete, they need financial and organizational assistance. There is no rationale for maintaining sanctions that hurt only U.S. companies and limit American advancement of its own environmental interests.

Getting it right

Discord and distrust are hallmarks of the Sino-American relationship. Despite recent efforts by both U.S. and Chinese leaders to move beyond the current stalemate, little has been achieved. Domestic politics on both sides and weak institutions in China confound efforts to achieve compromise. Although both sides want China's emergence as a global power to proceed smoothly, neither is willing to forgo short-term interests for long-term gain. In this rather bleak political climate, the environment offers a fresh start. Gore and Zhu have the opportunity to accomplish something significant. By addressing environmental protection Gore will also serve broader U.S. interests of human rights and democracy, U.S. business development, and international security. By influencing China's economic and environmental choices, the United States will fundamentally shape the China that will emerge in the 21st century. Ensuring that China becomes a constructive participant in the international system will take time. Progress on the environment, as on other issues, requires both sides to commit themselves to a long-term strategy of institution-building to enable China to meet its domestic challenges as well as its international obligations. This does not mean that the United States should allow China to ignore its commitments in the interim. But the United States is best served by engaging China and helping it develop the capacity to be a respected and effective international actor. America's interests in China are significant and growing. We should take the time to get the relationship right.

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Featured Essays – China's Energy Efficiency and Renewable Energy Industry

The China Clean Energy Project of the Natural Resources Defense Council (NRDC)

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The Natural Resources Defense Council, Inc. (NRDC) is one of the leading U.S. nongovernmental environmental organizations promoting energy efficiency and sustainable energy policy in the U.S. and abroad. NRDC launched its China Clean Energy Project in 1997 with the long-term goal of accelerating the adoption of energy efficiency as an alternative energy source for meeting China's rapidly growing demand for energy. Our primary objectives are to (1) demonstrate energy efficient technology, demand-side management methods, and financing mechanisms; (2) help guide the development of energy policy at the municipal and national level; and (3) build national capacity to develop energy efficient and environmentally sound technologies and policies. We have targeted our efforts in three major areas: the promotion of more efficient buildings, the increased use of natural gas, and the development of innovative national energy policies.

Model Building Energy Code

Due to rapid economic growth and improvements in living standards, energy consumption in buildings is growing much faster than in other sectors in China. The Chinese government estimates that by the year 2000, energy consumption in buildings will reach 199 million tons of standard coal, representing over 13% of the total national consumption of energy. A more recent study estimates that energy consumption in the building sector, including the production of building materials, already makes up 35-40% of the country's total energy use, and will likely grow to 40-45%.[9]

Article 37 of the 1998 Law on Energy Conservation directs all building design and construction, in accordance with relevant laws and regulations, to employ energy-saving types of construction structures, materials, facilities and products; improve heat and insulation properties; and reduce energy consumption for space heating, cooling and lighting. Individual provinces and provincial-level municipalities, including Beijing and Shanghai, are now developing detailed regulations, standards and incentives for implementing these requirements.

NRDC is working with Chongqing, China's largest municipality, to develop and implement a model building energy code for the "transition zone" climate, one of China's three major climate zones. Chongqing has the fastest growing building market in China, with nearly 100 million square feet of residential and commercial floorspace forecast to be built in 1999 alone. The average household energy use increased by about 70% between 1990 and 1994, and energy consumption in Chongqing's non-industrial building sector has grown by about 25% a year. The development and enforcement of building codes that are technically feasible, economically justified and environmentally beneficial could have a tremendous impact in reducing Chongqing's runaway energy growth.

NRDC is organizing technical assistance to the Chongqing government in the development, adoption and implementation of the model code, and will organize and participate in informational seminars on policy options to stimulate the transformation of Chinese construction markets. The Institute for Market Transformation, another U.S. nonprofit agency, is seeking funding to participate in this effort. If funding is available, NRDC and IMT will also assist the Ministry of Construction in promoting Chongqing's model code to other provinces along the Yangtze River Basin that share a transition zone climate.

Efficient Building Demonstration

On the demonstration side, NRDC has been selected by the U.S. Department of Energy (DOE) to implement an energy-efficient building demonstration project in Beijing that was launched last year by DOE and China's Ministry of Science and Technology. The building will house China's Agenda 21 (ACCA21) office and other governmental and non-governmental environmental offices, and will include a "hands-on" Demonstration Center for energy efficient building technologies. Chinese government and building industry representatives will be directly involved throughout the design, construction and operation of this project to provide a strong capacity-building framework for the future use of these strategies.

NRDC will build upon its extensive experience in the United States and Russia to help demonstrate appropriate and economically attractive building design strategies and technologies in Beijing as a significant practical step

1. China Energy Conservation Investment Corporation (CECIC), 1998 memo.

toward reducing China's contribution to global climate change. NRDC will work closely with the current project participants, including ACCA21, Lawrence Berkeley Laboratory, and the National Renewable Energy Laboratory, to explore a number of innovative approaches to project implementation. These parties are currently undertaking the first phase of the project, which consists of the development of economic energy design criteria and a project plan, including engineering and financial feasibility analyses.

Once the preliminary project design is completed, NRDC will seek to involve a wide range of U.S. and Chinese experts from the building industry, academia, non-government organizations and government agencies in a thorough review of the plan's design, engineering and financial analysis. In both the review and implementation of the project plan, we will seek in-depth involvement from the U.S. and Chinese members of the Energy Efficient Building Demonstration Team established as part of the U.S.-China Energy Efficiency Steering Committee. This team includes representatives from a number of potential U.S. suppliers as well as Chinese research institutes, building industries, technology associations and government agencies.

If the project is found feasible, NRDC will be responsible for bringing together the necessary financial, technical and other components and resources for the bidding, construction and commissioning of the final design of the energy efficient and renewable aspects of the building. In addition to recruiting potential suppliers who will donate products and services to this showcase demonstration project, we will also explore the possibility of utilizing the services of an energy services company to provide initial financing for energy efficiency upgrades. The ESCO's investment in the project would be paid out of agreed-upon energy savings.

A primary focus of the project will be to ensure that the energy and greenhouse gas reductions achieved can be measured and documented in order to provide valuable information to the building profession in China and others. NRDC strongly supports DOE's desire to have the energy performance of the building monitored and verified as a possible emissions tracking model for the Kyoto Protocol Clean Development Mechanism (CDM). NRDC will ensure that DOE's International Measurement and Verification Protocol is implemented in the building, with particular attention paid to the Emissions Trading appendix. The choice of implementing Options A-D will be determined through discussion with DOE and our Chinese partners to adopt whichever option will meet the desired level of verification desired for CDM that is feasible given the budget.

To ensure appropriate information sharing among the interested parties, NRDC will establish and maintain regular communication with the U.S. building community and the public at large as the project progresses. NRDC will include a home page for the project on the Internet, linked to NRDC's award-winning home page, and will also regularly include information on the project in communications sent to its over 400,000 members.

Efficient Production of Clean Energy and Chemicals

Fertilizer production is one of the most energy intensive and environmentally-polluting industries in China. Production principally comes from approximately 800 small (< 45,000 tonnes per year) and inefficient facilities. Coal is the primary feedstock for about 65% of fertilizer production, as well as the primary fuel burned for process heat. Fertilizer production accounts for approximately 50% of China's chemical industry energy consumption and 20% of all industrial electricity consumption. The fertilizer industry is a major source of emissions of hydrogen sulfide, ammonia, carbon and sulfur dioxide and nitrogen oxide. The industry also pollutes the water with sulfuric acid, cyanide and coal oil among other effluents.

NRDC is working with the U.S.-China Energy and Environment Technology Center (EETC), a joint effort between Qinghua and Tulane Universities sponsored by the U.S. Department of Energy, to conduct a feasibility study of options for efficient production of clean energy and chemicals in Chongqing. Chongqing fertilizer production consumes over 400,000 tonnes of coal equivalent per year, resulting in the emission of nearly 1 million tonnes of carbon dioxide and thousands of tons of sulfur oxides, nitrogen oxides and particulates.

The project will collect production and market characteristics of the 24 small fertilizer plants in the Chongqing Municipality. Using one test plant, the assessment will recommend and implement measures to improve production efficiency through the expansion and modernization of ammonia production for nitrogen fertilizer, as well as the on-site development of a large-scale compound fertilizer production facility. Evaluation of the ammonia production expansion will emphasize the demonstration and use of high efficiency gasification technology and on-site electric power generation through fuel cell technology or combined cycle co-generation.

The potential of coal bed methane and coal gasification as a chemical feedstock also will be evaluated. Other strategies will include evaluation of the closure of

inefficient coal-based ammonia plants in conjunction with the expansion of natural gas-based fertilizer production. Based on the results of the initial test plant's evaluation, we will analyze the possibility for the modernization and expansion of natural gas-based fertilizer as a prelude to the consolidation of coal-based production and the privatization of the fertilizer industry in Chongqing.

The Chongqing Municipal Economic Commission is the implementing agency for this project, with the close cooperation and participation of the Chongqing Energy Conservation Technical Service Center, the Chemical Industrial Administration Bureau, and the Development Planning Commission.

Implementation of the National Energy Efficiency Law

NRDC worked closely with the State Development and Planning Commission (SDPC), Lawrence Berkeley National Laboratory and the Beijing Energy Efficiency Center (BECON) in organizing a national seminar in December 1997 concerning implementation of China's newly-enacted Law on Energy Conservation. The seminar brought together over 40 Chinese experts from central and provincial organizations to discuss innovative energy efficiency mechanisms that have proven successful in the U.S. The U.S. delegation included representatives from NRDC, the Department of Energy, the Alliance to Save Energy, the American Council for an Energy Efficient Economy, the California Energy Commission and the Oregon Public Utilities Commission.

NRDC is now developing a pilot project with SDPC, the State Economic and Trade Commission and BECON to assist in the drafting of provincial level regulations to implement the national energy conservation law. SDPC plans to use these regulations as a model for other provinces and independent municipalities in China. We will be exploring the possible development of a provincial demand-side management program and energy-efficiency financing mechanisms as part of this implementation process.

Electric Utility Restructuring

NRDC and EETC are also developing a project in Shandong Province that will recommend regulatory, programmatic, and economic incentives for encouraging responsible environmental performance, including energy efficiency, in the developing market-based power sector in China.

The project will gather energy and environmental information in Shandong as for use in demonstrating an environmental incentive program that could be transformed into a national energy program. The first phase of the project will train PRC personnel to integrate environmental performance into a socialist market economy, analyze different incentive options to determine the most appropriate ways to encourage the use of innovative environmental and energy efficiency technologies in China, and develop recommendations which could be implemented in Shandong.

This project will be led by the State Power Corporation, which was established in 1997 to spearhead "the historic transformation of the administrative system of China's electricity industry from that of the planned economy to a socialist market economy." The State Power Corporation is operating under a mandate by the State Council to oversee reforms and development of the electricity and power sector in China.

Conclusion

The barriers to improved energy efficiency and greenhouse gas reduction in China are substantial, and NRDC's agenda is an ambitious one. Yet through a network of strategic partnerships, access to critical points of policy leverage, building of local capacity and a long-term perspective, NRDC hopes to assist China in its efforts to develop a more sustainable energy path.

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Combined Heat and Power and its Applications in China

Dr. Jim Qin, Trigen Energy Corporation.

What is Combined Heat and Power (CHP)?

Combined Heat and Power (CHP) systems, sometimes called cogeneration systems, generate electricity and thermal energy simultaneously. Today's central power plants typically convert only one-third of the energy in the fuel to electricity. The remaining two-thirds of the fuel energy remains as heat, which is usually wasted. Meanwhile, thermal energy users have to burn additional fossil fuel at on-site boilers to generate needed steam or hot water. Using CHP systems, much of the thermal energy normally lost can be recovered and used for a wide variety of thermal needs, including hot water, steam, and process heating or cooling.

A Brief History of CHP

Thomas Edison invented the electric light bulb and commercialized electricity generation in New York City. This world's first commercial power plant, built in 1879, was a CHP plant. At the turn of the century, many manufacturing plants and district heating plants in the U.S. operated CHP facilities. As a result of improvements in the cost and reliability of electricity generated by the separate electric power industry as well as increasing regulation, the electric generation capacity at most CHP facilities was abandoned. In the late 1970s, interest in CHP was renewed in response to a new law passed by the U.S. Congress, which included measures to promote CHP as an energy efficiency measure.

The optimal power plant size has changed over the last sixty years. In 1930, a 50-megawatt (MW) power plant was probably cheapest to build on a dollar per kW basis. By the 1950s, technology had improved and the cheapest unit produced 200 MW, by the 1970s, 500 MW. This steady march of optimally sized units to larger capacity peaked in the early 1980s with 1,000+ MW units. But in mid-1980, a startling thing happened. The size of the cheapest plant dropped dramatically. Today the cheapest unit to build on a cost per kW basis is a gas turbine in the 50 to 150 MW range. The lead-time has been cut from10 years for 500+ MW plants to 1 year for 100 MW plant.

Recent advances in technologies such as combustion engines, steam turbines, reciprocating engines, fuel cells, and heat recovery equipment have decreased the cost and improved the performance of CHP systems. These developments have renewed the interest in expanding CHP applications. Environmental policies, including the need to address concerns about greenhouse gas emissions, have created pressures to find cleaner and more efficient means of using energy.

China's first CHP plants were imported from the Soviet Union in the 1950s. These plants were built in the northeast for residential and industrial heat loads utilizing steam extraction turbines. The growth rate of CHP systems from 1950 to 1965 was very high at 20 percent of new generation capacity - about 2.4 GW.[10] Most of the growth occurred in heavy industries. During this period, CHP plants were typically large systems with capacities greater than 100 MW and were municipally controlled. The growth rate of CHP systems, however, dropped to 6.4 percent for the period from 1965 to 1980, with less than 2 GW of additional capacity. By 1980 the factory-owned CHP plants accounted for 77 percent of the total CHP capacity, most of them small scale (<25 MW). The average CHP plant size in 1993 was about 20 MW.

Energy efficiency in power plants has improved significantly over the years. Only 8 percent of the total energy in the coal was converted to electricity at Edison's first power plant. Since then average efficiency has risen steadily to a peak of 33 percent in the late 1950s. Today's gas turbines achieve from 42 to 45 percent efficient. Combined cycle gas turbines are 55 percent efficient. The average energy efficiency has remained essentially unchanged over these forty years. This is because so many old and inefficient power plants are still in service.

What are the Benefits of CHP?

Today, the average national system efficiency for electric only generators in the United States is still around 33 percent while CHP systems can achieve system efficiencies greater than 70 percent. Some CHP systems have achieved an energy efficiency of 90 percent.

CHP systems have many energy, environmental and economic benefits due to their inherent high efficiency. This translates into energy cost savings and significant reductions in pollutant emissions compared with separate centralized generation of electricity and thermal energy.
CHP systems move the generation of electricity closer to the end-user, reducing the distance required for electricity transmission, thereby avoiding many transmission and distribution choke-points. CHP can help to alleviate electricity supply shortages and improve the urban

[10] A gigawatt (GW) is one billion (1×10^9) watts.

environment. Using CHP systems can also conserve precious natural resources.

Reduced coal consumption as a result of increased efficiency means that less coal needs to be mined and burned, reducing soil erosion and water pollution. Reduced coal consumption for energy production, especially the replacement of extremely inefficient boilers, ovens, and household stoves, results in the reduction of local air pollution, regional acid rain, and global warming impacts.

In the U.S., CHP has been identified as an important national strategy to reduce the emissions of greenhouse gases such as CO_2 while promoting economic growth. In order to raise awareness of the energy, environmental and economic benefits of CHP and foster increased use of CHP through the United States, the U.S. Department of Energy (DOE) initiated the CHP Challenge last December. The DOE's goals are to break down the barriers and double by 2010 the use of CHP systems in commercial, industrial, and institutional buildings, and in communities throughout U.S. This would reduce carbon emissions by 40 million metric tons, a figure equivalent to the output of 50 medium-sized power plants or eliminating 40 million cars.

China can and should use CHP as a strategy to reduce pollution while using energy resources more efficiently.
CHP Technologies and their Applications in China

Common CHP technologies are boilers with steam turbines, combustion turbines with heat recovery and steam generating units (HRSG), spark ignition engines with HRSG, compression ignition engines with HRSG, combined cycle combustion turbines, and fuel cell technologies. Coal is the primary fuel for CHP plants in China, accounting for 95% of the total CHP capacity. Steam turbines are the most commonly used technology in China. So far, no CHP plants using biomass, garbage, or other fuels have been built in China. In 1996, CHP systems in China account for about 11 percent of China's total electric power generation capacity.

The CHP market is evolving, driven by changes in the electric industry and in technology. CHP systems are found in several broad market segments in China, including systems in petroleum refining, chemical and forest products industries, district energy systems providing heat and cooling to a network of several buildings, and various manufacturing plants.

In China, large-scale CHP plants (capacity over 100 MW) are typically found in petroleum refineries, chemical plants, food processing plants, and district heating systems. Medium size CHP plant (capacity between 25 to 100 MW) can be found in sugar mills and district heating and industrial parks. Small CHP system (capacity less than 25 MW) are commonly found in the chemical, textile, and paper industries. In 1993, CHP plants smaller than 6 MW accounted for about 750 MW total generation capacity.

In 1993, a total CHP capacity of 1.3 GW was put into operation in China, representing 11% of all new capacity for that year. Current trend indicates the expansion or retrofit of existing plants were at a slower rate than new CHP plants even though, in many cases technical upgrade projects are more cost-effective than new construction and require less time and less initial capital.

CHP and Environmental Protection

China's energy production is based on fossil fuels, with coal contributing over 75 percent of the total supply. Energy use in China is still relatively inefficient. China currently is one of the top greenhouse gas emitters in the world. Emission levels are expected to grow even higher in the coming years with rapid economic expansion. Accordingly, greenhouse gas emissions and other environment impacts are of great concern to China as well as other countries.

Up until the 1980s, environmental issues were not required to be addressed for power development projects including CHP projects. The Environmental Act passed in 1979 and subsequently two policies were enacted in 1984 and 1986 by requiring power plants to perform environmental impact studies and comply with relevant environmental regulations. However, these regulations are rarely enforced because electricity in some areas is in such great demand that economic growth still takes precedence over environmental concerns.

In general, the Chinese government wants to improve the environment, but not at the expense of economic growth. Improving energy efficiency is a cost-effective way to reduce greenhouse gas emissions as well as other pollutants, without hurting economic growth. CHP systems have enormous potential for energy savings, greenhouse gas reductions, and local and regional improvements of air quality.

For example, the Jingzhou CHP plant, which was built in 1986 to alleviate electric power shortages, also provides steam for 28 industrial customers and 1.3 million square meters of residential heating area. As a result, 115 small inefficient boilers were eliminated. The concentrations of SO_2 and particulate matter in the local area declined by

32% and 48%, respectively. Although the impact of CHP on environmental protection has not been fully incorporated into government policy making or CHP project evaluation, the Chinese government has begun to take advantage of this potential. In 1987, the central government issued regulations to strongly encourage retrofitting boilers as CHP plants in China.

How are CHP Projects Financed in China?

Economic reforms have transferred CHP plant ownership--and at the same time financial responsibility--to non-central government entities. These reforms have also meant that central government direct investment has dropped considerably so that those interested in developing CHP have to provide their own funding or seek it elsewhere.

There are many different sources of investment capital for CHP projects in China. These sources can be grouped into four main categories: central government investment, domestic bank loans, foreign investment, and fundraising, which includes local government capital, internal enterprise funds, collective savings, union funds, private savings, and stocks and bonds. Investment from the central government has dropped significantly. Since the mid-1980s, the most significant increases in financial resources for power development have come from fundraising. Non-governmental funds now play a major role in CHP development. This change suggests that CHP projects have become local projects.

Foreign investors are also becoming more active in the CHP market, though their involvement is still limited to the early stages of negotiations and project feasibility studies.

Why Isn't CHP System More Widely Used?

As indicated earlier, CHP growth in China has slowed down significantly. Why is that? Why hasn't more foreign capital been invested in CHP projects in China? The answer is that there are too many barriers. The primary market barriers for CHP development in China are electric utility monopoly and regulated heat prices. In addition, the bureaucratic structure for approving CHP projects is complicated. Current CHP-related policies in China are contradictory, sometimes working against CHP development.

CHP projects are capital intensive. When foreign investors look at a potential CHP project, they evaluate investment risks associated the project very closely. One of the most important risks to any CHP venture in China is the rates for the electricity and heat or steam. In most cases, electricity prices are still regulated by the provincial or regional electric power administrations. Typically, a rate of return of around 15% on investment is used as the starting point for calculating electric rates. Depending on the location of the project, electric rates can be negotiated with local governments. CHP plants have been allowed to negotiate electricity prices, but the heat prices are still tightly regulated.

Residential heat supply is treated as social welfare. No deregulation in heat rates has been made to date, although reports indicate that Harbin is experimenting with market reforms. Thermal energy in many cases is still seen as a benefit and not a commodity. Prices are held artificially low to meet basic human needs. Most of the CHP plants are not able to cover heat generation costs. The CHP plants make up for their losses in heat production with gains in electricity generation. This causes investors to ignore CHP projects and seriously affect CHP development in China.

Another risk for foreign investors is the currency risk. There are no guarantees of compensation for losses to investors if the Chinese currency is devalued. Foreign investors also worry about the enforceability of the price and power and steam purchase contracts.

Current tax policies are not in favor of CHP projects. Depreciation periods are 17-21 years for CHP systems and 25 years for heat-distribution systems.

Even though various policies have been developed by the central government to address CHP development projects, they have not been effective so far in fostering CHP growth in China.

What's Ahead for CHP Projects?

One study forecasted in 1993 that the share of CHP capacity would reach 12% of the total thermal power capacity by 2000. The recent rapid buildup of electric only central power plant capacity makes this percentage figure appear optimistic.

There is huge potential for CHP retrofits projects in China. It's estimated that there were 450,000 boilers in operation in 1992. In addition, there are thousands of small power plants with an average capacity of 26 MW. In general, these boilers and power plants can be retrofitted into CHP plants. The total retrofit potential in China is about 20 GW. If 10-15% of these 450,000 boilers could be retrofitted into CHP, the energy savings and pollution reductions would be significant.

Natural gas-fired CHP is an area for new CHP development. The Chinese government has emphasized coal-fired CHP to use coal more efficiently. However, natural gas-fired CHP plants can be built in cities and residential areas to alleviate electricity shortages as well as local pollution problems. District energy CHP projects including district heating and cooling are good candidates for gas turbine CHP projects. CHP in district energy systems can eliminate hundred, maybe even thousands of inefficient boilers.

There is an untapped potential market for CHP in the iron and steel, chemical, paper, rubber, textile, and printing and dyeing industries. Either retrofitting or building new CHP systems can be developed in these industries utilizing existing heat loads.

New electricity generation capacity will be needed as China's economy continuous to expand. China needs to find a middle ground between economic development and environmental protection. Barriers to efficiencies need to be eliminated. Utilizing natural resources more efficiently is essential to sustainable development in China. CHP offers a reliable, efficient, low emission alternative to building new, central station power plants and transmission infrastructure. CHP projects should have a higher priority in the energy conservation as well as environmental protection policies in China.

More competition in the electric and thermal energy fields will help China to achieve its economic development as well as environmental protection goals. This has been proven in other countries. For example, in the five years after the 1989 deregulation of the electric market, United Kingdom experienced dramatic efficiency improvements. The result has been a reported 15 percent savings for the average retail electric customer. Carbon dioxide from U.K. electric production has been reduced 39 percent since 1989. Many States in the U.S. either have deregulated electric market or are in the process of developing deregulation rules. There is no doubt that CHP provides a cost-effective way for China to utilizing limited energy resources and minimizing the environmental impacts. Changes need to be made to fully utilize the benefits of CHP systems.

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Wind Energy Development and Dissemination in China: Prospects and Constraints in an Institutional Context[11]

Dr. Lin Gan

Summary

This study intends to provide a better understanding of the functional roles and dynamics of institutions in determining the effectiveness of national and regional public-sector initiatives to promote the dissemination of wind turbine technologies in China. The structures, roles, and relationships of relevant institutions involved in wind energy development are analyzed. It examines wind energy development in the last four decades and divides them into four different stages of development. The objective of the study is to identify the steering mechanisms in wind-energy technology dissemination, and the obstacles involved. It is argued that institutional problems constitute major barriers for cost-effective development of wind turbines in China. These include investment loans, tax systems, electricity prices, technology transfer and adaptation, and human resources development. Two empirical studies about the Inner Mongolia region and the Dachen Island in Zhejiang Province are presented as illustrative cases. It concludes that establishing stable frameworks for private sector participation in the wind-energy market holds the key for effective dissemination of wind turbine technologies in China.

Introduction

The utilization of wind energy technologies (wind turbines) has been proposed as an important component of efforts to achieve sustainable energy development (IPCC, 1996). Wind energy development is part of the global effort to promote renewable energy technologies. In recent years, we have seen the increase of the production capacity of wind power at the rate of 30% per year worldwide (Financial Times, 1998, p.10). Initiatives have been undertaken to promote the dissemination of wind energy technologies in developing countries, mostly backed up by governments, and some are supported by multilateral and bilateral aid initiatives. This is due, in part, to the perception that wind energy technologies can meet the need for more flexible, decentralized and environmentally-friendly energy systems in rural areas of developing countries (IPCC, 1996). It is claimed that wind energy development can contribute to the reduction of poverty and increase the quality of life for the poor in isolated rural communities. China is a particular case (The World Bank, 1996).

It is commonly recognized that promoting wind energy technology development in developing countries will contribute to efforts to reduce the risk of international conflict over energy resources and to avoid large-scale expansion of the global stock of fossil-based energy-supply systems. Wind energy is also a promising option for mitigating global climate change, in particular carbon dioxide (CO_2) emissions, compared with fossil-fuel based energy technology systems development.

In some developing countries, wind energy technology development has become institutionalized with support from national and regional governments, mostly through subsidies, and partly through policy incentives. Some are supported by multilateral and bilateral aid agencies with the involvement of international corporations. Although there is continued optimism regarding the potential to disseminate wind energy technologies, their uptake has been slower than what was expected in the 1992 United Nations Conference on Environment and Development.

The reasons why the uptake of wind energy technologies has been slower than projected or desired in developing countries are still not well understood. I believe that current governmental policies in some developing countries have provided inadequate conditions, or incentives, for disseminating wind energy technologies. The reasons can be attributed to ineffectiveness in operation, related to institutional barriers. This has been the case in China, although recent changes have shown positive signs of development. It is hypothesized that, in addition to inadequate financial resources and technical obstacles, barriers between and within institutions impede the use of wind energy, and limit their adaptation to societal needs.[12]

Past research on wind energy technologies have focused almost exclusively on technical issues and options for policy intervention. Some emphasize historical successes

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[12] One example is shown in the wind power project in the Dachen Islands, which is one of the case studies held by the author.

and failures in project implementation. In particular, most research efforts focus on issues, such as energy modelling, technology assessment, cost-benefit analysis as well as scenarios to project future development. Most studies tend to exclude the social and institutional dimensions of wind-energy technology development and utilization. The process of technology dissemination is neglected in many case studies.

It is argued in this study that institutional barriers are perceived as being primary sources of constraints, including inadequate policy incentives, ineffectiveness in project management, and conflicting sectoral interests between established institutions. For example, different goals and interests of production-oriented energy industrial organizations and governmental agencies can lead to sub-optimal policies that do not support cost-effective wind-energy technology adaptation and dissemination. Instead, policies may be directed toward support of conventional fossil-fuel based energy expansion.[13] There are also tensions between central and regional governments in priorities and interests in supporting wind power development.[14] The roles and capacity of the private sector in wind energy development are still not clearly understood. In particular, mechanisms to encourage private sector's participation in wind energy development are still in a primitive stage of development in China.

I emphasize that institutional barriers contribute to ineffective use of financial resources in project design and implementation,[15] and they also affect technological choice, and adaptation of infrastructure to meet local circumstances.[16] Increasing industrialization has already led to a strong preference to rely on conventional energy systems, which tends to restrain the adoption of renewable-energy technologies, such as wind turbines.

[13] One example is the plan to develop a 1,100 MW coal-burning power plant in the Chongming Island near Shanghai, which is proposed by the Huaneng Corporation, a state owned large energy company, as a major energy development project. This project is considered as an extension to the newly constructed 250 MW coal power plant, due to be completed by 1998. There are disputes over this new plan. Alternative suggestions are made to establish a huge wind farm with 1,200 MW of generating capacity at the same island. See: *Wind Power*, No.2, 1995, pp.23-28.

[14] In China, there are different technology trajectories in different regions in efforts to indigenize foreign wind turbine technologies. This is illustrated in the following sections.

[15] This is the case in the Dachen Island project.

[16] The example is the Inner Mongolia as shown in the case study.

There exist tensions between institutions in decision-making over choice of different energy systems. On the one hand, there are strong preferences to build up economic competence for raising income; on the other hand, there are dynamic forces that support flexile and environmentally benign energy systems to meet local demands. Small-scale, environmentally friendly technologies are often dominated by supply-oriented, large-scale development, pushed by desires for industrialization. It is assumed that these factors constitute primary sources of conflicts in implementing wind energy development.

This study attempts to analyze the development trajectories of wind energy in China. It is argued that at the current stage of wind technology development in China, most projects still need support from public-sector finance and international aid. The lack of adequate policy support, i.e., various incentives, is often claimed to be a major obstacle to promote the dissemination of wind energy technologies, despite inadequate financial and economic conditions. The case study from China indicates the above assumptions. It demonstrates the need for proper institutional settings as a precondition for effective dissemination of wind energy technologies.

The article describes the historical trend of wind energy development and the main characters in each of the four phases of wind energy development. It shows what actors are involved in the wind energy market and their interest and motivation. It discusses the issues of technology development and market potentials, in which various institutions play a role, in particular investment loans, taxes and price mechanisms. In the last part of the article, two case studies about wind energy development in Inner Mongolia and the Dachen Island in Zhejiang Province are presented as illustrative examples.

Development Objectives and Approaches

China has taken a decentralized approach to wind energy development, especially on off-grid applications, and has placed strong emphasis in exploiting local resources and developing technologies that suit local conditions and needs. Until recently, China's wind energy market has been targeted to small-scale applications of domestically manufactured wind turbines. However, there is an increasing demand for imported large wind turbines (300-600 kW) at the regional level with different purposes, e.g., demonstration, or commercial expansion.

The rationale for promoting wind energy technologies and their applications in China is multiple-faceted. China has large potentials for wind energy development. The

exploitable wind resources are very large, estimated at 250 GW (ZERI, 1996, p.4). Historically, promoting wind energy technologies has been linked with such development objectives as providing electricity to poor people in rural communities in order to increase their living standards, or reducing poverty through electrification. In recent years, objectives for wind energy development have become widened to include: 1) Social: poverty reduction and socioeconomic development; 2) Economic: increasing the cost-effectiveness of wind energy dissemination; 3) Environmental: reducing environmental pollution; 4) Technological: increasing R&D capacity for wind turbine technologies, accumulating operational experience, improving design and competitiveness; 5) Commercial: increasing production capacity of domestically designed wind turbines for export and domestic market expansion; and 6) International relations: improving China's international image and bilateral and multilateral relations.

In light of the historical trends and the recent increase in wind energy development at the regional level, this study investigates the institutions and policies at both the central and regional levels. The objectives, policies, and mechanisms involved to promote wind energy technologies are often different at these two levels. Such differences are also reflected in the promotion of small-scale vs. large-scale wind technologies, as well as local/indigenous vs. imported technologies.

Historical Perspectives

Wind energy technology in China has gone through four phases of development with different characteristics, approaches, and results as shown in the following sections:

1958-1977 This is an exploratory stage with the self-reliance policy as the guiding principle, mostly depending on domestic research and development (R&D) of small-scale wind turbine technologies. This technology development is limited by the R&D capacities of the industry. It is mostly dependent on the outcome of R&D from state owned research institutions. Wind turbines developed during this period focused on mini-wind turbines (50-150W). Market demands for such products were high, because of the governmental subsidies and the needs of small off-grid end-users. Small wind turbines with the capacity up to 12 kW were also developed and tested, but failed to commercialize in market, due to lack of demands.

1978-1983 This is a period of policy adjustment and technology expansion. Small wind turbines were targeted with the increasing emphasis on R&D and technology dissemination. From 1978, the state government prioritized wind energy development, in order to provide electricity to people living in poor rural communities. R&D efforts were combined with demonstration projects. Inner Mongolia was active as the main promoter of this development, with the support from the central government (see the case on Inner Mongolia).

1984-1989 This is a period for market expansion and institutional establishment. This is particularly seen in the Inner Mongolia region where the development of wind energy was institutionalized through the establishment of the New Energy Office in the government in 1994. Policies to provide subsidies were established, with the aim to support local users. Technology dissemination became widespread across different provinces. In this process, Inner Mongolia has played a leading role in demonstrating the potentials in fulfilling the rural electricity demand. In the period, more than 30 R&D institutions were established and over 20 manufacturers were under operation. Meanwhile, import of foreign technologies (50W-10 kW) was promoted, directed and supported by central governmental institutions, such as the State Planning Commission (SPC) and the State Science and Technology Commission (SSTC).[17]

1990-present This is a period of rapid expansion of imported wind technologies with the increasing involvement of major wind turbine producers from Denmark, USA, Germany and Austria. Indigenization of foreign technologies has been targeted as an important objective of the state policy. This is mostly motivated by the fact that domestically developed technologies for large units (more than 200 kW) have difficulties to compete with imported products in terms of technical maturity and reliability. Domestic R&D and production capacities also cannot meet the rapid growth in market demand for large wind turbines.

Commercialization has become an important feature of the wind energy industry. Focus of development at the regional level has shifted from small units for households toward large wind farms for grid-connected electricity production. Due to the reduction of governmental subsidies and the increase in production costs from 1990, market demand started to decline, particularly with small wind turbines. After several years of adjustment,

[17] As part of the restructuring process of the state reform in 1998, the SSTC has become the Ministry of Science and Technology (MST). However, as most of the analysis in this article emphasizes on the past experience, the name of the SSTC is used in the following sections.

production of small wind turbines began to recover in 1994. However, the main emphasis is now on large commercial wind farms for grid-connected electricity generation. Regions with large wind resource potentials are eager to lead this development. In particular, we have seen rapid expansion of wind electricity production capacity in Inner Mongolia, Xinjiang and Guangdong Province.

China's growing interest in wind energy is justified by the following factors. Out of the total population of more than 1.2 billion, China has about 900 million people living in rural areas, of which more than 100 million still do not have access to electricity supply and services. About 270 million people still living under the poverty line, despite the progress achieved in poverty reduction in the past two decades.[18] In addition, over-consumption of biomass resources, and the heavy dependency on fossil-fuel based energy sources, especially coal, have all put pressure on the environment of the country. To reduce such an impact, going for wind power is a preferred choice.

China has set a capacity target of 1,000 MW wind-energy by the year 2000. It is estimated that to realize this objective will need about 10 billion Yuan (US$1.2 billion) of investment (Zhou, 1996, p.18). Several large-scale wind farms in Xinjiang, Inner Mongolia, and Guangdong Provinces are under rapid development. In Guandong Province, the first domestically manufactured wind turbines (200 kW and 300 kW) are installed and demonstrated.

There are two ambitious plans of the SDPC. The first is the "China Light Program", which intends to provide electricity to 8 million people living in remote and isolated rural areas. The short-term objective is to install 40-60 MW of wind generating capacity for 2,000 villages, 100 military sits and 100 telecommunication stations in five years from 1997 to 2001. The long-term objective is to provide electricity to more than 23 million people by the year 2010. The main characteristic of this program is the decentralized objective with the emphasis on small wind turbine development. The second program is the "Chengfeng Plan", or "Go with Wind Plan", which aims for large-scale development of wind farms. More than one billion Yuan will be invested in projects to indigenize foreign technologies and establish domestic production capacity for large wind turbines.

[18] According to the World Bank, the poverty rate in China has declined by 60 percent, as 200 million Chinese living in absolute poverty have been raised above the minimum poverty line since 1978. See: Ahuja, 1997.

Another initiative is initialized by the State Economic and Trade Commission (SETC), entitled the "Shuangjia Plan", aiming to speed up the process of technical innovation for wind technology development. During 1996-2000, 1.2 billion Yuan is to be committed to support key state owned industries. Most of the money is to be used to purchase wind turbines from foreign suppliers.

International Development Assistance Agencies are notable stimulators in China for wind energy development. Bilateral aid initiatives from, e.g., Denmark, Germany, the Netherlands, Spain and the USA, have provided incentives or favoured conditions, such as grants and soft loans, for regional programs to take place. So has the financial stimulus from multilateral development assistance agencies. Their initiatives have promoted interest from regions with large wind resources.

Companies in the Wind Energy Market

State owned companies are the main players in China's wind energy market. The most dynamic is the China Fulin Windpower Development Corporation established in 1992, which is the main actor in the domestic market. Other active players are at the regional level, particularly the regional wind energy companies in Inner Mongolia, Xinjiang and Guangdong Province where wind energy is a high priority. The main trend is that most provinces have shown a growing interest in monitoring and exploiting wind potentials. From the central governmental perspective, pragmatic policies are undertaken to allow more flexible arrangement in investment and contract with foreign investors. This is part of the shift in the state energy policy that has, historically, been centralized with state monopoly and control. However, total opening-up of the wind market is anticipated, as barriers for free market competition still exist.

It seems that regional players, such as the Wind Energy Corporation in Inner Mongolia, has made a shift in its business strategy from relaying on domestic finance, i.e., investment from the state, to emphasizing international investment provided by development assistance agencies. However, this may represent a distorted vision of the potentials from domestic sources of financing.

The private sector is active in China's wind energy market, but with different perspectives. Large foreign companies, such as MICON, Vestas, BONUS, started their engagement in China from the late 1980s. Their involvement in China has become intensified in the past few years, particularly through cooperation with regional governments and wind energy companies. Their interest in China has, to a large extent, been motivated by the national strategy to expand grid-connected large wind

farms. However, most foreign investors in the wind energy sector are still suspicious about the policy barriers and risks in the wind energy market in China (Moynihan, 1995).

Companies with private ownership in China involved in the wind energy industry are rare. They are still not encouraged by the state policy in practice. This is very much related to high risks in investment, long pay-back times, thin profit margins, and uncertainties in governmental policy.[19] However, there are indications that some private enterprises, and groups, are showing strong interest in investing in wind development, but they are reluctant to take decisive actions because of the lack of policy incentives.[20] This indicates that without adequate policy stimulus, there will be a low-level engagement from private investors, both domestic and international alike.

Technology Development and Market Potentials

Small wind turbine development has been the main objective of the governmental policy until the late 1980s. By 1996, a total of 159,000 units of wind turbines were produced and the installed capacity reached 56 MW. The shift of policy emphasis toward large wind turbines started in early 1990s. Currently, there are 16 wind farms with 237 units and about 60 MW of installed capacity. Almost all of the production units are imported from suppliers in Denmark, USA, the Netherlands, Austria, and Germany.

In 1990, China had wind generating capacity of about 13 MW from wind farms. By 1997, this number has increased to 160 MW, or 12 times increase. This can be compared with the total increase of 150% in world wind generating capacity between 1990 and 1995 (Flavin, 1996). Currently, there are 140,000 small wind turbines in use in remote rural areas in China. The main driving force for this development is from governmental support, particularly at the regional level. In regions where there are active wind energy projects, governmental support holds the key, which is reflected in policy schemes, such as tax relief and subsidized electricity prices. The other dynamic is the assistance from bilateral aid that gives soft loans with lower interest rates and long pay-back times (ten years or more).

A plan for a wind-power site with a generating capacity of 64 MW recently passed the state technical appraisal. The site lies in Dabancheng, in Northwest China's Xinjiang Uygur Autonomous Region and cost $60 million to complete. At present, more than 200 wind generators are under operation. Another 20 units of 600 kW wind generators and 51 units of 500 kW generators will be installed later this year (*China Business Net*, May 19, 1998).

China’s small wind turbines have already become a mature technology, and its export potential is increasing. Currently, products are exported to 22 countries in Europe and Asia, in additional to the expanding domestic market. In 1996, about 160,000 units of small wind turbines were produced in China. There are several trends in wind energy development in China as indicated below:

First, from small to large units. One of the dynamics for wind turbine development is the changing demand of rural people. In the past, market demand was mostly on mini wind turbines (50-100W). In recent years, demand for larger units (300-500W) is on the rise, mostly because of the increase of living standards.

Second, from individual to collective use. Utilization of wind turbines has changed from individual household to collective (several households) and communities/village levels, which tend to encourage purchase of larger wind turbines. It is also a reflection of demand for higher operational efficiency of wind turbines.

Third, from single wind turbines to wind/diesel, wind/solar, and wind/solar/diesel systems, which aims to increase the quality of electricity supply, and fulfil the needs of isolated rural communities and individual households.

Fourth, from dependency on domestic design and production to joint ventures with imported foreign technologies. This has increased the competitive advantage of the domestic producers with low production costs. 5 kW and 10 kW units have already become competitive in international market, being exported to many countries.

Fifth, from small off-grid wind units and farms to large grid-connected wind farms. This change is motivated by the desire, mostly governmental driven, to turn wind energy into an important source of electricity supply, and

[19] According to interviews with key company managers in China, conducted in March 1998.

[20] According to an interview with Yan Yize, Executive Director of Xunfeng Wind Power Corp. The company has already accumulated a total amount of 500 million Yuan from individual shareholders with each valued at 250, 000 Yuan. However, they are still reluctant to start the business operation due to lack of proper policy, such as reduction of taxes and electricity price incentives.

connect these electricity generating capacities into national and regional grids.

Institutional Conflicts

There are considerable barriers in wind energy development. We see the origins of these barriers coming from different institutions. From an organizational perspective, there are three State Commissions all responsible for wind energy development in China: the State Development Planning Commission (SDPC)[21], the State Science and Technology Commission (SSTC) and the State Economic and Trade commission (SETC). SDPC is in charge of planning and budget approval for large wind-power projects. SSTC is in charge of planning and administration of R&D activities related to wind energy development. It is also responsible for matters related to technology transfer, particular with regard to foreign technologies. SETC co-ordinates economic operations, enterprise restructuring and reform, and upgrading of technologies in industry. The three State Commissions all have a particular division dealing with renewable energy development and they often overlap in their operations and sometimes compete for power and control. This management system for renewable energy is, to some extent, ineffective in project approval and implementation, due to conflict of sectoral interests (The World Bank, 1996, p.48).

In addition to these Commissions, there are four key actors at the ministry level: the Ministry of Hydropower, the State Machinery Industry Bureau,[22] the Aerospace Industrial Corporation[23] and the National Electric Power Corporation.[24] They are powerful agents, all attempting to take a share of the wind energy market in China. These actors sometimes have different motivations and interest, which can become sources of conflicts.[25] With this diversification in interest and power relations, there exist considerable problems of coordination.

Investment Loans and Taxes

Wind energy development in China is restrained by relatively high investment costs. According to estimates (*Wind Power*, No.4, 1997, p.4), cost for wind energy development in China is at 9,000-12,000 Yuan/kW, compared with solar (50,000 Yuan/kW), nuclear (24,000 Yuan/kW), coal power plants (5,000 Yuan/kW without desulphurization equipment and 8,000 Yuan/kW with desulphurization equipment).

Current bank loans for wind energy investment have certain limitations, e.g., higher interest rates (11.7%), and short pay-back times (less than 5 years). Taxes for imported equipment are: import tax (12%) and VAT (17%). Soft credits provided by foreign governments usually contain 35% grants, but this advantage is overtaken by these taxes. In addition, VAT for electricity produced from wind turbines is also set at 17%. VAT is the same as for the electricity generated from coal-based power plants, which enjoy depreciation for equipment. No depreciation incentives for wind turbines are available so far. Comparatively, VAT for small hydroelectric development is at 6%. There are only two types of credits: commercial loans and the loans provided by the Shuangjia Program. Long-term (more than 10 years) and low interest loans are generally not available by commercial banks. These are important barriers for wind energy development at the current stage of development. Clearly, wind energy needs policy incentives in order to become competitive in the energy market place.

Price Distortions

Although the potential market for wind energy is high, current development is handicapped by low prices for wind generated electricity. There exists wide energy price distortions in the energy market. Wind energy competes unfavorably with other conventional energy sources. With the lack of proper energy price structure, which could internalize social and environmental costs of energy production, distribution and consumption, wind energy is still unable to compete with conventional energy sources such as coal (Wang and Shi, 1994, p46).

There are large differences in wind electricity prices between provinces, for example, Liaoning (0.9 Yuan/kWh), Xinjiang (0.86 Yuan/kWh), Hainan (0.8 Yuan/kWh), Guangdong (0.7 Yuan/kWh), Inner Mongolia

[21] Formerly the State Planning Commission (SPC) before 1998.
[22] Former Ministry of Machinery Industry.
[23] Former Ministry of Aerospace.
[24] Former Ministry of Electric Power.
[25] For example, the former Ministry of Electric Power supports the reduction of VAT from 17% to 6% for electricity generated from wind farms, but this interest is not consistent with that from the National Electric Power Corporation, which tends to disregard this request.

(0.63 Yuan/kWh), Fujian (0.2 Yuan/kWh).[26] In Xinjiang, total pay-back times for Dabancheng Wind Farm is estimated at around 6-7 years under the current price system. This quick return in investment is mostly due to the higher electricity price set up by the regional government. By contrast, The Pingtan Wind Farm in Fujian Province has seen a major decline in performance. It is mostly caused by the low electricity price for which the company has had a budget deficit for years (Lin, 1997, p.32).

The price for imported wind turbines is becoming lower in recent years at around 7,000 Yuan/kW (Zhang, 1997, p.54). If other costs are estimated, including VAT for imported products, large wind turbines may cost 10,000 Yuan/kW. Comparatively, the cost for coal based power plants is around 5,000 Yuan/kW (without desulphurization equipments) and 8,000 Yuan/kW (with desulphurization equipments). Although wind energy is not very competitive at the current stage of development, compared with the investment costs for fossil-fuel based power plants, the inclusion of environmental externality in power generation in coming years could change this situation drastically.

Foreign Technology vs. Domestic Technology

There are two trends in wind turbine development in China. China has devoted considerable R&D resources and efforts to establish indigenous capacity for wind turbines. Development of small wind turbines has been standardized through eleven national standards and 25 industrial standards. Prototypes for wind turbines of 100-200 kW were tested and demonstrated during 1985-1995, but largely failed to commercialize them in the market place. The reasons can be attributed to: high-tech contents of large wind turbines, lower input of investment and high costs of 6,300 Yuan/kW (*Wind Power*, No.2, 1997, p.32).

For larger wind turbines (over 200 kW), China has, in practice, relayed on imported foreign technologies. By 1996, out of the 56 MW of installed wind turbines nationwide, only 950 kW of the generating capacity came from domestically made wind turbines. It accounted for only 1.7% of the total installed capacity (*Wind Power*, No.2, 1997, p.21). Clearly, China is still in the early stage of establishing its domestic R&D capacity and manufacturing competence for large wind turbines. In recent years, economies of scale in wind turbine development have become a concern in wind industrial policy. It has been realized that small units are relatively expensive, although they meet decentralized needs and satisfy local demands. To meet industrial development objectives at the regional level, large wind turbines are considered more cost-effective, because of the scales of the economy (Liu and Luo, 1997, p.34).

Government is so far the main player in the drive for wind energy development. There are four different types of technology trajectories so far: 1) self-reliance, i.e., relaying on domestic R&D capacities; 2) assembly of imported spare parts; 3) full import of foreign technologies and products; 4) joint ventures to import foreign technologies and indigenize them by building up domestic production capacities.

Aiming to succeed in the Chinese market, three steps are usually undertaken in disseminating foreign technologies: first, establishing demonstration sites through grants provided by bilateral and multilateral sources; second, selling of wind turbines through soft loans provided by foreign governments; marketing products produced by companies of the credit making country. Comparatively, prototypes made by domestic manufacturers go directly to market development and there is a lack of intermediate steps to test the maturity of products, and so is the demonstration process. This explains in part the insignificant performance of the domestic products.

Case Studies

The following two cases show how different results can be achieved due to different policy arrangements and corresponding management practice. The cases indicate that back-up of adequate policies and management expertise holds the key to achieve sustained growth in wind energy development.

Wind Energy in Inner Mongolia

Wind energy development in Inner Mongolia started in the 1970s and it is the earliest promoter among different regions in China. Inner Mongolia has very good wind resources with the total exploitable capacity of 100 GW, which accounts for 40% of the total national capacity. Inner Mongolia has adopted a strategy of becoming the pioneer of wind energy development. This is realized through two parallel development: first, widespread small

[26] In some cases, local governments set up particular policy for wind electricity prices. In order to support the development of the wind farm in Nanao County, which is now the largest wind farm in the coast areas in China, Shantou City government increased the wind electricity prices as follows: 1989-92 (0.42 Yuan/kWh), 1992-93 (0.52 Yuan/kWh), 1993 (0.65 Yuan/kWh). See: *Wind Power*, No.1, 1995, p.10.

wind turbines for decentralized off-grid household use, aiming for the increase of living standards of 150 million rural residents in the region; and second, large wind farms for grid-connected electricity generation, aiming for industrialization and energy export to other regions.

By 1997, more than 140,000 small wind turbines were installed with an annual increase of 5,000 units. These units are all made within the region, supported by the extensive network of services. By 1997, total installed wind capacity from four wind farms reached 45 MW, which is the No.1 among the regions in China (Chen, 1997, pp.29-31).

The regional government has prioritized wind energy development with an established institution for wind energy technology innovation and management. Subsidies have been instrumental in stimulating interest of rural residents. Farmers receive 200 Yuan of subsidies for each purchased wind turbine unit. Another major stimulation is the demand for energy services, particularly based on electricity, as living standards increase.

Inner Mongolia has two of the ten largest wind turbine manufacturers in the area of small wind turbine production (*Wind Energy*, No.2, 1992, p.2). The utilization of loans from bilateral sources is the main stimulant for large-scale wind energy development. In 1990, the small wind turbines under operation in Inner Mongolia account for 78% of the national total. Among the 88 counties, 60 have established institutional frameworks for wind technology dissemination and maintenance service. 28% of the rural population are now using wind electricity. In the best case of Siziwang Banner, the dissemination rate for wind energy has reached 90% with more than 8,000 installed units (Wang and Chen, 1992, p.2). The widespread use of wind turbines has increased the quality of life for rural people, which can be measured through increasing use of home electric appliances in the region.

There is a problem of dissemination of wind turbines within low wind-resource intensity areas. It was reported that more than 10,000 units were sold in these areas that resulted in inefficient use of capital and low utilization rates of wind turbines. To solve this problem, wind/solar systems were introduced, which showed promising results (Wang, 1992, pp.4-6). The regional government has envisioned the development of wind energy as a key industry, and become a dynamic leader in this field in the country.

Dachen Islands: Wind/Diesel System Development

In China, there are 6,500 islands, in which only about 400 islands are inhabited and the rest without inhabitants. The main problem is the lack of energy supply that has limited the development of the island economy. Dachen in Zhejiang Province consists of two big islands and 15 small islands located 54 km to the Eastern China Sea. There are 8,000 people living in the islands with the fishing industry as the major source of income. These are isolated islands with an off-grid electricity supply system (diesel electric generator). There were big energy shortage problems in the 1980s, which limited the local economic development and affected the lives of the local residents. The desire to solve the energy shortage problem and experiment with new off-grid wind energy systems motivated this wind/diesel energy project as shown below. The project also meant to demonstrate the usefulness of such a technology in isolated coast regions, particularly islands, in China, and in the Asian-Pacific region (European Community, 1986).

The European Community, jointly with the Chinese government, provided a grant of 4 million ECU and technical assistance to build up a wind/diesel system (DES) in Dachen islands in 1988. Three units of Danish-made 55 kW wind turbines were installed, plus two Chinese-made 20 kW wind turbines. This is a demonstration project with ambitious plans to disseminate the experience to other isolated islands and those in the Asian-Pacific region. The project was claimed to be successful by both the European and the Chinese counterparts in 1989 (Lian, 1989). The project showed its usefulness in the early years till 1993-1994, but stopped operation in 1994. After four years since 1994, the wind turbines have become unusable. This result is different from what was predicted in the project evaluation made in 1989, which showed a promising future for disseminating such a technology in coast areas in China and the Asia-Pacific region (Lian, 1989). Above all, the performance of the wind farm indicates the gap between project design and operation, in which effectiveness is of concern.

The main causes for the problem can be attributed to the following, according to my interview and investigation at the Dachen Island:

1. The control and management framework for the wind-diesel system is inadequate. This is reflected in the electricity price set up by the local public-owned utility company. The high electricity prices have played a role to disencourage the private sector, mainly the fish processing and ice-making industries, from using the electricity provided by the public

utility. Instead, each private enterprise installed its own diesel generator. The cost of electricity production is about 0.5 Yuan/kWh, compared with the monopoly price of 1.3 Yuan/kWh from the public utility.

2. The public utility is in huge budget deficit (about 800, 000 Yuan per year), due to inefficient management. This has led to higher electricity prices set up for different end-users.[27] This price barrier has limited the local economy to grow.

3. There is a lack of demand for electricity due to: the self-reliance strategy of the local industry, the decline of the fishing industry because of the depletion of fishery stocks,[28] the slow development of the service sector, including tourism.

4. There is a lack of competence in managing the wind-diesel system, mostly due to inadequate training.[29]

5. Migration of local residents to the mainland, due to better economic opportunities in the mainland, and lack of development in the Dachen islands.

Conclusions

This study indicates the importance of institutional roles in wind energy development process. It shows through the analysis that sustainable wind energy development is not only determined by technical issues and components, but also depended on cost-effective mechanisms for operation, e.g., economic, financial, political and legal institutions. China's experience in wind energy development demonstrates that lack of adequate policy frameworks constitutes a major barrier for cost-effective wind energy dissemination. This is in part due to distorted energy policy in favor of conventional, i.e., fossil fuel based, energy expansion. There is little doubt that governmental policies and incentives, e.g., tax benefits, subsidies, electricity price, and market mechanisms, can play decisive roles in stimulating wind energy development and dissemination. In addition, improved coordination between different domestic actors is useful in situations such as negotiation with foreign suppliers and contractors.

It must be realized that many distorted policies are made, due to the lack of awareness and understanding of wind energy related social and environmental benefits. It is important to make more efforts in human resources development and capacity building for wind energy development and dissemination. The role of education, training and media reporting is, therefore, crucial in fostering development in the long run.

China is still in the initial stage of wind turbine development. The current development is, to a large extent, sustained by the incentives provided through soft loans and grants from bilateral and other international assistance programs. To reach sustainable development of wind energy programs, mechanisms for encouraging interest from the private sector and commercialization of domestic products should be improved, at both the national and regional levels. China's move in wind energy development with two ambitions is encouraging: small-scale development for satisfying rural needs, and large-scale development for industrialization and commercialization. It is expected that China has a huge potential to become a dynamic nation in wind energy development, if inadequate institutional barriers are reduced. To realize this potential, vigorous policy measures need to be established.

[27] Electricity prices are for local residents at 1.05Yuan/kwh, industry at 1.3 Yuan/kwh and the service sector at 1.5 Yuan/kwh. However, the cost for the electricity generated from this wind/diesel system is at 0.7 Yuan/kwh (*Wind Power*, No.1, 1994, p.59).

[28] There were more than ten fish processing industry enterprises in the Dachen Islands in the 1980s, but only seven are under operation by 1998.

[29] Based on an interview with the manager at the local public utility.

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China Environment Briefing

Compiled from the China Daily *by Changhua Wu*

Zhu Rongji on Sustainable Development

At the National People's Congress annual meeting this month, Chinese Premier Zhu Rongji touched upon environment and sustainable development issues in his Work Report to the Congress.

He noted that China will carry out a sustainable development strategy and protect natural resources and the ecological environment while developing its national economy. "We should always bear in mind our responsibility to the people and our future generations...improving planning for resources and their management, avoiding waste of resources for short-term gains, protecting resources and making a more comprehensive use of resources," he said.

Efforts should be made to enhance public awareness of the importance of environmental protection. Investment should be increased to intensify efforts to control and treat pollution in major cities, regions, valleys and sea areas. The premier stressed that enterprises that discharge pollutants in levels exceeding standards should remedy the situation within a specified time. Those that fail to do so must be closed down.

He said control of air pollution in Beijing, the capital, is a major task being tackled this year and asked relevant departments of the State Council to give full support to this effort. "We should do a better job of formulating urban and rural development plans and strictly implement them, punishing those who violate stipulations of the plans," he said.

China to Stop Leaded Gasoline Production

China's state-run oil refining company will stop producing leaded gasoline by 2000. Sinopec has been revamping and upgrading its refineries to meet demand for cleaner fuels.

China imports diesel with a sulfur content of 0.5 percent to 1.0 percent, but such imports will be cut off later this year and replaced y diesel with 0.2 percent sulfure content. (3/8)

Pollution Threatens Cultural Heritage

China is facing a urgent task of rescuing its cultural relics from pollution. Prompt measures should taken to protect the country's rich heritage of cultural relics from further damage by pollution, according to the government.

Acid rain, suspended particles produced by coal burning, and sulfur dioxide emissions are the culprits to blame. Some 23 million tons of suspended particles are emitted by burning coal each year in China. Those particles have accelerated the corrosion of stone sculptures at such rich cultural sites as the Yungang Grottoes in Shanxi Province, the Yaowangshan Grottoes in Shaanxi Province, and the stone sculptures at the Song Tombs in Henan Province, where most of the emperors of Song Dynasty (960-1279) are buried.

Acid rain has led 500-year-old bronze astronomical instruments in Nanjing Purple Mountain observatory in Jiangsu Province to corrode at four times the spped bronze normally corrodes in an unpolluted environment. Sulphur dioxide emitted by chemical plants within 10 kilometers of Guangsheng Temple in Shanxi Province since the 1970s has darkened the temples' 400 square meters of frescoes and 100 colored sculptures.

In an effort to curb the pollution damage to relics, experts established an environmental monitoring network at major relics sites in 1995, aiming to assess pollution damage and sources. (3/2)

A Look into Water

The problem of fresh water supplies is likely to be the most important issue of the 21st century in China, according to some members of the CPPCC. Right or wrong, China has been struggling with water shortage and pollution for many years. The challenges are expected to continue right into the new century. In the last couple of months, many water-related stories have appeared in different media in China, which has painted very different pictures of water in the world's most populous country.

- Zhengzhou, capital of Henan Province with a population of 6.2 million, is facing a water supply shortfall as a result of worsening pollution in its principal water source – the Yellow River.
- Guangzhou, capital of Guangdong Province in south China, faces the most serious crisis in drinking water in 50 years due to the invasion of salty tides from the sea.
- Shandong in east China is experiencing the worst dry spell of the century. The drought has affected more than 2 million hectares of farmland.

- Climate change has been blamed for the Yellow River drying up. Chinese scientists say dramatic changes on the Qinghai-Tibet Plateau are the main reasons for the ecological deterioration and drying up of the river.
- Heilongjiang and Fujian provinces are building water control facilities to upgrade their capacity to fight floods this year.
- The Xinjiang Uygur Autonomous Region in NW China is planning to spend 1.5 billion yuan (US$180 million) on improving the environment of the Tarim river, the world's second-longest inland river.
- An estimated 20 billion yuan (US2.4 billion) of funds will be poured into water conservancy projects this year, focusing on intensification of the management of their construction, according to Ministry of Water Resources.
- Zhejiang Province gets tough on the quality management of water conservancy projects. From now on, all people in charge of construction will be held responsible for life for accidents caused by the poor qualiy they have supervised.
- Members of the Chinese People's Political Consultative Conference voiced support to diverting water from the south to the thirsty northern and western areas of China. Once the project is finished, it is expected that 110 billion cubic meters of water, twice the current volume of the Yellow River, can be piped north each year. It is also suggested that the costs shall be restricted to one-third of that incurred using diesel-engine pumps.

National Climate Center Releases Report

China last year experienced various climate-related catastrophes, especially the worse summer rainstorms and floods since 1954, which caused great damage.

Last year's climate changes featured excessive rainfalls in some seasons and persistent warmer weather in the rest of the year, according to the NCC's '98 China Climate Bulletin.

Temperatures in 1998 were abnormally high, with a hot autumn and a warmer winter. As a result, China has experienced warm winters for 12 years running since 1987, and the last year saw the warmest autumn since 1949. Winter temperature last year were one to two degrees centigrade above average in the North and 0.5 to one degree Celsius above average in the South. (3/10)

Nations co-operate in marine studies

Sustainable oceanic-resources exploitation lies at the heart of 20 years of Sino-US co-operation on oceanographic science and technology. The two countries signed cooperative protocol 20 years ago.

The protocol enabled the United States to become the first country to sign inter-governmental agreements with China on oceanic science and technology co-operation.

At present the two countries are working together as partners in the field of integrated coastal management at six sites, three marine areas under State protection in each country, to address common environmental concerns.

The sister sites have different focuses in co-operation:
The Rookery Bay National Estuarine Research Reserve in Florida and the Shankou Mangrove Ecosystem Nature Reserve in the Guangxi Zhuang Autonomous Region mainly concentrate on protecting and restoring mangroves in Shankou, which have been damaged by increasingly intensive agriculture and other human activities.

The Florida Keys National Marine Sanctuary and the Sanya Coral Reef Nature Reserve in Hainan Province are introducing advanced techniques for managing coral-reef preserves and training preserve managers in Sanya.

The Chesapeake Bay National Estuarine Research Reserve and the Tianjin Paleo-coastal and Wetland Nature Reserve are working together on wetlands conservation and in education of the public and decision-makers in Tianjin about the ecological and economic values of wetlands resources.

Project aims at saving river

A forest project launched in Dongying is part of a campaign aimed at improving the ecological environment in the Yellow River and Yangtze River valleys.

More than 66,700 hectares of trees will be planted in the lower reaches of the river within the next five years to prevent soil erosion and help restore ecological balance.

The Yellow River runs for more than 5,000 kilometres and is North China's most important water source. It starts in Qinghai Province and flows eastward across seven provinces and autonomous regions to empty into the Bohai Sea at Dongying.

However, the environment in the Yellow River Valley has been deteriorating in recent years due to worsening soil erosion brought by excessive logging.
Every year the river washes more than 1 billion tons of sand into the sea, scientists estimate.

According to official figures, the lower reaches of the Yellow River went dry for 226 days in 1997 and 136 days last year.

Scientist cites danger of indoor air pollution

URBAN dwellers spend 80 per cent to 90 per cent of their time indoors in an environment that is dangerous to their health, according to a Beijing environmental scientist.

Recent statistics from Beijing's Chemical Poisonous Substances Test Centre indicate that more than 400 poisoning accidents reported annually are the direct result of indoor air pollution caused by construction and interior decorating materials. The statistics also revealed that some 10,000 people suffer from related accidents on an annual basis.

Indoor pollution includes carbon monoxide, nitrogen dioxide and microscopic airborne particles resulting from the use of coal, gas and tobacco. Interior decorating materials, furniture and household chemicals also release formaldehyde and various other volatile organic compounds. In addition, various construction materials and household appliances release radon, ammonia and electromagnetic waves.

New Renewable energy program launched

China will turn to renewable energy resources to reduce the consumption of fossil fuels and help clean the environment. The State Economic and Trade Commission (SETC) and State Environmental Protection Administration (SEPA) launched a major initiative yesterday in Beijing.

The project is aimed at speeding up application of renewable energy technologies and establishing feasible power generating and supply systems to meet market demands.

"Renewable energy resources offer a good solution to our country, which depends heavily on fossil fuels, and is now facing an energy shortage and environmental pollution,"said Zhai Qing, vice-director of SETC's Energy Resources and Utilization Department.

Officials expect the project will benefit 60 million people in China's vast rural areas, where access to electricity generated by fossil fuels is not available.

China boasts rich renewable energy resources _ including the wind, water, the sun and thermal power. Wind-generated power provides 255 million kilowatts, experts suggest.

However, more than 90 per cent of China's power supply is derived from burning coal and other traditional energy sources.

"The potential of renewable energy sources remains untapped in China, largely due to insufficient efforts to publicize advanced technologies, and to prove to people the technologies are economically viable," said Liu Hongpeng, the SETC official responsible for the project.

The initiative will address this problem by establishing power-generating pilot projects, utilizing the wind and solar energy, in rural areas.

Energy experts will use mature technologies to generate power through bio-gas and search for the best ways of utilizing solar energy.

The Chinese Government will inject US$11.5 million into the five-year project. The initiative is expected to cost US$25.8 million.The United Nations Development Programme (UNDP) and Global Environment Facility (GEF) donated US$8.8 million. The remainder of funding will be provided by the Australian and Dutch governments.

The project involves the largest technical assistance provided by the UNDP to any country.

Forestry

Surviving in the Jungle: Public Policy and the Role of State in a Changing Forest Landscape in China

Changjin SUN

WWF in Beijing

WHAT'S IN A FOREST

China is a forest-poor country

China has limited forest resources. According to the Fourth Inventory (1989-1993), China's forest coverage rate was only 13.92% (in comparison average forest coverage rate for the world is about 22%). By 1994, the total forest area in China was 134 million ha with standing stock volume of 11.785 billion cubic meters. This gives a per capita forests resources of 0.11 hectares (ha) or 8.6 m^3 for China. This total acreage of forests in China equals about 4% of the world's total, whereas China's arable farming land and population are 7% and 22% of the world's total, respectively. Among the existing forests, a large portion (34.3 million ha) are plantations. This makes China the country with the largest plantations in the world (Li eds, 1996, Chapter 1; FAO, 1997, Forestry Action Plan, 1995; UNDP, 1996).

China is a mega-biodiversity country and forests are a primary storehouse of biodiversity

The large territory, diversified geography and topography as well as varied weather patterns have made China the No. 1 country in the Northern Hemisphere in terms of biodiversity richness. There are currently in China a total of 30,000 species of higher plants (ranking third in the world): 1,340 terrestrial vertebrates, 499 species of mammals (equivalent to 11% of the world's total), 1,186 species of birds (equivalent to 13% of the world's total), 800 species of aquatic vertebrates including 12% of world's fish species, 380 reptiles and over 280 amphibians. China also has great endemism in species. It is recorded that 18,000 of the 30,000 higher plants in China are endemic; 62 of 499 species of mammals are endemic. China has many rare and precious species as well as pre-tertiary relics which are long extinct in other parts of the world such as the Giant Panda (Carey ed., 1996, Part II; IUCN, 1998; Harkness, 1998; Biodiversity Committee, 1995; China National CBD Implementation Report, 1998).

The rich biodiversity in China has significant economic and social importance. Forests provide the genetic foundation for many industries. For instance, there are over 1,000 species of wild plants still extensively used in traditional Chinese medicine today, and over half of China's population depends at least in part on traditional medicine for their health needs.

The multiple functions of forests

Forests are a source of multiple utilization and service to human-beings. These multiple functions and services have only been more or less rediscovered in China recently. Today, forests in China are recognized to provide at least the following five categories of functions:

Production—timber, non-timber forest products, fuelwood, and others;

Protection—land and farming protection, soil and water erosion control, wind protection and sand control, carbon dioxide sequestration;

Conservation—as a major biome of land ecosystem and host of biodiversity, wildlife and natural beauty;

Development—rural livelihood, poverty alleviation, asset building for rural households;

Recreation—tourism, spiritual healing, aesthetic value (Forestry Action Plan for China, 1995).

This rediscovery is the result of a variety of factors, including increasing resources scarcity, evolving consumer tastes and preferences, and changing demands on forests. Broadly put, the author supposes that there is an evolution in the priority use of forest resources in China in the past half century as follows:

Year 1950-80:
- Timber
- Fuelwood
- Eco-protection
- Non-timber forest products (NTFP).

Year 1980-present:
- Eco-protection
- Timber
- Biodiversity
- Recreation
- Poverty relief/rural development
- NTFP.

This changing pattern of forest resource use can be directly detected from the evolution of the forestry profession and the role of the state in such an evolution.

FORESTRY—AN EVOLVING PROFESSION OF UTILIZING FORESTS

A forestry kaleidoscope

The past twenty years have witnessed many changes in the forestry profession in China. These include, most notably, the fall of the state timber economy, the explosion of nature reserves, the experiment on community forestry, ICDP (Integrated Conservation and Development) and forestry for poverty alleviation, the 10 shelterbelts construction campaign, the "Military Pledge on Greening" which resulted in 9 provinces claiming to have eradicated "barren lands" in their provinces, the rise of eco-tourism and forest-recreation, the "Sihuang-four wastes" auction initiative under which contractees of wastelands gain 50 years or longer use rights over their contracted lands, the private investors' frenzy over the development of fast-growing (pulp) plantations, the timber-shopping around the globe by Chinese timber companies, the loss of many valuable wildlife and plant species, the flooding in the Yangtze, Songhua and Neng rivers and the public outcry over up-stream deforestation in summer 1998, and the initiation of the Natural Forest Conservation Action Program by the central government (China National CBD Implementation Report, Forestry Section, 1998, Natural Forest Conservation Action Program, 1997).

Against this background of rapid changes, it is clear that forests remain unchanged; the changes are in forestry as a profession as prompted by increasing resource scarcity and altering demands of the Chinese economy on its forest resources. Discussed below are some of the most significant events which have occurred in the past twenty years or so that have contributed to the changes of the forestry profession in China.

The fall of the state timber economy

The story of the state timber economy in China is one of collective exploitation of "common" property. The central government, namely the former Ministry of Forestry, has had a state timber sector with 1.5 million workers, producing over a half of the total timber in China. By 1992 accumulated state investment in 138 major logging companies was 11.62 billion yuan. These companies produced over 1 billion cubic meters of timber, paid taxes and profits of over 16 billion yuan, and accumulated fixed capital of 16 billion yuan (Li ed., 1996, chapter 7; Natural Forest Conservation Action Program, 1997).

The enormous forest stock inherited from early eras prior to the People's Republic of China, plus a large workforce and sizable state investments, have not saved the state timber sector from deep financial and resource crises. As detailed in the table below, harvestable resource stock in state company lands are now close to depletion.

Year	*Year 1950*	*Year 1995*	*Rate of Change*
Harvestable forest area	12 m ha	5.6 m ha	-53.0%
Harvestable forest stock	2 b m^3	0.47 b m^3	-76.6%

Source: Li ed., 1996, p.163.

More detailed statistics show that over 80% of state forest bureaus are close to be running out of harvestable forests, some of which are out of operation already. On the financial account, many state logging companies are close to bankruptcy. Since 1990 the entire state forest industry has been loss-making. Average debt/asset ratio in the state timber sector equals 70%, many are over 100%. About 2/3 of firms have salary pay over-due to employees, with unemployment rate reaching 17% (Li ed., 1996, chapter 7).

The history of state timber economy is essentially one in which the state runs a logging operation instead of a logging industry. Coupled with fixed low prices set on timber by the state, inadequate investment in replanting and inefficient management, the state timber economy finally drifted into a status of both financial crisis and resource exhaustion.

The explosion of protected areas

China's first nature reserve was established in Guangdong Province in 1956. In the early 1990s, nearly 100 new reserves were being established each year. As of 1993 there were over 760 reserves with a total area of approximately 66 million ha or 6% of the country. By the end of 1995, there were a total of 799 nature reserves which was 7.19% of national total land area, or 71.85 million ha. By the end of 1997, there were all together 926 nature reserves covering an area of 76.98 million ha (Intelligence on Forest Products, 1998; Forestry Action Plan for China's Agenda 21, 1995; China National CBD Implementation Report, Forestry Section, 1998).

Nature reserves are emerging as a new frontier for the state in managing forests. However, the state's role is again a difficult one because of a number of factors. First, the threat to and loss of biodiversity are proceeding at an accelerating pace in China. For instance, 15-20% of plant and animal species in China are threatened, which is above 10-15% of world average. Home to 156 of the 640 species listed in Appendix I of CITES, today 350 species of higher plants, 40 mammals and 83 birds in China are

officially listed as threatened (China National CBD Implementation Report, Forestry Section, 1998). Second, the enormous human and financial resources requirements and the potential conflicts between reserve management and local economic development in managing these newly-established nature reserves are all challenges that the Chinese conservation community is just starting to learn to grapple with (Harkness, 1998). Third, the government has yet to develop mechanisms for reserve management that appropriately define its role in the provision of public goods in the decentralizing Chinese market economy.

The dwindling timber supply—"Who Will House China?"

China started large scale importing of forest products since early 1980s, with annual net import value of 2-5 billion dollars. China has quickly emerged as the second or third largest timber importer in the world in the past decade or so. Some statistics related to timber import in China are documented below:

YEAR	MAJOR TIMBER IMPORTS (000 M^3)	MAJOR FOREST PRODUCTS IMPORTS (000,000 US$)
1981	2,211	1,757.03
1982	5,307	1,842.66
1983	7,084	2,013.91
1984	9,130	2,438.26
1985	10,794	2,761.11
1986	8,605	2,450.87
1987	8,714	3,112.48
1988	12,444	4,419.65
1989	7,621	3,125.29
1990	5,828	2,680.75
1991	5,894	3,300.13
1992	7,466	3,786.83
1993	6,626	3,984.37

Notes:
a) Major timber imported includes logs, sawn timber, plywood and veneer, whereas major forest products imported includes round log, construction lumber, veneer, pulp, waste paper, and major timber.

b)Source: Li ed., 1996. Table 1 on p. 112 and Table 3 on p. 116.

Current estimates put domestic timber shortage at 40 million m^3 /year by 2000, partially because of continued growth in domestic timber demand and partially because of a foreseeable decline in domestic supply prompted by the implementation of the China National Natural Forest Conservation Action Program (NFCAP) (Forest Products Intelligence, Issue 20, 1998). The implications of this foreseeable timber shortage in China for international timber supply and for conservation in other parts of the world are enormous.

From tree-planting to biosafety—the long-journey of constructing 10 shelterbelts

In addition to timber shortage, soil and water erosion, desertification and the loss of vegetation have long been considered as among the most fundamental threats to soil and freshwater and therefore the ecological basis of China. Over one third of China's land mass, or 3.67 million square km, are subject to soil erosion; 27.3% or 2.622 m km^2 are desertified lands, and desertification is proceeding at 2460 km^2/year (FAO, 1997; China National CBD Implementation Report, 1998; UNDP, 1996). Each year 2.467 m ha of stocked forests degenerate into unstocked forest lands or shrub forests. This amount of deforestation is close to ½ of total new plantings in acreage in China. Annual damages to crops are estimated at 20-40 million ha, with a value of 200 billion yuan (Li ed., 1996, Chapter 4).

China faces a daunting task of afforestation and reforestation. Stocked forests account for only 50% of total forest land in China, leaving 63 million ha barren land suitable for afforestation. In the past fifty years, China has been constantly attempting to promote tree-planting, with a beautiful target of "greening the motherland". The construction of large scale shelterbelts initiated in late 1970s with the "three-norths shelterbelt project" using primarily the socialist planning approach. This type of planning and mobilizing public resources has continued into the present days, with an expanded target of constructing 10 shelterbelts throughout China. The 10 shelterbelts that are being planned cover over 70% of national territory and would require a budget of 1.2 billion yuan/year but state investment has averaged only 0.12 billion yuan/year. More importantly, public campaign and moral persuasion have remained a major strategy of project implementation (Forestry Action Plan for China's Agenda 21, 1995; FAO, 1997).

The ineffectiveness and inefficiency of this old planning approach toward afforestation are obvious. According to government statistics, total annual tree planting has run at a staggering 5.4-6.0 million ha in China, and man-made timber forests increased 8.82 million ha between the 2nd and 3rd Inventories and 5.98 million ha between the 3rd and 4th Inventories. However, the survival rate for new plantings has been very low. For instance, current official

statistics put total accumulated tree planting and regeneration since 1949 at 210 million ha, whereas the total current stocked forests including natural forests are only 133.7 million ha! (Forest Products Intelligence, Issue 18, page 2.) Deforestation continues along side the mass afforestation campaign, and each year some 2.467 million ha of stocked forests degenerate into unstocked land or shrub forest. The following table shows the extent of deforestation in the years between 1984-93).

Period	*Deforestation Million ha*	*Degradation Million ha*	*Total forest loss Million ha*
3rd Inventory (1984-88)	3.82	19.56	23.38
4th Inventory (1989-93)	2.19	9.89	12.08

Source: Li ed., 1996, p. 13 in Chapter 1.

It is only recently that the concept of biosafety has started to gain acceptance in China, primarily in the professional community. The intellectual advance from preventing erosion to safeguarding biosafety is a historic achievement in ecological protection in China. However, making the concept of biosafety accepted and integrated into the greening efforts of the China government remains a challenge.

ADVANCES IN GOVERNANCE

The evolution of forestry as described above has both necessitated and been prompted by changes in the governance of forest use by the state. A number of the most important such changes are discussed below.

a) The "Specialized Management Principle"

The Specialized Management Principle (SMP) is the strategy adopted by the Chinese government for managing multiple uses of forests. Under SMP, all forests in China are classified into one of the following three types:

- Commercial forests: for the production of timber and other forest products;
- Non-commercial forests/public goods forests: for biological conservation or ecological protection;
- Mixed purpose forests: for both types of functions as depicted in both commerical and public goods forests.

An interesting change that has occurred with plantations involves a switch from fast-growing plantations with a primarily biological orientation to targeted cultivation with a primarily financial orientation.

b) Timber is a "common" commodity, not a "special material"

Forest products particularly timber have long been treated as special materials whose production, distribution and consumption are put under strict state control. Since 1985 the timber market has been gradually opened and a free market for forest products has been established. In general, there is widespread recognition that the state should not act as an economic agent in commercial forests management. In the commercial forestry sector, logging operations that have long characterized the state timber sector have evolved into a forest industry by private investment, particularly in the Southern non-state forest region.

c) The project concept and project management approach are being gradually introduced into the management of initiatives involving public financing.

d) The central forestry administration has been significantly down-sized in response to a reduced role in forestry investment by the state.

ROUGH TERRAIN AHEAD

Forestry development will continue to face major challenges in the future. As discussed below, the most important feature of forestry in China for the new millennium is the coexistence of timber shortage, ecological degradation and biodiversity stress.

Depleted forest resource endowments

Forest endowments inherited from eras prior to the People's Republic of China are being rapidly exhausted. The speed of draw down in mature or over-mature forest stocks in China is alarming. For instance, between the 3rd Inventory (1983-88) and the 4th Inventory (1989-93), 49 million m^3 of forest stock were lost each year, and between the 2nd Inventory (1977-81) and the 4th Inventory, total mature forest stock in China decreased by 50% from 3.846 billion m^3 to 1.962 billion m^3 (Li ed., 1996, Chapter 1).

In spite of large-scale afforestation campaigns, man-made timber forests have only a limited supply capacity. Due to poor design and tending, man-made forests in China have

a very low productivity. For instance, the average stock of mature or over mature man-made stands is 75 m^3/ha, which is only about 1/3 that of natural forests nationwide (208 m^3/ha). Securing a stable long-term timber supply, including overseas supply, will remain a challenge facing the Chinese timber industry (Li ed., 1996, Chapter 1).

Lack of financial resources—under-investment by the state

Transforming the near-bankrupt state timber sector, financing the management of nature reserves, making tree-planting by small farmers an asset-building activity, building all the shelterbelts, and making China a responsible consumer of timber in the international timber market, and implementing the new initiative of the NFCAP would necessarily require a significant increase in state investment in the forestry sector, a sector that has been traditionally exploited by low timber price in the planning economy and by heavy tax and fees as well as under-investment in the days of market transition. For instance, the ratio of state capital investment in forestry over total state capital investment in 1981 was 3.01%, and it quickly decreased to 0.86% in 1992 (Li ed., 1996, Chapter 1 and 6 in Second Section).

Lack of institutional resources in governance

As can be seen from discussions above, creating the right governance arrangements in forestry is important to forestry development in China. The following two conflicting themes in governance philosophy will remain chronic and ubiquitous challenges.

a) To plan or not to plan

It is now widely recognized that land tenure can be separated from tree tenure. Realizing the incentive potential implied in this separation remains a challenge, particularly in the Southern collective forest regions. In the state sector, state timber companies remain sole state-owned companies. Timber is now a common commodity in domestic market and more recently in international trade. However, timber production is not "free" production—timber production is still subject to the national logging quota management system and timber transportation is under state control. High rates of taxes and fees on timber are being levied to generate local revenue. It should be mentioned that the logging quota management system has been highly ineffective in preventing resource depletion. For instance, during the Eighth Five-Year, annual logging quota was 243.6 million m^3, whereas actual resource depletion obtained from the Fourth Inventory was 320 million m^3 (Li ed., 1996).

These conflicts reflect the struggle between market-based governance and the planning economy approach to governance. It is a well-known syndrome of the Chinese economy that "The economy becomes a mess once the state loosens its control, and it becomes dead once the state tightens its control". The root cause of this syndrome is of course the lack of microeconomic basis for the Chinese economy that is in accordance with a market economy.

b) The challenges of public goods and externality

In forestry policy making, the first order of challenge is to define the appropriate role for the state versus that of the market in the provision of market goods such as timber. The second order of challenge is related to the provision of public goods by the state. Both the non-commercial forests and mixed forests provide public goods and generate externality. Even timber production generates negative externality in the process of logging. The challenges associated with public goods and externality are therefore widespread in forestry, and some of the most significant ones are: which level of the government should pay for nature reserves management (assuming that reserve management is the responsibility of the state)? How to incorporate the damages of logging into logging operations? How can the government make small farmers' tree planting an asset-building activity while collecting high taxes and fees on timber for local revenue? Can the beneficiary pays principle be implemented in order to realize ecological compensation in forestry?

SOME REFLECTIONS

a) The paradigms on multiple-use, market timber production, and state provision of public goods are being accepted and institutionalized in the governance structure of the Chinese government. The reconstruction of the microeconomic base of forestry is however far from being completed.

b) In commercial forestry, the emphasis should and the utmost challenge will be the restoration or reconstruction of the micro-economic base of forestry, i.e., the producer (firm and households) as the basic unit of economic activities. The microeconomic base of market economy is of fundamental value in forestry. This is because forestry has a long cycle of production which makes producer expectations important and because expectations are the basis of long term

investment. Therefore, the essence of forestry production should be forest stewardship. A related implication is that it is necessary to establish secure forest tenure, and it is a danger to start with communities instead of households in rural forestry development in China.

c) In non-commercial forestry, the dual objectives of conserving biodiversity and safeguarding biosafety are being well established in the agenda of public forestry policy. However, it is inadequate to establish a market and rely on the market to provide the right incentives for forest stewardship. Also, there has been an obvious marginalization of the rural sector and forestry in recent market-based reforms. State investment should therefore be increased and public financing mechanisms improved. These include applying project management approach and pursuing co-financing between governments and using market mechanisms in public financing—bidding and other competition arrangements; going beyond the market—providing marketing service, subsidies, credit, technical extension by the government—and experimenting with new ways to conservation, such as integrated conservation and development and ecoregion-based conservation.

d) NFCAP is an integrated and ambitious package of commercial production, ecological restoration and biodiversity conservation. It plans to reemploy 1 million state loggers, reduce state timber production by 10 million m^3/year and protect 15 million ha of natural forests by year 2000, and phase out logging in old-growth forests owned by the state by year 2010, with a total budget of 100 billion yuan. NFCAP will be a real test of the strength of forestry in China.

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Field Notes – Abstracts from recent research

Public Consultation for China's Environment

Desmond M. Connor

Introduction

As continuing rapid economic growth takes its toll on China's environment, rising public concerns have led to instances of "supervision by public opinion" (quzhong yulun de jiandu) in which concerned citizens express their views about environmental problems. This is encouraged by front page newspaper stories about environmental problems and the loss of aagricultural land to industry and urban encroachment.

While the last Communist Party Congress in Beijing indicated that no political reforms were contemplated, rapid economic growth is typically followed by social and political development, an occurrence also noted by Karl Marx.

"Supervision by public opinion", a reactive and very limited form of public participation, is reminiscent of the "Stop the (construction proposal)" of the 1960s in North America which soon gave rise to systematic and proactive citizen involvement in planning and decision-making. In turn, this led to university courses in participative planning, sections at professional conferences on public involvement and the founding of the International Association for Public Participation. (Note - the World Bank has recently proposed that "public involvement" be used as a generic term, "public consultation" for activities seeking the advice of the public, and "public participation" for sharing decision-making responsibility with the public. However, this usage is not yet established; many still use the three terms interchangeably.)

This brief paper seeks to: identify some of the rationale for the development of public consultation in China, indicate some current and potential applications to help resolve environmental and land-use issues, and stimulate an exchange of comments, suggestions and experiences amongst newsletter readers.

Rationale

In a recent paper (Connor, 1998), some universal human values underlying public consultation were identified, based on earlier research (Lasswell and Kaplan, 1950) and more recent work (Schwartz, 1994; Bok, 1995). These values include: community, education, trust, purposeful action, mutual support and loyalty, equity, conflict management, coordinated social interaction, benevolence and procedural justice. Public consultation seems to resonate with these values which permeate all human societies, including China and its various subcultures.

In China Doesn't Want to be "Mr. No": Problems of International Strategy in Today's China (Shen, 1998), peaceful evolution (heping yanbian) is advocated as a means to deal with endemic parochialism and rigid hierarchies (fengjian thinking and behaviour) which is a serious problem for Chinese society as a whole (pp.222-227). The careful introduction of some forms of public consultation could be a kind of peaceful evolution to help deal with fengjian social and administrative paralysis.

Very accessible insights into Chinese values and their relevance for public consultation are provided in Confucius: Work Ethic (Tan, 1992) which includes chapters on the protection of the natural environment, harmony (chung yung) and the culmination of the various elements in the Confucian work ethic in the moral person (jun zi). These draw on the earlier and larger Dialectica Reconciliae: The Dialectic of Reconciliation (Tan, 1983) in which he notes: "Chung Yung is the harmony between individual self-interest and community self-interest." (p.177).

At the village level, the widespread use of local elections across China provides a stimulus for public consultation on other issues besides community leadership. Just as local leaders must now listen more closely to community residents, some bureaucrats may come to see public consultation as an aid rather than a threat to their management.

Public Consultation

Public consultation is a systematic process through which citizens, planners, managers and politicians can better understand each other and work together to create a plan. This plan will be technically sound, economically attractive, generally understood and accepted by most of those affected, and will thus be politically viable. The objective of public consultation is to develop informed,

visible majority public understanding, acceptance and support for a valid proposal.

In each case, a program is developed which reflects and respects the characteristics of the various publics involved and affected, and the nature of both the proposal and the proponent. A systematic understanding of the communities affected is obtained by preparing a social profile of each.

Information about the proposal is distributed, often in a Question and Answer format, with a means to reply. Then informal open houses enable interested residents to talk face-to-face with the staff of the proponent about their questions, comments and suggestions. Subsequently, workshops are held with the leaders of key groups to review issues and develop solutions for them (See Connor, 1997).

Application in China

My approach to public consultation in China is to suggest that the traditional Decide-Announce-Defend (DAD) administration is increasingly ineffective and inefficient in a period of rapid change. In Canada and the U.S. in the '60s, when bureaucrats became out of touch with the "flower power" generation, the DAD system in place then broke down. I believe that a structured, incremental approach to public consultation, which does not threaten the existing power structure, is worth a trial in China. e.g. for a specific land use situation in a community, (1)provide information recognizing that there is a problem which needs to be solved, (2) outline in a publication three possible solutions and their features, noting that the administration is willing to implement any one of them, (3) following an incubation period and some open houses, solicit feedback from the residents (e.g. reply coupons in the publication, checklists at the open houses) to rank the alternatives, and (4) tabulate the responses, announce the results and indicate the administration's action plan.

This limited and controlled form of consultation (technically, "information-feedback") is designed to be acceptable to administrators who have perhaps experienced "supervision by public opinion" and are understandably nervous about opening up the decision-making process. After some successful experience with the above method, they might be willing to try a more open and creative form of consultation, properly so called. This includes encouragement for participants to (1) review, revise and weight proposed evaluation criteria, (2) suggest additional alternative suggestions and later (3) rank the final set of technically sound and administratively acceptable alternative solutions to an issue, problem or opportunity. This participative planning is usually a three stage process - Introduction, Alternative Generation and Evaluation & Recommendation.

I have outlined this approach to public consultation in a presentation to several sets of Chinese delegates who visit the Canadian College for Chines Studies in Victoria, B.C. These people include senior aviation industry managers, human resources managers in the downsizing heavy steel industry, environmental managers, etc. Most seem to think that public consultation is feasible and even necessary, especially to increase the understanding, acceptance and support for the reforms being introduced. They indicate that the DAD system in place in China is under increasing pressure.

An encouraging sign is provided by a $6 million community health worker training project in Yunan province sponsored by the Canadian International Development Agency. Project director Nancy Edwards of the University of Ottawa says that the key is community involvement: "We want them to integrate clinical skills with learning how to involve local people in their own health care." See "Resurrecting China's 'barefoot doctors'" (Mickleburgh, 1998)

Conclusion

This paper has sought to develop some of the rationale for the development of public consultation in China, outline some current and potential applications to help resolve environmental and land use issues, and act as a stimulus for the exchange of comments, suggestions and experiences by the readers of this newsletter. Letters to the editor and messages to the writer are warmly solicited.

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PACE Workshops: Recent and Upcoming

China Energy Efficiency Buildings

Buildings in China will consume nearly one-third of the country's total energy use. How to achieve energy efficiency in buildings in China has become crucial in its energy conservation efforts in the new century.

To address the issue, PACE and the World Bank East Asia Environment Department co-hosted a lunch discussion on China's energy efficiency buildings on February 8 in Washington, DC. The discussion featured speakers of Professor Leon Gilicksman and Dr. Qingyan Chan of MIT, and their partner from Tsinghua University, Professor Yi Jiang.

The discussion examined issues such as new technologies and design and applications of existing technologies that will significantly increase the efficiency and improve indoor environment of new and renovated Chinese buildings. Their case studies focused on residential buildings in large Chinese cities like Beijing and Shanghai, and how materials and building styles shall be adopted in accordance with local conditions and resource availability.

It is agreed that the major barrier to the improvement in building energy efficiency in China today is lack of information and strong interests.

Conference Corner

International Conference on Biodiversity Coservation and Sustainable Development

October 15th -19th, 1999
Organized by:
Yunnan Provincial Science and Technology Committee
China Yunnan International Cultural Exchange Center
Center for Biodiversity and Indigenous Knowledge

Yunnan, China

Sponsored by:
99 International Horticulture Exposition
Yunnnan Provincial Science and Technology Committee

The Government of the People's Republic of China will host 1999 the International Horticultural Exposition in Kunming, Yunnan, from May 1 to October 31, 1999. Under the theme "Man and Nature - Matching into the 21st Century," this expostion is designed to promote mutural understanding and friendship in the world by showcasing gardens in a variety of national horticultural and landscaping style and many traditions of horticulture and achievements in protecting the natural environment and maintaining ecological balance.

One of the most important activities will be the International Conference on Biodiversity conservation and Sustainable Development in Kunming from October 15th to 19th. It will provide a forum for scientists to present their work on a broad range of biodiversity conservation and sustainable development. Scientific excursions are also planned to visit all exhibition halls and galleries involved to the Expo'99.

For further information, please contact: Prof. Pei Shengli, President Center for Biodiversity and Indigenous Knowledge
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Call for Contributions

To ensure the quality of SINOSPHERE, the editorial staff needs contributions from you, our members. We hope to establish a backlog of pertinent articles that we can draw on from time to time over the next few months, but our success ultimately depends on your willingness to provide us with information. In general, we need three types of contributions:

Abstracts

If you have written, published, or presented any articles that are relevant to the study of China's environment, please send us an abstract of the article and information on how we can obtain a copy (Publication date and location, or personal address). We would like to include these abstracts in our upcoming issues to inform our readers of the type of research that is being carried out by PACE members and to stimulate discussion about environmental issues.

Articles

For those of you interested in specific issues, we would like you to express your views in short scholarly essays devoted to a single topic. We welcome articles on any subject, including technological developments, business trends, and policy issues. These articles should be approximately 2000 words in length, although quality is more important than quantity.

Autobiographical Sketches

Please send us brief descriptions of your educational background, current occupation, research interests, and any specialized information regarding your involvement in issues related to China's environment. You should also include a current address and a contact number. (100-200 words)

Remember that SINOSPHERE will be read by more than 500 people worldwide, many of whom have influential positions in the public and private sectors, academia, and NGOs. This is your chance to communicate with like-minded individuals who share your interest in China's environment and to tell them of your research and concerns.

Please send all submissions to the editors at
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