Ripening Renewable Energy Markets in China –

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Capacity Building for the Rapid Commercialization of Renewable Energy in China

The year 2000 saw the establishment of the Chinese Renewable Energy Industries Association (CREIA), the convening of the first international trade fair targeting renewables in China, and the inclusion in the draft National Tenth Five-Year Plan of a proposal to develop a mandated renewable energy market-share mechanism. These are all signs that the Chinese renewable energy dragon is awakening to establish the conditions necessary to realize its long-held dreams.

Many of these dreams stem from the Government's *1995 New and Renewable Energy Development Programme*, which laid down future market penetration targets for several renewable energy technologies[#] up to 2020. That these targets have not been met (installed windpower capacity, projected to reach 1000MW by the end of 2000, has reached only 345MW) is partly attributable to a slowing in demand for new capacity. However, this cannot hide the conspicuous absence of certain basic conditions required to take China's renewable energy development from a project-based approach to a market driven process.

Launched in March 1999, *Capacity Building for the Rapid Commercialization of Renewable Energy (CCRE),* is a five year programme of activities which aims to accelerate this transformation by addressing critical stumbling blocks facing commercialization of selected renewable energy applications. Village hybrid power systems, industrial-scale biogas plants, solar-water heaters, grid-connected windfarms, and bagasse cogeneration facilities have each been selected as priority market sectors.

The status of each of these market sectors is discussed below, along with their most pressing commercialization constraints, and the areas in which the CCRE programme is aiming to make a difference. One of the novel features of the CCRE programme is its attempt to drive market expansion by showcasing successful projects and encouraging their commercial replication through a concerted capacity building effort. The process encompasses support to generate market information and identify suitable sites, to project development and, ultimately, to the convening of investment opportunity fora. The first of these fora will be held for industrial-scale livestock farm biogas applications from 26th –28th February in Hangzhou, Zhejiang Province. In shadowing a commercial project development cycle, the process addresses the real barriers facing each market sector.

[#] *The New and Renewable Energy Development Programme* omitted small-hydro (<25MW), as does this article. Through strong Government support since the 1950s, China has achieved full commercialization and more installed capacity of small-hydro power than any other country (>20GW).

While each market sector faces its own unique set of challenges, the programme is careful to include more broadly targeted activities, such as business and finance training, policy recommendations, and institutional development, to enhance the prevailing conditions for commercialization of all renewables in China.

Nurturing New Players in Market-based Renewable Energy Development

CCRE has supported the establishment and early growth of the Chinese Renewable Energy Industries Association, CREIA. As an independent, industry-led, self-financing association, CREIA represents a fundamentally new type of player in market-based renewable energy development in China. CREIA provides a business network for its industry members, raises awareness of renewable energy investment opportunities in China, and tenders advice on key policy areas to the Government.

Since its inauguration in January 2000, under the leadership of the Director, Mr.Zhu Junsheng, CREIA has grown into a network of 40 of China's leading renewable energy companies. A series of events held last year brought CREIA members together for business training courses and built consensus on issues including technology standards and policy recommendations. A major contribution to promoting exchanges between Chinese and international renewable energy business communities has been made by three CREIA-organized study tours to Europe (twice) and the US.

Furthermore, CREIA was a co-organizer of the major renewable energy event of the year in China. Between November 28th and December 1st 2000, over 50,000 people visited the stands of 200 companies exhibiting at the first *China International Energy Efficiency, Renewable Energy, and Environment Exhibition and Conference*. As well as Chinese companies, there was a strong international presence, with stands representing companies from Canada, Denmark, Italy, the Netherlands, UK, and USA. The atmosphere in the exhibition hall was one of a business hungry trade fair, and the event secured high profile coverage across the national media.

Perhaps CREIA's most ambitious goal is the establishment of an Investment Opportunity Facility (IOF), to link bankable investments with appropriate sources of financing. This is a direct attempt to overcome concerns expressed by financial institutions that credit-worthy renewable energy investments are hard to find. Assistance will be given to develop proposals, and those accepted will be held in an online database for marketing to interested investors. Potential projects are currently under the early stages of development.

As is the case for renewable energy associations throughout the world, CREIA must work hard to generate the revenues required to achieve long-term sustainability. Early activities have benefited from considerable support through the CCRE Programme. However, CREIA has already won four Government contracts, and has been contracted by the US DOE to produce a Chinese language directory of US renewable energy companies and products. In the near term, CREIA is also seeking partners to publish a

similar directory of European products. The association's long–term sustainability will depend on the provision of high value services to its members, and active marketing of quality services to other interest groups. Ongoing work on a CREIA business development plan aims to provide a road-map to reach this goal.

Rural Energy Markets - Accelerating Commercialization and Meeting Economic and Social Development Needs

Recent estimates place the number of people in China without access to electricity at around 70 million. This includes close to 150,000 villages, situated primarily in China's western provinces. Under the ongoing process of power sector reform, in which provincial electricity utilities are closely scrutinizing their balance sheets, the prospect of a conventional solution to deliver modern energy services to these low-load (and hence unprofitable) markets seems further away than ever. At the same time, being situated in regions enjoying some of China's best wind and solar resources, these communities represent a golden opportunity to harness renewable energy applications as least cost energy supply solutions.

By the end of 1999 over 160,000 stand-alone wind turbines (100W – 5kW) and a further 16MW of PV power had been installed across China. This represents only a small fraction of the potential market, and it is a telling fact that rural electrification still lags behind communication applications in terms of PV market share. *The Brightness Programme* of the State Development and Planning Commission represents the first concerted effort to launch a national renewable energy electrification programme. Significantly, the programme requires individual provinces to submit annual plans detailing the number of households and villages to be electrified for central Government approval. This effectively opens a channel for multi-annual support for the deployment of renewables from budgetary resources outside those of provincial governments and power utilities.

This is not to say that the rural renewable energy market is dependent on Government support. Entirely commercial hybrid and solar home system markets served by local dealers have developed in Inner Mongolia, Qinghai, Sichuan, Tibet, and Xinjiang. Here systems are normally purchased on a cash basis, following annual livestock sales. This practice has led to financing being cited as a major barrier to market development. However, a survey in Xinjiang[1] found that although 43% of rural households had experience with credit arrangements, they preferred to use this to generate additional income (e.g. by buying extra livestock), rather than to make quality of life improvements. Thus a lack of access to financing is not the only barrier to more widespread commercialization. The establishment of sales support and servicing networks, national technology standards, and increased levels of public awareness are further keys to unlock the doors of volume sales and mass market cost-reductions.

[1] ESMAP Paper, *Assessing Markets for Renewable Energy in Rural Areas of Northwestern China*, The World Bank, Washington DC

A solar home systems project supported by the World Bank and the GEF pending implementation this year targets exactly these areas. The project activities include installing some 10MW of PV power through accredited dealers, building the capacity of PV company staff, and a public information campaign. In its preparation phase, the project developed its own component and system standards, providing a strong base for the subsequent development of national standards. Nineteen companies have successfully submitted business plans to be eligible to sell systems under the project, and hence for a $1.50/W post-sales subsidy. This is to be used to improve product quality and after sales service, and to increase marketing efforts.

Although village-scale renewable energy power systems are a step further away from true commercialization than household systems, their associated social and environmental benefits mean that they remain strong candidates for Government and community support. With national and international support, around 70 village power systems (10kW- 200kW) have been installed across the country to date. These are sited in two distinct types of location—on islands in China's coastal regions, and in remote regions of the northern and western provinces.

For this market, the high upfront cost of system design and installation is the first challenge faced by project developers. Communities cannot cover the full cost of the system themselves, and financial returns are inadequate to attract commercial investors. Financing therefore still requires a significant grant element, which even when available (e.g through *the Brightness Programme* or *the Poverty Alleviation Programme*), can have unintended secondary effects. Grant financing from sources outside the community can confuse system ownership arrangements, already a potential weakness of such systems. Furthermore, grant financed projects do not normally have the same incentives to achieve cost recovery as commercially financed projects. As a result systems are more likely to be poorly managed and maintained, creating the impression that this market is further from commercialization than may really be the case.

In supporting the increased the deployment of hybrid village power systems, CCRE is working to place system management and operation on as a commercial a footing as possible, maximizing cost recovery and system lifetime. Exploring new business models for harnessing grant support in commercially implemented projects is a key area of activity. In addition to installing three new systems, the programme is also supporting work to better characterize the village power market, on-site wind and solar resource assessment, and organizing technical training.

Industrial-scale Biogas – Sharing Experiences and Improving Financial Returns

China has extensive experience in the application of anaerobic digestion technologies, a network of research centers, and the capacity to manufacture anaerobic digesters. Although the country boasts over 5.5 million household-scale biogas digesters,

experience with industrial biogas applications is limited. However, stricter enforcement of environmental wastewater regulations is obliging many industries to invest in wastewater treatment processes or face being closed down In this context, anaerobic digesters producing valuable biogas represent the chance for industry to turn an environmental obligation into a business opportunity.

Current estimates place the fraction of liquid organic waste from agricultural and industrial processes treated in anaerobic digesters at less than 10% of the potential. Nationally, there are over 40,000 livestock farms with more than 10,000 chickens on hand and over 3,000 farms with more than 3000 pigs. If all of the waste from medium to large pig farms were captured, roughly 600 Mm^3 per year of methane could be generated. Distilleries and other industrial entities could generate a further 900 Mm^3 of methane annually.

The current low market penetration of larger-scale biogas digesters in the agricultural and industrial sectors is attributable to certain conditions preventing these applications from reaching economic and financial viability. These include: (i) a lack of standardization of the design and construction of large-scale anaerobic digestion systems; (ii) use of inadequate separation, control and handling equipment; (iii) limited application of knowledge gained from the operation of existing plants in the design of future plants and limited acquaintance with international best practices; (iv) inconsistent enforcement of existing wastewater discharge regulations; (v) policies creating few, if any, incentives to increase biogas production; and (vi) a lack of familiarity with biogas investments amongst the financial community. Overall, the sector currently lacks transparency, with design institutions owning different levels of technology, and a low level of project information sharing.

CCRE is targeting a market expansion effort on industrial-scale biogas applications for wastewater treatment in industries such as large-scale livestock farms, distilleries, food processing plants, and others. There are high hopes that activities to address the above barriers can result in market expansion, catalyzing genuinely commercial projects. Activities combine support for the installation of three advanced technology application projects (see Table 2) with a market development programme. This includes market analyses, business and financial capacity building, publication of a project development handbook, support for national standards development, and the arrangement of regional investment opportunity fora. At these fora, livestock farm and distillery plant owners will be brought together with project developers and financial institutions to generate project development opportunities.

Finally, as a key parallel activity, grassroots technology experience will be provided as an input to the review of wastewater discharge standards by the State Environmental Protection Administration. Establishment and enforcement of appropriate wastewater standards would create a massive near-term market expansion.

Solar Water Heaters –Securing Investment and Ensuring Quality

Domestic solar water heaters (SWHs) have already achieved extensive market penetration in China. By 1999, annual production exceeded 2.5M m^2 [(2)] in over a thousand factories, and installed national capacity exceeded 15M m^2. SWHs manufactured in China are sold nationwide and exported to South East Asia, Europe and elsewhere. China currently serves over 50% of the world market for this technology and it is estimated that by 2010, the total installed capacity of SWHs in China will reach 50M m^2.

The most common types of domestic SWHs are combined storage tanks, flat plate solar heaters, and evacuated tube solar heaters. Typically, combined storage tanks and flat plate solar heaters are found in the western and inland regions, while evacuated tube solar heaters are found in the eastern and coastal regions.

In addition to the market for domestic heaters, commercial applications for solar water heating have increasingly been found in public bathrooms, residential houses, hotels, swimming pools and commercial businesses. A further area of future market expansion lies in space heating and cooling. The reform of the housing market, rationalization of energy prices, closer relationships with the construction sector and better energy efficiency standards will all help to bring solar space heating and cooling onto the commercial stage.

For the time being, demand has already outpaced production capacity, requiring the industry to modernise and consolidate production lines. However, the industry faces some fundamental challenges to scaled-up future growth. Firstly, as a young, unfamiliar sector, SWHs struggle to attract commercial financing. On one hand, there is low awareness of the potential for investment in this sector amongst financiers, and on the other, companies need training on how to present financial information to investors. Where credit is available, loan pay-back periods tend to be inappropriately short. Investment companies providing long-term equity might be explored as an alternative way of financing company expansions.

Secondly, the presence of poor quality products on the market is threatening to undermine consumer confidence in the industry as a whole. Industry-wide standards are essential to clearly identify the quality products and save the market. Finally, manufacturers must work ever closer with the construction industry to increase markets through integration of solar water heaters in new residential and commercial developments.

CCRE is helping to answer some of these challenges. CREIA has been supported to build industry consensus for the establishment of national technology standards through a series of workshops and training events.. Standard SWH certification and testing procedures will be developed, and the establishment of a national testing centre will also be supported. Additional business and finance training activities will directly address commercialization objectives to support market expansion. At present, opportunities also

[2] ADB TA No.3056-PRC, *Renewable Energy Development Project*, Draft Final Report

exist in the residential and commercial buildings sectors of urban centers in China to attract commercial financing in support of new market opportunities on a project scale several times larger than presently practiced. Intervention here involves promotion of building codes, solar rights of way, new construction procedures, as well as equipment standards.

Wind – Limbering up for a Commercial, Competitive Generation ?

Boasting some of the world's best wind resource sites, the potential for grid-connected wind to contribute to the national energy portfolio in China has been placed at around 250GW. In spite of this phenomenal resource, the wind power market in China is still at a relatively early stage of development. By the end of 2000, China had 26 grid-connected wind farm sites with a total installed capacity of 345 MW. Much of the existing installed capacity has been financed through bilateral soft loan programmes, which, while necessary in the initial stages of market development, cannot sustain market expansion beyond the tens-of-megawatt scale.

Although existing windfarms rely heavily on the imported turbines, a recent Government-sponsored programme supporting the establishment of joint-venture companies has brought the capacity to manufacture wind turbines suitable for grid-connection (>250kW) in-country. The development of the domestic manufacturing base continues to be a high Government priority, as witnessed by SETC's current 100MW wind localization programme.

In the meantime, the absence of an open and competitive market for windfarm development makes wind power an unnecessarily expensive alternative in China. Until recently investors in wind capacity were entitled to charge a premium, "cost-plus-profit" price for the electricity this generates. As a result, utilities were usually only prepared to pay this price when they themselves were the investor. This situation effectively restricted market access for independent power producers, and removed market forces capable of delivering cost reductions. This lack of a competitive market-place, institutional issues, and the reluctance of national financiers to invest in new, unfamiliar, wind projects have meant that the development of wind power in China has made slower than expected progress in recent years.

Wind resource concessions and a mandatory renewable energy market share are two mechanisms recently gaining serious interest as suitable, and in many ways complementary, vehicles with potential for scaling-up the commercial development of wind power in China. Capable of producing power on a larger scale than most renewables, grid-connected wind farms would be one of the primary beneficiaries of a mandated market-share policy. However, much required groundwork, including initial piloting of various policy options in two to three provinces, and legislation to establish an enforceable regulatory framework, means that it will be several years before this represents a genuine market force.

Under the resource concessions model, the Government could sell an exclusive concession to develop the wind resource in a given region. Whether this model is pursued or not, there is a critical need for better wind resource information to direct the next generation of wind power development in China. CCRE plans to support State Power Corporation of China to conduct a wind resource measurement and analysis programme. Following the identification of promising locations, the programme will conduct detailed, on-site resource monitoring.

Emerging Markets for Modern Bagasse Cogeneration Technologies

Burning sugar-cane residues for generation of process heat and power production is a practice already well established in the Chinese sugar industry. It has been estimated that over 800 MW of bagasse derived power production capacity are presently installed in Guangdong and Guangxi alone. The technology currently used employs multiple medium pressure boilers, typically ranging between 15 – 75 tonnes per hour capacity, and turbine generators of between 1.5 – 6 MW. Energy produced from these installations, as process heat, electricity, and steam, is almost all consumed on-site.

The introduction and commercialization of modern bagasse cogeneration technologies, producing enough electricity to satisfy plant requirements and a surplus amount which can be sold to the grid, may offer a sound investment opportunity for the largest sugar mills. In addition, there is a significant market for retrofitting existing boilers, swapping out burners and improving efficiency.

Despite the potential for 700-900 MW of cost-effective bagasse cogeneration power capacity in the sugar industry in China, little new technology has been installed. The poor economic health of the Chinese sugar industry in recent years has been a major factor in holding back new investments. Oversupply and inefficient production have contributed to this situation. However, the ongoing restructuring process, including the closure of smaller-scale mills and consolidation of larger mills, will help to create an environment in which the industry is in a better position to take advantage of the benefits of modern bagasse technology applications.

As is the case for other renewables, longer loan terms would make a huge difference to improving the financial performance of projects. Even so, low electricity pool prices can mean that using bagasse to produce alternative products, such as paper pulp, can be a more lucrative option. A further dilemma is the seasonal nature of the fuel source. On average, the cane-crushing season only lasts for about five months. As a result, large quantities of bagasse must be stored for off-season burning, or an alternative fuel source found.

CCRE will be supporting the installation of two advanced bagasse cogeneration plants as project models for commercial replication. Project development will be conducted as a systematic and integrated process, involving preparation of investment grade feasibility studies, and culminating in the acquisition of financing from local investment and loan sources. Lessons learned, in terms of the technical and economic performance of these

plants, will be disseminated through a series of workshops. Through these events and additional training for business development and for financing, CCRE aims to facilitate the commercial replication of advanced technology and economy-of-scale power development.

Crossing the Divide into Self-sustained Commercial Market Expansion

While renewable energy markets have fallen behind Government development goals, recent signs from both the business and Government communities are consistent with taking renewable energy development from a project-based approach to a market driven process. CCRE is only one of a large number of nationally and internationally supported efforts encouraging the development of renewable energy markets in China. Indeed the level of activity is so high that international groups in Beijing have begun convening information sharing meetings on a semi-annual basis.

Following full domestic commercialization, China's solar thermal industry needs to protect its markets through technology standards and attract the investment necessary to modernize and expand production. Commercial windpower development has captured strong international interest but slower than expected market expansion has held up the next generation of investment. At the same time, increasing links between Chinese and foreign companies are directly fuelling market development in other areas. Joint-ventures in PV module and wind turbine manufacturing have been established, there is increasing international interest in the Chinese market for biogas applications, and some international participation in hybrid system development

Intensifying international attention reflects the fact that China has much to offer foreign renewable energy companies, not only in terms of an unrivalled market opportunity but also as a manufacturing base to serve domestic, regional, and global markets. For some sectors the seeds of commercialization have only just been sown, while for others there is promise of continually increasing harvests.

Table 1: Status of Application of Selected Key Renewables in China in 1999

RE Technology Application	*Cumulative Installed Capacity*	*To end of Year*
Solar PV (MW)	19	2000
Solar Water Heaters (10^6 m^2)	15	1999
Grid-Connected Wind (MW)	345	2000
Small Wind (MW)	26	1999
Geothermal Power (MW)	30	1999
Biogas Livestock Farms (10^8 m^3)	0.6	1998

Biogas Industrial Wastewater (10^8 m^3)	3.2	1998

Table 2 Characteristics of CCRE-supported Biogas Facilities

	Dengta	Shunyi	Jiuchang
Location	Hangzhou, Zhejiang Province	Shunyi County, Beijing Municipality	Jiazhou City, Qingdao
Type	Livestock farm, 200,000 pigs and aquatic produce	Livestock farm, 60,000 pigs	Distillery 10,000 tons/y alcohol; 18,000 tons/y finished products
Wastewater Effluent	3,000 tons/day	600 tons/day	450 tons/day conc. waste 500-1000 tons/day diluted waste
Biogas Production	8,500 m^3/day	2,200 m^3/day	10,000 m^3/day
Use of Biogas	Generate electricity and some heat	Generate electricity and some heat	Boiler fuel to generate process heat
Electricity Production	13,500 kWh/day	4,000 kWh/day	N/A
Generating Capacity	230kW	100 kW	N/A
Use of Electricity	Sold to local grid PPA	All used on site	N/A
Other Value	142 tons fertilizer per day	8 tons fertilizer per day	Solid recycling to minimize waste

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