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ANNEX I

CHINA COUNTRY REPORT

FROM IDEAS TO ACTION: CLEAN ENERGY SOLUTIONS FOR ASIA TO ADDRESS CLIMATE CHANGE

June 2007

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ANNEX I

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FOR ASIA TO ADDRESS CLIMATE CHANGE

CONTENTS

LIST OF ABBREVIATIONS

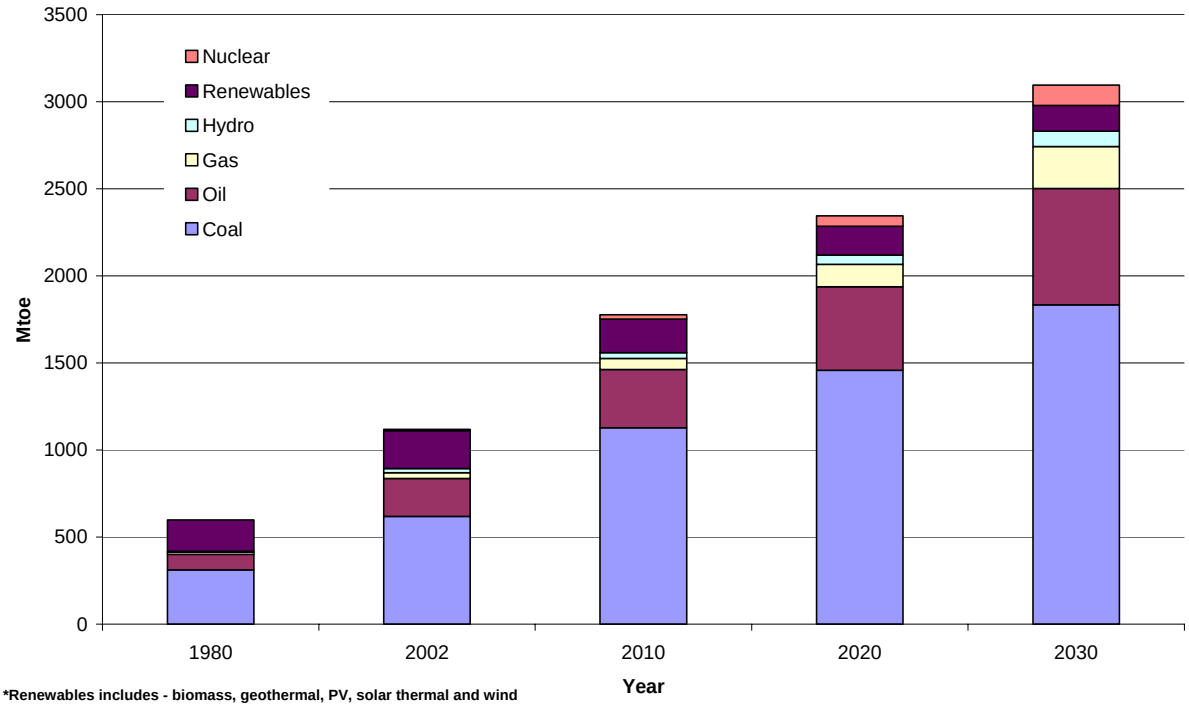
ACCA21	China Agenda 21 Administration Center
AQSIQ	State General Administration for Quality Supervision, Inspection and Quarantine
BRT	Bus Rapid Transit
CALI	China Association of Lighting Industry
CDM	Clean Development Mechanism
CECP	China Certification Center for Energy Conservation Products
CECA	China Energy Conservation Association
CECTA	China Chemical Energy Conservation Technology Association
CER	Certified Emission Reduction
CFL	Compact Fluorescent Lamp
CFB	Circulating Fluidized Bed (combustion technology)
CNIS	China National Institute of Standardization
CNPC	China National Petroleum Corp
CNOOC	China National Off-shore Oil Corp
CREIA	China Renewable Energy Industrial Association
CPC	China People's Congress
CPIC	China Power Investment Corp
CSC	China Standard Certification Center
CSEP	China Sustainable Energy Program
DRC	Development Research Institute of the State Council
ECSCs	Provincial Energy Conservation Supervision Centers
EE	Energy Efficiency
EEP	EU-China Energy and Environment Program
EF	Energy Foundation
EMCA	Energy Management Company Association
ERI	Energy Research Institute of the NDRC
ESCO	Energy Service Company
EUEEP	End-Use Energy Efficiency Program
FGD	Flue Gas Desulfurization
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEI	Global Environmental Institute
GHG	Green House Gas
IBRD	International Bank for Reconstruction and Development
IFC	International Finance Corporation
IGCC	Integrated Gasification Combined Cycle
MoCon	Ministry of Construction
MOF	Ministry of Finance
MOFCOM	Ministry of Commerce
MLRC	Ministry of Land and Resources of China
MLTEC Plan	Medium and Long Term Energy Conservation Plan
MOST	Ministry of Science and Technology
Mt	Million Metric Tons
Mtoe	Million Tons of Oil Equivalent
MoWR	Ministry of Water Resources of China
NDRC	National Development and Reform Commission
NELG	National Energy Leading Group
NBS	National Bureau of Statistics of China
PRC	People's Republic of China
PV	Photovoltaic
RE	Renewable Energy
RMB	Renminbi (China's Currency)
SERC	State Electric Regulatory Commission
SGCC	State Grid Corporation of China
SINOPEC	China Petroleum and Chemical Corp
UNDP	United Nations Development Program
VAT	Value Added Tax
WB	World Bank
WHO	World Health Organization
WTO	World Trade Organization

1. CHINA'S CLEAN ENERGY CHALLENGE

1.1 TRENDS IN ENERGY RESOURCES[1]

China's primary energy consumption increased two-fold from 2000 to 2005, to 1,557 Mtoe. High demand spurred a rapid supply expansion. The supply of primary domestic energy rose to 1436 Mtoe in 2005. This energy growth momentum is expected to continue over the next two to three decades. Between 2002 and 2030, it is projected that industry will consume three times the amount of energy while the transportation sector will consume four times as much, and energy use in the commercial sector will have grown six-fold. The residential sector will see significant growth as well. It is estimated that China will need to supply a total of over 3,000 Mtoe of primary energy by 2030 (see Figure 1).

FIGURE 1. PRIMARY ENERGY SUPPLY BY SOURCE



Source: APERC, 2006.

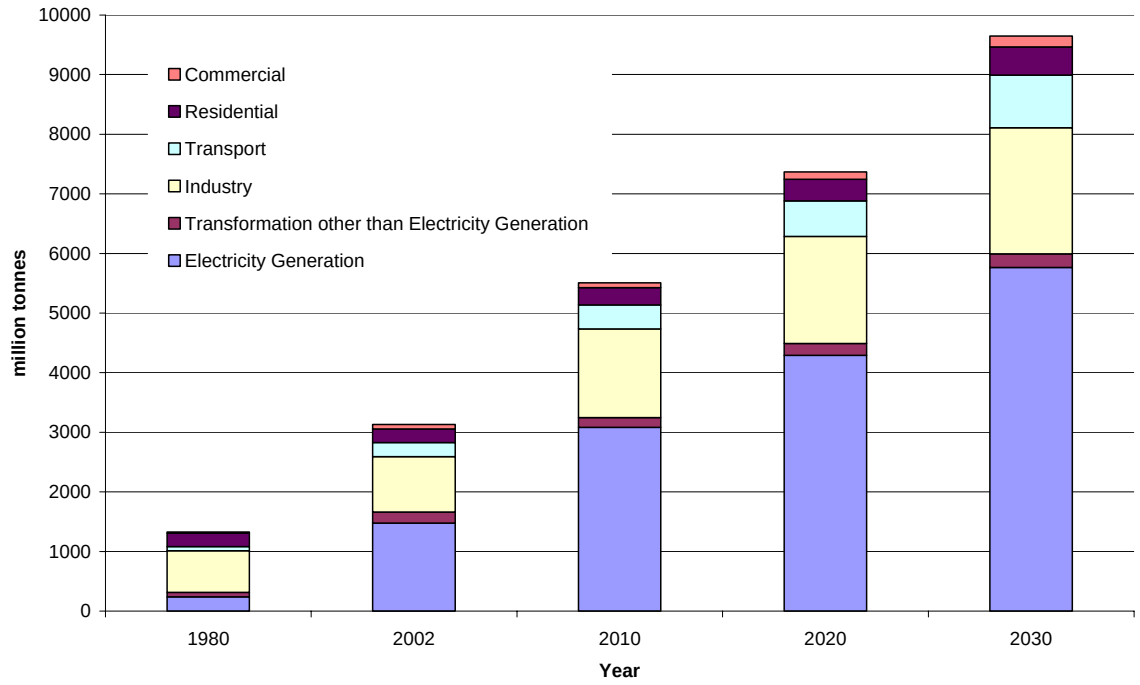
Coal is the main energy resource in China and this will continue to be the case in the middle to long term. China can meet its growing demand for coal from its large reserves, and will increase imports of oil and gas to support its transportation and industrial needs. Since 1993, it has increasingly relied on imported oil and the rapid growth in the number of vehicles in China will continue to drive its oil consumption. Renewable and nuclear energy will gradually increase their shares in the energy mix, but – based on the current path of energy development – neither will alter the outlook of the country's energy structure, according to the draft Medium and Long Term Renewable Energy Development Plan.

[1] The following conversion factors have been used: 1 Mtoe = 10*106 Kcal; 1 Mtce = 7*106 Kcal; 1 Mtoe = 1.43 Mtce.

1.2 IMPACTS OF ENERGY USE

Since China's energy consumption is mainly coal based, environmental problems have become increasingly serious. Coal consumption surged from 1.42 billion metric tons in 2002 to 2.11 billion metric tons in 2005. About 70 percent of raw coal was directly burned without washing and treatment. The emissions of SO_2 and particulate matter from coal burning amounted to 70 percent to 80 percent of total emissions. The area affected by acid rain due to SO_2emissions covers one-third of the national land area. CO_2 emissions from fossil fuels are the main source of GHG in China as shown below:

FIGURE 2. CO_2 EMISSIONS BY SECTOR



Source: APERC, 2006.

In 2002, China's CO_2 emissions totaled about 3,100 Mt. The sector analysis of CO_2 emissions indicates that close to 50 percent came from electricity generation and about 30 percent from industrial activity. Since investment in coal-fired power plants has increased greatly in recent years (34 percent growth in 2005), electricity generation consumed 860 Mt, 983 Mt, and 1,110 Mt of coal in 2003, 2004 and 2005 respectively. Without future policy changes, the power sector's share of CO_2 emissions will rise to about 60 percent by 2030.

High energy consumption in the past has had detrimental effects on the environment. Declining air quality has made many cities unsuitable for human habitation, as their PM_{10}, SO_2, and NO_2 levels are above national standards. Economic growth will result in the emission of more atmospheric pollutants if no action is taken. One key reason for the deterioration of air quality is the increase in the number of vehicles. In 2004, China became the No 4 automobile producer and No 3 automobile consumer in the world, with annual production of 5.07 million units, and at the end of 2005 it had accumulated stock of 31.6 million vehicles.

The deteriorating environment has caused serious health problems. In 2000 in western China, over 263,000 people died from cardiopulmonary disease, over 27,000 died from lung cancer, and over 5,000 died from acute respiratory infections. Pollution has had many other negative effects, such as declining crop yields. China's projection for O_3 concentrations in 2020 are expected to cause a 2 percent to 16 percent yield loss in wheat, rice, and corn, and a 28 percent to 35 percent yield loss in soybean.

A number of studies conducted in the 1990s have documented the economic costs of air pollution. Depending on the methodology used and assumptions applied, the studies projected an annual cost ranging from 0.5 percent to 7.1 percent of GNP (Table 1). In Shanghai, the health benefits from implementing various policies to control air pollution are estimated to range from US$113 million to US$950 million in 2010, and from US$327 million to US$2 billion in 2020.

TABLE 1. ECONOMIC LOSSES CAUSED BY AIR POLLUTION

Study	Base Year	Economic Losses (billion RMB)	Research Categories	GNP (percent)
Guo & Zhang	1983	12.4	Health and crops	2.2
Xia	1992	57.9	Health, crops, animals, and materials	2.4
Sun	1992	60.5		2.5
Zheng et al.	1995	30	Health damage due to TSP pollution; crop, forest, and materials damage from acid rain	0.5
Xu	1993	39.1	Health, agriculture, acid rain, household upkeep (cleaning)	1.1
Smil	1999	15.1±4.1		0.86 ± 0.16
World Bank	1995	44.88	Health effects from urban air pollution, damage from indoor rural air pollution; crop, forest, materials, and ecosystem damage from acid rain; lead exposure for children	7.1

Source: ADB, 2006.

2. CLEAN ENERGY REGULATORY FRAMEWORK

2.1 KEY LAWS, DECREES, AND POLICIES

TABLE 2. KEY ENERGY LAWS AND DECREES

Year	Title	Purpose
2006	**11th Five Year Plan**	Contains the blueprint for the development of energy and energy efficiency, and forms the basis for the Government's economic and social development efforts.
2006	**Medium and Long-term Energy Conservation Plan (MLTEC Plan)**	Sets detailed energy conservation targets in four areas and macro-management goals.
2006	**Renewable Energy Law**	Establishes the framework for the national development of renewable energy.
2005	**Measures for Operation and Management of CDM Projects**	Embodies policies, regulation, and procedures for CDM.

TABLE 2. KEY ENERGY LAWS AND DECREES

Year	Title	Purpose
2003	**Cleaner Production Promotion Law**	Promotes cleaner production, more efficient use of resources, reducing and avoiding the generation of pollutants, and protecting and improving the environment.
2000	**Prevention and Control of Atmospheric Pollution Law**	Prevents and controls atmospheric pollution.
1998	**Construction Law**	Affects the application of clean energy technologies in construction and energy conservation in buildings.
1998	**Energy Conservation Law**	Promotes energy conservation by all sectors of society, increasing energy efficiency and national economic and social development.
1996	**The Electric Power Law**	Guarantees and promotes the development of the electric power industry and theist safety.
1996	**Coal Law**	Promotes the rational development, use and protection of coal resources, standardizes production and marketing of coal, and promotes and ensures the development of the industry.
1996 revised	**Mineral Resources Law of China (MRL)**	Develops the mining industry by promoting the exploration, development, utilization and protection of mineral resources, and ensures socialist modernization.
1989	**Environmental Protection Law**	Prevents and controls pollution and other public hazards, safeguards human health, and facilitates the development of socialist modernization.

Source: USAID ECO-Asia Clean Development and Climate Program, 2006.

China has not enacted an integrated energy law, and has no oil or gas laws either. Overall energy sector policies and objectives were established in the 11th Five Year Plan, with more details added in subsequent sub-policies such as the Medium to Long Term Energy Conservation Plan. Table 2 summarizes the key energy laws and decrees that were effective as of December 2006.

2.1.1 Overarching Framework

China's 11th Five Year Plan (2006-2010)

This legislation was formulated in 2005 and endorsed by the National People's Congress with two goals:

- Achieve annual GDP growth of 7.5 percent, with the aim of doubling 2000 GDP per capita by 2010.
- Reduce energy consumption per unit of GDP by 20 percent and the total discharge of major pollutants by 10 percent from their 2005 levels by 2010. The average annual energy savings rate should be 4.4 percent and 390 Mtoe should be saved during this period.

These energy conservation goals are mandatory for central and local governments.

Medium and Long Term Energy Conservation Plan (MLTEC Plan)

The National Development and Reform Commission (NDRC) launched the MLTEC Plan in 2004. It covers two phases: 2005-2010 and 2010-2020. The Plan sets detailed energy conservation targets in four areas, as well as macro-management goals. The four areas include: (1) a relatively sound system of energy conversation laws and standards, (2) policy support systems, (3) supervisory systems, and (4) technical service systems. The plan requires that the four systems be compatible with China's market-oriented reforms and be implemented by 2010. It also includes a multi-program initiative, entitled Ten Key Energy Conservation Programs, which is expected to save 170 Mtoe between 2006-2010 – about 40 percent of the energy savings goal (per unit GDP) in the 11th Five-Year Plan.

Other laws related to clean energy development include the Energy Conservation Law (1997), Renewable Energy Law (2005), Environmental Protection Law (1989), Prevention and Control of Atmospheric Pollution Law (2000 revised), and Cleaner Production Promotion Law (2002).

2.1.2 Energy Efficiency

The Government launched a massive national energy conservation program in 2005 called The 1000 Enterprise Initiative. So far, 1008 large companies, which consumed 470 Mtoe in 2004, have been identified in nine energy intensive sectors, from both the demand and supply sides. The goal of the initiative is to save 70 Mtoe during 2006-2010.

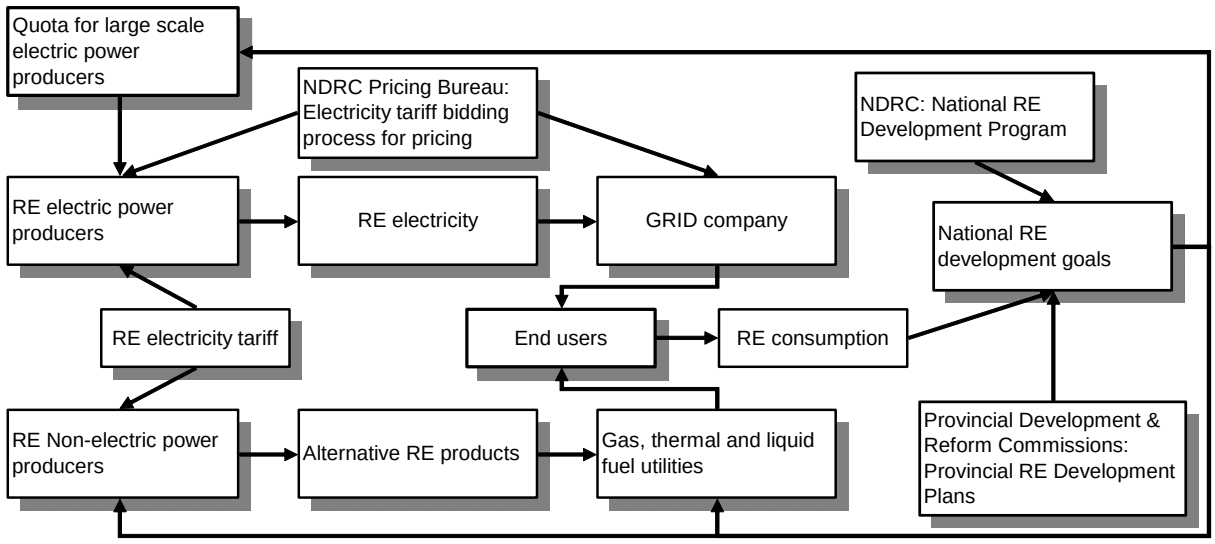
Demand Side Energy Efficiency: The MELTEC Plan set principles to promote demand side energy efficiency management. In 2004, the Energy Bureau of NDRC and SERC jointly issued Guidelines on Enhancing Demand Side Management (DSM). In the same year, the Government introduced energy efficiency labels for refrigerators and air conditioners, and started mandating their use on 1 March 2005.

Supply Side Energy Efficiency and Clean Fuels: The MELTEC Plan also covers the supply side. It encourages the application of advanced technologies such as ultra-super critical IGCC and large scale (over 600 MW) coal-fired generator units. Small scale generator units will be phased out and grid networks will be upgraded. The MELTEC Plan also sets energy consumption thresholds for coal-fired power plants: 360 gce per kWh generated by 2010, and 320 gce per kWh generated by 2020. In 2005 the level was 377 gce per kWh generated.

2.1.3 Renewable Energy

A complete policy framework (Figure 3) has been established under the Renewable Energy Law (2006).

FIGURE 3. POLICY FRAMEWORK UNDER THE RENEWABLE ENERGY LAW



Source: WANG Zhongying (2006), Implementation of the Renewable Energy Law: Practice and Considerations.

In this framework, NDRC plays the key role. It operates the National RE Development Planning Program, and oversees the electricity tariff bidding process. Additionally, there are 12 regulations supporting the implementation of the RE Law as shown in Table 3 below:

TABLE 3. REGULATIONS AND AGENCIES FOR RENEWABLE ENERGY LAW

	Regulations	Responsible Agency
1	Specific provisions on hydro-power relevant to the RE Law	NDRC
2	Technological specifications on renewable energy resources survey	NDRC
3	National targets for renewable energy development	NDRC
4	Renewable energy development planning	NDRC
5	Renewable energy industrial development directory	NDRC
6	Feed-in-tariffs for renewable energy power	NDRC Pricing Bureau
7	Cost-sharing methodologies	NDRC Pricing Bureau
8	Special fund for renewable energy development	MOF
9	Fiscal support policies for renewable energy development in rural areas	MOF
10	Interest subsidy loans and preferential tax policies for renewable energy development	MOF
11	Technical specifications of solar systems integrated in buildings	MOC
12	Technical specification for grid-connection and national standards for renewable energy technologies and products	AQSIQ

Source: USAID ECO-Asia Clean Development and Climate Program, 2006.

Renewable Energy Development Planning Program: Under this program a draft Renewable Energy Development Scheme was completed by the office of National Energy Leading Group in 2006 and is being reviewed and enriched by NDRC. The Scheme aims to increase the proportion of renewable energy to 16 percent of total energy consumed in China.

The main goals of the Renewable Energy Development Scheme include:

- Hydropower: installed capacity will reach 180 GW in 2010 and 300 GW by 2020, with an overall development rate of 70 percent;
- Wind power: installed capacity will reach 5 GW in 2010 and 30 GW in 2020;
- Solar: solar water heaters will reach 300 million square meters in 2020, replacing conventional fossil fuel of 28 Mtoe, while solar PVs will reach 2GW in 2020;
- Biomass: combustion of compressed pallets will reach 0.7 Mtoe in 2010 and 35 Mtoe in 2020;
- Biomass power: capacity will reach 5 GW by 2010 and 20 GW by 2020; and
- Biogas and biomass gasification: production will reach 11 billion cubic meters (BCM) per year by 2010 and 24 BCM per year by 2020.

2.1.4 Clean Transport

The legal framework for clean transport is mainly related to the national plan and vehicle emission standards. The MLTEC Plan regards transport as a key area for energy conservation. It requires unit energy consumption of passenger cars to be reduced from 9.5 liters per 100 kilometers in 2000 to 8.2-6.7 liters per 100 kilometers. Some general guidelines are provided in the Plan and more specific management measures need to be developed. China also implemented new gasoline standards for

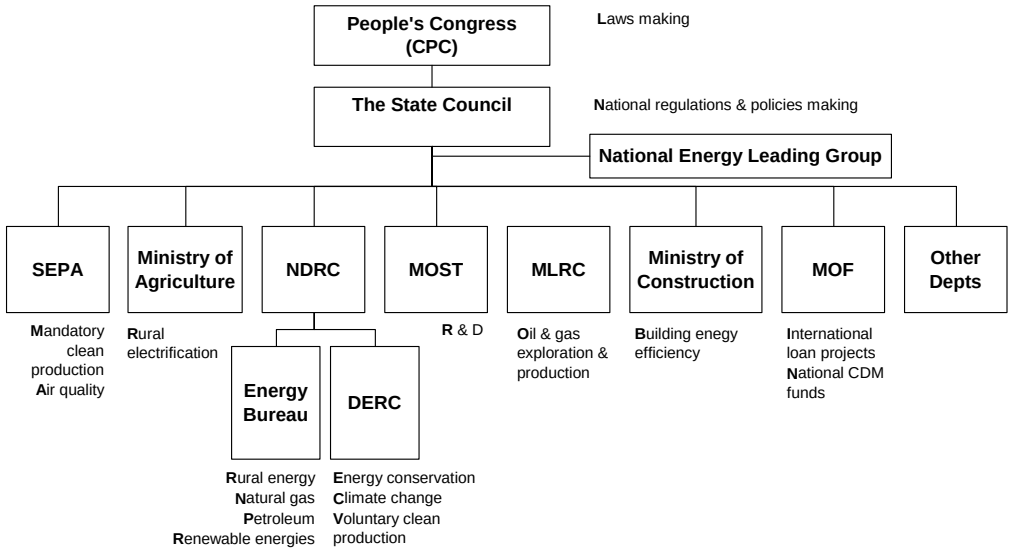
passenger vehicles equivalent to European III in July 2005. The new standards require that the sulfur content of gasoline be reduced from 800 ppm to 150 ppm. China is now heading towards the European IV equivalent standards and some large cities are planning to implement them before 2008.

3. INSTITUTIONAL ANALYSIS

3.1 ORGANIZATIONAL OVERVIEW

China does not have a Ministry of Energy. Instead, energy administration is divided among a number of ministries, as illustrated in Figure 4.

FIGURE 4. KEY GOVERNMENT ENERGY AGENCIES



Source: USAID ECO-Asia Clean Development and Climate Program, 2006.

TABLE 4. CLEAN ENERGY INSTITUTIONS IN CHINA

Organization	Scope of Work
China Agenda 21 Administration Center (ACCA21)	Research policy and strategy in the area of sustainable development, provide policy support to government decision-making, and promote international cooperation
China Energy Conservation Association (CECA)	Promote the efficient use of energy, improve the environment, and increase economic benefits
China Chemical Energy Conservation Technology Association (CECTA)	Promote energy conservation in the chemical industry and provide energy saving information for petroleum and chemical enterprises
China National Institute of Standardization (CNIS)	Study and formulate energy-related standards. Undertake the secretariat work of the China National Standardization Technical Committee for Basis and Management of Energy Resources as well as that of the Standardization Subcommittee for New Energy Resources and Renewable Energy Resources
China Renewable Energy Industries Association (CREIA)	Promote the adoption of advanced technologies by renewable energy enterprises in China and develop capacity for the rapid industrialization of the renewable energy sector

TABLE 4. CLEAN ENERGY INSTITUTIONS IN CHINA

Organization	Scope of Work
China Standardization Center (CSC)	International harmonization of energy efficiency standards and labels, and participation in international cooperation activities
Development Research Center (DRC) of the State Council of China	Comprehensive policy study and decision-making centre for the State Council. Contributes to all five-year and long-term plans
Provincial Energy Conservation Supervision Centers (ECSCs)	Promote energy conservation and energy efficiency at the local level
Energy Foundation (EF)	Implementing agency of the China Sustainable Energy Program
Energy Management Company Association (EMCA)	Facilitate the switch of China's energy conservation mechanism, increase investment in energy conservation projects, improve energy efficiency, reduce GHG emissions, and protect the environment
Energy Research Institute	A very influential and active semi-official institute that acts as the think tank for the NDRC in energy and climate change policies
China Association of Lighting Industry(CALI)	Promotes green lighting in China, participates in the development of product standard, and tests procedures for Chinese lighting products
Global Environmental Institute (GEI)	A Chinese non-profit, non-governmental organization formed to make conservation profitable and economic development ecologically sound by supporting conservation efforts with market-oriented solutions
Power Utilities: Five Groups	Invest in and operate power generation facilities throughout China
State Electricity Regulatory Commission (SERC)	Regulate the national electric power sector
State Grid Corp of China (SGCC)	Build and operate power grids and provide secure and reliable power supply

Source: USAID ECO-Asia Clean Development and Climate Program, 2006.

Governmental agencies are playing a fundamental role in clean energy development and in the formulation of development plans, laws, regulations, and industrial standards which monitor and control the industry's growth. NDRC is the leading policy-maker in the energy sector in China. It formulates national plans, strategies and policies for energy resources, energy conservation, renewable energy and climate change. In the formulation of national energy policy, DRC and ERI are key advisors to the government.

The National People's Congress (NPC) is the top legislative institution and is involved in approving the legislative motions proposed by the Chinese State Council and its ministries. NPC is also responsible for the implementation of China's energy policies and laws, and has the authority to enact regulations and rules under the relevant laws. Enforcement of energy policies and laws requires technical standards that are formulated and implemented by the State General Administration for Quality Supervision, Inspection and Quarantine (AQSIQ), NDRC, MoCon, SEPA and MOST. The China Standardization Center (CSC) reviews and approves these standards. The CSC also implements the Efficient Lighting Initiative (ELI), a global labeling program for lighting products funded by the Global Environment Facility (GEF). The China National Institute of Standardization (CNIS), restructured under AQSIQ, specializes in the research of

standardization theory and methodology for energy savings. Both CNIS and CSC play important roles in creating standards and labeling end-use equipment.

Many ministries are involved in the administration of clean energy resource development. The Ministry of Land and Resources of China (MLRC) is responsible for administrating the usage of such natural resources as crude oil and gas in China. MOST oversees numerous rural technology development projects, such as rural methane development. The Energy Bureau and DERC of NDRC are responsible for promoting and granting renewable energy construction projects and energy conservation projects. The Ministry of Agriculture is in charge of rural electrification developments, while the Office of the National Coordination Committee for Climate Change is in charge of developing a national strategy and policies on climate change and promoting CDM projects.

At the enterprise level, the dominant players are giant gas, oil, and electricity utilities. Under them are numerous energy service companies (ESCOs), consulting firms, and end users. China has three big oil and gas companies, one national grid company and five power production companies. Because they are so huge, they are able to influence policy. To some extent, policy-makers should consider their interests so that policies can be enforced effectively.

Industrial associations and NGOs are actively promoting clean energy for their industrial clients and members. Specifically, EMCA plays an important role by promoting the Energy Contract Performance mechanism, which can be connected with clean energy technologies.

Provincial energy conservation centers perform energy efficiency monitoring for local enterprises, and assist provincial governments in the enforcement of energy conservation policies, while a number of universities – such as Tsinghua, Beijing and Tianjin – provide clean energy and CDM development consulting services to the government and enterprises.

3.2 INSTITUTIONAL NEEDS ASSESSMENT

Laws governing China's energy sector are neither integrated nor comprehensive, resulting in legal barriers and inconsistencies for the further development of clean energy. The Chinese Government attaches particular importance to its first Energy Law and amending its Energy Conservation Law. In early 2006, China first comprehensive law governing the entire energy sector and energy-related issues took effect. It should benefit from foreign experience in making the law enforceable and effective. At the same time, it began preparing to amend its Energy Conservation Law in order to strengthen it. To make the amendments more relevant and effective, training on the content of the law and subsequent rules, regulations, and standards will be needed.

China needs substantial training assistance in capacity building, at both the local and national levels, in renewable energy technologies, policy consultancy, integrated development planning, etc.

- Wind technology: China relies heavily on imported expensive wind turbines, thus hindering the development of its abundant wind resources.
- Renewable energy microgrid: Distributing renewable energy through microgrids provides a cost-effective and clean alternative to the costly utility grid. However, there are barriers to their

use including: unclear incentive policies, high capital costs, lack of governmental support, etc.
- Training to provincial and regional institutions for renewable energy resources on planning, exploration, development and financing, etc.
- Developing natural gas power generation regulations and incentive policies.

Since three key programs – Ten Key Energy Conservation Programs, 1000 Enterprise Initiatives, and Renewable Energy Development Scheme – together should save 240 Mtoe of energy and replace about 105 Mtoe by 2010, a substantial amount of investment is needed. To encourage desired investments, MOF and NDRC should build their capacity in setting strategic plans, financing and tax motivating policies, and market mechanisms.

More capable renewable energy associations and technical consulting firms are needed to serve investors in clean energy. Training governmental officials in this area is also important.

4. CURRENT STATUS AND POTENTIAL OF CLEAN ENERGY

4.1 OVERVIEW OF FUELS AND RESOURCES

China's energy consumption is mainly supplied by fossil fuels such as coal, oil and natural gas. Coal is the major energy source for power generation and industry, oil is mainly used for transportation and industry, and gas is used for some industries and the commercial and residential sectors. This basic structure is very likely to be maintained in the future, but the share of renewable energy will increase due to the introduction of the 11th Five Year Plan and MLTEC Plan. Several government programs will further enhance the development of clean energy.. These include Ten Key Energy Conservation Programs, which aims to save 170 Mtoe between 2006 and 2010, and 1000 Enterprise Initiatives, which aims to save 70 Mtoe in the same period. In the power sector China's total installed capacity increased from 138 GW in 1990 to 517 GW in 2005 when it generated 2475 TWh of electricity. This rapid growth trend is expected to continue and the amount of electric power generated will exceed 7100 TWh by 2030, with overall power generation capacity of 1240 GW.

4.1.1 Fossil and Nuclear Energy

Coal. In 2005, China consumed 1556 Mtoe of primary energy, 69.6 percent of which was derived from coal. Coal is primarily used for power generation and in industry. In 2005, China produced 2,140 Mt of coal, of which 1,031 Mt (49 percent) was used in coal-fired plants with a total capacity of 391 GW and generating 2,018 TWh. By the end of 2005, coal-fired power generating units installed with flue gas desulfurization (FGD) reached 46 GW, accounting for 9 percent of total installed capacity. The coal supply will continue to grow because coal has a cost advantage and China has massive reserves. By 2020, China is forecasted to consume about 2,800 Mt of coal per year, or 1,400 Mtoe. This massive use of coal makes clean energy technologies increasingly vital. Clean coal and high sulfur coal treatment technologies are very much needed by power plants. Governments and enterprises are becoming more interested in circulating fluidized bed (CFB) combustion, high-efficiency burner, and absorption heat

pump technologies, among others. By 2010, FGD-installed capacity should reach 380 GW.

Oil. In 2005, 21.1 percent of China's energy consumption or 328 Mtoe was derived from oil. Oil is primarily used for transportation and industry. Driven by the rapid increase in the fleet of cars and industrial growth, China's oil consumption will rise up to 480~608 Mtoe per year by 2020. The clean energy development in the oil sector is related to extraction, refinery and alternative fuels.

Gas. In 2005, 2.7 percent of China's energy consumption, or 42 Mtoe, was derived from natural gas. Natural gas was used in the chemical (32.2 percent), manufacturing (38 percent), and residential and commercial (22.4 percent) sectors. The usage share of gas in transportation increased to 3.4 percent by 2005 and will continue to increase as an alternative to oil. By 2020, it is forecast that China will consume 168-203 Mtoe of natural gas per year.

Nuclear Power. In 2005, only 0.8 percent of China's energy consumption, or 12.6 Mtoe, was derived from nuclear power. By the end of that year, China had installed 8,674 MW of nuclear power capacity in six project sites. In 2006, China decided through tendering to invest in two nuclear power stations, in Guangdong Sanmen and Shandong Haiyang, with total installation capacity of 4 x 1,000 MW. By 2020, it is forecast that China will consume 49-56 Mtoe of nuclear energy per year, or about 2 percent of its total primary energy consumption.

4.1.2 Renewable Energy and Distributed Generation

Hydropower is China's main renewable energy. It accounted for about 6 percent, or 90 Mtoe, of China's primary energy consumption in 2005. Total installed capacity was 117 GW, and 401 TWh of electricity, was generated. Other renewable energies account for only a small share in the energy consumption structure. For example, as of 2005, wind power had 1,226 MW of installed capacity and generated 1.5 TWh of electricity. The share of renewable energies is anticipated to rise due to the introduction of the 11th Five Year Plan and MLTEC Plan. By 2020, they will supply 259 Mtoe, or 10.62 percent of total primary energy consumption.[2] Renewable energy development will need to focus on grid-connected wind power, small hydro development, biomass development and rural electrification.

Electricity from renewables usually has a higher cost than coal-generated electricity, resulting in its biggest barrier to grid connection. However, since the promulgation of the Renewable Energy Law in 2006, this barrier against renewable energy's development has been removed. The RE Law establishes a framework for the bidding process for grid-connection of renewable electricity, which allows the renewable energy generated electricity to be connected to the grid at favorable prices, about 40 percent higher than coal-fired electricity. For example, since January 2006, for power generated from biomass, the generator will receive a subsidy on feed-in price of 0.25 RMB (or 0.04 USD) for each kWh of electricity. After this law was established, investment in renewable energy increased significantly.

4.1.3 Energy Efficiency

There is huge potential for clean energy development in the Energy Efficiency (EE) fields. A primary example is industry, which accounts for 70 percent of China's entire energy consumption. The total

[2] This is higher than APERC's projection (2006).

energy consumption of 1,008 energy-intensive industrial enterprises as selected in the 1000 Enterprise Initiatives was close to 470 Mtoe in 2004, accounting for 33 percent of the nation's total energy consumption and 47 percent of industrial energy consumption. Table 5 illustrates China's energy consumption per unit product in comparison with World averages, while Table 6 compares the energy efficiency of China's consumption equipment with World advanced levels.

TABLE 5. DIFFERENCE IN ENERGY CONSUMPTION PER UNIT PRODUCT IN CHINA COMPARED WITH WORLD AVERAGES

Thermal power	+22 percent
Steel	+21 percent
Copper smelting	+65 percent
Cement	+45 percent
Synthetic ammonia	+31 percent
Paper and board	+120 percent

TABLE 6. ENERGY EFFICIENCY OF CONSUMPTION EQUIPMENT COMPARED WITH WORLD ADVANCED LEVELS

Operating efficiency of coal–fired industrial boilers	-15 to -20 percent
Average design efficiency of fans, water pumps, and medium and small-sized motors	-5 percent
Average operating efficiency of fans, water pumps, and medium and small-sized motors	-20 percent
Fuel economy level of motor vehicles	-25 percent (Europe) -20 percent (Japan) -10 percent (the US)
Oil consumption efficiency of trucks	-50 percent
Oil consumption efficiency for inland river transportation ships	-10 to -20 percent

Source for Tables 5 and 6: China's 2020 Energy Efficiency Plan, NDRC.

At present, energy consumption of heating per unit of building area in China is two to three times higher than in developed countries with similar climatic conditions. Therefore, it is both practical and feasible to set 50 percent energy savings standards for public and residential buildings in China.

On the supply side, energy efficiency efforts are more likely to have the power supplier's cooperation. With help from the government, the power industry is striving to develop over 600 MW supercritical and ultra supercritical units, and large-scale combined cycle power plant technology. It is also focusing on the development of high-efficiency clean combustion technology and improvement in unit capacity through the Large-scale Substitute Small-scale program. It is anticipated that high-efficiency technologies, such as ultra-supercritical units, will be universally applied by 2010, and that energy consumption of coal-fired power will be lowered to 360 g/kWh as required by the MLTEC Plan. Since the five national power investment companies are all huge players, with hundreds of billions of RMB in assets, they are usually able to obtain financing to invest in economically feasible energy efficiency projects.

4.1.4 Clean Transport

China's vehicle inventory expanded by 1.48 times from 2000 to 2004 due to rapid urbanization and rising incomes. This trend is expected to continue. It is estimated that vehicles sales will see double-digit growth annually and that the total volume of vehicles will reach about 250 million by 2015, further rising above 400 million by 2035. The more cars there are, the more important it is to introduce clean energy

into the vehicle industry. China issued the Euro-III equivalent fuel economy standards for passenger vehicles in 2005, and now it is focusing on developing new fuel economy standards for light and heavy-duty trucks, and low-speed or agricultural vehicles. Establishing a mandatory vehicle fuel efficiency labeling system is on the agenda as well. In addition, compressed natural gas (CNG) is starting to be used to fuel taxis and buses in many large cities like Beijing and Chongqing, creating a new market for CNG cars.

4.2 COMPARISON OF ECONOMIC POTENTIAL AND COST EFFECTIVENESS

4.2.1 Economic potential

Table 7 summarizes the substantial development potential for renewables according to the MLTEC Plan.

TABLE 7. COMPARISON OF CLEAN ENERGY POTENTIAL BY RESOURCE

Energy Resource	Capacity by End of 2005	Capacity by 2020	Increased Capacity
Hydro (MW)	117,000	300,000	183,000
Wind energy (MW)	1,226	30,000	28,774
Biomass power (MW)	2,000	20,000	18,000
Biomass gasification (Million M3)	8,760	11,000	2,240
Solar heating (Million M3)	110	300	190
Solar PV (MW)	70	2,000	1,930

Source: MLTEC Plan (2005).

In terms of energy conservation and efficiency, there are two main programs: the Ten Key Energy Conservation Programs and 1000 Enterprise Initiatives. Through them, China aims to conserve 240 Mtoe of energy during 2006-2010. Clean energy plays an important role in both.

Power sector and energy-intensive industries are responsible for the majority of CO_2 emissions. Below is a summary of the potential for CO_2 emission reductions in China's power plants.

TABLE 8. SUMMARY OF CO2 EMISSION REDUCTION POTENTIAL IN POWER PLANTS

	50 MW Scrap and build (50-200 MW)	100 MW Retrofit	200 MW Retrofit	300 MW Switching fuel from coal to natural gas	Total
CO_2 Reduction potential (1,000 metric tons of CO_2)	11,695	7,180	9,004	45,550	73,429

Source: USAID ECO-Asia Clean Development and Climate Program, 2006.

4.2.2 Cost effectiveness

Coal has advantages in terms of capital investment requirements and its relatively low cost, but burning it produces significant emissions of SO_2, CO_2, and NO. Hydropower has a higher capital investment requirement, but a lower electricity price than coal. Since many large to medium hydropower resources have already been developed, small hydro will be the next development focus. Biomass gasification also

has low costs, but the technologies vary and its usage is limited. Other renewable resources require much higher investment costs and generate energy at a higher cost as well. DSM/EE has a wide range of capital requirements, but the delivery cost is usually much lower than it is for electricity generated from coal. Table 9 compares the cost effectiveness of different energy resources.

TABLE 9. COST EFFECTIVENESS OF CLEAN ENERGY

	Capital Cost (US$/kW)	Delivery Cost (cents/kWh)	FGD Cost (US$/kW)	SO_2 emission g/kWh	NO emission g/kWh
Coal-fired power	516	4.65	129	4	4
Hydropower	650-950	3.48	-	-	-
Wind energy	1,019	5.00-7.00	-	-	-
Biomass power	1,613	7.87	-	-	-
Biomass gasification	450-838	2.50-5.80	-	-	-
Solar PV	6400-9000	20.00-25.00	-	-	-
Nuclear power	1,290	5.16	-	-	-
DSM/EE	249-2970	1.55	-	-	-

Sources: Wang Qingyi (2006). 2006 Energy Data.; ADB Guangdong EPP project Mid-term Report (2006); Huang Mengfu and Li Hejun et al (2006). Annual Report on China's New Energy Industry; Wu Chuangzhi (2005). China's Biomass Gasification Power Generation Technology

The cost effectiveness of clean energy is usually ignored because the environmental and social costs are not included in the cost analyses of governments or enterprises. Taking these costs into consideration, including flue gas desulfurization (FGD) costs and clean energy applications, will make renewable energy and energy efficiency projects more economically feasible.

4.2.3 Carbon reduced per USD of investment

The cost of CO_2 reduction per US Dollar invested varies even within a sector. According to Tsinghua University, the cost is 2.5-8.3 US Dollar for each ton of CO_2 reduction for scrapping and building power plants of below 50 MW. The cost rises to 8-19 USD for retrofitting power plants at the 100 MW level, and 12-28 USD for modifications of 200 MW level power plants. The cost will be as high as 40-60 USD to switch fuel for a 300 MW power plant.

5. CARBON AND GREENHOUSE GAS ABATEMENT

5.1 STATUS OF ACTIVITIES IN THE CARBON MARKETS

The Chinese Government signed the United Nations Framework Convention on Climate Change in 1992 and in the same year the Standing Committee of the NPC ratified it. China approved the Kyoto Protocol in 2002 and actively encourages the development of Clean Development Mechanism (CDM) proposals. A high-level cross-ministerial body, the National Coordination Committee for Climate Change (NCCCC), has been established under the NDRC to handle CDM administrative issues. To further regulate CDM activities, the Chinese Government issued Measures for Operation and Management of Clean Development Mechanism Projects in China in 2006.

China is regarded as the largest CDM market in the world and the NCCCC has recently accelerated approval procedures. By 12 May 2006, China had approved only 46 CDM projects, by 8 October 2006 it had approved 126 and by 15 December it had approved 208. Together they are expected to offset 108 million atmospheric tons of CO_2 equivalent (tCO_2e), according to the estimates in their project design documents. Thirty-five of the projects have been registered with the UN CDM Executive Board.

5.2 INSTITUTIONAL CAPACITY FOR MEASURING AND REPORTING GREENHOUSE GAS ABATEMENT

China's capability for measuring and reporting GHG emissions is improving. This is due to CDM development and greater public pressure to protect the environment and reduce pollution. However, reporting GHG emissions is not mandatory and this may lead to insufficiencies in measuring them.

With the expansion of CDM awareness and the development of CDM projects, China's capability for measuring and reporting GHG emissions is increasing for several reasons. Firstly, CDM project owners and potential owners have a direct interest in measuring and reporting reductions in GHG emissions. Consequently, they must purchase the necessary measuring equipment to comply with CDM protocols. Secondly, the role of the designated operational entity includes validating CDM projects and certifying emission reductions. Most of these entities – such as Bureau Veritas Certification, DNV Certification and TUV – actively measure and verify GHG abatement. Thirdly, the Chinese Government has established the National CDM Board under the NCCCC to review CDM applications including project design documents, baseline methodologies, monitoring plans and examination of CER production. This helps ensure the quality of measuring and reporting of GHG emissions under CDM projects.

Along with the impetus from CDM, public concern about air quality is driving China to enhance its capability for measuring atmospheric emissions. The public is becoming increasingly concerned about environmental pollution and administrative agencies are under more pressure to control it. For example, every provincial government has signed an agreement with the central government to control SO_2 emissions by 2010. As a part of these pollution prevention efforts, industrial enterprises' ability to measure components of atmospheric pollutants and emissions of hazardous waste air have improved, especially in high-emission factories.

In addition, China's weather bureaus report on air quality in many large cities on a daily basis through TV and Internet. With their technological capabilities, it is relatively easy for them to assist in measuring and reporting GHG emissions.

Still, although some CDM-related projects have installed monitoring equipment for GHG emissions, and many governmental agencies have instruments to measure air quality and emissions, it is not a common business or official practice in China to measure and report GHG emissions. There is no mechanism in China to systematically measure and report national and local GHG emissions since reporting GHG emissions is not a binding obligation of enterprises or the government. The websites and reports of the National Bureau of Statistics of China and SEPA include statistics for hazardous air emissions, such as emissions and disposals of SO_2, NO_2, industrial soot, and industrial dust. However, GHG emissions data is seldom available. China's GHG emission data is provided mainly by special research programs and

academic institutions, which base their estimates on sampled data and calculations. It is clear that these figures do not represent actual emissions.

Therefore, to systematically measure and report actual GHG emission changes, China needs to increase its capacity in the following areas: policy study on cost-benefit analysis of reporting GHG emissions; establishment of both national and local measuring and reporting systems; GHG emission control planning and strategies; and publicly advocating these plans and strategies. However, accomplishing this will be very difficult because reporting GHG emissions is not regarded as a priority by the Government.

6. DONOR ACTIVITY IN CLEAN ENERGY

There are many foreign donors helping China enhance its capacity in clean energy and energy efficiency (EE). The most notable are the Global Environment Facility (GEF), World Bank (WB), Asian Development Bank (ADB), and European Union. Many GEF grants are attached to WB/ADB loans, or used to initiate and subsidize EE projects. Among private donors, the David and Lucile Packard Foundation and the William and Flora Hewlett Foundation provide funding to the China Sustainable Energy Program, which has had significant influence on China's energy policy and legislation. The most influential ongoing international clean energy projects in China are summarized below.

TABLE 10. KEY ODA AGENCIES AND THEIR CLEAN ENERGY PROGRAM PRIORITIES

	Qty. of Projects	Demand Side EE	Supply Side EE	RE	Clean Fossil Fuels	Clean Transport
Asian Development Bank (ADB)	5	✓		✓	✓	
EU Delegation in China	4	✓	✓	✓	✓	
Global Environment Facility (GEF)	5	✓	✓	✓	✓	✓
Gesellschaft für Technische Zusammenarbeit (GTZ)	3	✓	✓	✓		
Japan Bank for International Cooperation (JBIC)	1			✓		
Swedish International Development Aid (SIDA)	1	✓				
World Bank (WB)	5	✓		✓	✓	✓
United Nations Development Program (UNDP)	1	✓				

Source: USAID ECO-Asia Clean Development and Climate Program, 2006.

ADB is one of the main donors in supporting clean energy development in China. In 2005, it launched the Energy Efficiency Initiative Program, focusing on EE improvement and energy conservation from both the supply side, including renewable energies, and the demand side. In the past five years, ADB has introduced the concept of Efficiency Power Plant to Guangdong province; provided technical assistance to Gansu province for clean energy development, and helped Inner Mongolia Autonomous Region to improve its central heating supply and gas transmission/distribution in eight areas. In Liaoning province,

ADB supported coal bed methane (CBM) and coal mine methane (CMM) reutilization, gas distribution improvement, and central heating supply in a few cities.

The US and China have been closely cooperating in the area of energy. They have signed several bilateral agreements – including the Sino-US Cooperation Agreement on Nuclear Energy and the Sino-US Protocol on Energy Efficiency and Renewable Energy Cooperation – and have had their first energy policy dialogue, in Washington D.C. in June 2006. China has also signed a number of cooperation agreements with the US Environmental Protection Agency (EPA) and Department of Energy (DOE). Under these bilateral agreements, China and the US have designated priority areas for cooperation. The cooperation will focus on the development of new energy conservation policies, promoting energy conservation in China, establishing and promoting EE labels and standards, developing certification systems for energy efficient products, introducing market mechanisms such as Energy Service Company, and other voluntary agreements.

The European Union (EU) has a strong interest in cooperating with China in the area of clean energy. In 2003, it launched its Sixth Framework for Research and Technology Development, which emphasizes cooperation with China in the fields of energy structure reform, clean energy, renewable energy, and energy efficiency. In 2003, the EU-China Energy and Environment Program was established to strengthen cooperation in energy, especially policy development, energy efficiency, renewable energy and natural gas.

The WB is a major international donor in supporting clean energy development in China. With GEF, it funds the China Energy Conservation Promotion Program (CECP). CECP aims to introduce, demonstrate and promote energy contract management in China. So far, three model ESCOs have signed 283 energy service contracts with a total investment of RMB 600 million (or USD 80 million) and an energy savings benefit of RMB 820 (USD 100) million. These contracts combined can save 510,000 toe per year and reduce CO_2 emissions by 480,000 metric tons per year. The International Finance Corporation, the private sector arm of the WB, initiated the first program to bring together three key players: -- utility companies, suppliers of EE equipment, and commercial banks – to create a new financing model for the promotion of energy efficiency. The WB also runs the China Renewable Energy Scale-Up Program, which pushes the development of grid-connected renewable energy from mature technologies – such as wind, small hydropower and biomass – and off-grid renewable energy including PV.

German Technology Cooperation (GTZ) works mainly for the German Federal Ministry for Economic Cooperation and Development, and is currently involved in about 40 projects in China, including 10 public/private partnerships. Its priority areas include environmental policy and energy management, natural resources management, and sustainable urban development.

The GEF supports a number of initiatives in China, with the WB or UNDP as its implementing agencies. One current project is Heat Reform and Building Energy Efficiency (HRBEE), which began in 2005. HRBEE aims to improve the energy efficiency of new building construction in China through a combination of building equipment market transformation and heat supply policy approaches, and to promote demand in the housing sector for more efficient building materials as well as more effective heat metering and control equipment. The project also promotes new policies and institutions for metering, controlling, and managing centralized heat supply systems.

UNDP has financed a number of clean energy programs in China, including the End-User Energy Efficiency Program and the China Green Lighting Program. The latter is a joint initiative with the Chinese Government to improve the quality of Chinese-made efficient lighting products and stimulate demand for them nationally and internationally. The targets of this project are to reduce energy use in lighting in China by 10 percent by 2010 relative to a constant efficiency scenario, and to increase exports of efficient quality lighting products, which will aid the Chinese economy while helping to reduce energy use and GHG emissions worldwide. This project achieved 15.78 billion kWh in cumulative power savings by the end of 2003, six product standards were developed and approved, and more than 600 lighting products were certified from 46 firms in eight different product types.

7. BARRIERS AND NEEDS ASSESSMENT IN CLEAN ENERGY

The legal system pertaining to the energy sector is neither integrated nor consistent: As mentioned, there are substantial institutional barriers among various ministries. Since the administrative powers in relation to energy have been delegated to several departments, there is a real need for efficient coordination. In addition, in order to execute authority over influential state-owned or state-controlled utilities, an integrated energy ministry is necessary and should be established. To improve the current legal and institutional system, the Chinese Government is drafting a new Energy Law and amending the Energy Conservation Law.

Insufficient investment in EE and clean energy: As a result of market barriers and inadequate policy incentives, since the 1990s there has been a sharp drop in the percentage of energy investment and EE investment in total capital construction investment. The EE investment percentage fell from 13 percent in the early 1980s to about 3 percent at the end of 10th Five Year. It is estimated that between 2005 and 2020, a total of RMB 18 trillion (US$2.4 trillion) of capital should be invested in energy construction projects. About 40 percent, RMB 7 trillion (US$0.9 trillion) – RMB 400 billion (US$50 billion) a year – should be invested in clean energy, energy conservation and energy environment protection. Although China has taken steps in its fiscal and tax system to achieve these goals, it is generally recognized that they are insufficient to reach this investment target. Although the government budget should bear a significant share of this investment demand and increase its inputs, especially through the Ten Key Energy Conservation Programs, considering the fact that China has a massive national budget deficit, private capital should be encouraged to play an important role in investment in clean energy and energy efficiency. This obstacle indicates that China needs to set up additional and effective investment and financing policy incentives.

Lack of public awareness: Neither the government nor individuals are sufficiently aware of the importance of energy efficiency and clean energy since they are new concepts in China. During the current economic boom, numerous energy-intensive enterprises are exerting heavy pressure on energy resources and the environment. Enterprises have a very low level of energy and environmental awareness. At the current stage, China needs to increase public awareness through various means. Compulsory measures and enforcement make sense.

Imperfect planning: Previous national planning emphasized only industrial energy conservation, neglecting many other energy conservation areas, such as conservation in buildings, governmental agencies and transportation, resulting in inadequate development of energy conservation potential in these areas. China's renewable energy program is a relatively insubstantial and uncoordinated effort, mostly under the management of government research institutes, and has suffered from a lack of an overall strategy and market orientation, as well as its relative isolation from the international community.

Implementation problems: Legally binding measures are lacking in the energy savings field. At present, China does not have such regulations as Extended Impact Assessment and relevant standards are few. More importantly, there is no watchdog to enforce policies and regulations. Irresponsibility and negligence by officials in this regard does not affect their career prospects. This is why the original Energy Conservation Law is more of a token than a law with real power. As for lack of enforcement, many compulsory energy saving standards and other regulations are ineffective. Thus, China must endow some government agency with the responsibility of enforcement to compel enterprises to save energy.

Market barriers: Energy Efficiency equipment suppliers are faced with a very scattered market, and different industries require totally different technologies. This results in the EE market for a specific equipment supplier being very small. EE equipment suppliers exert a huge effort to approach a great number of potential clients and it takes a long time to build up their market reputations. As for the EE project developers, it is not easy to find appropriate EE equipment suppliers, as the technical solutions required are normally very specific to the plants in demand. In terms of project financing, Chinese banks often assess loans based on collateral asset size, not the project cash flows, and this has caused huge financing problems for SMEs and affected their ability to secure EE project financing.

A lack of uniform methodology on energy saving measurements and verification is another market barrier for encouraging the use EE equipment. When there is no proof of the energy savings to be gained through the introduction of EE equipment, it is difficult to convince clients to spend money on the services.

Demand Side Energy Efficiency: Although the EE potential on the demand side is large, it has not been actualized yet. The biggest barrier to the promotion of DSM is a lack of punitive measures against grid companies and power plants for unsatisfied energy demand. Additionally, EE projects encounter serious financing barriers. Apart from government-sponsored 1000 Enterprise Initiatives, the active organizations in DSM are limited to a few ESCOs, which were founded under the WB/GEF China Energy Conservation Project during 1997 to 2002. The ESCOs achieved excellent results but lack the capability to contribute large-scale EE on the demand side where attention should be given to monitoring and managing energy conservation, technological innovation, access to financing and increasing the economic benefits to enterprises.

Supply Side Energy Efficiency and Clean Fuels	
Clean Coal	There is strong demand in supporting China in formulating clean coal strategies, taking effective measures, and enhancing the development and popularization of clean coal technology.
Oil and Gas Extraction	Supports are needed in optimizing equipment technology for oil extraction systems, energy saving technology for thick oil hot extraction, operation technology for water filling system, comprehensive energy saving technology for enclosed oil and gas gathering and transferring, and reutilization

Supply Side Energy Efficiency and Clean Fuels	
	technology for exhausted natural gas.
Petroleum Refining	Measures are needed to increase equipment operation load and heat exchange efficiency.
Ethylene Production	Raw material structure should be optimized, advanced technology should be used to rebuild ethylene cracking furnaces, operation of rapid cooling system should be optimized, equipment management should be strengthened and energy consumption in non-production process should be reduced.
Power Generation Technologies	Clean coal, natural gas and high sulfur petroleum coke should be used to replace fuel oil (light oil), more work is needed in disseminating and applying circulating fluidized bed (CFB) combustion technology and petroleum coke gasification technology. Also, heavy oil emulsification, high-efficiency burner and absorption heat pump technologies should be adopted to recover waste heat and terrestrial heat.

Renewable Energy	
Grid-connected Wind Power	More work can be done on wind concessions and insurance schemes for wind farm operation.
Small Hydro Development	More policy work is needed in small hydro. More practices could be brought in from advanced countries.
Biomass development	More can be done on polices for biomass development.
Rural Electrification	More work will be needed to ensure the success of the National Electrification Plan. The Chinese Government has financed equipment for 1,000 townships in Western China and is preparing to target 24,000 smaller villages in the near term. Operation and maintenance, ownership, and sustainable management of these systems need to be addressed urgently for the program to have appropriate leverage.

8. CONCLUSIONS

8.1 RECOMMENDATIONS FOR A CLEAN ENERGY STRATEGY

During the development of this report, the authors conducted discussions with representatives of key private and public institutions concerned with clean energy development in China. The discussion focused on three questions:

1. What are the opportunities and priorities with the greatest potential impact that program sponsors and their partners can pursue in the near term and in the medium term?
2. How can a regional program be most effective in addressing these opportunities?
3. What measurable results can be achieved in the near term?

The results of those meetings and subsequent analysis of the data obtained produced the following recommendations. The most important clean energy opportunities for China are as follows:

Energy Efficiency

- Development of clean coal technologies
- Energy conservation and efficiency in China's energy intensive industries
- Promoting energy efficiency benchmarking in Chinese industry
- Energy efficiency standards
- Development of economic incentives and market mechanisms

- Decentralized energy

Renewable Energy

- Introduction and commercialization of grid-connected wind power
- Small hydro development
- Biogas development
- Renewable energy development in the process of rural electrification
- Economic and fiscal incentives for promoting renewable energy development

Climate Change

- National and provincial strategies on climate and CDM
- Adaptation to climate change
- Measurement of the impact of climate change on different economic and social sectors
- CDM methodology development for energy efficiency and renewable energy projects

8.2 RECOMMENDED INTERVENTIONS AND ACTIVITIES

Energy sector stakeholders offered the following specific suggestions (Table 11) for activities where regional collaboration could advance China's national objectives. In many cases, the activities have been elaborated or augmented by the authors' analysis of the clean energy sector in China.

TABLE 11: RECOMMENDED INTERVENTIONS TO SCALE-UP CLEAN ENERGY IN CHINA

Activity	Potential Implementing Agencies and Stakeholders
Energy Legislation and Local Regulations	National platform: NDRC, Provincial Development and Reform Commission, NELG, SGCC, etc. Implementing partners: DRC, ERI, etc.
Voluntary Agreements with Industrial Associations	Implementing partners: NDRC, industrial trade associations, EMCA, ESCOs, EF, UNDP/GEF:EUEEP, etc.
EE Appliance Labeling	National platform: CNIS, CSC Implementing partners: AQSIQ, NDRC, EF, UNDP/GEF:EUEEP, ACCA21, ECSCs
Build Energy Consumption Monitoring System	Implementing partners: NDRC, ERI, MoCon, National Bureau of Statistics of China, ECSCs
Development of Small Engine Vehicles	National platform: NDRC, SEPA, MOF, Standardization Administration of China Implementing partners: EF, CNIS, Tsinghua University
Bus Rapid Transit	Implementing partners: NDRC, MoCon, municipal governments, EF

TABLE 11: RECOMMENDED INTERVENTIONS TO SCALE-UP CLEAN ENERGY IN CHINA

Activity	Potential Implementing Agencies and Stakeholders
Energy Saving in Buildings	National platform: NDRC, MoCon, SAC Implementing partners: ERI, China Building Energy Conservation Association, ESCOs, CECA, EMCA, CNIS
Capacity Building for Boiler Operators and Managers	Implementing partners: NDRC, ESCOs, ECSCs, industry trade associations
Local Authority Training for EE	Implementing partners: PDRCs, ERI, Provincial Energy Conservation Centers
Further Development of ESCOs in China	Implementing Partners: WB, EMCA, NDRC, trade associations, 1000 Energy Intensive Enterprises, Provincial Energy Conservation Centers
Clean Coal	Implementing partners: Energy Bureau of NDRC, SERC, CPIC, CGDC, and PDRCs, Provincial Energy Conservation Centers
International Dimension in Chinese Energy Policy	Implementing partners: ERI, DERC of NDRC, DRC of the State Council
RE Cost and Pricing Policies	National platform: NDRC, SERC, MOF Implementing partners: the Energy Bureau of NDRC, ERI, SGCC
RE Market Reform Studies, Including Policy Measures to Promote Use of Renewable Energy at Regional and Local Level	National platform: NDRC, PDRCs Implementing partners: DRC, ERI, CREIA, ACCA21
Renewable Energy Law Implementation Consultancy	Implementing partners: NDRC, NPC, provincial governments, ERI, CREIA
Grid-connected Wind Power, Especially Wind Concession Projects, Small Hydro Development, and Biogas Applications	Implementing partners: NDRC, MOA, MoWR, SGCC, CREIA
Standards and Certification for Renewable Energy Equipment	Implementing partners: NDRC, ERI, CREIA, CNIS
International Harmonization on Energy Efficiency Standards and Labels	National platform: NDRC, AQSIQ Implementing partners: CNIS, CSC, CALI
Rural Electrification	National platform: MOA, NDRC

TABLE 11: RECOMMENDED INTERVENTIONS TO SCALE-UP CLEAN ENERGY IN CHINA

Activity	Potential Implementing Agencies and Stakeholders
Non Village Power RE Technologies	National platform: MOA, NDRC, MOST
Technical Assistance to Chinese Trade Associations	Implementing partners: WB, ADB, EMCA, ERI, EU-China EEP
Feasibility Studies on Renewables	Implementing partners: CECA, CREIA
Micro-grid Demonstration Projects	National platform: SGCC, NDRC
Technical Assistance to RE CDM Projects	National platform: National Coordination Committee for Climate Change, NDRC Implementing partners: NDRC, ERI, ACCA21, CECA, CREIA, IT Power, etc.

Source: USAID ECO-Asia Clean Development and Climate Program, 2006.

These options are divided into three categories: energy efficiency, renewable energy, and climate change.

ENERGY EFFICIENCY

Energy Legislation and Regulations. China's energy conservation law was passed in 1998. It is currently under review and China is drafting its first Energy Law. China will undergo a 25 percent increase in urbanization by 2020. Building standards are of key importance because they are the main tools in affecting energy efficiency in new buildings.

Voluntary Agreements with Industrial Associations. A pilot project has been supported by the Energy Foundation with the Iron and Steel Association in Shandong province. Preliminary consultation indicates that extending this project to other sectors and other provinces may be appropriate. This will complement efforts from EUEEP, which is planning to support eight additional pilot implementations:, four additional iron and steel plants, and four more plants in two additional sectors, with a proposed budget of US$1.5 million. There is a need to identify necessary investments and potential mechanisms for upgrading Western industry to Eastern levels of efficiency. Potential tools that merit further investigation are twinning of enterprises and/or local governments, setting up a centre of excellence in the Western region to assist in the development of CDM projects, and cooperating with ESCOs for attracting investment into the Western region.

Energy Efficiency Appliance Labeling. There are many donors in support of the EE appliance labeling program (UNDP/GEF, Energy Foundation, and EUEEP). There is a need to support compliance activities, particularly with local governments who have the mandate, but not the capacity, to assist in involving suppliers at an early stage in the process, and to establish a consultative process with

manufacturers and stakeholder groups in developing new standards and test procedures.

International Cooperation on the Harmonization of Standards and Labeling. The NDRC/UNDP/GEF's China Green Lighting Program has successfully promoted the application of green lighting and improved energy efficiency in China. Currently CFLs produced in China have a large market share in China and the world. But due to the lack of harmonized test procedures and standards, the highly efficient CFLs are affected by low-quality products and this hinders progress in the application of green lighting in China and Asia. Regional harmonization of CFL product standards and testing procedures would further the opportunity to promote CFLs both within China and to market Chinese lamps to the region.

Build Energy Consumption Monitoring System. Establishing an energy monitoring system is important for measuring performance of large-scale industrial enterprises' energy consumption.

Development of Small Engine Vehicles. In 2005, NDRC and other government agencies issued the directive On Encouraging the Use of Energy-saving and Environmentally Friendly Small-displacement Cars. It states that relevant policies should be formulated to guide and encourage consumers to buy and use energy efficient, low-emission, small-displacement, and new-energy cars. Conducting a study on tax incentives for small vehicle development and fuel economy standards would of the first steps in this initiative.

Bus Rapid Transit. Bus Rapid Transit has been promoted by the Energy Foundation and has had an important influence in large cities such as Beijing and Shanghai. More efforts are needed to extend this form of transport to other medium to large Chinese cities.

Energy Saving in Buildings. Not much progress has been made in China in the area of energy savings in buildings; thus, it deserves more attention. The low market-entry cost for the construction industry results in the prevalence of low-level and high-energy-consumption buildings, which impacts China's energy demand. Policy studies can be launched on efficient building design and construction, energy-saving building structures, materials and appliances.

Capacity Building for Boiler Operators and Managers. NDRC seems keen to improve the energy efficiency of small and medium-size boilers. Currently, most boiler houses in China collect data from monitoring and targeting but do not use them in management. There are potential linkages between monitoring and targeting and further development of ESCOs if boiler energy efficiency is a focus.

Local Authority Training. Most activity happens at the central government level and local government is informed of changes via a cascade system with limited provisions for training. Since the local authorities are the frontline organizations involved in implementation and frequently in enforcement, encouraging provincial governments to comply with energy labeling and building standards is important, as is providing training to provincial decision-makers, and supporting provincial governments in developing provincial strategies on climate change and CDM.

Further Development of ESCOs in China. This is an area with a huge amount of donor activities. The Netherlands Development Finance Company is financing studies on the feasibility of setting up

training centers and ESCOs for the Iron and Steel industry. UNDESA is considering actions in training energy service companies that will market boiler and steam system maintenance and technical retrofits to industrial plants in selected pilot cities. To develop the ESCO industry in China, it is important to focus on enabling the nascent commercialization of ESCOs where technically and financially viable projects have been identified, facilitating projects identified in the steel plants participating in the Iron and Steel Voluntary Agreement in Shandong province, improving small and medium-size boilers, providing support to train and support building services ESCOs, and encouraging capacity building in ESCOs in the West.

Clean Coal. The central government would like to reduce pollution by switching partly to natural gas. Unfortunately, for social and financial reasons, provincial governments want to keep as many coalmines open without having to invest in clean coal technology. Support is needed in the development of stricter environmental standards and incentives such as tax subsidies to encourage the transition to clean fuels.

International Dimension in Chinese Energy Policy. Chinese energy policy-makers have tended to consider energy policy development in a national context. As a major energy consumer in the world, energy policy decisions will have significant regional and international impacts. With China's admission to the WTO, investment in the energy sector will accelerate and Chinese energy companies will be increasingly concerned about investment outside China.

RENEWABLE ENERGY

Cost and Pricing Policies. Financing is a key area of need and must be linked to project development and capacity for development of investment grade projects in China. There is a need for establishing Renewable Energy Investment Funds for selected RE technologies in China linked to project development. There is potential for transfer of financing instruments from international practice to China, and for developing financial policies conducive to RE development.

Market Reform. There is potential to develop market regulation mechanisms for market reform of renewable energy management. For example, a green certificates trading demonstration project can be tested and studies can be carried out on how grid-connected RE technologies can be integrated into a decentralized electricity system.

Renewable Energy Law. China can benefit from being introduced to international best practices in renewable energy law promotion from countries such as the US, Germany, UK, Denmark, Spain, Holland, and France, etc.

Grid-connected Wind Power. More work can be done on wind concessions. The UNDP conducted a study in the past and the Energy Foundation has some policy work ongoing, but more expertise can be brought in, notably from the US or EU on how to develop concessions at the national level in China and how to link to the Renewable Energy Development Scheme and National RE Law. In addition, a study of insurance schemes for wind farm operation should be considered.

Small Hydro Development. Currently not much policy work is conducted in small hydro. However, the sector is now largely commercial with favorable VAT schemes in place. More best practices could be

brought in from the US and cooperation with US trade associations encouraged. More can be done on policies for biogas development, in cooperation with UNDP for industrial scale biogas and with WB for biogas development in Western provinces.

Renewable Energy Awareness and Capacity Building Activities. In the capacity building area, there is a need to contribute further to village power development, development in Western China, and poverty alleviation through the provision of efficient standards and certification for renewable energy equipment, rural and village energy services, and technical assistance to related trade associations, etc.

Standards and Certification for Renewable Energy Equipment. There is scope to develop standards for the national solar thermal industry. A National Testing Centre has been established, but more resources are needed to effectively market and disseminate the objectives and advantages of the centre. Currently the World Bank is developing standards for Solar Home Systems under the PV component of its Reconstruction and Development Program, but no standards are being developed for village power/village level systems or mini grids. Therefore, there is a need to develop Chinese technical committees for standards at the provincial level. Special attention should be paid to committees in charge of village power standards.

Rural Electrification. A lot of work will be needed to ensure the success of the National Electrification Plan. The Chinese Government has financed equipment for 1,000 townships in Western China and is preparing to target 24,000 smaller villages in the short term. Operation and maintenance, ownership, and sustainable management of these systems need to be addressed urgently.

Business Models for Sustainable Village Power Generation. More business models need to be developed to test sustainable village power operation in different provinces. Provincial conditions differ and can require specific models. There is potential to target a number of other Western provinces to test business models for productive and sustainable uses of village power.

Entrepreneurial Funds are currently not developed and could become an area of priority for RE development in rural Western China. There is a clear need for seed money for business plan development and proposal development by local RESCOs or potential RESCOs. Micro-credit for RE development has been talked about but is not yet on donors' agendas. Therefore, expertise is needed to study the feasibility of developing micro enterprise financing institutions which would in turn organize village lending to develop business brought about by potential productive uses of energy.

Development of Rural Energy Service Companies in Western China. There is a clear need to stimulate the development of rural energy service companies in Western China. There is also a need to link efforts conducted in village power development with poverty alleviation and to incorporate social studies and elements of social anthropology in relation to township authorities and provincial governments, and poverty alleviation bureaus, etc.

Non-village Power Renewable Energy Technologies Management Training. Non-village power RE technologies management training for non-village power applications can be developed in the biogas field, picking up on UNDP's work on industrial scale biogas development.

RE Financing and Business Development Training can be developed in selected Western provinces by conducting a series of workshops and training seminars on RE technologies and barriers most relevant to each particular regional setting.

Technical Assistance to Chinese Trade Associations. There is a need for technical assistance for project proposal preparation, business plan development, CDM training, technology transfer opportunities, financing for RE development, industry exchange opportunities, and contacting associations and RE businesses in the US and EU as well as existing Chinese RE trade associations like CREIA, CAREI, CSES.

There is potential for provision of technical assistance for the creation of a provincial RE trade association, or a Western China Renewable Energy Development Association with representatives in each Western province.

Clean Energy Technologies. There is potential to conduct a feasibility study on small hydro in select provinces with focus placed on financing aspects, and for feasibility studies on solar water pumps along major infrastructure developments like pipelines, roads, and railways. There is potential for the demonstration of select state-of-the art village power technology in coordination with capacity building activities in village power.

CLIMATE CHANGE

National and Provincial Strategy on Climate Change. The World Bank has supported China's national climate change strategy studies. However, at the provincial level it is not widely recognized that the local government needs to incorporate climate change into the policy making process. There is an urgent need to support provincial government in developing climate change strategies.

Adaptation to Climate Change. The EU and UK have supported a Climate Change Adaptation project in China, aiming to study the impact of climate change on China's agriculture sector. More impact and adaptation studies need to be carried out to assess the impact of climate change on China's other economic sectors.

CDM Projects Capacity Building for Renewable Energy and Energy Efficiency Projects. There is potential to provide technical support to a yet to be established provincial trade association in Western China to develop small CDM projects. There is also potential to provide support to existing trade associations in developing CDM projects at large, developing CDM financing studies in China, and outlining opportunities and challenges. Seed financing should be provided to local or international consultancies to develop CDM pre-feasibility studies, in particular renewable energy and EE technologies for particular provinces in China. In addition, there is potential to incorporate lessons learned from international accession countries in carrying out their national emissions inventories.

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