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CDM projects in China's energy supply and demand sectors – Opportunities and barriers

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**CDM PROJECTS IN CHINA'S
ENERGY SUPPLY AND
DEMAND SECTORS
– OPPORTUNITIES
AND BARRIERS**

**Axel Michaelowa
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Abstract

China has had an enormous growth of energy and electricity consumption during the last decades. This has been fuelled primarily by using domestic coal resources. Until 1997, annual construction of power stations averaged around 15 GW which was not sufficient to alleviate the demand surplus. Forecasts envisaged continuation of this growth. The majority of power stations is small scale and rather inefficient. Local air pollution is becoming very strong and is increasingly seen as a political issue. Foreign investment in the power sector has been hampered by bureaucracy and unclear competencies. On the demand side, energy efficiency has improved markedly in the last two decades, albeit from a very low basis. Due to the economic transformation, many proven incentives for efficiency improvement cannot be used any more. The Clean Development Mechanism (CDM) opens a host of possibilities to link foreign investment in the energy supply and demand sectors with projects that enhance efficiency and reduce greenhouse gas emissions. All big industrial countries have been very keen on climate policy cooperation with China. While the official Chinese negotiation position towards the CDM and climate policy in general has been extremely cautious, many government bodies show great interest. The Asian financial crisis, which led to an electricity oversupply in 1998, gives the possibility to retire the most inefficient power plants.

Zusammenfassung

China wies in den letzten Jahrzehnten ein enormes Wachstum des Energie- und Stromverbrauchs auf. Es wurde hauptsächlich durch heimische Kohleressourcen gespeist. Bis 1997 belief sich der jährliche Zubau an Kraftwerksleistung auf ca. 15 GW, aber selbst das reichte nicht aus, um den Nachfrageüberhang abzubauen. Die Mehrzahl der Kraftwerke ist klein und ziemlich ineffizient. Die lokale Luftverschmutzung wird sehr stark und zusehends als politisches Problem angesehen. Ausländische Investitionen im Energiesektor sind durch bürokratische Hürden und unklare Kompetenzverteilung behindert worden. Auf der Nachfrageseite ist die Energieeffizienz in den letzten Jahrzehnten stark verbessert worden, allerdings von einer sehr niedrigen Ausgangslage. Aufgrund der ökonomischen Transformation können viele bewährte Anreize zur Effizienzsteigerung nicht mehr eingesetzt werden. Der CDM eröffnet vielfältige Möglichkeiten zur Verbindung von Direktinvestitionen in Energieangebot und -nachfrage. CDM-Projekte erhöhen die Effizienz und verringern Treibhausgasemissionen. Alle großen Industrieländer sind sehr an Klimaschutzkooperation mit

China interessiert. Während die offizielle chinesische Verhandlungsposition bezüglich des CDM und Klima-Politik im allgemeinen sehr zurückhaltend ist, sind viele Regierungsinstitutionen sehr stark am CDM interessiert. Die Asienkrise, die 1998 zu einem Angebotsüberhang im Stromsektor führte, ermöglicht die Abschaltung der ineffizientesten Kraftwerke.

1. INTRODUCTION

The Chinese emission of CO₂ at 2.2 tons CO₂ per capita amounts to 50% of the global average, while it makes up only 20% of the German average. The rapid growth of the Chinese economy currently leads to a strongly increasing demand for energy, though. In order to sufficiently meet this demand, the Chinese Ministry of Electric Power (MOEP) planned to expand electricity generation capacity from currently about 280 GW¹ to 530 GW in 2010 and 800 GW in 2020 (Blackman/Xun 1997). However, the recent financial and economic crisis in neighbouring Asian countries should lead to caution concerning such projections. Even if the expansion remains below the projection, it will lead to a massive increase in local environmental pollution and Chinese emission of greenhouse gases.

When the 9th Five-Year Plan was discussed in the early 90s, it was planned that an important share of investments for the 70 GW programme until 2000 would be financed by foreign capital. So far, the realisation of this plan has been fraught with difficulties and only a small share of the capacity expansion financed by foreign investors. However, foreign investment will be crucial concerning greenhouse gas reduction. Projects under the Clean Development Mechanism (CDM) of the Kyoto Protocol can provide an opportunity to transfer highly efficient, low-greenhouse gas energy supply and energy use technologies to China and thus stabilise the environmental impact of its economic growth at a relatively low level.

2. CHINA, THE ENERGY GIANT

2.1 Energy production

China is the most populous country on Earth. Nevertheless, its energy production has been very low historically- just 1.85 GW electric power plant capacity were installed in 1949! Only in the last four decades energy production started to grow. Its rise was not steady but erratic and several strong shocks such as the catastrophic Great Leap Forward or the Cultural Revolution intervened. In the early 1970s over 80% of national primary energy production was supplied

1 Concerning the interpretation of Chinese statistical data one has to be very cautious. Even if the extent of open forgery encountered in the 50's and 60's (Zhang 1997) is no longer likely, doubts remain. Often data calculated by different agencies differ by a factor of two. Also, data are only partially collected - see e.g. Sun (1996, p. 838), who estimates rural household energy use to be 2 to 4 times the official value. Surprises such as those encountered after the demise of socialism in Eastern Europe cannot be ruled out. Even the highest politicians have to rely on anecdotal evidence for policy decisions. See Studwell (1997) for a detailed discussion. Thus the data presented in the paper must be considered as tentative.

from national coal resources. This rate has now dropped to 75% and by the year 2010 it is expected to be below 70%. Oil is the second largest supply option at 20%.

In the 1990's, growth of electric power capacity reached 15 GW per year (see Table 2) and power production increased by 75 TWh per annum (see Table 3). The bulk is coal-fired.

**Table 2:
Installed electricity capacity (GW)**

	1971	1976	1981	1986	1991	1992	1993	1994	1995	1996	1997
Thermal	18.5	32.5	47.2	66.3	113.5	125.8	138.3	150.8	165.0	178.9	192.0
Hydro	7.5	14.7	21.9	27.5	37.9	40.7	44.6	49.1	52.2	55.6	59.7

Source: EP (1996), Logan, Zhang (1998), Wiesegart (1998), p. 20f.

**Table 3:
Electricity production (TWh)**

	1981	1986	1991	1992	1993	1994	1995	1996	1997	1998
Thermal	243.7	355.2	552.7	622.9	685.7	760.9	807.4	878.1	912.6	929
Hydro	65.6	94.4	124.7	131.2	150.6	167.0	186.3	186.7	184.7	195
Nuclear	-	-	-	-	-	-	13.0	12.8	14.1	14.1
Renewable	n.a.	n.a.	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3
Total	309.3	449.6	677.5	754.2	836.4	927.9	1006.9	1079.4	1117.6	1140

Source: Zhang Z. (1995), Wiesegart (1998), p. 20f, Ögütçü (1999), p. 8

Despite the low age of the bulk of Chinese thermal power plants, their average efficiency is below 30% compared to 35-40% in industrialised countries. This efficiency gap is due to several factors. Compared to industrial countries, the average size of the thermal power plants is very small (see Table 4). China currently is not able to produce generators larger than 350 MW (Blackman/Xun 1997, p. 5) but outweighs this handicap with capital costs of 600 US\$/kW, a third lower than in industrial countries (Logan/Zhang 1998, p. 13). Moreover, small power stations with outdated technologies

are used beyond their usual lifetime lowering average efficiency (see sixth column in Table 4). However, the recent emergence of oversupply allowed to avoid building of 4 GW of small, inefficient plants between the years 1998 and 2000 (Logan/Luo 1999); in January 1999 China's State Electric Power Corporation (SEPC) announced a three-year ban on the construction of new conventional thermal power stations. Moreover, small diesel or coal-fired plants which were opened by provincial or municipal governments in the 1980's shall be closed.

Fuel quality, especially of coal, is low; only 20-25% of coal is washed (Vernon 1999, p. 10). Considerable management problems also lower efficiency by two to four percentage points (Blackman/Xun 1997).

**Table 4:
Size and origin of generating units (1995) and their efficiency (1988)**

Capacity MW	No. of units	Installed capacity (GW)	% of total (1995)	% of total (1990)	Efficiency (Japanese average=100)	% of units imported ¹
>299	147	51.9	24	38.8	87	38
200-299	202	41.8	19		83	13
100-199	318	36.8	17	19.7	n.a.	13
50-99	402	22.2	10	41.5	77	22
25-49	577	16.3	8		25	
12-24	955	12.5	6		65	21
6-11	1575	11.5	5		37	
0-5	n.a.	24.2	11		42	n.a.
Sum	n.a.	217.2	100		100	82.2

¹ The high import share of extremely small units can be explained through the prevalence of imported diesel generators.

Source: Electric Power Publishing House of China (1995); Sathaye (1992), Zhang Z. (1995) für 1990

High regional differences can also be observed. Average efficiency varies by over 10 percentage points between regions as shown in Table 5.

**Table 5:
Regional differences in efficiency of coal-fired power stations**

Region	North	North-east	East	Central	North-west	Shandong	Fujian	Guang-xi	Si-chuan	Guiz-hou	Yun-nan	China
g CO ₂ /kWh	1048	1024	1005	1075	1085	1029	1240	1053	1123	1171	1248	1051
Own use (%)	8.4	7.5	6.7	5.8	6.1	6.9	3.0	3.9	6.7	5.8	3.8	6.7

Source: Wiesegart (1998), own calculations using emission factor from Vernon (1999)

MOEP set the goal to reach an average efficiency of 33% in 2000 and 35% in 2010. Nevertheless, despite of a 230% increase in capacity between 1980 and 1995 average efficiency rose only by 3 percentage points, of which one point was achieved between 1990 and 1995. Thus, MOEP scaled back its projection for efficiency improvement between 1990 and 2000 from 6 to 3.5 percentage points (Blackman/Xun 1997).

The share of hydropower has fallen from a high of almost 25% in the early 1980s to less than 17% in 1997. However strong development of hydropower resources, the largest being the Three Gorges Dam at the Changjiang river which will be the biggest hydropower station in the world (18GW) or the Xilodu project with 11 GW begun in 1997, shall stop this trend. So far only 10% of the hydro potential have been tapped (Blackman/Xun 1997). However, due to negative ecological side-effects it is doubtful whether the full potential should be exploited.

Li Peng stressed nuclear expansion in his 1997 energy policy programme while stating in the same paragraph that renewable energy „should not be ignored“. He saw renewables as a local solutions to local problems - they did not even get an own paragraph! Their major role was to free oil to alleviate projected oil shortages. Therefore, 60 million US\$ were spent on rural renewables development. Nevertheless, the expansion programme for wind energy was very ambitious as 1 GW shall be installed in the next years.

Due to the lower than expected growth in electricity demand after the financial crisis in 1997 and growing budget problems of the central government, expansion of nuclear power supply is unlikely to reach the planned 9 GW by 2005.

2.2 Energy use

From 1979 until 1997 economic reforms led to a sharp and sustained increase in energy consumption levels (see Table 5a). Growth in energy demand was accompanied by an overproportional increase of electricity demand which led to frequent shortages in power supply, particularly in urban areas.

Table 5a:
Primary energy consumption (Gtce)

	1981	1986	1991	1992	1993	1994	1995	1996	1997	1998
Gtce	0.59	0.81	1.04	1.09	1.16	1.23	1.29	1.40	1.32	1.22

Source: Wiesegart (1998), p. 41, Ögütçü (1999), p. 8, Sathaye, Jayant (1992)

In the early 1990s, MOEP estimated the demand surplus at 15-20% and forecast that by 2015 the gap could increase by 150% (EP 1996, p. 37). Demand was projected to increase by 280% between 1994 and 2010. Moreover, still over 100 million rural Chinese have no access to electricity (U.S. Embassy 1997a). Thus the baseline for emission reduction was very high.

Nevertheless, the Asian financial crisis of 1997 and its consequences that led to an absolute decline in energy consumption show that an extrapolation of past economic and energy demand growth rates for several decades may lead to gross overestimates. China's coal and electricity sectors became rapidly oversupplied beginning in 1997. Coal stockpiles totalled nearly 200 million tons in June 1999, despite the closure of 23,000 small coal mines and a reduction in output of almost 200 million tons of coal from the 1997 level. The power generation sector was oversupplied by an estimated 24 GW in mid-1999 (Logan/Luo 1999, p. 2). Besides the decrease of exports due to the Asian crisis this surprising swing has also been caused by dismantling of energy subsidies which kept fuel prices well below world market prices are successively dismantled. Coal subsidies were reduced from 37 % in 1984 to 29 % in 1995 and fully dismantled in 1997, and petroleum subsidies from 55 % in 1990 to 2 % in 1995 (Wu/Logan 1997). Coal and oil prices have been liberalised countrywide – they fell by 15% in 1998 - and electricity prices in the coastal provinces. Mathai (1997) shows that even state owned enterprises react on these increases - the price elasticities he found are comparable to industrial countries. Nevertheless, delivered heat and residential fuels continue to be heavily subsidised (Martinot et al., 1997, p. 385).

The low efficiency of Chinese energy consumption is significant. The average intensity per unit of GDP lies eight times above the Japanese average. Corrected by purchasing power it still remains four times higher. However, in the last two decades, Chinese energy efficiency has improved markedly. While it declined between 1950 and 1980, it rose by 3.6% p.a. in the 80s and by almost 6% p.a. in the 90s (Zhang Z. 1995). The lion's share of the efficiency increase is due to a comprehensive set of policy directives, procedures, regulations, technical assistance programs, and project financing initiatives to promote energy efficiency (for a detailed description see Sinton et al. 1998)¹. Only a limited part of it was due to a lower share of heavy industry, especially in the first half of the 1980s. Companies were assigned energy use quotas. If they exceeded their quota, they had to pay substantially higher energy prices (up to 2005). In addition, an extensive network of energy conservation offices was established throughout the country. Moreover, subsidised loans were provided. In some provinces, companies had to invest 20% of depreciation funds in energy conservation. China is one of few developing countries that introduced building energy standards. These are modelled on the standards of the American Society of Heating, Refrigeration and Air-Conditioning Engineers of 1989 (Duffy 1996, p. 11). It also has standards for all relevant domestic appliances introduced in 1989 and for industrial motors and boilers supervised by the State Technology Supervision Bureau (STSB) (Duffy 1996, p. 24f.). The former refrigerator standards are 5% lower than comparable Mexican standards and 10% below Swiss target values. Air conditioner standards are 8-24% below comparable Japanese standards. However, it is unclear whether the standards are actually enforced. The government sponsors an annual week of energy efficiency campaigning (Zhou et al. 1997, p. 2). A large-scale success has been the sale of efficient biomass/coal stoves in rural areas. The central and local government subsidised promotion and training and selected pilot areas (Qiu et al. 1996). In the last decade 120 million stoves were sold that doubled efficiency and thus save 22 mtce per year. The target is to provide each rural household with such a stove by 2000 (U.S. Embassy 1997a).

Rumsey and Flanigan (1995, p. 31) evaluate China's programmes as „by far Asia's most successful in achieving actual energy savings, both in gross amount and in percentage savings“. With deregulation of energy prices and the growing share of private companies, however the impact of the programmes is likely to be reduced. Government support for energy conservation offices is shrinking (Martinot et al. 1997, p. 389) even if the government states that efficiency improvement is a short term

1 However, some analysts think that a considerable share of the efficiency improvement is fictitious and due to the progressive inclusion of the informal sector in the calculation of GDP.

priority (Li 1997) and has enacted an energy efficiency law in 1997. However, many of the provisions in the energy conservation regulations are extremely vague or soft; „encouraging“ certain actions, „supporting“ others, using broad language with multiple possible meanings. Even where more concrete duties are created (*e.g.*, to create a set of standards) very little guidance is provided in the regulations as to how extensive the regulations should be or what goals/values they should achieve. It is unclear, in many cases, what behaviour would constitute a violation of the provisions (Wang 1999).

While energy intensive industries are located in the eastern and northern parts of the country, energy supply centers in the west and south, necessitating long-distance coal transport and transmission lines and associated losses. Coal accounts for 40% of rail freight transport in China (Logan/Zhang 1998)!

2.3 Local environmental damages from energy production and consumption

Increasing energy consumption causes striking damages to the local environment (Dasgupta et al. 1997). Serious air pollution has become the most common cause of deaths in urban areas, causing respiratory diseases. Abatement benefits of reduction of a ton of SO₂ in big Chinese cities are calculated by Dasgupta et al. (1997, p. 35) to be above 50 US\$. Chinese studies calculating total damages from SO₂ even come to figures of an order of magnitude higher (see Table 6).

Table 6:
Economic values of acidification damages in China (billion Yuan, 8.3 yuan=1 US\$)

Damages	1995	2000
Agricultural products	21.8	28.5
Health	17.2	19.6
Forestry	77.6	128.3
Total	116.6	176.4
<i>Damages per unit emission (Yuan / ton SO₂)</i>	<i>4,978</i>	<i>6,461</i>

Source: Lao (1998)

However, air pollution problems will get worse in the coming years, due to the economic growth. Especially township and village enterprises that account for 50% of China's industrial production are major polluters and extremely inefficient. This is mainly due to lack of credit (Martinot et al. 1997, p. 389). Until now, no statistical data about their pollution were available (US Embassy 1997a)! Preliminary studies anticipate

that Chinese sulfur dioxide emissions will increase by 30% and industrial particulate emissions by 68% if these enterprises are included (U.S. Embassy 1997a). A 2020 scenario without SO₂ mitigation sees levels of acid deposition three times higher than the worst ever recorded in the infamous „black triangle“ of Central Europe (IIASA 1998).

However, the situation has been changing recently. "Two controlled Area" (Acid Rain Controlled Area and SO₂ Controlled Area) were established as demonstration project in the ninth 5-year national plan. Furthermore, to combine the prevention and control of industrial (including township and village enterprise) and urban pollution with promotion of cleaner production, a "Control Plan on the Total Amount of Pollution Discharge and Trans-century Green Engineering Project" was also set as a national policy. However, central government control over the actions of provinces and municipalities has weakened in the last years. It currently more often rests on persuasion than on regulatory authority. Thus, environmental policy implementation differs strongly between provinces. While Guangdong has enacted implementation in some sectors, inland provinces lag behind (Dasgupta et al. 1997).

3. VOLUME OF FOREIGN DIRECT INVESTMENT IN THE CHINESE ENERGY SUPPLY SECTOR AND BARRIERS TO ITS EXPANSION

According to Shin (1999), 99% of the power plant constructed after 1990 are independent power producers. The planned expansion of the electricity generating capacity requires a total finance volume of 200 billion US\$ until 2010 (Blackman/Xun 1997, p. 6). Internal Chinese savings will not be sufficient to meet such requirements. Therefore, it will be necessary to attract foreign investors for at least 30% of the investment costs. Moreover, current Chinese production capacity for electricity generation equipment amounts to only 9 GW per year compared to the current expansion rate of 15 GW and a projected rate of 23 GW in the decade 2000-2010 (Blackman/Xun 1997, p. 6). Thus imports and foreign direct investment (FDI) are crucial to reach the expansion targets.

From 1978 to 1993 overseas sources invested approximately 14.3 billion US\$ in the Chinese power sector, approximately ten percent of total investment during that period. These funds were used in 63 large- and medium-scale projects that have a combined capacity of 40 GW. Many of these projects were hydro. 85% of the foreign funds were provided by public-sector sources - foreign governments and multilateral lending institutions like the World Bank and Asian Development Bank. FDI played a very

minor role (Blackman/Xun 1997). As the Chinese government recognised its crucial role, it introduced policy changes.

In March 1994, the State Planning Commission promulgated Interim Regulations for the Use of Foreign Investment for Power Projects which, for the first time, specified explicit rules for FDI. In August 1995, China issued a notice for tendered Build-Operate-Transfer (BOT) projects. In December 1995 the Law on Electric Power was proposed, which included explicit rules for foreign investment in the power sector. At the same time, the MOEP created the China Power Investment Corporation to raise international capital for power projects. An increase in the decentralisation of decision making processes also supported FDI: Regional authorities try independently to acquire foreign investment capital for their projects.

Despite these efforts to attract FDI and an intense project preparation activity, in the last years actual levels of FDI in Chinese power generation have been moderate. Only a small percentage of contracts negotiated have actually been implemented. By June 1998, 24 FDI plants with a total capacity of 4.9 GW were in operation, and another 12 plants with a total capacity of 9.0 GW were under construction. Thus, only somewhat more than 10 GW will have been added by 2000 (Blackman/Xun 1999). 25 projects were financed from the U.S., 4 from the UK, 3 from France, 2 from Germany and one each by a company from Japan and Taiwan (Blackman/Xun 1999, p. 701). The projects are concentrated in the coastal provinces. The share of coal is even higher than in the Chinese average: 90.7% of installed power, whereas gas has 6.1%, oil 1.9% diesel 0.8% and hydro 0.5%.

The reason for this low activity is that investors so far have encountered several important institutional barriers (Blackman/Xun 1997, p. 19ff.). These include: ownership restriction, rate of return regulation, exchange rate risks, uncertainty governing laws and regulations that create financial risks; risk that power purchase contracts will not be honoured; delays in approval that also lower return on investment.

1994 rules stipulate that Chinese partners in non-BOT joint ventures maintain a controlling interest in plants with a unit capacity larger than 299 MW or a total capacity larger than 599 MW. Wholly owned foreign ventures of any scale were allowed. Finally, foreign entities were not be permitted to own more than thirty percent of existing plants. Because of the low activity, the rules were eased in 1996. Foreign

partners in joint ventures are now allowed to have a controlling interest in all type of plants except hydro plants larger than 250 MW and nuclear plants.

The central government feared that foreign investors would be able to negotiate extremely favourable terms with local governments faced with chronic power shortages, especially if local governments were given the opportunity to become partners in a joint venture. By stiff rate of return regulation it tried to prevent such „exploitation“. Although not officially documented, there is general agreement that beginning in 1993, the State Planning Commission, which must approve all projects costing more than 30 million US\$, stopped approving all FDI power projects with projected rates of return in excess of 12%, and later 15% This cap was set at an unusually low level given the risks involved. In other Asian countries, rates of return in excess of 20% are the norm. In 1996 the rate was raised to 15% after tax. After the financial crisis the cap was de facto abolished (Blackman/Xun 1999, p. 703).

Thus investment in relatively less efficient small-scale plant that are less regulated and generally less risky than large investments became attractive (Ma et al. 1997), see Table 7. 30% of the implemented projects remained below the 30 million US\$ cap. Especially striking was the initial prevalence of diesel-fired plants despite a professed preference for other types of plants (Blackman/Xun 1997, p. 29).

**Table 7:
Size of FDI power plants (MW)**

Sum	>300	200-299	100-199	50-99	25-49	12-24	<12
36	8	3	6	9	6	3	1

Source: Blackman/Xun 1999, p. 702, own calculation

Power purchase contracts require that the power purchaser - usually a local government owned power bureau - buy a ‘minimum take’ from the plant for a fixed term at a fixed price schedule. The minimum take, term, and price schedule are all negotiated before plant construction begins based on the plant’s projected operating costs. The term of the contract can range from 10 to 30 years. Electricity produced above the minimum take can be sold at a price that is higher than that specified in the contract. Perhaps the most serious risk run by FDI power plants is that the power purchaser will not to buy the contracted minimum take. At the present time, the Chinese government maintains that, given existing electricity shortages, power purchase contract default should never

actually occur. Nevertheless, default risk is real, especially in areas where large economically unstable state-owned industrial enterprises account for a major share of electricity demand. In any case, financiers of FDI ventures often require some type of assurances regarding default. Since default is not officially expected, contingency plans are fragile. The Chinese legal system is not accustomed to enforcing power purchase contracts. Government guarantees that existed in the past will no longer be available. Exacerbating the problem is the fact that joint venture plants often include power purchasers as a partners, an arrangement that enables foreign investors to obtain favourable contract terms, but limits legal recourse in case of contract default.

While in the beginning all projects had to be approved by the Ministry of Foreign Economic Relations and Trade (MOFERT) and the State Administration of Exchange Control (SAEC) all projects smaller than 150 MW or costing less than 30 million US\$ can be negotiated locally.

A survey by Blackman and Xun (1997, p. 25) showed that majority control of a non-BOT co-operative joint venture with a local governmental organisation was the most popular institutional arrangement for FDI in the power sector. Foreign direct investors have a controlling interest in fully three quarters of the joint ventures. Martinot et al. (1997, p. 386f.) explain the prevalence of joint venture with the need for local partners that know the regulatory and bureaucratic system. So far, these joint venture typically have involved state-owned enterprises.

Blackman/Xun (1999, p. 706f.) tentatively conclude that the efficiency of the FDI plants is higher than of comparable new Chinese *and* U.S. plants but could have been better in a less regulated environment.

4. CHINESE CLIMATE POLICY AND CDM PROJECTS

4.1 Chinese climate policy

It is clear that the Chinese environmental policy priorities are on the local and regional level (Information Office of the State Council 1996). Thus, greenhouse gas reduction is only attractive if it includes direct or indirect reduction of local pollutants. Domestically, climate policy objectives were included in China's Agenda 21 adopted 1994. They include formulating a national programme for controlling greenhouse gas emissions by afforestation and energy development. Later, emission targets shall be set. Interestingly, a paragraph states that China „will actively seek investment from the

international community for projects which assist in the slowing of climate change. These include projects for coal-fired power plants, hydroelectric power stations, coal gas projects, coal methane utilisation and tree planting“ (EP 1996, p. 87). Despite the lack of mention of energy saving measures, these have actually been at the forefront of domestic activities (see 5.2 below).

China’s institutional structure for climate policy is very complex and yet evolving. Major actors are:

- the State Environmental Protection Commission (SEPC), the highest decision body on environmental policy who unites ministers and heads of agencies,
- the State Planning Commission (SPC),
- the National Environmental Protection Agency (NEPA) which is the secretariat of SEPC and comparable to an environment ministry.

China has been very cautious in the international climate negotiations and always tried to prevent any decisions that might lead to emission constraints for developing countries. Its resistance was crucial for the deletion of a Kyoto protocol paragraph that allowed non-Annex-I countries to set voluntary emission targets (Hogue 1997). In the same spirit, it was very critical of emissions trading and Joint Implementation as these instruments were seen to pave the way for commitments of developing countries. In March 1998, the Chinese government established the National Co-ordination Group on Climate Change (NCGCC) to foster a comprehensive approach on the climate change issue¹. The NCGCC is one of 20 committees/groups that are under direct supervision of the State Council and composed of following four subgroups similar to IPCC grouping:

1. Scientific assessment team
2. Influence and mitigation team
3. Social and economical influence team
4. International negotiation team

Each of the team has members from various ministries. Members from the Foreign Ministry are in charge of international matters such as negotiation as well as Activity Implemented Jointly (AIJ) project proposals.

1 In May 1998, China became the 37th signatory country of the Kyoto Protocol of the U.N. Framework Convention on Climate Change UNFCCC.

Many projects that reduce greenhouse gas emissions simultaneously affect other pollutants such as SO₂, nitrogen oxide (NO_x), total suspended particles (TSP), etc. By implementing these projects, 1) emission reduction countermeasures of air pollutants will be avoided for the host country, 2) the local environment will be improved. This means that two types of secondary benefits will occur. The first one is the benefit created by the avoidance of air pollutants emission reduction cost originally needed at the host country (avoided cost). The second is the benefit created by the decrease in damage cost. The consideration for these secondary benefits at calculating the emission reduction cost will greatly change the aspects of the GHGs emission reduction project's overall evaluation. One of the points of the carbon-offset project is the existence of the benefit accruing to the host country. Moreover, even in developing countries, especially in China, the improvement of air quality is becoming a policy issue with a high priority. Therefore, at negotiations regarding the amount, the price, and the sharing of the carbon credit between the host and investing country, the quantification (monetary valuation) of secondary benefits generated by the project is important.

In early 1999, the State Development Planning Commission (SDPC) published a major study on China's future energy policy that takes climate policy astonishingly serious to derive goals for the energy supply sector in 2050 (US Embassy 2000). The study frankly argues that China must halve its dependence on coal while sharply boosting natural gas production and oil and LNG imports to meet eventual climate change treaty commitments. The share of coal should be 35 % of Chinese energy consumption in 2050 with oil and natural gas accounting for 40-50 % and primary energy sources such as nuclear, hydro, solar and wind power account for 15-20 %. Interim targets for 2020-30 would be 50% coal and 35% gas.

4.2 Climate cooperation – JI, AIJ and CDM

The idea of Joint Implementation (JI) was based on Art. 4, 2a of the 1992 U.N. Framework Convention on Climate Change (UNFCCC). It has been refined in Art. 6 and 12 of the Kyoto Protocol negotiated in 1997. Industrial countries with legally binding emission targets may achieve their target not only through domestic measures, but also through activities in other countries with targets (Art. 6). The Clean Development Mechanism (CDM) (Art. 12) is used with countries without emission targets. In this way, industrial countries can use international low cost emission reduction while transferring financial resources and know-how to developing countries.

China is the ideal country for large scale greenhouse gas reduction projects. Thus, the U.S., Japan and other industrial countries have been very eager to start projects and have provided capacity building since 1995. Nevertheless, for a long time China and other developing countries were strictly opposed to JI because they feared that a participation in JI would be the first step towards a commitment to climate protection measures. Thus, the Berlin conference in March 1995 decided to test JI under the new term „Activities Implemented Jointly“ (AIJ) until 1999 in a pilot phase, where no crediting of reductions was allowed. The criticism of JI did not prevent Chinese officials from discussing AIJ issues with the Norwegians, Dutch and Japanese (EP 1996, p. 98). It seems that there were interministerial differences concerning the attitude towards AIJ. While NEPA and SEPC were favourable, the Foreign Ministry remained sceptical - and the latter dominates China's negotiating position.

In spring 1997, parts of the Chinese government changed their position concerning a participation in the AIJ pilot phase (Wu/Liu 1997). Now they promote AIJ investments in China. The reason for this reorientation was the idea to attract additional capital. Moreover, they realised that they would not receive intensive transfers of technology by pure grants as originally envisaged. Another positive influence for this reorientation was the reduction of local environmental pollution, as a side effect of the carbon mitigation. The need for reduction of local pollution has led to the first initiatives in this respect. The city of Beijing is currently converting all central heating boilers from coal to gas.

In 1997, the first Chinese AIJ pilot project was concluded with Japan. It entails the installation of dry fire-extinguishing facilities for coke at a large steel plant in Beijing to ensure more effective use of heat energy at a cost of 24 million US\$ and reduces 86,900 t CO₂ per year (Anonymous 1997f.). Asuka (1999) made an economic evaluation of this project. Various issues relating to the estimation of the specific size of the GHG emission reduction cost and amount through negotiation have become apparent. In addition, the monetary valuation of the local emission reduction effect of SO₂ has had an impact on cost assessment.

4.3 U.S.-China climate policy Co-operation

Already in the late 1970s, the U.S. promoted clean coal technologies in China and a joint research programme on CO₂ and climate change was agreed in 1987 (Price 1998). After ratification of the UNFCCC in 1994, the collaboration deepened considerably. The U.S. set up Energy Efficiency teams as a result of the Protocol for Co-operation in the Fields of Energy Efficiency and Renewable Energy Technology Development and

Utilisation signed in February 1995 between the U.S. Department of Energy and the Chinese State Science and Technology Commission (SSTC). In this context, the U.S. provided funding for energy efficiency studies (DOE-OIT 1997a). Obviously it wanted to open up markets for American technology. The U.S. Ex-Im Bank set up 50 million US\$ export credits for renewable energy and energy efficiency projects (Anonymous 1997b). Several workshops have taken place, inter alia a U.S.-Japan-China workshop on „Technology transfer, GHG mitigation and sustainable development“ in November 1997 (Ma et al. 1997). A joint U.S.-Chinese statement on energy and environment co-operation was signed during the visit of Jiang Zemin in the U.S. in October 1997. It was an outgrowth of the U.S.-China Environment and Development Forum established in March 1997 during Gore’s visit to Beijing (White House 1997). The U.S. government initiated the Technology Co-operation Agreement Pilot Project (TCAPP) in 1997 as a mechanism for the technology transfers to the developing countries in the field of the climate change. In 1997, China had identified 20 projects that would reduce carbon emissions, are financially viable, and for which U.S. investment would be welcome. A collaborative effort between U.S. and Chinese researchers evaluated these projects (DOE-OIT 1997a). However, no U.S.-Chinese AIJ project has been notified so far even if China has been one of the host countries which the US government is focusing its efforts through TCAPP. So far, various investment programs and actions to remove market barriers have been identified by the TCAPP China team (U.S. government, 1999). When the U.S. vice president Al Gore and China’s Prime minister Zhu Ronqi met in Washington in April 1999, both sides agreed that they would establish a 100 million \$ fund for technology transfer in the field of energy conservation and power generation from the US to China. Concessional loans managed by the EXIM bank are supposed to play a main role in this fund.

4.4 EU energy and climate policy co-operation with China

In the last years, the EU has called for a more active energy co-operation with China. In 1995, the Commission issued a communication on long-term relations with China mentioning the energy sector. The latter was focus of a communication in 1996 on the „Europe-Asia co-operation strategy for energy“. It sets the following priorities:

- Modernising the electricity sector
- Introducing „clean coal“ technologies
- Raising energy efficiency

- Rural energy supply through use of renewables
- Promotion of natural gas

While the second point clearly has no greenhouse gas benefit, the third to fifth points all lead to emission reduction. The emission benefits of the first point depend on the concrete measures. Interestingly, nuclear and hydro power are not mentioned.

There is no instrument of co-operation concentrating on China. The JOULE-THERMIE and the SYNERGY programme provide funds for energy projects. THERMIE has financed a couple of conferences on energy issues, focusing on coal technologies. Its overall funding for projects in China in 1991-1996 was 1.29 million ECU (EP 1996, p. 121g). SYNERGY is only funded with 8 million ECU per annum and thus not relevant. Its role has been confined to energy management courses for over 3,000 people (EP 1996, p. 108). The European Investment Bank in 1995 signed a framework agreement with China mentioning energy and environment projects. The first loan of 55 million ECU financed an offshore oil operation.

Environment co-operation is much less developed. In 1996 negotiations on an EU/China Environmental Management Co-operation Programme were held. The Netherlands concluded an two-year agreement on environmental co-operation in 1996 including greenhouse gas emission reduction (EP 1996, p. 98).

Compared to U.S. companies, EU companies have been less active in energy-related FDI in China, even though the member states pursue a policy of strong subsidisation by public funds to procure Chinese orders. For example, a third of the total amount of German development assistance was used to build subway lines in Shanghai and Guangzhou.

4.5 Japanese climate co-operation

Asuka (1999) discusses that Asian countries, especially China, may be considering the existing financial and technological support from Japan as part of the „post-war compensation“. Therefore, it can be predicted that the issue of „financial additionality“, which states that the funds for the international collaboration for global warming mitigation measure should be newly and additional, may strongly be persisted on. Moreover, even if the government of the host country approves utilising the existing

ODA, Japan will be forced to compromise in other parts, and as a result, it is possible that the cost becomes higher.

Therefore, in regards with public funds, it is better to clarify the distinction between the part dealing with fields such as global warming which is a multi-lateral international environmental policy based on economic rationality as well as a domestic industrial economic policy and the part dealing with bilateral development aid which is a diplomatic tool against developing countries with historical complications. Furthermore, it is considered that the Japanese Export/Import Bank loans that do not count as an ODA, can be used constructively in the international collaboration on global warming mitigation. In other words, by giving a part of the public fund a „fresh new look“, a title as such as the „Climate Fund“ implemented by the Norwegian government, and a special budget on an onerous financial support could be provided. Needless to say, such as an expansion of subsidies (i.e. the current Green Aid Plan by MITI) with energy-related tax as the originating fund and 'flexible' application of the Export Insurance could be considered as well. For example, it could be considered that the Export Insurance system could be modified to be able to absorb the risk of the price volatility of the carbon credit. In this context, establishment of carbon tax as a fund source would be an important issue for further discussion in near future. In any rate, from both sides of the appeal to the international society and of the accountability to the domestic society, the consideration of the introduction of a budget with a new title regarding the public support of global warming mitigation by international collaboration is necessary.

Asuka (1999) recommends Japan to consider the global warming issues as important diplomatic and economic issues. It should thus deal with it more positively and construct a mechanism in Asia similar to the World Bank Prototype Carbon Fund. In specific, it can be considered to let the Asian Development Bank (ADB) carry out such function. As a matter of fact, in Europe, the European Bank for Reconstruction and Development (EBRD) has a plan to begin its own Carbon Brokering Program (Energy Efficiency Equity Fund) other than that of the World Bank. Furthermore, it should be possible to relate the institution building regarding the global warming issue with the institution building with regard to the acidification issue, which is also an urgent issue in the East Asia.

5. OPTIONS FOR A COMBINATION OF CDM WITH COMMERCIAL ACTIVITIES IN CHINA

If the crediting of CDM projects will be allowed after COP 6, an incentive for CDM projects could be that investors can credit emission reductions against carbon taxes and other climate policy instruments. Thus investors earn an extra revenue through provision of efficient energy technology.

5.1 Energy supply

The BOT modus offers a good possibility to introduce CDM projects, because the investor controls the performance of the project. We will discuss different project types and start with the coal sector due to its overwhelming importance. Obviously, general coal-to-gas conversion would yield enormous greenhouse gas benefits, but is difficult due to the need for big infrastructure investment. However, Logan/Luo (1999, p. 12ff.) roughly calculate that a CDM credit valued between 5 and 10 US\$/t CO₂ would lead to equal power prices from coal and gas fired power plants over much of China. Due to high coal transport costs, gas would already now be the cheapest option in southern coastal provinces.

5.1.1 Upgrading of existing and new coal-fired power stations

An especially interesting CDM option is the substitution of small-scale, extremely old and inefficient plants through large efficient ones. Whereas in the past the small plants had to remain operative because of the demand surplus, China has stated its intention to shut down these plants progressively (Anonymous 1998a). However, even if larger units are built, this will not necessarily entail use of advanced technology such as integrated coal gasification (IGCC) due to the price differential. Internationally, the cost of building an IGCC plant lay at 1450 US\$/kW in 1997, while pulverised coal (PC) plants cost 1150 US\$/kW. The cost disadvantage is substantially greater in China, where the capital cost of building a PC plant has been, in some cases, less than 500 US\$/kW; the average cost of well-designed plants (including desulphurisation) is about \$880 US\$/kW (Nautilus Institute 1999). Even „normal“ supercritical units with efficiencies of 40% are not necessarily the default option; currently only 6 GW are operating in China (Vernon 1999, p. 16). There is thus a wide range for CDM projects. Another option is to upgrade old facilities as the example below shows:

Case study: Upgrading of 125 MW coal-fired power plant

A plant improvement study of the Banshan Power Station, Hangzhou, supported by the Australian Government, recommended the following activities to improve efficiency and reliability (Anonymous 1998b):

- complete turbine upgrade;
- reinstatement of sootblowers and burner tilts; reduction in excess oxygen levels and unburnt carbon losses through furnace modelling and improvements to
- mill maintenance;
- air heater upgrades to improve thermal efficiency;
- upgrade of the boiler airflow and draft control system.

The expected benefits from these upgrades with a gross investment of about 3.5 million US\$ were an improvement in plant relative thermal efficiency of 7.2% and an increase in the maximum output of 6.4% to 133 MW. The impact on CO₂ emissions would be a reduction of about 94 kt per year. The pay-back time for the proposed improvements would be four years, making the project profitable.

The plant operator has now decided to proceed with the turbine upgrade, which in itself will reduce CO₂ emissions per kWh by 5.1%. Moreover, switching from local coal to imported coal with a lower ash content and higher specific energy would reduce coal consumption by 27% for the same output. Modelling indicated that switching would improve boiler efficiency from 86.6 to 87.9%, so that 1.3% less fuel energy would be required. This would result in a 6% reduction in specific CO₂ emissions from 1211 g/kWh to 1137 g/kWh. The plant operator is considering replacing or blending existing coals with higher-quality imported coal (Vernon 1999, p. 14f.).

Would this project be attractive as CDM project or not?

- Rules may decide that profitable projects are not eligible for the CDM. However, the investor could argue that in the Chinese context barriers have to be overcome (see section 3.). This is shown by the fact that only the turbine upgrade is done autonomously.
- Due to the reduction of SO₂ by 1720 t per year local benefits would amount to 90,000 to 1.3 million \$ (taking the figures from section 2.3).
- Use of import coal may be difficult due to foreign exchange restraints
- The project is easily replicable as Zhejiang province has 19 power stations of the same design.

Liu (1999) made a feasibility study of cogeneration (CHP) and circulating fluid-bed combustion (CFBC) power stations. CHP and CFBC reduce energy consumption as well as air pollutants. There are currently 285 MW of CFBC operating in China (Vernon 1999). The baseline scenario in this case study was the conventional low-efficient industrial boiler in a specific city of Henan province. According to its incremental cost calculation, the emission reduction cost was 6.40 US \$ /ton CO₂.

5.1.2 Capture of coalbed methane

All coal mines, especially underground ones, emit methane that has to be collected and ventilated to guarantee safety. Captured coalbed methane can be used like natural gas. The reserves of coalbed methane in China are estimated at 30 to 55 trillion m³ (Anonymous 1998c), i.e. 25 to 40 times its natural gas reserves (BP Amoco 1999). In January 1998, Texaco contracted with the China United Coalbed Methane Corporation to capture 0.5 billion m³ per year in Anhui province (Logan/Zhang 1998, p. 16), i.e. about 2% of Chinese natural gas production. Three other companies have followed since (Logan/Luo 1999). Wei and Chen (1998, p. 48) calculate a cost of 16 \$/t CO₂ but use a strange baseline (they do not calculate the methane reduction but compare CO₂ emissions from burning of coal and burning of methane).

5.1.3 Electricity and natural gas import from Russia

In relative geographic proximity to China the vast energy resources of Eastern Siberia are situated. This invites speculation on large-scale export of electricity and natural gas from Russia to energy-hungry China. Even if Russia will not need CDM investments due to its lax emission targets, it might be interested to sell CDM emission credits achieved through projects in China to other industrial countries.

Russia has a relatively low CO₂ intensity for power production (approximately 500 g CO₂ per kWh). Due to the shutdown of heavy industry there is a power oversupply in most regions of Siberia that is mainly based on hydropower. Recent improvement in power transmission technology makes power export from Russia a realistic option. Besides Russian companies, also the German Siemens showed interest in technical realisation of such projects. Concrete plans have already been developed by the utility Irkutskenergo that calculates the costs for a long-distance line with 1.5 billion US\$. Then it could export 18 TWh per annum to China, i.e. 1.5% of China's current consumption (Ziener 1998). As Irkutskenergo generates more than two thirds of its electricity by hydropower, the CO₂ content per kWh would be less than a third of the

Chinese average. A rough, but cautious calculation using a difference of 500 g CO₂/kWh gives a potential CO₂ credit of 9 million ton per year.

Already in late 1997 China signed a memorandum of understanding with Russia to build a US\$12 billion pipeline system from Siberia to China's Pacific coast. The distance from Russia's Irkutsk Basin gas fields to China's eastern coast is comparable to the distance covered by the existing pipelines from Western Siberia to Western Europe.

According to estimates of gas demand in China made by the Institute of Energy Strategy in Moscow, in 2010 gas export to China could reach 10-12 billion m³, i.e. 50% of current Chinese natural gas production. Several versions of pipelines are under discussion, with two of them considered by the Russian gas monopolist GAZPROM as feasible: 1) Kovykta - Irkutsk - Mongolia - Beijing with branches to Ulan-Ude and Chita, in total 3000 km and capable to carry 30 billion m³; 2) Kovykta - Irkutsk - Tsitsikar (China) - Beijing with branches to Ulan-Ude, Chita and Kharbin, in total 4580 km. Projected capital expenses vary depending on sources from 3.5 - 4.8 billion US\$ estimated by the Russian Ministry of Fuel and Energy (1999) to 7 billion US\$ (Logan/Chandler 1998). Again using a rough estimate coal-to gas conversion yields credits of 2.5 million t CO₂/ billion m³, i.e. the pipeline 25 to 75 million tons per year.

In the current state of Russian economy financing of large-scale electricity and natural gas export from Russia to China is unavailable. Only the involvement of international banks and foreign investors could help to overcome this barrier. Therefore power and gas export from Russia could prove its financial additionality and qualify for CDM. The different carbon intensity of power generation for Russia and China could serve as baseline. Due to the mentioned oversupply of electricity, there would be no leakage.

5.1.4 Renewable energy

A promising field for small-scale CDM projects in China is wind power (for a good overview see Lin 1998). By 1997, there were 140,000 small, locally manufactured turbines in rural China providing electricity for lighting, radios, televisions and small appliances. Most are located in Inner Mongolia, due to favourable policies by the local government started already in the early 1980s; about 35% of the non-grid-connected population there is now electrified in this manner, reaching 90% in some areas (for a detailed description of the situation see Zhang et al. 1999). These small turbines contributed about 19 MW to installed capacity. These programs have been successful in creating a domestic industry of wind turbines: however, these are mostly 100 W units

used in single households (Lew et al. 1996). China has a technical potential of 250 GW and plans to increase its installed capacity from below 100 MW to 1 GW in 2000 and 3 GW by 2010. The best sites with a potential of 1 GW in Inner Mongolia have average annual windspeeds of 9 m/s (Zhou et al. 1997, p. 19ff; Lew et al. 1996). Because of import duties on wind turbines of 20%, the price per kWh amounts to 5 US cents which is not yet commercially viable if compared to the 2-3 US cents a coal-fired kWh cost in North China (Lew et al 1996, p. 6). Zhou et al. thus recommend the set-up of domestic turbine manufacturing that could lower costs by around 40% (Lew et al. 1996, p. A9). As long as the fixed buy-back rate for wind power, set by the State Planning Commission for each province, is held up, wind power development is clearly profitable. In 1996 buy-back rates ranged from a low in Inner Mongolia of 6.5-7.6 US cents/kWh over 7.8-8.4 US cents/kWh in Nan'ao Island to a high of 10.5 US cents/kWh in the far western region of Xinjiang (Lew et al 1996, S. 3). Installed windpower has picked up recently, albeit from a low base (see Table 8).

**Table 8:
Installed wind power**

	1992	1993	1994	1995	1996	1997	1998
MW	5	13	31	n.a.	57	70	224

Source: Sinton (1996), Lindley (1999)

Besides large wind farms, also small scale wind/solar hybrid rural electrification can be interesting. The province of Inner Mongolia has set up a legal framework to facilitate such projects by setting up revolving accounts (U.S. Embassy 1996b). Biogas is also a relevant option for the major part of the rural areas. In Guangdong province alone, 160,000 biogas household digesters were constructed in 1996, while 19 larger projects provided 110 MWh of electricity (Anonymous, 1997c). Moreover, 2.1 million ha shall be afforested for fuel use. Nevertheless, in the short term woody biomass use cannot be expanded sharply as almost 90% of the fuelwood forests is young (Clarke 1998, p. 11). Overall biomass electricity capacity shall reach 50 MW by 2000. The same target is set for geothermal electricity generation and an additional heat use of 0.75 mtce. Tidal power, which currently has 6 MW installed has a target of 50 MW for 2000 and 300 MW for 2010. Solar thermal power shall reach 1.5 mtce (U.S. Embassy 1997a). Already now the installed thermal collector area equals the European level (Chun/Ruhdorfer 1997). The U.S. has financed a rural photovoltaics project in Gansu in 1995 to provide 600 20 W systems with 0.2 million US\$. It provides subsidised credit and operates as a

revolving fund (U.S. Embassy 1996b). Total installed photovoltaic capacity amounted to 8.5 MW in 1996.

5.2 Energy demand

As the Chinese energy prices reach world market prices, efficiency projects on the energy demand side become interesting for commercial investors. For the time being, they are still only done if additional foreign funds can be obtained. Despite the achievements outlined above, the Beijing Centre for Energy Efficiency (BECon) established in 1993 and partly funded by the U.S. and WWF estimates the no-regret potential at over 30% (BECon 1995, p. 2).

**Table 9:
Energy conservation potential compared to business-as-usual**

Year	2000		2010	
Sector	Energy conservation potential Mtce (%)	CO ₂ emission reduction potential MtC(%)	Energy conservation potential Mtce (%)	CO ₂ emission reduction potential MtC(%)
Industry	183.6 (79.6)	131.6 (84.0)	354.0 (74.1)	257.9 (79.5)
Agriculture	11.3 (4.9)	7.4 (4.7)	16.3 (3.4)	11.2 (3.5)
Transportation	13.5 (5.9)	8.7 (5.6)	38.1 (8.0)	23.4 (7.2)
Household	22.2 (9.5)	9.0 (5.7)	69.1 (14.5)	32.1 (9.9)
Total	230.6 (100)	156.7 (100)	477.5 (100)	324.6 (100)

Reference: Tsinghua University (1995)

The Global Environment Facility (GEF) plays a pioneering role in this respect. It finances the upgrading of industrial boilers with 32.8 million \$. The average efficiency of the 430,000 Chinese industrial boilers is 65% whereas industrial countries attain 80%. The corresponding upgrade would save 1.7 EJ. Part of the difference is due to low coal quality (BECon 1995).

Table 10:
Comparison of unit energy consumption of industrial processes using furnaces
(GJ/t)

Production process	China	Japan	China:Japan
Steel	29	18	1.6
Coarse copper	50	41	1.2
Cement clinker	5.6	2.9	1.9
Liquid glass	88	41 (UK)	2.1 (UK)

Source: BECon 1995, p. 8

In 1996, a big GEF project started to set up three energy service companies (ESCOs) in Beijing, Liaoning and Shandong. Funding entails a 35 million US\$ grant from the GEF, 4.5 million from the EU, a 65 million loan from the World Bank and about 100 million domestic funds (Anonymous, 1997a). At payback period of 1 to 3 years, these projects should be profitable after initial hurdles have been overcome. In a second stage, ESCOs shall be established countrywide. Zhou et al. (1997, p. 17) estimate the carbon reduction at 5.5 million t per year for a 10 year period.

According to the World Bank (1994), internal rates of return for typical industrial energy efficiency projects ranged between 20 and 100%. Why has this potential so far only been tapped to a small extent? A detailed explanation is provided by BECon (1995, p. 21): One main reason is the „expansion drive“. It is a legacy of the centrally planned period, when government agencies at all levels set high production targets. Government officials and managers still tend to stress expanding production by increasing inputs while neglecting to raise internal efficiency. Those managers who are willing to invest in energy efficiency are often unable to obtain a loan because the government pressures banks to direct their limited financial resources to capital construction projects, leaving very little for energy conservation.

Unclear ownership rights also affect efficiency. Managers still do not own their enterprises and are often transferred between different enterprises. Therefore, they have no stake in the firm's long-term success or failure. In order to get a good performance review and be promoted to manager of a bigger plant, the manager must produce more output value, more profits, and more benefits for workers. This emphasis on short-term results discourages investment in energy efficiency. When an engineer proposes an

energy conservation project (e.g., replacing an inefficient piece of equipment with a highly efficient one) to the manager, and suggests that the loans be paid back in three years, the first thought that occurs to the manager is that his/her term is just three years, and that s/he may not even be around to receive praise when the investment begins to pay off. Thus, the manager has no incentive to take the risk associated with a long-term investment.

"Forced substitution" refers to the involuntary use of inappropriate inputs due to shortages, a common phenomenon in planned economies. This particular type of shortage is not an absolute but relative; it is the result of irrational allocation of goods in the absence of market mechanisms. Forced substitution results in the use of inappropriate types and qualities of fuel and equipment. For example, due to scarcity, most Chinese enterprises use coal rather than oil or gas, and they often use low quality coal that is not suitable for their equipment, both of which lead to lower efficiency. Limited selection of equipment poses a similar problem.

Corruption is another contributing factor. Managers are classified as "officials" in China. Government agencies at all levels often appoint officials as managers, or transfer managers to official posts. Exchanges of power and money within this unified system sometimes interfere with raising energy efficiency. For example, low efficiency, substandard products can easily be sold on "commission" or through "connections," while highly efficient products are unable to compete.

China's lighting is a major area for efficiency improvement as it is currently responsible for 15% of electricity use. Lighting levels are set to increase sharply as until now, recommended light intensities were only 20-40% of industrial countries' values (Min et al. 1997). Chinese companies produced 300 million compact fluorescent lamps (CFLs) in 1996, 80% of which are exported. The quality of the CFLs sold on the domestic market is low: studies showed that the average lifetime is below 1,000 hours while the international average is 10,000 (Zhou et al. 1997). Its efficiency is also only 50% of international average (Min et al. 1997, p. 80). Shandong province already has differentiated electricity tariffs and a diffusion programme for CFLs which led to sales of over 10 million lamps in 1996. Thus, energy savings of 400 MW peak load, i.e. 7% of total electricity use, could be reached in 1996. In the city of Waifang alone the sale of 4 million CFLs led to a decrease of power cuts by 89%. Nevertheless, evaluation showed significant takeback effects of over 50% and high failure rates of CFLs (Zhou et al. 1997, Anonymous 1997d). Shanghai set a goal to raise energy efficiency by 6% per

year (Anonymous 1997e). BECon also offers various projects in this area. It supports the China Green Lights government five-year dissemination project for CFLs by housing an exhibition and issuing recommendations for the distribution of 60 million US\$ subsidised loans (BECon 1997). UNDP granted 995,000 \$ for the project. The target is to save 7.2 GW peak load by 2000 by distribution of 200 million CFLs and 100 million efficient tubes - an emission reduction of 7.4 million t C (Zhou et al. 1997, p. 5f.). National standards for CFLs aim to increase their reliability. A National Energy Efficiency Center has been set up that delivers information to companies free of charge.

From 1986 to 1996, the number of cars quadrupled. However, there is still only one car per 100 people. The share of transport in energy use is currently 7%. Fuel consumption of trucks is 20-30% higher than in industrial countries. To alleviate local air pollution, there are some trials with natural-gas fuelled vehicles (Cannon 1998). LPG use for buses has already started on a small scale in Guangzhou, Shenzhen and Haikou and 300 LPG buses are to be introduced in Beijing this year.

5.3 Overarching programmes

The World Bank launched a Clean Coal Initiative in 1996. According to Takahashi (1998), the Initiative is a whole coal chain approach starting from win-win options such as coal and power sector reform. As the first step of the Initiative, the World Bank has started a Clean Coal Programme in China that includes coal mining, transportation and utilisation. As the low efficiency of the coal power stations is partly due to the lack of coal processing, coal washing could increase efficiency by more than a percentage point (Zhang Zhongxiang 1997, p. 291). Domestic and industrial coal use can be reduced by 20% if briquette use is introduced everywhere.

In the programme two parallel activities have been started: one starts from sector reform and another start with Clean Coal Technology Assessment and Environmental Control Options Least Cost Case Study. This study in Henan province identified cost-effective countermeasures to CO₂ emission for energy supply, households and industry. For example, briquette use at rural households replacing coal can reduce 25 million tons of CO₂ during 1997-2020 at a cost of \$15/ton of CO₂, while briquette use in industry can reduce 70 million tons of CO₂ at the same period at a cost of \$25/ton of CO₂. In the power sector, accelerated retirement of small inefficient power plant is the most cost-effective way, and it can reduce 33 million tons of CO₂ at a cost of \$25/ton. On the other hands, highly advanced technology such as IGCC remove 15 million tons of CO₂ at a cost of \$260/ton.

Sector programmes can be an important framework for clusters of successful CDM projects. However, it is unclear whether they could create greenhouse gas credits on their own.

6. CONCLUSIONS: CHANCES AND RISKS OF ENERGY-RELATED CDM PROJECTS IN CHINA

The preceding discussion has shown that there is a wealth of possible CDM projects in the Chinese energy sector including projects of widely different scale. However, a clear methodology for baseline-setting, additionality determination, monitoring, verification and certification will be necessary before large-scale CDM can take off. It is likely that the cornerstones will be set by the 6th Conference of the Parties to the UNFCCC in November 2000. Even if this is done, the huge Chinese CDM potential can only be tapped if the following prerequisites for successful CDM investment can be fulfilled (DOE-OIT 1997b):

- transparency , i.e., how can companies identify the public institutions with authority to implement contracts and projects;
- security, i.e., how can repayment be guaranteed and how can financial security be provided; and
- initial project support, i.e., how can companies find sources of support for feasibility studies and other initial project costs.

6.1 Opportunities

China gives CDM investors the broadest possible portfolio of project types. CDM projects offer an accelerated market penetration and an extra revenue to investors while the Chinese local environment is going to improve. Especially the latter reason may be the key to convince local and provincial authorities.

6.2 Risks

Risks result mainly from the political insecurities in China as we see from the sluggish and distorted FDI in the energy sector. The energy market is still highly regulated, and changes of the political framework could occur overnight, without warning. Decentralisation leads to higher barriers of penetration of efficient technologies (Martinot et al. 1997, p. 389).

The current oversupply in the electricity supply sector may be another barrier. Besides these constraints, there seems to be a fundamental problem in the context of the Kyoto mechanisms. That is the fear, anxiety and scepticism shared by the Chinese side that participation in the CDM might trigger discussions on quantitative emission reduction commitment in the near future. In other words, at this moment it is very difficult for China to judge the consequence of the CDM in the long run, which naturally results in a cautious attitude towards CDM. This may change, however, after the 6th Conference of the Parties.

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