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The Clean Development Mechanism and the Promotion of Sustainable Development in China's Western Regions: Policy Instruments for Cleaner Technology Transfer

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Executive Summary

Climate Change is the most pressing environmental challenge faced by the international community. For almost ten years, negotiations have taken place under the auspices of the United Nations to forge a common response to the main cause of climate change – the emission of greenhouse gases as a result of human activity. Through these international negotiations, there has been a common understanding that both industrialized countries and developing countries have a part to play.

China is the largest developing country. As a result of rapid economic growth during the past 20 years, China's contribution to global greenhouse gas emissions has grown steadily. Despite rapid modernisation, China's energy needs are still dependent on coal, the most carbon-intensive fossil fuel. Coal continues to account for about 70% of annual energy use, and is the major contributor to China's atmospheric emissions of greenhouse gases. China's emissions of carbon dioxide reached 3,000 million tonnes in 1996, a figure that accounts for 13.5% of the global total.

The prospect of rising greenhouse gas emissions and persistently high emissions of other pollutants has increased China's need for cleaner technologies and more efficient processes. As well as contributing to global efforts to tackle climate change, cleaner technologies can reduce emissions of the gases which cause urban smog and acid rain. The Clean Development Mechanism (CDM), which is being established as part of the international agreement on climate change, can potentially help China to reduce its emissions through the acquisition of cleaner technologies from international sources.

China's Western provinces contain some of the country's poorest, least technologically advanced and most polluted areas. They also contain a large part of China's energy resources as well as its industrial base. Against this background, the Chinese government has prioritised the sustainable development of Western China to try and bring its economic performance up to the average national level. As part o this process, firms in Western China require access to international technology and skills to help them modernise and improve their economic and environmental performance.

This report summarises some preliminary results from a joint study of the Clean

Development Mechanism and its potential role in facilitating cleaner technology transfer to Western China. It is the result of a collaborative effort by the Guanghua School of Management at Beijing University and SPRU – Science and Technology Policy Research at the University of Sussex, UK. The study has been conducted under the auspices of the Working Group on Trade and Environment of the China Council for International Co-operation on Environment and Development, and it builds upon previous collaborative work by these institutions[1].

The report consists of four parts. Part one introduces the background on the Clean Development Mechanism (CDM) and Western Region Development. The analysis points out that, as an important supplement to internal capital and technical sources, the CDM can not only promote sustainable development of the China's West but also be helpful to reduce the greenhouse gas (GHG) emissions in China. Because of varied economic development etc., not all the Western provinces are suitable and capable of implementing CDM projects. South-western provinces such as Sichuan and Chongqing, and Inner Mongolia, and Xinjiang and Shaanxi in northwest can be selected as the main pilot areas for the CDM. In the second part, on the basis of pilot interviews, the attitudes of five participants in CDM projects are assessed. We analyse advantages and disadvantages of internal implementation modes of CDM and find that the central-government-led mode should be used initially whilst the capabilities of Western Chinese companies are developed. Conclusions and recommendation are made at the third part. The last part summarises the interviews in an Annex.

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[1] Jin Yunhui and Liu Xue Prospects of CDM for Promoting Sustainable Development in China: Accelerating Foreign Investment and Technology Transfer Working Group on Trade and Environment, CCICED (2000) and J Watson et al International Perspectives on Cleaner Coal Technology Transfer to China Working Group on Trade and Environment, CCICED (August 2000).

1. The Potential for Implementing CDM in China's Western Region Development

During the 20th century, with the scientific development and extremely great improvements in social productivity, mankind has created great material treasures and sped up the process of culture development. In the meantime, problems such as the rapid increase in population, excess consumption of resources, environmental pollution and the gap between the North and the South have become increasingly severe. In some areas of the world, this has seriously hindered economic development and the improvement of people's quality of life. Faced with this situation, mankind has to review his own social economic performance and learn lessons from the past. One conclusion from this experience is that there is a need for a sustainable development path that can not only meet the needs of this generation but also not threaten the capacity to satisfy the needs of future generations. This path is more likely to lead to mutual harmony between economy and society, environment and resources.

1.1 Clean Development Mechanism

The link between increasing greenhouse gas concentrations in the atmosphere and global climate change has been studied since mid-1950s. However, it was not until the early 1980s that this phenomenon attracted wide attention among scientists. Although there exists some different views, most scientists believe that climate change caused by the increase in anthropogenic greenhouse gas emissions is now underway.

1.1.1 Climate change and international collaboration to limit and reduce greenhouse gas emissions

Carbon dioxide plays a critical role in maintaining the energy balance on the Earth surface. However, since the Industrial Revolution[2], the atmospheric concentration of greenhouse gas has greatly increased as a result of the large amount of greenhouse gas emissions from human activities. Consequently, the natural greenhouse effect is enhanced, which has affected the stability of the global climate system.

The second assessment report (SAR) by the Intergovernmental Panel on Climate Change (IPCC) points out that during the 21st century the global temperature will rise by about 1-3.5^{0}C if no measures are taken for emission reduction[3]. The most direct and outstanding expected influences of such change include: weather patterns on the earth

[2] For example, the concentration of CO2 in the atmosphere remained at around 280 ppmv before Industrial Revolution, but rapidly increased to 355 ppmv in 1992 (IPCC, 1996), and now it is 370 ppmv (American State Science Committee, 2001).

[3] The globally averaged temperature is projected to increase by 1.4 to 5.8^{0}C over the period 1990 to 2100 according to the third assessment report of IPCC which is available at http://www.ipcc.ch/pub/. The temperature increases are projected to be greater than those in SAR of IPCC, and the projected rate of warming is much larger than the observed changes during the 20th century.

will change, agriculture regions (the mid-latitude crop yields) will shift poleward by 150-550 km, the sea levels will rise 15 to 95 cm by the year 2100, etc. These changes will bring harm to the whole of mankind. Southern countries, especially small island countries and less developed countries will suffer the most, a large number of environmental refugees will come into being, whereas Northern countries may perhaps benefit from the changes in the agricultural field.

The most effective way to slow climate change is to limit and reduce man-made greenhouse gas emissions. Considering climate change is irreversible and the degree of change depends on the level of greenhouse gas concentration without any relation to concrete emission amount and place, emission reductions must be achieved on a global scale. Otherwise, the efforts of a few countries to reduce emissions will be undermined by increasing emissions elsewhere. Based on this common knowledge, countries all over the world signed the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 and it entered into force in 1994. This convention sets out the basic principles for international co-operation on greenhouse gas reduction.

1.1.2 The Kyoto flexibility mechanisms: The theoretical basis and the limits

International negotiations have continued since the UNFCCC came into effect. The Kyoto Protocol to the United Nations Framework on Climate Change, the most important international agreement after UNFCCC, was adopted in 1997. Starting off from the principles of "Common but Differentiated Responsibilities" and "Fairness" and noting that the largest share of historical and current global emissions of greenhouse gas originated in developed countries, the Kyoto Protocol set out targets for reductions in GHG emissions for these countries (known as Annex I countries). At the same time, the Protocol provides flexibility mechanisms to help Annex I countries to achieve their commitments cost-effectively. These mechanisms are Joint Implementation, Emissions Trading and the Clean Development Mechanism (CDM).

The CDM has attracted a large amount of interest among both developed countries and developing countries. The CDM allows companies in Annex I countries to achieve emissions reductions by investing in abatement projects in developing countries. This allows them to take advantage of the large number of low cost abatement opportunities in the developing world. The CDM therefore has the potential to make a major contribution to South-North co-operation in the future.

Under the constraints of the Convention and the Kyoto Protocol, Annex I countries have a duty to transfer new technologies to developing countries to help them reduce greenhouse gas emissions. Annex I countries will also provide financial support to help developing countries to adapt to the climate change and establish relevant capabilities.

The theoretical rationale for the Kyoto Mechanisms is the achievement of compliance at minimum total cost. The varying marginal cost of GHG reduction in different countries provides a basis for the application of this theory. Many western scholars

have delivered empirical studies on the basis of this theory and estimated the influences that different levels of implementation might have upon the economy of each country. Scholars regard the cost savings for developed countries and the international trade profits through the accumulation of emission credits by developing countries as increases in the respective countries' welfare and, therefore, as a global 'win-win' scenario.

1.1.3 The initiative to realise the two-tier goals of the CDM should be taken by developing countries

GHG emission reduction relates to both the global interest and national interest. But the two are not necessarily coincident, and contradictions among countries may exist. The nature of international negotiation on climate change is one of compromise between different countries' interests. Such a bargaining process has lasted for nearly 10 years and will continue in the future as details of the Kyoto Mechanisms are established.

The CDM is the foundation stone of the co-operation between South and North to combat climate change. It is the only way that developing countries can participate in the global emission reduction actions. Though developing countries have not signed up to targets for emissions reduction, their participation is absolutely necessary and extremely important since the cheapest reduction opportunities exist in such countries.

Article 12 of the Kyoto Protocol defines the basic rules of the CDM, and points out that the two-tier purpose of CDM shall be to assist developing countries in achieving sustainable development and to assist Annex I countries in achieving compliance with their quantified emission limitation and reduction commitments. The latter goal means that developed countries can partly meet their commitments by implementing emission reduction projects with lower marginal cost of mitigation in developing countries. The former goal of the CDM is critical because it is not necessarily the case that all projects implemented in developing countries can meet the demands of sustainable development. The South-North negotiation focuses on how to protect the interests of developing countries and promote their sustainable development as well as save reduction costs of Annex I countries.

In general, the level of economic, social and environmental developments in developing countries are greatly lower than those in developed countries, so their current urgent task is to develop their economies and improve people's life quality. They think about co-operation projects primarily in terms of economic benefits, with environmental effects as a secondary consideration. As a result, emission reduction projects performed in developing countries ought to satisfy their legitimate priorities. In this way, developing countries can be persuaded to take part in co-operative activities which will promote their sustainable social and economic development.

In brief, the initiation of CDM projects should be controlled by developing countries. Developing countries should have detailed input in the certification of CDM projects,

environmental technology selection, the calculation of reduction credits, project management and auditing, etc. And the distribution of projects' benefits should be equitable between Annex country firms and firms in host countries.

1.1.4 Capacity building in developing countries is a prerequisite for implementing CDM projects

Capacity building is extremely important to developing countries particularly to those that are vulnerable to the adverse effects of climate change. It is a precondition for them to participate fully and effectively in the UNFCCC and the Kyoto Protocol.

The goal of capacity building is to help developing countries establish, develop, strengthen and improve their ability to perform the commitments of UNFCCC, and prepare them to join the Kyoto Protocol so as to fulfil the ultimate purpose of slowing the long-term trend of climate change. Without these capabilities and preparations, developing countries can not practically participate in the global co-operation and provide benefits to the whole world.

Capacity building mainly includes financial support, technology transfer, information collection and changes in organisational structure, etc. The first two of these are core elements. To successfully implement CDM projects in developing countries, developed countries must contribute financial investment and appropriate technologies whilst the host countries must match these commitments with their own domestic resources. However, developing countries are usually lacking in matching abilities, and therefore developed countries are required under the Kyoto Protocol to provide help to them. During the second part of the sixth Conference of the Parties to the UNFCCC (known as COP6 bis) held in Bonn in July 2001, the 'Core Elements for the implementation of the Buenos Aires Plan of Action' was passed[4]. It defines concrete mechanisms of funding and technology development and transfer to developed countries. A new fund of $410m per year from 2005 was announced by developed countries to support this process. This will definitely help promote the capacity building of developing countries and greatly strengthen their ability to participate in global co-operation.

1.1.5 The participation of the private sector is key to ensure the CDM is effective

Governments are subjects of international agreements. However, governments themselves can not realise GHG emission reductions. The real reductions will be performed at the level of enterprises. Thereby in the course of South-North co-operation, the enthusiasm of private sector investors has to be stimulated to make the CDM effective.

Private sector companies have their own interests. They often have little interest in environmental protection for its own sake, a goal which may have little relation with their primary goal of profit maximisation. When designing the details of the CDM, characteristics of firm behaviour should be taken into account to make the mechanism

[4] For further details, see the conference website at http://www.unfccc.int/cop6_2/index.html.

attractive and create conditions for firms to participate fruitfully. There is a need for further empirical studies to establish how this can be achieved.

1.2 Strategy for China's Western Region Development

1.2.1 The basic economic, social and environmental situation in China's Western provinces (Autonomous Regions, Municipalities)

The 7th Five-Year Plan on National Economic and Social Development of P. R. China, which was ratified by the 4th meeting of the 6th National People's Congress in April 1986, divides the whole country into three regions: the East, the Central Areas and the West. The West includes 9 provinces that are Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang. The 5th meeting of the 8th National People's Congress decided to set up Chongqing Municipality in 1997, thus the total number of Western provinces increased to 10. At present, all sides hold a variety of opinions on the regional range of the Western Development. According to economic and technical development level, geographic location and nationality distribution, the Leading Group for Western Region Development of the State Council suggests that Western Region Development should cover the former 10 provinces plus Inner Mongolia and Guangxi. The West regions in this paper include these 12 provinces. According to such a division, the territory covered by China's West is 6,850,000km^2, about 71.4% of the whole country. The population at the end of 1999 was 0.358 billion and the GDP RMB 15.4 trillion Yuan, respectively 28.5% and 17.5% of the national total sum. The detailed situation is shown in table 1.

Table 1: Economic and Social Development Statistics of Western Regions in 1997

Region	Population (10000)	GDP (billion)	Per capita GDP (yuan)	Annual per capita net income of urban residents (yuan)	Annual per capita net income of rural residents (yuan)
Total	**123626**	**7477.240**	**6079**	**5188.54**	**2090.13**
Inner Mongolia	2326	109.452	4691	3968.09	1780.19
Guangxi	4633	201.520	4356	5139.52	1875.28
Chongqing	3042	135.010	4452	5343.12	1643.21
Sichuan	8430	332.011	4029	4787.86	1680.69
Guizhou	3606	79.298	2215	4458.29	1298.54
Yunnan	4094	164.423	4042	5616.21	1375.50
Tibet	248	7.698	3194	NA	1194.51
Shaanxi	3570	132.604	3707	4022.20	1273.30
Gansu	2494	78.134	3137	3613.43	1185.07
Qinghai	496	20.205	4066	4015.50	1320.63
Ningxia	530	21.092	4025	3836.65	1512.50
Xinjiang	1718	105.014	5904	4878.52	1504.43
The West	**35187**	**1386.461**	**3940**	**4780.00***	**1539.00**
West / Total	**28.46%**	**18.54%**	**64.82%**	**90.74%****	**73.63%**

Sources: *China's Central and Western Region Development Yearbook*, China Innovation Press, 1998. *, ** means Tibet is excluded.

China is a unique society, with a large population and vast territory, thereby leading to a developmental imbalance among regions. This is one of the basic characteristics of the situation in China. We may see from table 1 that the Western provinces are backward in economic performance with a lower income level than the national average apart from Xinjiang. The poorest is Guizhou province: in 1997, its GDP per capita is merely 36.44% of the national average level; and the similar numbers for Gansu, Tibet and Shaanxi are all about 50% of the national average level; the others' GDP per capita are all below the average line. Currently, China still has 34 million people living in poverty, 60% of whom live in Western regions.

West China is vast in territory and rich in resources, hence the most important national energy base and industrial products base. Table 2 shows the output of the Western regions' main industrial products. Compared with other provinces (Autonomous Regions, Municipalities), Sichuan's outputs of coal and crude oil are respectively the 4th and the first among the whole country; Inner Mongolia's production of coal is the 8th; Xinjiang's outputs of crude oil and natural gas are respectively the 4th and the 6th. But the main industrial outputs of the West do not exceed those of the Central Areas, which means that the West has not converted its resource advantages into production advantages.

Table 2: Output of Main Industrial Products in the West, 1997

	Coal (100 billion ton)	Crude oil (10 thousand ton)	Natural gas (100 billion m^3)	Electricity (100 billion kwh)	Steel (100 billion ton)
Total	**13.73**	**16074.14**	**227.03**	**11355.53**	**10894.17**
Central Areas	**7.70**	**6824.00**		**3577.60**	**3007.40**
Inner Mongolia	0.83	131.51	0.10	342.23	453.32
Guangxi	0.11	8.64	0.01	237.26	98.58
Chongqing	0.29		2.44	148.16	138.93
Sichuan	0.62	23.25	80.03	491.97	548.84
Guizhou	0.66		0.95	255.75	78.77
Yunnan	0.33	0.16	0.03	253.14	184.00
Tibet				5.78	
Shaanxi	0.49	242.77	2.17	269.78	47.95
Gansu	0.23	185.86	0.30	246.42	170.69
Qinghai	0.03	160.24	2.20	84.26	43.13
Ningxia	0.17	80.18	0.26	113.42	8.23
Xinjiang	0.30	1629.25	21.30	150.58	97.21
The West	**4.06**	**2330.35**	**109.69**	**2256.52**	**1416.33**
West / Total	**29.57%**	**15.32%**	**48.36%**	**22□89%**	**17.16%**

Sources: *China's Central and Western Region Development Yearbook*, China Innovation Press, 1998.

As China is at the stage of industrialisation and urbanisation, the conflict among economic development, population increase and environment protection is worsening. The deterioration of the environment in the Western Regions is remarkable. By the year of 2000, the loss of water and soil have affected more than 3600 thousand km^2

nationwide, 80% of which is in the West; more than 90% of crop failures which affect about 24 billion km^2 lie in the West; the sloping-field above 25^0 in the West account for 70% of the total; the average percentage of forest coverage in the West is only about 7%; and the problem of desertification in northwestern Gobi desert areas and erosion in Yunnan, Guangxi and Guizhou are increasingly becoming serious. Many cities in the West have severe pollution issues of air, water and wastes. The supervision and access results of World Health Organisation in 1998 show that 8 among the 10 top polluted cities of the world lie in China, and the 1st, the 2nd and the 4th are respectively the cities of Guiyang, Chongqing and Lanzhou in West China.

1.2.2 Sustainable principle is the most important element of China's Western Region Development Strategy

That the development in the West dropping behind the Central and the East is due to the combined influences of geographical and natural conditions, historical and social backgrounds, and the influences from central government's policy. The West has complicated land forms, inconvenient transportation and a lack of communication with the outside world. For the past 20 years of 'opening up' and reforms, the central government has pursued a strategy of developing the coastal areas. Compared with the China's Eastern regions, Western economic reform progress is slower with a large proportion of State-owned economy and heavy historic burdens.

In June of 1999, after a review of the West, President Jiang Zemin clearly advanced that "speeding the development of the Western Regions is a macro strategy and conception of the whole country's development". On March 15th, 2001, the Outline of the 10th Five-Year Plan on National Economy and Social Development passed by the 4th meeting of the 9th National People's Congress confirmed the Western Regions Development strategy. It points out that the country will implement measures to support the West, increase the flow of financial and construction capital into the West and form favourable policies for opening up, taxation, land use, resources and intellectuals[5].

The basic train of thought on the Western Regions Development is as follows: China should adjust to the new situation of opening up and reform, take new ideas, new methods and new mechanisms to promote the strategy step by step. We should regard speeding up the capital construction as the basis of the development strategy, regard strengthening environment protection and construction as fundamental to the strategy; regard industrial adjustment as key to development; regard developing science, technologies, education and training as the guarantee of the strategy; regard strengthening opening up and reform as the motive, regard making the economy prosperous and improving the people's living level as the basic starting point and the purpose of the Western Region Development.

The train of thought above has sustainable development at its heart. Sustainable

[5] The Outline of the 10th Five-Year Plan on National Economy and Social Development, available at http://www.sdpc.gov.cn/index1.htm

development is not only popular among the people of Western regions but also attracts concerns of both the Central and the Eastern regions. It is the most important principle of the Western Province Development. The common viewpoint among the people all over the country is that we should avoid the old way of "to develop in cure after pollution" in developing the West.

1.2.3 Shortages of capital and technologies are the main barriers to Western Region Development

The development strategy of the West is of significance. In the short term, it is important to enlarge internal demand and further the whole economic development of China. It is hoped that developing the West will provide large markets and bright development prosperity for the Centre and the East. In the long term, it is envisaged that there will be benefits to national harmony, social stability, boundary enforcement and balanced development between the East and the West. It is an overall strategy of not only great economic significance but also great social significance. Viewed from the point of the Chinese people's living environment, Western Region Development plays an extremely important role in protecting the whole country's ecological environment.

Despite the potential benefits, Western Region Development is a long-term and difficult task. The main challenges are the provision of enough capital and technology. The fiscal incomes of the West are not high (See table 3) and the region is unable to meet its own needs for large-scale development and construction. Other financial resources are limited. For instance, in 1997, the national budget for the capital construction and renewal and reformation in the West was far less that that for the investment in the Eastern and Central regions (See table 4). Furthermore, the available foreign capital available to the West is also relatively small. It is hoped that compared with the past, both the central government and the local governments will increase their investments in the West when the strategy is being implemented. But the sum will still be less than the actual needs. Consequently, in the course of developing the West, not only the policy investments from the central government and self-financing capital by local governments are needed but also the investments from the East and the Central Areas. China's Western regions need not only internal capital sources but also foreign investments.

Table3: Basic Situation of Government Revenue and Expenditure of the West in 1997

	Total	The West	West / Total
Government Revenue	4263.20	809.70	18.99%
Government Expenditure	6562.70	1588.60	24.21%

Sources: *China's Central and Western Region Development Yearbook*, China Innovation Press, 1998.

Industrial and agricultural technical levels in the West are far behind those in the Centre and the East. Western Regions must actively encourage inward technology transfer to implement the strategy.

Table 4: Basic Situation of Capital Construction and Innovation in the West, 1997 (100 billion yuan)

		Grouped by source of funds					Grouped by administrative relationship	
		State budgetary appropriations	Domestic Loan	Foreign investment	Fund raising	Others	Central government projects	Local projects
Capital construction	Total	574.51	2329.88	1351.92	4432.24	1036.13	3858.22	6058.88
	West	131.07	529.10	120.29	838.11	214.11	746.82	1152.18
	West / Total	22.81%	22.71%	8.90%	18.91%	20.66%	19.36%	19.02%
Innovation	Total	36.84	796.09	272.35	2522.36	185.72	1407.73	2514.20
	West	6.71	157.28	18.36	461.68	42.84	308.66	391.21
	West / Total	18.21%	20.45%	6.74%	18.30%	23.07%	21.93%	15.56%

Sources: *China's Central and Western Region Development Yearbook*, China Innovation Press, 1998.

1.3 CDM can Promote Sustainable Development in West China

1.3.1 The GHG mitigation situation faced by China

China is a developing country that has no target to limit its greenhouse gas emissions under international agreements on climate change. However, China is at the stage of rapid economic growth and industrialisation, and consequently has big pressure on greenhouse gas emissions. According to the International Energy Agency's (IEA) estimate, China's CO_2 emission amounted to 3006.77 million tons in 1995, about 13.6% of the world total. and the total fell to 2893.15 million tons in 1998, a figure which was about half of that of US emissions and 12.66% of the world total. In 1998, Chinese CO_2 emission per capita was 2.32 tons, 60.22% of the world average level, far lower than that of the OECD countries' average level of 10.92 tons per capita, but higher than the amounts of Africa, South America and other Asian countries.

China has made some efforts to control its GHG emissions. From 1995 on, China has taken measures such as reducing coal use and reducing energy consumption in production. Due to these strategies, China's CO_2 emission lowered by 3.78% from 1995 to 1998 while its GDP increased by 36%. In the mean time, the CO_2 emission of the USA did not fall but rose by 3.35% to 20.10 tons per capita. This number is not only far higher than that of developing countries, but also 184.07%of the average level of developed countries.

After the Kyoto conference, some developed countries have tried to encourage developing countries such as China, India and Brazil to sign up to targets for GHG reductions. A number of developing countries especially AOSIS[6] began to ask the larger developing countries to take actions as an example to prevent the developed countries from reneging on their Kyoto commitments. It is possible that the chief developing countries like China will adopt targets for GHGs emission reduction after the first commitment period is completed in 2012.

Table 5: Selected Energy Statistics for 1998

	Population (million)	GDP (billion 90 US$)	Energy Prod. (Mtoe)	TPES (Mtoe)	CO_2 Emissions (Mt)	CO_2 Emission per Capita (ton)
World	5838.82	25941.46	9689.62	9559.22	22524.78	3.86
OECD	1100.55	20656.26	3790.32	5096.97	12016.63	10.92
Mid-East	159.90	534.60	1271.36	355.69	924.18	5.78
U. S. A.	269.09	7043.64	1695.43	2181.80	5409.75	20.10
Former USSR	291.67	529.00	1173.84	893.14	2206.44	7.56
China	1245.29	906.51	1020.32	1048.00	2893.15	2.32
Asia	1820.78	1437.22	917.66	998.89	1876.67	1.03
Latin America	403.07	1167.64	605.02	444.20	866.43	2.15
Africa	757.05	554.73	846.18	481.50	728.65	0.96

Source: IEA. Among these, World excludes Albania and Korea; No-OECD Europe excludes Albania; Asia excludes China and Korea; TEPS means total primary energy supply.

Chinese GHG emissions stem from its economic structure, industry and production structures and energy structure in particular. China's output of coal is no.1 in the world and with that, coal accounts for 70% of total energy consumption. China is one of the several countries whose energy supply depends mainly on coal. China's technology and relevant equipment are comparatively old. Its overall energy efficiency is 30% while the corresponding number of developed countries is about 50%. China's task of controlling GHG emissions is difficult since energy structure adjustment is limited by the availability of resources, and the improvement of energy efficiency faces technical and financial obstacles (Table 6 and table 7 show the situation of energy production and consumption.). It is expected that in the next 5 years, the share of coal in China's energy supply will stay relatively constant, though the overall demand for coal will decline. Shares for crude oil, natural gas and hydro-power will rise, with the increase for crude oil being the greatest.

Relevant studies show that China's GHG emissions chiefly focus on CO_2 and methane (CH_4), and CO_2 emissions account for about 90% of the total amount. The main sources of CO_2 emissions are energy and industrial processes, and CH_4 emission comes mainly from energy and agriculture.

[6] The AOSIS means Alliance of Small Island States which is a coalition of 42 small island countries whose survival is threatened by climate change.

Table 6: Total Production of Energy and Its Composition in China

Year	Total Energy Production	As Percentage of Total Energy Production□%□			
	□10,000 tons of SCE□	Coal	Crude Oil	Natural Gas	Hydro-power
1980	63 735	69.4	23.8	3.0	3.8
1985	85 546	72.8	20.9	2.0	4.3
1990	103 922	74.2	19.0	2.0	4.8
1991	104 844	74.1	19.2	2.0	4.7
1992	107 256	74.3	18.9	2.0	4.8
1993	111 059	74.0	18.7	2.0	5.3
1994	118 729	74.6	17.6	1.9	5.9
1995	129 034	75.3	16.6	1.9	6.2
1996	132 616	75.2	17.0	2.0	5.8
1997	132 410	74.1	17.3	2.1	6.5
1998	124 250	71.9	18.5	2.5	7.1
1999	110 000	68.2	20.9	3.1	7.8

Source: *China Statistics Yearbook*, China Statistical Press, 2001.

Table 7: Total consumption of Energy and Its Composition in China

Year	Total Energy Consumption	As Percentage of Total Energy Consumption□%□			
	□10,000 tons of SCI□	Coal	Crude Oil	Natural Gas	Hydro-power
1980	60 275	72.2	20.7	3.1	4.0
1985	76 682	75.8	17.1	2.2	4.9
1990	98 703	76.2	16.6	2.1	5.1
1991	103 783	76.1	17.1	2.0	4.8
1992	109 170	75.7	17.5	1.9	4.9
1993	115 993	74.7	18.2	1.9	5.2
1994	122 737	75.0	17.4	1.9	5.7
1995	131 176	74.6	17.5	1.8	6.1
1996	138 948	74.7	18.0	1.8	5.5
1997	138 173	71.5	20.4	1.7	6.2
1998	132 214	69.6	21.5	2.2	6.7
1999	122 000	67.1	23.4	2.8	6.7

Source: *China Statistics Yearbook*, China Statistical Press, 2001. Data on energy consumption in 1999 are estimated figures.

Our judgements are that with the stable economic growth and improve of the people's living level, China's energy production and consumption per capita will continually increase. Coal will still supply about 65% of total primary energy. China's GHG emissions reduction activity will focus on CO_2 emission from industrial sectors of energy activities.

China's central government has pointed out in its 10th Five-Year Plan that "Energy construction should enhance our resource advantages, perfect energy structure, improve energy efficiency and strengthen environment protection. Coal is the basis energy and the ratio of high quality coal must be raised." This energy strategy does not target CO_2 emissions but its implementation will be helpful in lowering China's GHG emissions.

Among China's coal reserves, hard coal occupies 75%, blind coal 12% and wood coal 13%. According to the division by power coal and coking, gas production, the former accounts for 85% and the letter 17%. The average sulphur content of power coal is 1.15% and the average ash 16.84%. Meanwhile, 80% of China's coal consumption is directly burning. Such resource state and such energy consumption level naturally bring about severe environmental pollution.

We may see from the above analysis that China's GHG emissions level closely related with energy strategy especially the strategy of coal production and consumption. It is possible that in the field of carbon dioxide emission reduction from industrial sectors, cleaner coal technologies such as coal preparation, coal washing, coal liquefaction and coal gas production will play a greatly important role. In addition technological innovation in industrial boiler design and utility boiler design can make a great contribution to mitigation.

1.3.2 Energy activity level and technology demands of Western Provinces

Among the technology resolutions and proposals for mitigating and adapting to climate change, improving in energy efficiency is the fastest and the most economic method of reducing GHGs especially CO_2 emission. This has been shown by a large number of scientific experiences and production practice[7]. This Strategy is particularly suitable for China. China's long-term coal-led energy structure means that the substitution of coal with low-carbon fuels such as oil and gas is not realisable in a few days and that the widespread deployment of 'cleaner' sources such as wind power and other renewables and possibly nuclear power are longer term prospects. But China's efficiency of energy conversion is very low (See table 8) thus it has space and potential to be improved. Therefore, the introduction of technology for the use of lower carbon energy fuels is often regarded as a more medium or long-term technology strategy for reducing CO_2 emissions. While improvements in the production and consumption efficiency of coal are not a solution to China's GHG emission problems, it represents an economic method of reducing CO_2 emissions in the short term.

Table 8: Situation of China's Energy Production and Consumption

	1985	1990	1995	1996	1997	1998	1999
GDP growth rate to preceding year(%)	13.5	3.8	10.5	9.6	8.8	7.8	7.1
Elasticity coefficient of energy production	0.73	0.58	0.83	0.29	-	-	-
Elasticity coefficient of energy consumption	0.60	0.47	0.66	0.62	-	-	-
Efficiency of conversion (%)	68.29	67.20	71.05	71.50	69.23	69.44	-

Source: *China Statistics Yearbook*, China Statistical Press, 2001.

[7] Edmonds, J. A. and C. M. Cracken (1998), "Unfinished Business: the Economics of the Kyoto Protocol", prepared for the U. S. Department of Energy; Jin Yunhui and Liu Xue(2000), "Prospects of CDM for Promoting Sustainable Development in China: Accelerating Foreign Investment and Technology Transfer", the Working Group on Trade and Environment, CCICED.

The chief energy activity indexes of China are below the average level of the world. Among the indexes the total primary energy supply (TPES) per GDP, CO_2 emission per GDP and CO_2 per TEPS are all far higher than those of OECD countries like America, or even higher than those of South America and Africa (See table 9). This shows that China's energy technology level is far behind developed countries and it is necessary to absorb intermediate and advanced energy technologies from abroad.

Table 9: Selected Energy Indicators for 1998

	TPES per GDP (toe / 000 90 US$)	CO_2 emission per TPES (t CO_2 / toe)	CO_2 emission per GDP (t CO_2 / 000 90 US$)
World	0.37	2.36	0.87
OECD	0.25	2.36	0.58
U. S. A.	0.31	2.48	0.77
Middle East	0.67	2.60	1.73
Former USSR	1.69	2.47	4.17
Asia	0.70	1.88	1.31
Latin America	0.38	1.85	0.74
Africa	0.87	1.51	1.31
China	1.16	2.76	3.19

Source: IEA. Among these, World excludes Albania and Korea; No-OECD Europe excludes Albania; Asia excludes China and Korea; TEPS means total primary energy supply.

The energy activity level in Western Provinces is lower than that of the East and the Central Areas. Taking Shaanxi and Sichuan as examples, the energy production and consumption of these two provinces is dominated by coal but the technology level is below the national average (See table 10). Comparatively speaking, the West has more needs for improved energy technologies than China as a whole. What is worth noticing is that since 1997, energy production and consumption in these two provinces have both fallen, which provides some evidence that China's Energy Adjustment Strategy is working.

Table 10: States of Energy Activities in Shaanxi and Sichuan

		1995	1996	1997	1998	1999
Shaanxi	Coal / Total energy production (%)	91.64	90.82	88.75	85.24	--
	Coal / Total energy consumption (%)	86.46	86.25	84.39	81.88	--
	Efficiency of energy conversion (%)	63.57	61.65	64.30	69.26	--
	Energy consumption per 10000 GDP (ton SIC)	2.86	2.55	2.36	2.12	--
Sichuan	Coal / Total energy production (%)	73.5	73.6	65.2	61.6	52.5
	Coal / Total energy consumption (%)	74.1	74.0	64.5	60.7	53.0
	Efficiency of energy conversion (%)	--	--	--	--	--
	Energy consumption per 10000 GDP (ton SIC)	2.54	2.21	2.00	1.89	1.72

Sources: Shaanxi Statistics Yearbook, China Statistical Press, 1999; Sichuan Statistics Yearbook, China Statistical Yearbook, 2000.

1.3.3 The implementation of the CDM as part of Western Region Development can promote sustainable development of the West and also lower China's overall GHG emissions

Many studies have shown that the implementation of the CDM can not only provide low cost mitigation opportunities for Annex I countries and lower their total implementation costs, but also promote capital and technological transfer to developing countries.

The chief purposes of the CDM and Western Regional Development coincide in their requirement for sustainable development. West China may acquire scarce capital and cleaner technologies via the CDM so as to protect the environment and make economic, societal and natural development harmonised. Meanwhile, the West is China's important energy and industrial base, and to implement CDM there is also helpful to reduce China's GHGs emissions whilst minimising the effect on economic development.

1.4 Possible Emphasis of CDM Projects in the West

The Western Region Development is the first strategic decision of China at the start of 21st century and has great significance. Viewed either from the point of promoting sustainable development of the West or from the point of reducing China's GHGs emissions, it is necessary to positively implement CDM in Western Regions. The following points should be noted when implementing CDM in the West:

1.4.1 Improvements of territorial environmental quality and urban air quality are essential in CDM projects

As a result of problems accessing information, enterprises and the people of the Western provinces know little about climate change and CDM, and have no deep experience of the opportunities offered by implementing CDM projects. Though the consensus is always emphasising sustainable development, most people especially the decision makers of economic organisations still put their main concentration on economic development. Some think that environmental protection contradicts economic development. Improved access to information is required to show that economic progress and environmental protection can – when properly managed - be achieved simultaneously.

There should be a criterion for CDM projects that can be easily accepted by the people of the Western provinces. In our view, the improvement of regional environmental quality and urban air quality is a good starting point. Damage to the Western environment is becoming more severe with the result that local people are keen to improve it. Furthermore, many cities have established supervision and forecasting systems for urban air environment quality which are widely supported. The implementation of CDM projects can help promote such improvement. For example,

the emission of CO_2 is usually accompanied by high TSP emissions and the emission of SO_2, as a result of high coal consumption in China. The introduced cleaner technologies via the CDM can reduce CO_2 while lowering the amount of TSP and SO_2. In this way, regional acid rain may be reduced and urban air quality improved.

1.4.2 The CDM is not the only route for the transfer of cleaner technologies to China's Western Regions

Besides research and development of technologies by themselves, the Western provinces may also introduce cleaner technologies from the Central and the Eastern Areas of China, which are possibly the main short-term technological sources. In the medium and long term, the implementation of CDM may strengthen this process, and also lead to the introduction of more advanced cleaner technologies. Cleaner technology transfer may focus on the field of energy activities whose emission reduction focus is CO_2. Technology transfer should not only satisfy the principles and standards of the Kyoto Protocol but the legitimate priority needs of Western Region Development and requests of China's energy strategy. China should ensure that foreign governments and firms transfer technologies during all CDM transactions.

1.4.3 Not all the Western provinces are suitable hosts for CDM projects

To implement the CDM not only requires local firms to have financial and technological capabilities, but also requires that they are able to gain project information, select technologies, negotiate on projects, manage operation and calculate emission reduction credits. This is one side. On the other side, if foreign governments and companies do not have sufficient confidence in local firms, CDM projects will be difficult to implement even if they have some capabilities. Therefore, in the initial stage of CDM co-operation in particular, the central government of China should lead and supervise the implementation, to select some appropriate Western provinces that have relatively sound financial resources, powerful firms with international horizons and the ability to cooperate. So we may select Sichuan and Chongqing in southwest, Inner Mongolia, Xinjiang and Shaanxi in the northwest as areas to implement a CDM pilot phase. This selection is consistent with the priorities of China's central government.

2. Study of the Implementation of the CDM as Part of China's Western Region Development

To ensure the success of the CDM in promoting sustainable development in China's Western provinces, details of individual CDM projects must be designed carefully. This is important to ensure that the CDM is a stable and effective collaboration mechanism in the long term.

2.1 Interests and Goals of All the Participants in the CDM

The design of the CDM must take into account the interests of many parties. There are five main participants in the CDM: foreign governments, foreign companies, the central Chinese government, local Chinese governments and Chinese firms.

This particular project focuses on the perspectives of Chinese enterprises and the local government in Western China. So far, a pilot study has been undertaken, based on interviews with 8 enterprises and some local government officials in Guizhou and Sichuan provinces (please refer to Appendix I for details). The questions to be put to the interviewees were designed jointly by the SPRU and Guanghua Management School research teams. The interviews were also carried out jointly, by Dr. Liu Xue, and Dr. Huang Tao of Guanghua Management School and David Shaw of SPRU. By virtue of the information gained through these interviews, we have formed an initial impression of some of the issues to be considered in implementing the CDM. These findings are reflected in the analysis contained in the remainder of Part 2 of this report.

The relevant parties have their own expectations and requirements for CDM projects. Therefore in the international negotiations to establish the detailed implementation of the CDM, compromise among all the parties is necessary. The Chinese government must consider the interests and expectations of each participant when forming its own view and strategy.

2.1.1 Foreign governments

The main benefit that Annex I country governments may get from the CDM is a reduction of the cost of meeting their targets for GHG emissions reduction. This assumes that the marginal emission reduction cost of developed countries is higher than that of developing countries. The benefit to Annex I countries would be the difference between their marginal abatement cost and the cost of the CDM project per unit of emissions saved. The higher this margin is, the more attractive the CDM becomes to Annex I governments and companies from Annex I countries.

In general, Annex I governments have tended to advocate a design for the CDM that

will benefit their industry. Though negotiations have not yet confirmed all of the details of the CDM, the overall philosophy is now established. It is accepted that a market system will be used, for example through the invitation of bids from companies to implement named projects. For developing countries such as China, it is important that those enterprises that are successful in being awarded projects should be those most able to help developing countries accomplish GHG emissions reduction. In this way, foreign enterprises play a leading role in implementing the CDM.

2.1.2 Foreign companies

Foreign companies, encouraged by government policy, will participate in CDM projects primarily for economic reasons - they do not have a direct interest in helping developing countries reduce GHG emissions.

The financial proceeds from each CDM project may be divided into two parts - one is direct proceeds; the other is indirect proceeds. The direct proceeds stem from the exchange capital and technology for confirmed emission reductions (CERs). The magnitude of these direct proceeds will depend on market price of CERs at the time of the transaction.

The indirect proceeds of CDM projects for foreign firms stem from factors such as access to new markets. By implementing a CDM project, a foreign company can find a foothold in the Chinese market for their technology and product. Through the support given by their home government and the Chinese government for CDM projects, foreign companies might find it easier to attract subsequent orders for equipment and services. CDM participation will effectively lower their marketing costs and benefit them by association with high profile 'flagship' projects. However, it remains to be seen whether these advantages will be enough to overcome existing barriers to the purchase of new foreign equipment and technology in China (e.g. lack of finance, lack of incentives to reduce pollution etc.[8]).

2.1.3 China's central government

Western Development is one of the most important initiatives of the central government of China. It aims to develop the economy and to rectify the poor state of development in West China. The Central Government of China attaches much importance to environmental issues in the course of Western development. As the Western regions are in possession of abundant resources, exploration of energy and mineral resources will inevitably affect the local environment. One main consequence is the emission of GHGs. For this reason, West China has great need of cleaner technologies and skills, a fact that is emphasised in the central Chinese government's strategy. The CDM provides an opportunity for Western China to step onto the road of sustainable development, and is therefore viewed with great interest in this region.

[8] For further details, see J Watson et al International Perspectives on Cleaner Coal Technology Transfer to China Working Group on Trade and Environment, CCICED, August 2000.

The central Chinese government's general attitude to the CDM has already been analysed in a previous report to the China Council[9]. This report analysed the advantages that the central Chinese government will gain from the CDM and issues to be considered in implementation. In brief, the report points out that as soon as the CDM is implemented, China will be a very important player in the CDM credit market due to its low marginal abatement cost and the large scope for reducing GHG emissions. Participating in the CDM will bring obvious short-term proceeds for China including foreign capital, advanced technical equipment and other environmental and social proceeds. In the long term, however, the danger of reliance upon foreign emission-reducing technologies does exist. It is possible that this reliance will go against China's indigenous development of environmental protection technologies, and weaken China's status in future global environmental negotiations. However, this risk can be mitigated by careful negotiation of the terms of technology transfer with foreign companies. Chinese firms should ensure that they gain access to technological knowledge embodied within new imported equipment as well as the hardware itself. In this way, there will be an improvement in the capabilities of Chinese firms in the management of further technical change in technologies to reduce emissions.

As for the Western regions, the central government's goal is to first promote economic development and then, secondarily, to protect the Western regions' environment. Consequently, the central government needs to invest capital, apply technology and set favourable policies. The CDM may help to increase the capital available and to provide the cleaner production technologies required. It has the potential to lighten the central government's investment burden in developing Western China while promoting sustainable development there.

2.1.4 Local governments in Western China

Economic development is the primary goal of local governments. The local governments of Western China want capital and technologies to develop the local economy. As China is still a huge developing country with low income per capita, the developed level in the Western regions is much lower than in other parts of China. The ten Western provinces have pretty much the same population as Eastern areas, whereas the ratio of GDP has grown to 1:2.77 in 1999 from 1:1.87 in 1980. In the 1999, the GDP per capita of Western regions was only RMB 4170 yuan (less than 500 U.S. dollars), significantly lower than the national average level (800 US $).

Due to this urgent need for economic development, Western local governments are not as interested in environmental protection as the central Chinese government. However, this distinction is not universal since the Western provinces differ from each other in their economic development situation, natural resources and economic strategies. Let's take Yunnan province as an example. Yunnan lies in torrid and subtropical zones. Naturally, it has rich agricultural resources and is known for its picturesque scenery. Six water systems enrich its hydro-electronic power resources, and tourism is becoming its

[9] Jin Yunhui and Liu Xue The Prospect of the CDM in China's Sustainable Development CCICED, August 2000.

most important service industry. As a result, the Yunnan Government has more need of environmental protection than other Western provinces. From this example, we can infer that the potential for applying the CDM in these provinces varies.

Given the slow economic development in Western China, local governments often lack the capital, technologies and talents to devote to environmental protection even though they regard this as important. For those local government departments with this attitude, the CDM is particularly attractive. However, whilst the CDM concerns global GHG emissions, local governments are often much more interested in improving the regional environment. They usually prioritise issues such as water (water pollution, loss of water and soil, desertification), SO_2 and particulate emissions, and solid rubbish. Water problem is usually the most important priority for local governments. In China, rivers and lakes are severely polluted and many parts of Western regions are short of water resources. Second to water pollution is the losses of both water and soil. Due to the enormous influence of the loss, reforestation has become an important problem that the central government is helping local governments to solve. In western and northern parts of China, desertification is badly affecting the production and life of peasants and herdsmen.

The emission of SO_2 leads to acid rain which also affects agricultural production. SO_2 may also reduce air quality together with particulates, a problem that has led many local governments to actively seek solutions. For the sake of urban construction, they also certain attention to solid rubbish. Generally they are not particularly concerned about GHG emissions, especially the emission of CO_2. As CO_2 has not been designated for inspection and measurement under environmental legislation, neither local environment protection departments nor local governments treat CO_2 as important.

Due to the perception that local economic benefits are limited, local governments are usually not willing to force enterprises to invest in environmental protection. The implementation of the CDM may help to change this attitude. During the course of CDM project implementation, local governments will have their own interests to fulfil, and they may not always act in ways which will ensure the long term effectiveness of this mechanism. For example, if they are eager for instant benefit, they might cut the capital they make available to CDM projects. Whilst they may support CDM projects in principal, they might be too weak in power to support the implementation by providing money for firms. It is therefore important that local governments are given resources and support by central government to get the long term benefits from the CDM.

2.1.5 Firms in Western China

Based on the information we got from the interviews with enterprises in Sichuan and Yunnan and other background materials, we can discuss some of the concerns of firms in Western about the CDM. In order to successfully implement CDM projects we must consider the characteristics and attitudes of these firms in the formation of policies for implementation.

(1) The current state of Western enterprises

Generally speaking, Western firms are facing the following questions:

Their general economic position is not strong enough and their competence is comparatively low

The Western regions' economic development is comparatively slow in speed, which has resulted in an exodus of capital and talent to the more prosperous Eastern provinces. A lack of large-scale investment makes the West short of motivation for economic development. The Western development strategy emerged against this background.

Since the open policy and reformation was delivered, there have appeared many energetic firms run by local people and some competitive modern firms developed out of old State Owned Enterprises (SOEs). Generally speaking, however, the enterprises in the West are commonly weak in economic power and low in average competence compared with Eastern Chinese firms and the world average.

Western firms lack modern technology, and are weak in research and development skills

Hi-tech development has a convergence effect - places with high technology develop fast and can attract capital and talents. Shanghai, Beijing and Guangdong province have experienced convergence due to this. Western firms find it hard to attract similar investments due to the comparative economic weakness of the regions in which they are based. It is difficult for the firms to maintain an active research department except in cities like Xi'an and some military firms. Some small-to-medium conventional firms, either owned by the State or privately, have very little independent ability to research and develop technologies. Those large SOEs that are based in the West find it difficult to get high quality college graduates to work for them, making it even harder for them to establish a research competence.

Large and Medium sized SOEs are in a poor state

These enterprises were set up in 1960s or 1970s - during the "Large-three Line" construction period, far away from city and towns, and heavily burdened for historical reasons. They are currently being reformed but their problems are too difficult to be solved in a short time span. As a result of these problems, Western enterprises are in need of support and help in their development. The CDM can be one favourable choice for them from the point of view of environmental protection, but it is difficult for Western firms to compete with Eastern seaboard firms for participation in international collaboration.

(2) International co-operation experience in Western firms

Among the Western enterprises, some with better benefits or with state supports have more experience in international collaboration. The vast majority are new to this field. Small and medium sized enterprises are particularly new for they have never contacted foreign companies or institutes and have no experience of technological collaboration.

In the developed eastern areas of China, local governments and firms have accumulated rich experience from collaboration with foreign companies and institutes, thanks to a large amount of foreign capital.

Under international collaboration agreements, comprehensive technology transfer seldom takes place. If there is any comprehensive technology transfer, it often occurs as part of projects under the central government's charge and carried on within Western regions' companies. Equipment transfer is the main way in which the Western enterprises acquire international technology. Due to financial and skills limitations, the introduced equipment does not usually incorporate the newest technology. Therefore, there is still a long way to go before Western enterprises reach the forefront of international technology.

Softer technologies like management expertise are mainly acquired within Western firms through home communication and study. Some management improvements are required by the government, such as the ISO certification procedures. In this field, enterprises usually send high-level managers and technical experts to review advanced companies within China and abroad. However, there is no systemic introduction of these procedures. Another acquisition channel is the joint venture enterprise. But this channel cannot at present influence the management skills of many Chinese firms because of a shortage of foreign capital.

Since Western Chinese firms possess little experience in international collaboration, their relevant abilities to make decision and negotiate are comparatively worse. In fact, the introduction of equipment and technologies into Western regions is usually performed under the instructions of central governing departments or a parent company (usually in based Shanghai or Beijing). Thus the ability of Western firms to perform international business co-operation and technology transfer is rather poor.

(3) Western firms' attitude toward environmental protection

Western Chinese firms have realised the importance of environmental protection for their regions and the whole country. However, they still have a primary focus on economic considerations. National and local environmental protection policies are perceived to be a great pressure and burden upon them and a restriction on their strategic choices. Due to the particularly severe financial restraints on these companies, their investment in environmental protection equipment is not extensive. What decides the amount is government's policy restriction and the extent to which it is enforced. They will make the minimum investment to satisfy the relevant standards (e.g. SO_2 emission limits). Western firms can be supported to a certain extent from local governments, for the latter usually takes a protective attitude towards them for economic reasons. This becomes an important part of the bargaining between firms and governments over the balance between environmental protection and economic well being.

(4) Attitude towards CDM

Some Western Chinese enterprises are very interested in the CDM. They think that the CDM can provide an opportunity to help them solve environmental problems once there are clear rules for its implementation. What they are interested in is as follows:

The prospect that CDM projects can provide equipment and technologies needed to solve environment problems

Firms in Western China tend to know little about the CDM, though some staff have a limited knowledge of the Kyoto Protocol. From their point of view, the CDM will be helpful if it supplies them with free (or nearly free!) equipment and technologies.

The transfer of 'soft' technologies

Comparatively limited information and a low-level of human and management resources are big obstructions for the development of Western Chinese firms. Those senior managers who have reviewed the state-of-the-art at home and abroad have clear knowledge of this, and see the importance of improving knowledge and skills within their own companies. However, they lack opportunities for technology acquisition and experience in relevant fields. They also have no clear idea about how to go about acquiring 'soft' technologies such as management skills.

While the Western regions firms welcome the opportunities offered by the CDM, they think that the following issues need to be clarified:

Operational fees

How will technologies introduced through the CDM link up with existing systems? To introduce new equipment or technologies will definitely bring about the question of whether the new systems contradict the old ones. Many of the existing equipment in Western firms is old, yet it plays an important role in production. The link problem is not so serious if the CDM implementation gives rise to completely new facilities. However, there is an issue about who will be responsible for the transition if the new equipment needs to be linked up with the existing equipment. Similarly, what happens if equipment that has worked well in developed countries does not perform in the same way in a Chinese factory?

How should the operation fees and maintenance fees be paid once the clean technologies or equipment are put into use? If the technologies or equipment are free of charge but they have expensive operation and maintenance fees, Chinese firms might lose more than that they gain. Similarly, who will be responsible for resolving operational or technical problems and ensure normal operation of foreign technologies and equipment? It is the experience of many Chinese firms that companies in developed countries charge very high fees for remedial technical services.

Will the technology transfer be accompanied by an 'inhibition effect' to independent home grown research? Since the CDM can be seen as an extra subsidy to companies

from developed countries, Chinese companies wishing to compete with them might be at a disadvantage. However, this situation may not arise in cases where the technology being transferred is genuinely new to China.

Fees for international collaboration

It is not easy for Chinese companies to take part in international collaboration, since it sometimes implies significant costs in terms of manpower and other resources. At present, there are also problems associated with the arrangement of travel visas and passports for Chinese employees. Sometimes it is necessary for an employee to wait for three months in order to go abroad. The Chinese Government is gradually loosening restrictions in this area, though it is felt that foreign governments add to mobility problems through their visa procedures. These restrictions are disadvantageous to international technical collaboration which often includes frequent travels by personnel on both sides for business negotiations, technical training, international conferences and technical communication.

Further transaction costs also exist because of geographical distances and cultural differences. The reduction of these transaction costs is an important factor which will influence the success of technology transfer under the CDM.

2.2 Modes and Critical Issues of Implementing the CDM in China's Western Regions

Whatever potential advantages the CDM may contain, its success or failure will depend heavily on detailed implementation. At the current preparation stage of the CDM, it is still possible to influence the final shape of the mechanism. We will, in the following section, review applicable modes and possible problems for the implementation of CDM projects in China's Western provinces.

2.2.1 The applicable CDM modes

In whatever mode the CDM is applied, the basis will be the agreements between governments. The performance of CDM projects will be tracked, supervised and assessed by both foreign governments and the Chinese central government. This study emphasises two modes: central-government-led mode and enterprise-led mode.

(1) Mode I: Central-Government-Led Mode

In this mode, the central government signs agreements with foreign governments on emission reduction and determines which companies should participate in the CDM project, what technology is needed and other detailed arrangements. Local governments will be responsible for implementing the central government's policies. Both foreign and Chinese companies will take part in the selection of projects compatible with the CDM's objectives.

In general, international firms will form a CDM credit market and foreign governments will use market mechanisms to select companies to implement each CDM project. At the same time, the central Chinese government will encourage Chinese firms to participate in CDM projects. Foreign governments and the Chinese central government will establish a joint supervision system to ensure that projects are run smoothly and to maximise the chances of success.

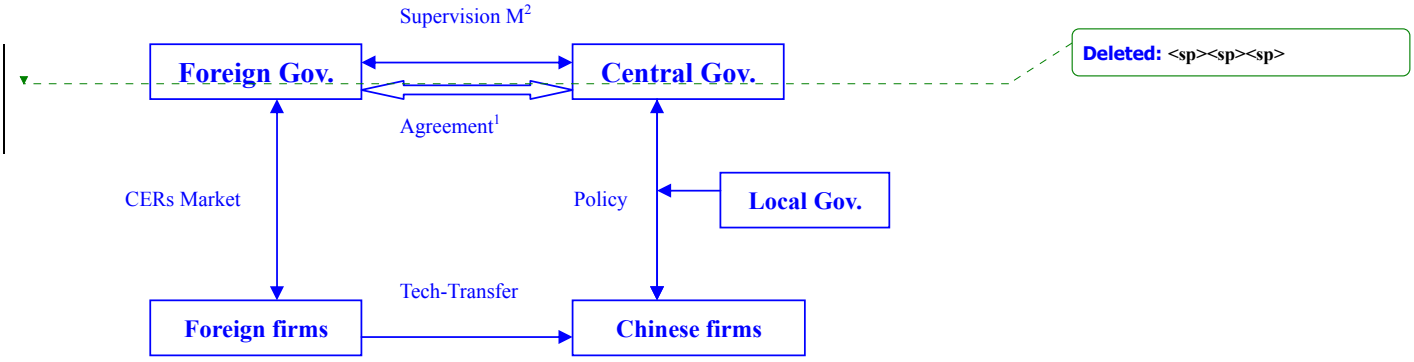

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Fig. 1. Implementation of Central-Government-Led Mode

Note: 1.The agreement is between the governments.2.M stands for Mechanism.

The key aspect of Mode I is the leading role of the central Chinese government. It leads the execution of CDM projects in China's territory and the technology transfer from foreign firms. It is a core feature that the critical emission reduction agreements are signed between foreign governments and the central government (often in the form of agreements between the executive centres of the CDM projects).

(2) Mode II: Enterprise-Led Mode

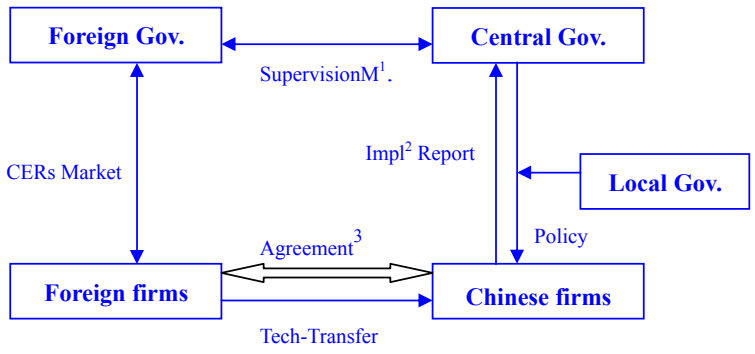

Fig. 2. Implementation of Enterprise-Led Mode

Note: 1.M stands for Mechanism.2. Implementation.3. The agreement is between the enterprises.

The substantial difference between Mode II and Mode I is that the core agreement for emissions reduction is signed between firms in Mode II. This is a market-led form in which the market decides who will implement each project. Firms will enter into partnerships freely at the beginning. Until now, this has been initiated by the foreign side due to the limited negotiations undertaken. The firms will then report to their respective government's, for example to a project implementation centre. The supervision and oversight of certifying emissions reductions is then the responsibility of both governments.

We suggest that Mode I should be used in the initial stages of the CDM for the following reasons:

Firstly, Western Chinese firms are weak in economic power. Their abilities to negotiate and research potential project partners are not sound. If Mode II is followed, the most successful firms in CDM projects will be those who are strong in technical power and economic power, rich in international collaboration experience and capable of bargaining. This will exclude most firms from Western China from the process.

Secondly, Mode I may become a helpful means for Western regions to develop. It may fit well with the priorities of the national Chinese government. The central government can bring its experience of international negotiations to bear, and may be able to protect less well resourced firms from entering into poor agreements.

2.2.2 Critical problems in implementing CDM

Due to the diversity in all parties' interests and goals, a series of problems have to be solved for the CDM to be implemented successfully:

(1) Baselines

The method for setting the baseline for CDM projects – the benchmark against which emissions reductions are measured – is important. Generally speaking, the options for this are single project baselines, multi-project (industry standard) baselines and national standard baselines. A single project baseline is set by looking at each project in detail, and considering the technology features and the GHG emission difference before and after implementation. This method has been criticised as too costly and time consuming. A multi-project or industry standard sets same baseline for projects of same type and would take into account industry features and generic technologies (e.g., the transfer from coal-burning power plant to natural gas). The national standard would be computed according to the average status of technology and end use efficiency within each country.

A national baseline is not appropriate for China. Since China is a large and diverse country, firms differ from each other in economic power, technical capability and performance, management level and access to international expertise. A national baseline cannot capture the wide variation in environmental performance across

Chinese industry.

Whilst the single-project baseline method is potentially the most accurate, it implies high transaction costs for the CDM. It is therefore argued that it is only appropriate for large CDM projects. As stated above, it is likely that the central government-led mode of the CDM will be most advantageous for China. Under such a mode, early projects are likely to be large. Those responsible for CDM implementation might select firms such as large State Owned Enterprise as the basis for a pilot stage.

When the central government has accumulated some experience it may encourage sets of CDM projects for small and medium-size enterprises with similar energy consumption and technical equipment. For each set, the government may seek international collaborators to supply technologies to reduce GHG emissions and improve skill levels within the Chinese firms. If successful, this would save emissions at a series of industrial facilities in a single transaction and would therefore reduce average implementation costs.

(2) Types of technology transfer under the CDM

It must be pointed out that while one of the aims of the CDM is to introduce advanced international technologies to developing countries, not all GHG reduction technologies are suitable for introduction via the CDM. Suppose a special coal-burning technology has been developed for improving energy use efficiency and reducing GHG emissions, and a company in a developed country would like to transfer such a technology under the CDM. Is it good for a Western Chinese enterprise to accept such a technology? It depends. If the technology transfer process is not comprehensive, a long-term effect of this scenario might be to inhibit home-grown Chinese technology in favour of imported technology. It is therefore crucial that the recipient of the foreign technology gains the knowledge necessary to fully understand and 'own' it.

Another reason for limiting the range of technologies to be transferred under the CDM is the potential for a 'free rider' effect. In the absence of the CDM, there would still be a large number of opportunities for emissions reduction in China that can be accompanied by large financial savings. For such opportunities (e.g. optimising the operation of industrial coal-fired boilers), the CDM can be seen as an unnecessary subsidy to foreign firms. Recent research by the Lawrence Berkeley Laboratory in the USA implies that at least some of these opportunities are being taken up[10]. Since the mid-1990s, China's GDP increased by 36% whilst CO_2 emissions fell by 17%. This was largely achieved by reducing the intensity of coal consumption in industry and developing cleaner energy.

Having said this, evidence from other studies reveals a lack of activity to take up energy saving opportunities which seem to be extremely attractive on both economic and

[10] D Fridley et al What Goes Up: Recent Trends in China's Energy Consumption *Energy Policy* Vol.28 No.10 (August 2000), pp671-687.

environmental grounds[11]. This suggests that a subsidy scheme such as the CDM is required to overcome financial, institutional and other barriers to technological improvement. In addition, there is some evidence that many Chinese firms (particularly those less advanced firms in China's Western provinces) simply do not have the capability to assimilate more advanced technologies. If this is generally the case, any move to limit eligibility under the CDM to more advanced technologies may do more harm than good.

(3) Relevant fees in the tech-transfer implementations

The main concern of Western Chinese firms is the extent to which technology transfer via the CDM will bring them economic benefits. They will be enthusiastic about such transfers if they promote economic performance but may be indifferent if the effect is mainly environmental. It is important that technology transfer does not impose large up-front costs. Even if the CDM project is economically attractive, it is important to consider who will take responsibility for meeting the costs of adjustment and the integration of new technology within existing Chinese facilities.

Two methods can be used to solve this problem. One requires that the foreign companies executing CDM projects should be responsible for costs incurred until the anticipated improvement in emissions is achieved. This method makes it a contractual condition for foreign companies to meet these costs in order for them gain credits for the emission savings achieved as a result of the project. If projects are designed in this way, there is an issue about the overall control of the project. If the foreign technology supplier is being asked to meet transitional costs, it is understandable that they may seek greater control over the management of the project. In this case, it may be more difficult for the recipient Chinese firm to acquire relevant management skills so that any new equipment will continue to function effectively once the involvement of the foreign firm is completed.

The main problem with this method of implementing the CDM project is that the up-front costs of integration and adjustment may be high, and may deter foreign companies from putting themselves forward. As a result, many Chinese firms are not convinced that this is the best way forward since they are concerned that many CDM opportunities will not be pursued. In addition, they are worried that they will not gain longer term benefits through improved skills and technological competencies.

Another possible method of CDM project implementation is a more co-operative one in which both sides work together in a more formal joint venture arrangement to achieve the reduction in emissions. This method will place more emphasis on the development of Chinese firms' capability in both technology and management. If properly managed, this method should lead to benefits for both sides – the foreign side gains credits and access to the Chinese market whilst the Chinese side gains new equipment and increased capabilities. Of course, there are potential conflicts here – the extent to which

[11] See J Watson et al op. cit.

the foreign side will be prepared to transfer privileged knowledge to the Chinese side will be limited by its wider commercial strategy. However, given the large gap between the performance of the average Western Chinese firm and most international firms, there is plenty of scope for compromise which still leads to improved economic and environmental performance.

(4) Government role

The Chinese Central government will take the leading role in the implementation of the CDM since implementation is based on the basis of agreements between governments. The central government should consider establishing national support systems for the CDM that include the following: information collection, policies, organisation, finance and technologies. A detailed analysis of many of these issues can be found in a previous report to the China Council[12]. Due to the poor capacity within the Western regions of China for the negotiation of international collaboration agreements and the weak economic and technical position of many firms in these regions, the central government should make use of such support systems to lead and supervise the CDM negotiation and implementation.

China also needs to establish comprehensive system for the monitoring of GHG emissions. The State Environmental Protection Administration (SEPA) has not yet started to monitor CO_2 emissions in detail. In order to support the implementation of the CDM, it will be necessary to determine both the regional distribution and industry distribution of Chinese GHG emissions.

(5) Exchange fees

The exchange fees or transaction costs of setting up and administering CDM projects are potentially large[13]. It is important that both foreign governments and the Chinese governments try to minimise these costs. Actions to do this might include streamlined examination and approval procedures and the progressive implementation of multi-project baselines (see above).

[12] Jin Yunhui and Liu Xue op. cit.

[13] For example, CDM investors will be required to contribute 2% of the credits (CERs) generated from the projects to the global adaptation fund under the Kyoto Protocol. This further reduces the competitiveness of CDM investment vis-a-vis other possible ways of obtaining credits.

3. Conclusions and Recommendations

This report has outlined some of the issues raised by the implementation of the CDM for firms and government departments in China's Western provinces. It is important to remember that the report is based on the results of a pilot phase of our research project. Therefore, any conclusions are preliminary and tentative.

The CDM could play an important role in promoting sustainable development in China's Western Regions. As the Western provinces differ from each other in the level of economic development, energy production and consumption and other factors, the potential for applying the CDM in these provinces varies. It would be desirable to select a few priority provinces and sectors for the implementing of pilot CDM projects. Candidates might include Sichuan and Chongqing in the southwest and Inner Mongolia, Xinjiang and Shaanxi in northwest since these provinces host many large energy intensive companies which are heavy users of coal.

The detailed design and implementation of CDM projects is crucial to their success. This study has reviewed the potential benefits for the five major participants in the CDM (foreign governments, foreign companies, the central Chinese government, local Chinese governments and Chinese firms). After an initial consideration of the different roles of each participant and pilot interviews with several enterprises in Sichuan and Yunnan, we have identified several issues to be borne in mind. These include the method for establishing project baselines, incentive mechanisms and provisions for monitoring of emissions.

This study has identified two broad approaches to the implementation of pilot CDM projects in the selected priority Western provinces and sectors: the central-government-led mode and the enterprise-led mode. Based on the analysis of advantages and disadvantages of these two modes, the study recommends that the central-government-led mode might be more appropriate for the implementation of pilot CDM projects in Western provinces. However, it would be desirable to move to an enterprise-led mode of CDM implementation in China in the long term.

This study reviewed a series of issues to be considered on the basis of all parties' interests. These are as follows: baseline determination, technology implementation costs, the identification of eligible technology types, supporting government policies and transaction costs. Each of these issues will affect the success of the CDM, both as a vehicle for emissions reduction and as a method of improving the technological capabilities of firms in Western China. Based on the preliminary analysis of these issues in our pilot study, we recommend that the central government of China should participate in the CDM, and use this mechanism to further the goal of technology transfer to develop China's Western Regions. Our specific provisional recommendations include:

- The Chinese government should take active attitude as a participant in the CDM and push for detailed rules in international negotiations that will yield economic, environmental and technological benefits for China.
- The criteria for selecting CDM projects should take into account the potential improvements in regional environmental quality and urban air quality. The reduction of CO_2 emissions may be linked to the reduction of SO_2 and TSP pollution. This link will potentially help Chinese firms and other stakeholders to appreciate the value of the CDM, and will help create widespread support for its implementation.
- For the CDM project implementation, the central-government-led mode should be followed in the initial period. The government should establish an operational office for CDM projects (such as Operational Centre for CDM projects) which will be responsible for selecting priority provinces, industries and enterprises. These should include large and medium-size enterprises in Western regions in which the potential for reducing GHG emissions is large.
- The central government should establish a sound GHG emissions monitoring system by expanding current daily monitoring activities of conventional pollutants to include CO_2 emissions.
- Consideration should be given to priority technologies for acquisition under the CDM. Whilst it may not be desirable for strict rules to be implemented which include and exclude certain technologies, a set of priorities could initially direct investment to those incremental technologies which will yield the most immediate benefits to China.
- The Chinese government should review both economic and non-economic incentives for collaborative arrangements between Chinese enterprises and foreign enterprises (e.g. joint ventures) to maximise the benefits of CDM projects for both technology suppliers and Chinese project hosts.
- The transaction costs associated with setting up CDM projects should be minimised by both foreign and Chinese government agencies. Whilst individual project baselines should be used in the initial stages of the CDM, multi-project baselines might be more cost effective once experience is gained.

Appendix: Summary of the Interviews

We performed interviews with 7 enterprises in July, 2001. Summary notes from the interviews are given below:

1. Sichuan Chemical Works, Ltd. (SCW)

Subject: Zhongping Zhou, Senior Engineer and Vice General Manager.

Sichuan Chemical Works, Ltd.(SCW) is built in 1956, with about 10,000 employees and a sales quantum of about 1.5 billions Yuan in 2000.

1.1 The involvement of Chinese firms in international collaborations

1) Has your firm ever taken part in an international collaboration?
SCW has many experiences in collaboration with foreign company.
In 1956, SCW started the construction, and introduced 12000 Tone nitrogenous fertilizer equipment.
Since 1976, SCW has imported large-scale fertilizer plant from a Japanese firm.
In 1984, SCW introduced large-scale melamine plant into Sichuan from Holland firm (DSM).
From 1995 on, in collaboration with Japan's firm, SCW started a project of Green Aid Plan (setting by Japanese government), introduced new type boiler which can improve the energy efficiency and environment quality.
Has one joint company with Japanese firm which produces lysine (setting in 1996).

2) To what extent was this collaboration successful (e.g. new technology transfer, new product released, greater efficiency, and so on.) ?
Most of the collaborations are successful. Especially the collaboration with Japanese firm is very happy. The project produces direct environment effects and economic result.

3) If the firm has entered into an international collaboration in the past would it like to do so again?
In the future, SCW certainly have strong will to take part in this kind of collaboration, especially projects like Green Aid Plan.

4) Would the firm be enthusiastic to be involved in an international collaboration that did not necessarily yield an immediate or short-medium term financial dividend ?
If the international collaboration does not negatively influence the normal operating of the equipment, SCW is willing to participate in it although it may not bring immediate financial dividend. Chemical industry adopts continuo production technology. Safety and stable operation is very important for our company. If the additional environment equipment could not operate stably, It would cause great loss.

1.2 Future technologies

1) What technologies and skills does your firm need to adopt in the future?

We are interested in many kinds of technologies, including hardware and software technologies such as monitoring and management skills. At present, our company faces the challenge of updating our product structure. So we are very interested with the new synthetical products, and other high added-value products that can't be found in China.

2) How long, on average, does it usually take to assimilate a new technology? Any example?

The period of assimilating imported technology is quite different, which depends on the equipment's scale, complexity degree and other factors. For example, In 1984, SCW introduced large-scale melamine plant from Holland firm (DSM). This plant could not reach the design capacity after 7 years' operating because of the equipment's problems. Although the experts from Holland tried many methods, they could not solve the problems. Finally, it was our engineers that solved the problems. The collaboration with Japan's Green Aid Plan is very successful. This project's negotiation started from 1996 and its construction began in 1998. In 1999, the project passed the checking and accepting.

3) To what extent does the enterprise believe in the accumulation of management, training and monitoring skills so as to maximize the efficiency of current equipment rather than the accumulation of capital equipment?

We believe good maintaining and management skills are very important for improving the efficiency of equipment. However, most of our skills are mastered through learning via doing. The learning curve is very obvious. We did not collaborate with foiling firm in this field, but get to the capability by our exploring and learning via doing.

1.3 International collaborations and factors for success

1) How does the firm react to the following concerns raised by European Union enterprises:

a) Intellectual property infringements
b) A technology may not be easily assimilated by a Chinese firm
c) Lack of management control during collaborations

a) For the intellectual property conflicts: SCW believes that it does not infringe foreign firm's intellectual property rights. However, SCW had an unhappy experience with Holland DSM Company. Chengdu local government initiated this project. The government acquired this set of equipment for another chemical plant (Chengdu Wangjiang Chemical Works, smaller than SCW) which belonged to the Chengdu local government. When they found that Wangjiang Chemical Works had not enough capacity to assimilate this set of equipment they transferred it to SCW. For the reason the local government officers had not enough experience, the technology contract was very disadvantageous to our side. In 1985, the imported equipment begun production, but could not reach the designed capacity, and could not operate stably. SCW's engineers resolved the problems by themselves, and got much knowledge in this

process. At the beginning of 1990, SCW negotiated with DSM, hoping to expand the capacity by introducing new equipment. DSM did not agree. SCW hoped to expand capacity itself. Nor did DSM because DSM was afraid of competition.

In general situation, it is unnecessary for large companies like SCW to worry for infringing foreign company's property rights. This is not only because the infringement behaviours are very obvious but also due to the fact that SCW values its reputation so much.

b) There are no problems for SCW to assimilate foreign firm's technologies. SCW's R&D capacity is much weaker than those of multinational companies are. However, its operation capacity is very strong. Its operation management is also very well.

2) What conditions would have to be satisfied in order to make an international collaboration successful for your firm? Can the enterprise highlight any possible barriers that would prevent an international collaboration? (Barriers may be from inside or outside China)

From SCW's point of view, the problems in international collaboration, part of them come from management, part of them arise from culture differences. Strengthening understanding is important.

1.4 Barriers to SCW's technology transfer are as follows:

Firstly, some foreign firm's conditions for technology transfer are too strict for Chinese firms to accept.

Secondly, It is relatively difficult to find a suitable way to balance two sides' benefit, especially in the distribution of stock share ratio and the power of control. In joint venture with a Japanese firm which produces lysine, Japanese side owns 70% share, SCW 30%, and technology licensee fee is 3% of turnover. The Japanese side controls the right of management. They adopt the strategy of low price high turnover for getting the technology transfer fees soon. Although the enterprise is in bad situation; the Japan side still gets enough profit. The loss on the SCW side is immense.

4) Is there a trend evident to the enterprise toward more or less international collaboration? At what level are these collaborations typically happening? (e.g. co-production, one off sales of capital equipment, co-research etc.)

SCW's involvement in international collaboration is certainly increasing in recent years. This can be seen from SCW's activities in recent years. Mr. Zou believes that Chances firm's involvement in international collaboration will soon increase in the near future

1.5 International Government Policy

1) To what extent has the Chinese Government encouraged international collaboration in the enterprise's industry?

No knowledge about it.

2) How can the Chinese Government increase the number and effectiveness of

international collaborations at

a) Firm level?
b) Regional level?
c) National level?

Would this be a desirable motive?
The government can do many things to improve international collaboration. However, at present stage, the priority should create fair and harmonic economic environment and economic order. SCW does not endorse the government do many things over their duty. The government did quite a lot in planing economy but did not induce good results.

3) Does the enterprise see the future tightening of Government regulations regarding the environment (e.g. pollution levy) as a barrier to growth? Do current regulations deter polluting activities?
Enterprises are greatly influenced by the raised environment standard of the Government. For the past a few years, investment in environment from enterprises has absolutely increased and so has the environment levies.

2. Chengdu Steel Works, Ltd. Co.

Subject:Anwu Sun, Operation Manager
Background: Chengdu Steel Works is the largest steel company belonging to Chengdu city government. It was founded in 1958. It has more than 10,000 employees, 1,500 engineers. Its turnover is about 1.3 billion yuan RMB in the year of 2000. Almost all of its products are architectural steel materials. From 1996 to 2000, its economic situation became worse and worse. Part of the reasons is in management system and mechanism. The other part is because its customers owed it too much money.

2.1 The involvement of Chinese firms in international collaborations

1) Has your firm ever taken part in an international collaboration?
CSW has never been successfully involved in collaboration with foreign company although it tried several times. Its economic situation is not very well.

2) If the firm has never taken part in an international collaboration would it be enthusiastic to try such a venture in the future? Would the firm be enthusiastic to be involved in an international collaboration that did not necessarily yield an immediate or short-medium term financial dividend ?
In the future, CSW has strong willingness to take part in international collaboration. However, if the involvement can not bring direct benefits to the company, it is very difficult for the company to participate because it has many problems to be dealt with now.

2.2 Future technologies

1) What technologies and skills does your firm need to adopt in the future? How long, on average, does it usually take to assimilate a new technology?

Almost most of the equipment should be updated. So it needs many technologies related with pudding, steel-making, energy and environment. The most important technologies at present stage are dust-removing technologies for converters, fuel gases dealing technologies, water cycle technologies.
All of the environmental technologies the firm adopted are Chinese technologies. They operated normally at the beginning stage. But most of them can not work continually.

2) To what extent does the enterprise believe in the accumulation of management, training and monitoring skills so as to maximize the efficiency of current equipment rather than the accumulation of capital equipment?
The firm makes one ton of steel out of 560kg burnt carbon at present, sometimes even around 600 kg. Needless to compare with developed countries, this is very backward even if compared with advanced level at home. Theoretically speaking, we should stress improve resource cost rate by management, equipment supervision, training and so on. In reality, however, we face difficulties such as capital shortage, arrangement of laid-off workers, sales problem of the products, problem of ticked products, and so on. We've no enough time to concern about the training or other events. Besides, China has closed a large number of small-scale steel factories, which forces us to enlarge our production scale so as to counteract the tense pressure. Therefore, we pay much attention to "hard wire" at present.

2.3 International collaborations and factors for success

1) How does the firm react to the following concerns raised by European Union enterprises:

a) Intellectual property infringements
b) A technology may not be easily assimilated by a Chinese firm
c) Lack of management control during collaborations

No experience till now.

2) What conditions would have to be satisfied in order to make an international collaboration successful for your firm? Can the enterprise highlight any possible barriers that would prevent an international collaboration? (Barriers may be from inside or outside China)
For our firm, money is perhaps the biggest barrier; after that, person with ability, management and conception are also troublesome. During the past a few years, the bad situation of the firm has caused many excellent persons flow away.

2.4 International Government Policy

We hope the government can provide favourable loan for us to solve the shortage of money.

3. Chengdu Jianjiang Cement Co. Ltd.

Subject: Yuqing Jiang , Office Manager; Gang Xie, Security Officer

Background: The firm lies in Pengzhou, Chengdu city,38 km to the urban. It was set up in 1985 and began production in 1989. It makes 220,000 tons annually now. The total number of employees is over 700, including over 160 professionals. The sales income in 2000 is RMB 7,000 yuan, with about less than 100,000 yuan.

3.1 The involvement of Chinese firms in international collaborations

1) Has your firm ever taken part in an international collaboration? To what extent was this collaboration successful (e.g. new technology transfer new product released, greater efficiency, etc.)? If the firm has never taken part in an international collaboration would it be enthusiastic to try such a venture in the future?

We received a few foreign visitors. Nearly no any international collaboration. NO doubt we are enthusiastic to it only if such activities may bring actual economic interests to us.

2) Would the firm be enthusiastic to be involved in an international collaboration that did not necessarily yield an immediate or short-medium term financial dividend ?

If it needs no additional fees or disadvantageous affection to the operation of the equipment, the firm may think about it. As for environmental benefit and economic benefit, the latter is preferable.

3.2 Future technologies

1) What technologies and skills does your firm need to adopt in the future?

Powder and dust transaction technology, kiln new technology, etc..

2) To what extent does the enterprise believe in the accumulation of management, training and monitoring skills so as to maximize the efficiency of current equipment rather than the accumulation of capital equipment? Can the increased use of management, training and monitoring skills be used to realise real gains in efficiency (financial and environmental) from the use of current capital equipment?

We concern more about improving efficiency by strengthening management. The production scale is stable now. We want money to renew the equipment. Every year we train the workers who operate the machines. Nevertheless, the training is not so obvious because of the deficiency both of the workers' responsibility sense and of our prompting policies.

3.3 International collaborations and factors for success

1) Can the enterprise highlight any possible barriers that would prevent an international collaboration? (Barriers may be from inside or outside China)

The main barrier is that we are not in good benefit situation and hence the lack of money. The shortage of information and relevant intellectuals are also restrictions.

4. Sichuan Xuhua Pharmacy Co., LTD (SXPC)

Subject: Zhiying, Luo General Manager; Daqin, Wang Chief Engineer.
Background: Xuhua is a joint venture with Taiwan. The Taiwan shareholder holds 27.1%, and we share 72.9%. The registered capital is 42,000 thousands. The total assets is 37,710 thousands and the profit is 2,400 thousands yuan.

4.1 The involvement of Chinese firms in international collaborations

1) Has your firm ever taken part in an international collaboration?

The company introduced a small quantity of analysis apparatus, control apparatus via agents. We didn't buy them through direct negotiation with foreign traders.

2) If the firm has never taken part in an international collaboration would it be enthusiastic to try such a venture in the future?

We are surly willing to participate in relevant international collaboration. The company is fairly interested in the technologies related to sewage transaction and Chinese traditional medicine waste residue transaction.

4.2 Future technologies

1) To what extent does the enterprise believe in the accumulation of management, training and monitoring skills so as to maximize the efficiency of current equipment rather than the accumulation of capital equipment?

We are quite concerned about improving employees' skills through training. They have 10 workdays training every year each person. The training for operation workers is usually given by technical personnel within the company; training for management personnel is given by experts from universities or consultant companies. Sometimes we send management personnel to universities or abroad to accept training.

2) Can the increased use of management, training and monitoring skills be used to realise real gains in efficiency (financial and environmental) from the use of current capital equipment?

The result is quite obvious. The employees master better skills so that it help to improve the quality of products and lower material cost. At the same time, training help the employees attain environment conception and understand the strategy of our company.

4.3 International collaborations and factors for success

1) Can the enterprise highlight any possible barriers that would prevent an international collaboration? (Barriers may be from inside or outside China)

Our knowledge of the laws abroad relevant to technology transfer is very limited. It's very difficult for us to tell the advanced level of some technologies and decide how much to be expended. View this from the lay of operation, capital and person with ability are also problems though not critical.

4.4 International Government Policy

To what extent has the Chinese Government encouraged international collaboration in the enterprise's industry? How can the Chinese Government increase the number and

effectiveness of international collaborations at Firm level, Regional level, National level?
Hope the Government to do well in their duties. They can create fair competition order, deal with kinds of problems according to international principles and provide necessary information support for enterprises. The government need not intervene in the inner fairs of enterprises.

5. Sichuan Guangtai Pharmacy Company, Ltd. (SGPC)

Subject: Guangwei, Zhang, Boss of SGPC; Mingcong, Kuang, Manager of Supply Department. Mr. Liang, Chief Engineer.
Background: Guangtai is set up in 1988, SOE in the beginning and corporation limited held by Mr. Zhang Guangwei. The total capital ///assets is 43,000 thousands yuan. The employees are 150 people.

5.1 The involvement of Chinese firms in international collaborations

1) Has your firm ever taken part in an international collaboration?
We nearly did not participate in any international collaboration. The main reason is that our scale is too small. Our market is at home. We are short of international markets' information. We have no opportunity to participate in international collaboration.

b) If the firm has never taken part in an international collaboration would it be enthusiastic to try such a venture in the future? Would the firm be enthusiastic to be involved in an international collaboration that did not necessarily yield an immediate or short-medium term financial dividend?
Whether Involvement in international Collaboration or not mainly depends on the economic and environmental results. Economic results are firstly considered. Environment is second. If involvement costs much money, and only produces environmental results, but no economic results, our company will not consider, except the government forced our company to do so.
We have strong willingness to participate in international collaboration. But how to participate and which a to participate? We need carefully make choice.
Whether or not to participate chiefly depends on the consequences. We are so small in scale. We think first about economic benefit and secondly environmental benefit. If the introduced equipment can only bring with it environmental benefit but no economic benefit and with high cost, we usually will not consider it, except that the government urge us to do it.
If the introduced equipment through CDM can bring some environmental benefits and some economic benefits we will also think about it times and again. We need to estimate: how much to invest at one time? How much is the maintaining cost and operation cost? Are the fittings easy to buy? Is the cost high? And so on. Our first judgement is if an enterprise is at the stage of construction or time of renewing the equipment, it will consider international collaboration. Yet if the equipment works quite well, we care more about the normal operation of production.

5.2 Future technologies

1) To what extent does the enterprise believe in the accumulation of management, training and monitoring skills so as to maximize the efficiency of current equipment rather than the accumulation of capital equipment?

We pay much attention to improving employees' skills by training. Every year we invite college teachers to train our employees. At present, the training is not fixed or standard.

5.3 International collaborations and factors for success

1) Can the enterprise highlight any possible barriers that would prevent an international collaboration? (Barriers may be from inside or outside China)

Lack of negotiation ability, including talents of foreign languages, foreign trades and techniques;

Lack of information about international technology markets;

Comparatively shortage of capital;

5.4 International Government Policy

To what extent has the Chinese Government encouraged international collaboration in the enterprise's industry? How can the Chinese Government increase the number and effectiveness of international collaborations at Firm level, Regional level, National level?

Hope the government can organise some medium agents to collect relevant information for we enterprises, represent us to attend relevant negotiations, and hope government can provide favourable loan for us.

6. Yunnan Copper Industry (GROUP) Co. Ltd.

Subject: General Manager, Manager in charge of production

Background: The corporation has possessed 35,000 workers and staff. Among them there are 5,000 technical personnel. By definitely speaking the ore deposit reserve worth reaches to 3 millions tons. Its annual production capacity is as follows: 50,000 tons of copper contained in copper concentration, 80,000 tons of blister copper, 100,000 tons of copper cathode, 30,000 tons of copper cod, 210,000 tons of sulphuric acid, 1.5 tons of gold, 100 tons of silver, 10,000 tons of aluminium, 15,000 tons of zinc and 10,000 tons of metal carbide. As for the high pure copper cathode, it accounts for 12% of domestic market. At the same time, the corporation also deals with machinery manufacturing, railroad and highway transportation, building, hotel, tourism, food and drink on a large scale. Its annual Sales income and revenue tax are 4 billion Yuan and 0.25 billion Yuan respectively.

6.1 The involvement of Chinese firms in international collaborations

1) Has your firm ever taken part in an international collaboration?

They have introduced several technologies from Australia, Germany and England to improve their boiler technology. They buy new equipment and new technology. As they have not much R&D competence, their engineers' major job is to absorb the new

technology and get the new equipment to work. They can get help from the provider, including training the workers and technology advisory. But they have not co-operated with foreign firms to do real R&D work.

2) To what extent was this collaboration successful (e.g. new technology transfer, new product released, greater efficiency, etc.)?
They feel the technology introductions are very successful. They are impressed by the providers from Europe, USA, and Australia and view them as credible partners. They master new equipment and get to know how it works. These improve their skill to do things right. As they are producing copper, the technology transfer's main effect for them is to improve the efficiency. Another important factor is than Yunnan wants to rely on tourism industry as a mainstay industry of the province. So they emphasise environmental protection more than central government. So the Copper Co. have to introduce some technology polluting less. One object of the new equipment and technologies is to help them cut down the pollution, otherwise they will be punished by the corresponding department of Yunnan government.

3) If the firm has entered into an international collaboration in the past would it like to do so again?
They have a big international project running, perhaps will complete by the end of this year. They are eager to do real collaboration with other partners. They are interested in the technology they can use to improve their financial situation, not just as a environmental protection tech. They are worried about one thing--- some technologies can improve environment but will need them to pay high maintenance fee.

4) Would the firm be enthusiastic to be involved in an international collaboration that did not necessarily yield an immediate or short-medium term financial dividend ?
They are interested in the collaboration as said, as they know pollution puts them in a very disadvantage situation facing government policy, especially in Kunming, the beautiful city. If they can cut down pollution, they can earn something not calculated in money. (e.g., favour of government). For example, the city wants to build a forest garden near their firms.

6.2 Future technologies

1) What technologies and skills does your firm need to adopt in the future?
They have invested about 400 millions yuan from 1980s to now to handle the water, SO2, and other pollution. For the CO2 abatement, they do not know much. So they are very interested in CDM mechanisms if it can provide them some technologies useful in this field, of course, better if free.

2) How long, on average, does it usually take to assimilate a new technology? Any example?
As they said, perhaps less than a year, they can absorb something new for them. Because they have visited and co-operated with many top firms in the copper industry

in the World, they are not isolated from the world trend in this field. For example, they have done a project with MIM Holdings Ltd. of Australia to introduce the ISA smelt technology. The project went on two years. They get to success.

3) To what extent does the enterprise believe in the accumulation of management, training and monitoring skills so as to maximize the efficiency of current equipment rather than the accumulation of capital equipment?
They recognise that management, training and monitoring is very important, sometimes is more important than technology. As for the question, "if you have 1 million yuan, are you going to improve the technology, or improve the management?", the answer is "the management".

4) Can the increased use of management, training and monitoring skills be used to realise real gains in efficiency (financial and environmental) from the use of current capital equipment?
They have learned from their experience, that they must have a good management, training and monitoring system if they want the new equipment to work successfully. They usually set a training plan for next year at the end of year. They have experiences in using equipment. For example, they have two fans made in 1960s still in work, and work very well. Another example is that an equipment introduced have been in its highest designed capability even after the designed duration is over (over 200 thousands tons of a type of production). Their investment in new equipment and technologies is small compared to western firms, so they must have their methods to keep competitiveness.

5) To what extent has the enterprise been active in the areas of management training, monitoring and the assimilation of other "software" technologies?
For the managers and engineers, they take part in many training programs organised by government (local and central) and some class by university. For the workers, they have their own training system. But the most important method is to employ new graduated students.

6.3 International collaborations and factors for success

1) How does the firm react to the following concerns raised by European Union enterprises:
   a) Intellectual property infringements
   b) A technology may not be easily assimilated by a Chinese firm
   c) Lack of management control during collaborations

a) As for intellectual property infringements, the managers say that they opposes it. For themselves, they are doing co-operation with many foreign firms and establishing good long-run relationship with them. So they do not want to destroy the relationship by intellectual property infringements.
b) Perhaps they are not very strong in R&D, but they are familiar with the technology progress in the world. Chinese learns things quickly. They have strong self-confidence

to assimilate related tech.
c) They are confident in their ability. They have passed the ISO10002 certification. As China will enter into the WTO, lots of Chinese firms want to do business in popular ways as the world does and are preparing to adjust themselves in accounting system, for example.

2) What conditions would have to be satisfied in order to make an international collaboration successful for your firm? Can the enterprise highlight any possible barriers that would prevent an international collaboration? (Barriers may be from inside or outside China)
They feel the greatest difficulties met in international collaboration is surprising one thing: they can not travel easily to outside. For example, if they want to take part in a conference about copper, they spend maybe 3 months to get passports and registration. Now things are better, as China permit people to get private passports of five years. But they meet many problems to get their men to outside world. The problem is both in bureaucracy of China and policy of foreign countries. For example, to get the visa to English is difficult to Chinese people. So they can do business and get their men training in other countries.

3) Is there a trend evident to the enterprise toward more or less international collaboration? At what level are these collaborations typically happening? (e.g. co-production, one off sales of capital equipment, co-research etc.)
Yes, growing. For the corporation, one off sales of capital equipment and technology trade is the main form of collaborations. For China, co-production is happening more frequently and more important for China's economy.

6.4 International Government Policy
1) To what extent has the Chinese Government encouraged international collaboration in the enterprise's industry?
China encourages firms to enhance the connection with outside world. In the copper industry, government knows the firms need new equipment and new tech. So technology introduction is welcomed and gets help by government. It needs to note, for the high pollution industry, government encourages firms to do research and co-operation with foreign firms. In fact, many collaboration projects are introduced by government, both in central level and local level.

2) How can the Chinese Government increase the number and effectiveness of international collaborations at Firm level, Regional level, National level?
They are not sure. Perhaps they need government to provide some tax incentives to them in pollution abating.

3) How could foreign Governments facilitate international collaboration?
They have not thought of this before and no idea about this.
4) Does the enterprise see the future tightening of Government regulations regarding

the environment (e.g. pollution levy) as a barrier to growth? Do current regulations deter polluting activities?
Yes, they need some motivation policy besides the more and more strict environmental policy. Yes, China's governments have organised many missions to do pollution control. The typical process is " if firm can not meet the standards at x time, then close it", many small firms of Kunming have been closed in a recent mission.

7. Kunming Iron and Steel Group Co. Ltd.

Background: The Kunming Iron and Steel Group Co. Ltd.(former as Kunming Iron and Steel Firm) was established in 1939. Now it is the biggest Iron and Steel Group in south China, including two iron mines and 35,000 employee. The fixed asset is about 9,700 millions yuan and the sale per year is more than 3,000 millions yuan. The planned production is 2-2.5 millions tons of steel. Last year, it produce 1.85 millions tons of steel, 2.04 millions tons of iron, 3.3 millions tons of iron ores, 0.98 millions tons of coke.

7.1 The involvement of Chinese firms in international collaborations

They have introduced several equipment from other countries. For example, the main product line used in iron metallurgy now is a suit of machine disassembled in Luxembourg. They sent many workers to disassemble it in Luxembourg and used 3 months to complete this work and then ship them to China. The rate is quick, as collaborator estimate the work perhaps need 1 year. After a year, they assemble the machine and put it into work. Now they add some auxiliary equipment to gas process. They have other experiences to do collaboration with other foreign firms such as of the Germany, England, Russia, etc. But some of them are not successful. They have not co-operated with foreign firms before to do real R&D work.

The main form of collaboration is equipment introduction. At all, they participate in international collaboration not frequently, especially in environment protection technology. They have no much experience for international collaboration, especially for middle manager and technician, not to say the bull-collar workers. Many top managers and technicians have gone to other countries to see about the foreign firms, but only in superficial visiting.

The problem lies in the financial situation of the Co. They have heavy burden as other state-owned enterprises, such as heavy retirement and "small society" (SOE have entailed heavy social responsibilities before, such as hospital, school, etc.). Now they are reforming. But they have many problems to overcome before they switch to a modern firm. So they are not in a position to renovate their manufacture system. Now their firms are like a machine museum. Some equipment produced in 1960's is still operating. Surprisingly, they said they function well, due to good maintenance. They also build a new firm in 1990's, using new machines and new tech. Though they want to introduce new tech, but money is limited.

They found the international collaboration is useful. But they are afraid the foreign tech and equipment used for environment protection is not easy to fit into their manufacture system. Sometime the technology functions well in foreign firms, but have no use in Chinese firms. For example, central government has introduced a new flue detector system from Japan in 1984 and given it to them. But the machine can not be fitted into their system.

7.2 Future technologies

They have invested about 278 millions yuan from 1980s to now to handle pollution. For the CO_2 abatement, they do not know much. So they are very interested in CDM mechanisms if it can provide them some technologies useful in this field, of course, better if free. They are most interested in three clean technologies: (1) graphite carbon processing; (2) secondary gas processing for converter; (3) low density SO_2 gas processing.

They have their own research centre to absorb new technology. But the really R&D capability is not strong. They relay other institution to do related research, such as university and research department of China.

They recognise that management, training and monitoring is very important. They want to pass the ISO14000 and ISO18000 authentication. So they are training their managers and workers for them.

For their technicians, they have training opportunity, both inside and outside. Sometimes they can attend the training project hold by industry department of government. But the contact to newest technology developing of the world is rare. They are far away from economic and technology centre of China such as Beijing, Shanghai, not to say the world.

7.3 International collaborations and factors for success

As for intellectual property infringements, they have not much to say due to the property of the industry. Technologies used in iron and steel are not useful in other places. No place to do property intellectual property infringements They think the property of knowledge need to be protected.

As for the success of international technology transfer, they think the answer depends on the nature of the equipment and technology. Sometimes the new technology is not suitable to fit into their system.

As for the CDM, they feel the greatest difficulties met in international collaboration is how the expenses are covered. If a new technology is introduced, they must spend much auxiliary fees, such as maintenance fee. They have a series of question about it: how about the subsequent expenses, i.e., accessories, technology service? What

happens if they meet problem in operation?(they feel the foreign technology consultation is too costly). If the new clean technology can not improve their profitability and consume large sum of money, then it is a costly toy, which can only be played by developed countries, even if the technology itself is free for them.

7.4 International Government Policy

Now China's government encourages them to do more collaboration with other countries. But they get no much virtual support for environment protection technology transfer. As for the question related to foreign governments, they have no idea because they are not familiar with the issues and never thought about them. Due to culture differences, they think "business is business", there is no problem for them to cooperate with people from other countries, except the language.