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Energy Conservation and GHG Emissions Reduction in Chinese Township and Village Enterprises – Phase II

Project of Government of the People's Republic of China

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Final Independent Evaluation

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Executive Summary

This final independent evaluation report was prepared with considerable input from the China TVE PMO (Project Management Office), MOA (Ministry of Agriculture, UNDP and UNIDO. However, the responsibility for the evaluation analysis and conclusions are solely those of the evaluators.

The Phase II TVE project had its funding approved by GEF (Global Environmental Facility) in May 1999, was launched in February 2001, and was supported by a GEF grant of US$ 8.0 million, with planned co-financing (in-kind and in-cash) of US$ 10.55 million, and with a four year planned project operational duration. UNDP was the international Implementing Agency, UNIDO was the international Executing Agency, and MOA was the domestic Executing Agency.

TVEs (Township and Village Enterprises) were established from the 1950's in China as rural, collective entities established at the township and village level to provide jobs for the huge amounts of surplus rural labor as well as to provide essential low cost local products. TVEs have now been largely privatized to their former managers, and still primarily sell their products into local markets. TVEs are an important source of local tax revenues, and generally retain strong links to local government and officials for their land tenure and to manage their exposure to the implementation of the numerous guidelines emanating from central, provincial and district government levels.

There are around 23 million TVEs in China, accounting for around 30% of GDP and providing around 143 million primarily unskilled rural jobs. TVEs provide more than half of the total output from the building materials (cement and brick), coking and metal casting sectors. These four TVE sectors account for one-sixth of China's CO_2 emissions. Key drivers in updating TVEs in a step-by-step process from their very backwards 1950's technology, investment and management levels are to improve their competitiveness and to reduce their high pollution levels.

The high-level outcome sought by GEF (as the provider of the core funds for the TVE project) was to reduce Greenhouse Gas (GHG) emissions in China's brick, cement, metal casting and coking TVE sectors. The TVE project was designed to remove key market, policy, technological, management and financial barriers to market transformation in the development and uptake of key energy efficient technologies and products in the four TVE sectors.

The overall purpose of this final project evaluation was to provide an independent review of the project's achievements towards meeting the high-level energy efficiency market transformation outcomes sought, evaluate specific project outputs, and examine indications and prospects of project sustainability. Project sustainability covers whether the project is on track to provide results, approaches and institutions that are likely to persist and continue to provide positive energy efficiency results after the project's formal operational completion (now scheduled for 31 July 2007). The primary focus of this evaluation is on the TVE project's impact on GHG emissions (for GEF purposes), as well as on the Chinese government's key interest in improving national and local energy sustainability, pollution reduction, poverty reduction, and TVE competitiveness.

The overarching TVE evaluation finding is that the project has been very successfully implemented, has achieved far greater than anticipated GHG reductions, and leaves a strong sustainability legacy.

In the eight pilot-demonstration projects implemented, GHG savings of 193,192 tons CO_2/yr have been achieved compared with the 85,000 tons/yr CO_2 savings anticipated in the project's design. Around $49 million of co-funding was invested in these pilots, including $10 million from commercial sources, leveraged from an $800,000 contribution from GEF.

In addition, 111 out of 118 formal replication projects, with CO_2 reductions of 1.3 million tons/yr are achieved or underway (with 714,000 tons/yr CO_2 savings in 101 projects implemented to date) - with funding provided by GEF and the TVEs, as well as from a range of grants, policies and other

support from various levels of the Chinese government. These results are a significant advance on the project design target of 1 million tons/yr of CO_2 reductions to be identified and designed in detail in 100 feasibility studies, but not necessarily to be implemented during the project's operation. GEF's $2 million has leveraged around $100 million of co-funding in these 101 replication projects.

The use of the PIC and LPICs – national and local Policy Implementation Committees – was a particularly relevant project design element– in particular in China's current stage of social market development. With the pro-active effort of the PMO, these policy co-ordination mechanisms provided strong and effective project leadership and co-ordination. The project also greatly benefited from strong policy implementation linkages. In particular, the project made good use of PMO and PIC links to assist the development of policies to prohibit some outdated and energy inefficient technologies as well as by provincial, city and district authorities. Through its LPIC links, the project then enhanced the local enforcement of such lists of prohibited technologies.

The use of formal co-operation Voluntary Agreements (VAs) between the TVE project, local government agencies (through the LPICs), relevant industry associations and pilot and formal replication sites proved to be very effective in China's TVE sector. The VAs facilitated tangible energy efficiency actions through a formal framework that coordinated global GHG objectives, national objectives and local environmental, employment and competitiveness objectives.

The project has clearly fostered a considerable number of independent energy efficiency self-replications that have been implemented without direct project funding support. These self-replications arose from the extensive technical training provided by the project, site visits and training provided by the pilot TVEs (including on a for-profit basis), project publicity efforts, the interest in energy efficiency arising from the project's pilot and formal replication results, and from the efforts of the LPICs to locally disseminate the technologies demonstrated by the project. These self-replications are estimated to account for around 30 million tons of lifetime CO_2 savings and an un-quantified but clearly large amount of co-funding. There also seem to have been self-replications in Bangladesh, India, and USA– but with also as yet un-quantified results.

The TVE project was large and complex, but with strong co-operation was successfully implemented in a period of dramatic technological, market and social change in China. As an example of the rapid pace of change in China during the project, most of the proposed pilot projects and technologies had to be completely updated or changed. For example, in the cement sector a third-generation of power generation plant has been developed and is in use only two years after the first formal first-generation pilot unit was installed by the project. This third generation waste heat recovery (WHR) plant is giving 50% more electricity output for the same capacity cement plants.

The project baseline needs to account for the huge rate of technological progress occurring autonomously (in the absence of the project) in China. There is no question that the project advanced the implementation of energy efficiency technologies in all four TVE sectors. However, much of the project's energy efficiency development and dissemination would have eventually occurred in the absence of the project. The project probably advanced the uptake of the relevant energy efficient measures by five years. With 907,000 tons/yr of CO_2 reductions, direct lifetime GHG reductions are around 4.5 M tons CO_2. Self-replication lifetime CO_2 savings are estimated at around 30 million tons. Co-funding achieved is in excess of $150 million. These are impressive figures for $8M of GEF funding and a co-funding target of US$10.55M. The project results also strongly supported the development of China's 11^{th} Five year Plan's 20% energy efficiency target.

The project had a challenging start and made numerous adjustments to evolving project circumstances and early implementation results. These adjustments have been critical to the project reaching and exceeding its design targets. The close UNIDO management of competitive bidding and implementation of 42 TVE project subcontracts has clearly been a major contributor to the project's success. The Ministry of Agriculture's (MOA) strong support has also clearly been a critical project success factor. The TVE project is clearly suitable for UNDP/ UNIDO and GEF promotion as a world best practice project in the rural industry/SME sector.

The evolution of the Revolving Capital Fund (RCF) mechanism into an entrustment loan facility (after considerable early implementation issues) was a logical and pro-active development. The RCF was very effective in leveraging US$25 million of co-funding from MOA and ABC compared with its $4 million target, even although the RCF funds were only 40% utilized. However, even a 40% utilization of a new funding mechanism is not unreasonable, as slow mobilization of new financing mechanism funds is very common in GEF projects. Post-project, the $1 million RCF funds are recommended to be used as a market-responsive revolving fund for the demonstration of new energy efficiency technologies in the four TVE sectors, with project risks reflected in the interest rate charged, and financial institutions beyond ABC able to be utilized as appropriate.

The focus and training arising from the attempts to implement the RCF fund provided the necessary capacity and motivation for both ABC and TVE enterprises to utilize non-GEF funding sources to implement energy efficiency measures in all the pilot/demonstration projects and formal replication projects. The GEF funding component was only 0.4 - 20% of renovation funding in the 8 pilots that were implemented. The pilot TVEs provided significant training assistance by hosting visits. The hosting of such site visits was a prime driver of the large number of independent self-replications, a highly useful outcome that was not specifically articulated in the design or funded by the project.

An issue that accounted for considerable management attention during the project was the evolution of the Production Technology and Product Marketing Consortium (PTPMC) co-operative energy management service delivery concept into the Hongyuan Company. In retrospect, the PTPMC concept was an over-ambitious concept, even at the time of project design. The effort and focus that went into trying to form a “club-ownership”, PTPMC was a distraction from a wider post-project sustainability perspective. Although Hongyuan was successfully established instead of the PTPMC, there will be many energy efficiency service providers operating in China who can continue the TVE project’s work in various ways. Hongyuan is unlikely to be the dominant contributor to post-project energy efficiency impacts as envisaged for the PTPMC. However, the formation and capacity building of Hongyuan has clearly produced a company with a promising long-term future.

The project identified that there are still very large untapped energy efficiency potentials in the four TVE sectors. In particular there is a major challenge remaining to update the more than 90,000 brick kilns throughout China that provide 95% of local rural construction materials. The energy efficient tri-arch Hoffman kilns demonstrated and replicated in the TVE project still need to be further developed and disseminated. There is also a need to introduce and prove the next brick-making technology, the tunnel kiln. The use of tunnel kilns would improve brick quality for increased insulation levels for the buildings using the bricks, as well as reduce the use of materials. There is also the potential to utilize heat recovery technologies for power generation in tunnel kilns by using industrial wastes of mixed partially burnt furnace coal and slag as a fuel and brick material. Simple access for such export electricity at fair technical and financial terms will be a key issue, as shown by the strong replication for export power from cement kilns where this support was available, and the lack of coking heat recovery power generation replication where such fair access was absent.

The PIC and LPIC policy support models used successfully in the TVE project are very relevant for similar future GEF projects, but are highly social, market development status, and political context dependant. Therefore, adjustment to local conditions will be required when promoting the China PIC and LPIC models to energy efficiency barrier removal projects in other developing countries.

There are useful lessons to be learned from the TVE project’s design and implementation regarding the desirability of having a more explicit focus on the overarching project purpose or outcome level, rather than on the achievement of a long list of specific project outputs. This project purpose focus could have included supporting self-replication projects and the quantifying their results worldwide; and on supporting and quantifying the co-funding achieved through ABC and TVE self-investment, rather than just focusing on the limited funding available from the GEF contribution to the RCF.

1. Project Introduction

China's township and village enterprises (TVEs) came into being from the 1950's onwards as rural, collectively owned entities established at the township and village level as a strategic component of the development of the rural economy. They also included the city branches of township enterprises. Overall responsibility for TVE administration and development rests with the Ministry of Agriculture (MOA). TVEs are still a major component of the Chinese economy, contributing significantly to the Gross Domestic Product (GDP), employing large numbers of people and contributing to social development, in particular in rural areas where there is a large amount of surplus labor available. By 2005, there were 22.5 million TVEs accounting for 143 million predominantly unskilled rural jobs in China.

TVEs currently provide more than half of the total output from the building materials (including brick), coking and metal casting sectors. However, it must be stressed that TVEs were originally established primarily to absorb surplus rural labor, to provide essential low cost products, and to contribute to improving livelihoods in local areas. TVEs originally relied heavily on direct interventions from local governments for access to resources and marketing opportunities. While the four sectors covered by the project still provide key inputs to China's economic development and have been a major contributor to China's strong economic development over the last 20 years, the level of technology utilized within them is still generally very low. Notably, these four TVE sectors account for one-sixth of China's total emissions of CO_2 and are also characterized by extremely high local pollution levels.

Based on the background situation for TVEs, as above, in 1994 the Ministry of Agriculture (MOA) - in cooperation with UNDP and UNIDO – developed the "Energy Conservation and GHG Emissions Reduction in Chinese TVEs" project. In early 1995, GEF approved this project and granted US$ 1 million in funding for its Phase I (implemented from 1998-1999). The positive Phase I results formed the basis of the current Phase II, approved by GEF in November 2000.

2. Project Design Overview

Phase II of the project was supported by a GEF grant of US$ 7.992 million and planned Government of China (GOC) and other co-financing (in-kind and in-cash) of US$ 10.55 M. In February 2001, Phase II of the project was launched for a planned four-year implementation period.

For the project, UNDP was the international Implementing Agency, UNIDO was the international Executing Agency, and MOA on behalf of the GOC was the domestic Executing Agency. UNDP and UNIDO have involved the project in their assistance program for China to help achieve their objectives to support sustainable industrial development in China.

The overall GEF goal of the project was to reduce greenhouse gas (GHG) emissions in China from the TVE sector by increasing the utilization of energy efficient technologies and products in the brick, cement, metal casting and coking sectors. The objectives of the project included: -

1) creating institutional mechanisms for barrier removal at the national, county and enterprise levels
2) establishing incentives and monitoring systems to strengthen existing regulatory programs at the county level
3) building technical capacity for energy efficiency and product quality improvement in TVEs
4) creating special access to commercial financing for TVEs in industries in the four sectors to undertake energy conservation and GHG emission reduction activities
5) commercializing the financing of TVE energy conservation projects
6) expanding the application of best practices for local regulatory reform to the national level

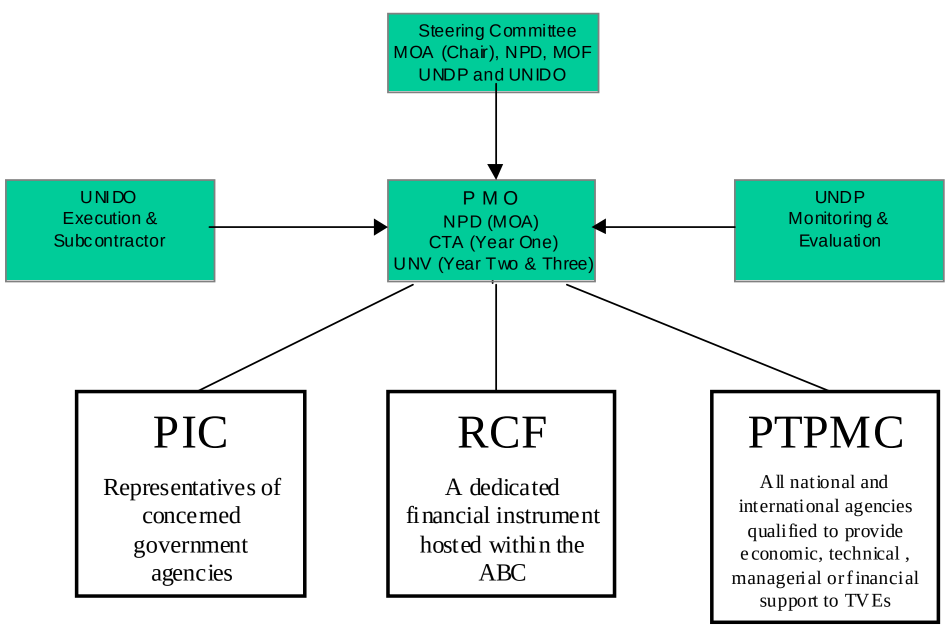
Based on the findings of Phase I of the project, the TVE Phase II project adopted a comprehensive, innovative and ambitious market transformation approach to promoting energy efficiency in the four TVE sectors. The two key elements of the TVE II strategy included building a sustainable barrier removal framework, and providing direct support to TVEs and local government agencies.

To overcome the barriers related to inadequate policies, techniques, markets and financing, the Phase II TVE project was designed to work through undertaking pilot projects in eight enterprises in the four industry sectors, and undertaking feasibility studies and detailed designs to underpin the duplication of the subsequent pilot project successes to at least 100 enterprises in 20 countries (out of a total of 2500 counties in China). The framework for overcoming the barriers comprised Policy Implementation Committees (PIC) at national, country and local levels, a Production Technology and Product Marketing Consortium (PTPMC), and a Revolving Capital Fund (RCF). The first step in building the barrier removal framework was for the project to establish barrier removal institutions covering 8 pilot counties. The institutions were designed to show the benefits of barrier removal in general by demonstrating how barriers could be removed in real-world applications in rural China. Then, based on the pilot experiences, the proven successful institutional structures and development approaches were to be replicated, expanded nationally, or absorbed into existing national and/or local institutions.

Several considerations were emphasized in the project's design, in particular: establishment of a financial mechanism, developing voluntary agreements with the larger TVEs, support to the small and medium-size enterprise (SME sized) TVEs, and addressing social issues.

The project had a planned wide and deep involvement of stakeholders, who came from relevant state and local governments, industry associations, financing organizations, research institutes, universities, private sector enterprises, NGOs, and international organizations and institutions.

The infrastructure scheme for the project management and implementation is shown below: -



3. Evaluation Methodology

The overall purpose of this final project evaluation was to provide an independent review of the TVE project's achievements, including the evolution of the project during its implementation to date. The evaluation also particularly focused on the issue of project sustainability - that is whether the project is on track to provide a rich legacy of results, approaches and institutions that are likely to persist and continue to provide positive project results after the project's formal completion (now scheduled for 31 July 2007).

Following evaluation best practice, two evaluators were chosen who were completely independent from the project's prior policy development, design and implementation. The evaluators provide a complementary mix of national and international experience, GEF experience, project evaluation and subject area policy and technical expertise. The evaluation is designed to meet the strong emphasis of UNDP, UNIDO and GEF on independent evaluation of all projects that they are involved in.

The key focus of the evaluation has been on examining evidence that the project had either achieved the outcomes and output results expected, or was achieving similar results from alternative new approaches developed during the project's ongoing evolution. With the rapid development of baseline technologies in the four target sectors in China since the project's inception, the evaluation has also been mindful that as far as practically possible the project's results should be compared to an adjusted project baseline. In other words, the evaluation must consider what would have been likely to happen in the absence of the project rather than just simply comparing the results to a frozen baseline. This is because, compared to a frozen baseline, many of the results would in due course almost certainly have happened, but just later on in time..

The evaluation adopted the following working approach logic: (a) Examine the overall aspects of the project's design and implementation through careful desk-review of the extensive project documentation produced; (b) Validate data and verify facts through interviewing key project stakeholders and selected site visits; (c) undertake in-depth analysis to underpin independent and evidence-based findings; (d) formulate and document evaluation results; (e) circulate draft evaluation results to key stakeholders and make suitable adjustments from feedback and suggestions received.

The evaluation makes use of two complementary analytical approaches. The first approach is output-outcome-impact analysis. The project's design, implementation and success were analyzed on the basis of project outputs, project outcomes, and linkages among outputs, outcomes and impacts. Such an analysis is instrumental in supporting the concept of results-oriented or results-based approaches in project design, implementation, evaluation and refinement. The second approach is to focus on the GEF-specific project design, implementation, monitoring and evaluation, and lessons learned. This analysis is based on understanding and utilizing the project design context and modalities for GEF projects, and reviews key issues of the project's design in its GEF context and its implementation in the context of the great changes in China's socio-economic development throughout the project's cycle since its inception in 1998/99.

4. Project Adjustments

4.1 Development and Policy Context

(1) National socio-economic development

China has experienced rapid and ongoing overall socio-economic development since the late 1970s. GDP in China has doubled in the last twenty years and is expected to double again in the next twenty years. However, the past high increase of GDP has been primarily driven by high labor, energy and of other inputs and resources, and has come at the cost of very high and widespread environmental pollution. In such a context, China is now aiming for more balanced and sustainable development by issuing and enhancing the enforcement of a wide ranging system of laws, strategies and policies on energy conservation, renewable energy development, integrated resource utilization and reuse, industry structure improvement, technical advancement, and environment protection.

To meet the high pressures on energy supply caused by inefficient energy use, China is both developing new energy resources and enhancing the conservation/efficiency of existing resources. Through adopting advanced techniques and industry structure improvements, the two approaches will decrease energy consumption and utilize currently wasted energy and resource streams.

Alongside this strong and enhanced energy supply and energy conservation focus, increasingly strict environment standards at both national and local levels, and their increased enforcement, are also driving the increased emphasis on cleaner production in industries. This step-by-step improvement in the enforcement of such standards is acting as a new driving force for enterprises to pursue low emissions and use currently wasted heat and materials in manufacturing processes.

Furthermore, the strong and continuing development of a more market-oriented economy in China offers enterprises both opportunities and pressures for them to reduce the consumption of energy and other resources to reduce costs, improve quality and enhance profits.

With China's ongoing socio-economic development, more and more Chinese people - not just decision makers, scientists and experts - but also entrepreneurs and the wider public, also have a growing awareness regarding environment issues, including climate change issues. People want to contribute individually and collectively to improved local and global environmental conditions. This new trend has proven to be very supportive of the TVE project's activities and outcomes.

(2) National industry development technical updating and structural improvement policies

To improve wider industry development approaches, and also to enhance industry technical capacities, China has issued a wide range of national, regional, district and local industry development policies. In 2000, a national catalog was updated on the industries, products and techniques that were to be encouraged in the future. In 2004, this catalog for phasing out backward production capacities, products and techniques was replaced by a newly issued national catalog (by the powerful and influential NDRC) for guiding China's improved industry structures.

The principles followed in updating these catalogs included considerations such as: market conditions and potentials, improving technical levels and standards, improving product quality, recycling currently wasted energy and other resources, enhancing environmental protection, utilizing regional comparative advantages, improving safety in production processes, generating greater employment, and so forth. For a number of categories in the new catalogs, new investment is forbidden and various measures are then undertaken to stop existing production in these forbidden categories. The TVE project has successfully worked with central decision makers to include the newly proven energy efficiency technologies in the categories of encouraged technologies, and to have outdated and superseded technologies included in the forbidden categories. In China, this is a powerful strategic approach to improve energy efficiency, step-by-step over time.

(3) Financial environment and development policies

In the early 1990s, a large number of stock investment funds were created in China. Some of these funds experienced a bumpy development process from their often-irregular establishment, governance and operations and their often-problematic property and other asset quality. Therefore, from the late 1990s China more closely regulated the development of such funds. The new policies strictly limited the establishment of not only new stock investment funds but also other new kinds of investment funds. This impacted on the development of the TVE project's RCF as originally proposed, and led to its subsequent evolution into an entrustment loan facility instead.

4.2 Project adjustments

The project document for the original project design stated, that "Given its innovative nature, the barrier removal framework will be subjected to constant monitoring and, if necessary, modification". As anticipated, the subsequent project adjustments were considerable, and they can be summarized as follows:

(1) RCF

The tripartite annual meeting at the end of 2002 approved that the RCF be adjusted from a "fund" to a "mechanism". Such an adjustment was based on the then current state policies of China on the establishment of new sector funds (as indicated in section 4.1 (3) above) and on the fact that the amount of capital involved was small. In October 2003, UNDP, UNIDO, MOA and the Agricultural Bank of China (ABC) signed a memorandum of understanding and approved the establishment of the revised RCF financing mechanism, which consisted of an entrusted loan (US$ 1 million from the TVE project's GEF grant), a commercial loan (US$ 2 million from ABC) and a capacity building fund (US$ 1 million from MOA). The entrusted loan was managed by Hongyuan Company and the subsequent commercial loans were allocated through the relevant local branches of ABC.

Under the framework of the RCF financing mechanism as established, the capital amount of the entrusted loan could not be enlarged, but TVEs could easily apply for and receive separate commercial loans without limit from ABC. The RCF mechanism was designed to bring about the necessary specific financing resource to support the pilot and replication energy conservation and emission reductions in the four industry sectors of the project. In parallel, the wider banking system in China was also becoming increasingly interested in making commercial loans to TVEs as they sought new business opportunities in an increasingly competitive banking marketplace.

(2) PTPMC

Following the restrictions from China's state policies and regulations on registering new non-government organizations once the TVE project was underway, the club-ownership PTPMC concept (as originally designed) had to be replaced by a new support concept. Therefore, a commercially focused Hongyuan Company (Hongyuan) was established in July 2003 to play the role of, and to substitute for, the functions envisaged for the PTPMC. To ensure that Hongyuan could develop itself, in a learning-by-doing approach, to establish its ongoing commercial operation during the project's operational period, UNIDO signed a contract with Hongyuan for it to provide a wide range of services related to the project's implementation.

(3) Pilot project enterprises

During its Phase I (1998-1999), the project screened eight enterprises for pilot energy efficiency opportunities to be undertaken in Phase II. Due to poor financial conditions and backward techniques in some of the proposed pilot project sites, as well as China's state policies for updating industry development and for enhanced environment protection, five of the proposed pilot project sites turned out to be unable to meet the criteria for pilot project selection once the TVE Phase II project was underway. Only three of the eight originally screened enterprises were eventually utilized as project pilots. Since 2003, six new pilot enterprises were chosen by utilizing the screening procedure and they were substituted for the original five pilots that could no longer be used (noting that one of the revised nine pilots now seems unlikely to be implemented).

Though those new pilot enterprises joined the project activities at a late period, eight out of nine worked effectively and satisfied the project requirements.

(4) Pilot project technologies for the four TVE Sectors

As introduced in section 4.1, when Phase II of the TVE project was launched at the end of 2001, China had in the meantime (since the TVE II project design phase) upgraded the state industry policies that the project had to take as its reference point of allowable technologies, especially in the cement and coking industries. For example, "1989 Type" coking ovens and shaft cement kilns were now in the National Development and Reform Commission (NDRC) catalog as technologies to be phased out. Therefore, the originally selected energy efficient technologies for these sectors had to be updated at this point. Through adjustment, residual heat power generation techniques based on "Clean Type" coking ovens and new dry process rotary cement kilns replaced the previously proposed and now superceded coking and cement project technologies. Similar adjustments were required for all the pilot technologies involved in the project. This means that the project results cannot be directly compared against the originally envisaged technologies, but rather need to be compared against the technologies that represented current practice in the absence of the project at the time the technical renovations were designed and the changes actually happened. So, for example, the energy efficient upgrades in the brick making pilots would probably not have happened without the project, whilst for cement and coking pilots the heat recovery technology would probably have been introduced in due course without the project. In most cases, a large component of the formal and informal replications that were actually implemented can clearly be attributed to the project as being accelerated compared to the baseline.

4.3 Barrier analysis and removal design

In the project design, four types of barriers were identified to be removed: policy barriers, technology barriers, market barriers and financial barriers.

In the original project design, the barrier-removal activities were almost completely concentrated on the 8 pilot/demonstration level projects and the eight county-level LPICs. Thus, the project design envisaged that the pilots/demonstrations were in themselves to be the trigger for wider further mass energy efficiency actions across the four TVE industry sectors. Further, 100 feasibility studies and detailed designs were envisaged to be undertaken to foster downstream replications, rather than being envisaged to lead directly to concrete replication implementation actions. The need for firm project replication action linkages was then introduced into the adjusted TVE project design following new national policies in 2001 and 2002 which were launched regarding TVE development, technology upgrading, finance and so forth. This was a major and very positive project enhancement.

Large-scale tangible replication actions could only happen when mass independent or self-replications were initiated. The need for, and means to achieve, such widespread self-replications, would normally be explicitly covered in the "sustainability" related sections in a project design. This was not included in the TVE II project design. This caused later problems in the monitoring of such self-replications.

In practice, such project independent or self-replications would need to have been supported by the following elements: (a) a socio-economic situation that supported self-replications; (b) suitable identification of barriers; (c) suitable mechanisms such as LPIC, RCF and Hongyuan and so forth to remove these barriers; (d) strongly enhanced capacity building and public awareness; and (e) monitoring of the self-evaluations in China and in other countries.

It is a credit to the project's implementation that the components of the necessary enabling environment, capacity building and concrete actions were well organized. The biggest contribution of the original plan and the adjusted project design to the self-replications was the formulation and implementation of effective PIC and LPIC mechanisms.

4.4 Risk analysis and management

In the project design, seven potential risks were identified and their expected risk levels were listed: insufficient project integration (medium); insufficient policy reform (medium–low); insufficient replication (medium-low); insufficient commitment to replication from pilot TVEs (medium-low); co-financing cannot be arranged (low); poor TVE performance after project implementation (low); and poor loan repayment by TVEs (low).

In retrospect, from the risk identification and risk analysis perspective, there were two problems with the treatment of project risks in the project design. Firstly, the main focus was on the potential risks within the project's working scope itself, and the risks from the supporting environment for the project's implementation were ignored. Secondly, measures for dealing with such supporting environment risks were not explicitly included in the project design. The lack of identification and analysis of such potential risks left the project unprepared for when the necessary adjustments needed to be made during project implementation. For example, on the risk of "insufficient policy reform", the analysis in the project design stated "Governments across China are looking for ways to reform. However, inertia and local pressures may sometimes slow reform." This analysis did not consider the emergence of new driving forces within China that might speed up such reform efforts, and hence cause project delays from superseded technologies in the project design that would no longer be able to be used. Therefore, the project had to make considerable unexpected adjustments to adapt to the unexpected supporting environment changes.

4.5 Project outputs and relevant activity design: mechanisms, demonstration and replication

In the original project design, the key barriers that block energy conservation in TVEs were correctly identified. Mechanisms and activities for barrier removal were designed that were appropriate for the socio-economic development circumstances of that time. During the early period of the project's implementation, useful progress in barrier removal mechanism establishment, demonstration and replication efforts were achieved before 2002-2003 when the abrupt changes appeared in socio-economic development circumstances. The adjusted project design was clearly very successful in adapting to such an abrupt change by practically adjusting and thus enhancing the project's implementation in terms of barrier removal mechanisms, pilot project technology identification, demonstration and replication approaches. The successful adjustment of the project design illustrates the value of a "results-based" project design and implementation approach over simply continuing to follow a long list of activities and outputs, even if they are increasingly irrelevant, that frequently occurs in such projects.

4.6 Project outcome design: self-replication and sustainability

In the project design description detailing the rationale for GEF funding assistance, there is an explicit expectation that the project will lead to wider sustainability of the technologies demonstrated in the pilots, as expressed by "The potential for nation-wide energy conservation and CO_2 reduction in the four TVE industries will be more than 1,000 times more than those that will be achieved in this project. This replication potential justifies the establishment of a barrier removal framework that will be self-sustained after project intervention". However, since the project was originally designed as an activity-triggering modality, rather than a direct impact replication approach, the project design did not contain very clear considerations regarding how the self-replications were expected to occur, nor the need to explicitly track and monitor such self-replications. With the positive adjustments made during the project implementation (in particular to ensure that 101 of the 118 formal replication project were actually implemented (with the implementation of another ten projects apparently underway, rather than 100 feasibility studies and detailed energy efficiency measures' designs just being undertaken), alongside rapid and positive changes in the social and economic situation in China, the project clearly facilitated a large number of, and impact from, self-replications. So the self-replications were a strong TVE project success factor, but remained largely un-monitored and un-quantified, largely because this element was not included in the original project design and was not subsequently added during the project's implementation phase. However, it seems almost certain that self-replications will continue after the project's formal end on 31 July 2007. The sustainability of the TVE project's LPIC mechanisms after the project will be a key factor in achieving ongoing self-replication sustainability post-project. This will require strong and ongoing post-project coordination support at the national, province, district and local government levels.

5. Policy Contributions

In the project design, there was no specific expectation that the project would directly support relevant new policy developments and enhancements. However, due to energetic and well-targeted PMO, PIC and LPIC activities, adjustment of selected pilot project techniques, and the success of the pilots – the project supported significant energy efficiency policy developments at both national and local levels. Specific examples include the following: -

The project conducted the first systematic energy survey since 1984 on TVE development in the cement, coking, foundry and brick industries. This survey proved to be a solid basis to support MOA in its establishment of the 10-Year National Plan on TVE Energy Aspects.

For the cement industry, the successful pilot of power generation utilizing residual heat from the new rotary kiln process facilitated the promotion of this technique in China. A preferential policy to this effect has been issued in Zhejiang Province, and seems to be effectively applied as well. Furthermore, in the Mid and Long-term National Conservation Plan issued by NDRC in December 2004, this technology is now on the list of encouraged techniques. Experts from the TVE project were involved in developing the relevant part of the NDRC national plan. More than 30 cement enterprises a year are now apparently adopting this new waste heat recovery (WHR) electricity generation technique. The provincial preferential policy's simplified grid access at fair technical and financial terms seems to be a key success factor in this sector.

For the coking industry, partly due to the successful pilot project, the innovative "Clean Type" coking oven technique has been listed in a national program for industrial sector technology improvement. The government of Shanxi province (the dominant coke producing province in China) is promoting both this type of oven and residual heat power generation, but does not yet seem to have considered or implemented the necessary positive grid access for export power.

For the brick industry, the successful hollow brick pilot demonstration, and the launching and support of replication efforts, has greatly supported the enforcement of the national policy on forbidding production and utilization of solid clay bricks. Upon the recommendation of the local brick association and the TVE project's LPIC members, the government of Chengdu, Sichuan Province has now speeded up the taking of firm steps to enforce the ban on the production and use of solid clay bricks in the local brick market.

The largest policy contribution of the project has been in its results being used to support the implementation of national strategies and policies, promulgated by the central government, which are then implemented in regard to provincial, district or county level conditions. For example, the central government issued the national "Eleventh Five-Year Plan" development plan (for the period 2006-2010), with its strong emphasis on the objective of "Energy consumption per unit of GDP to be reduced by 20 percent in five years", and in which "Building the New Socialist Countryside" was also one of the national development strategies adopted for China. The specific policy contribution cases of the TVE project supported the formulation of national development strategies and policies, and for their subsequent implementation in relation to local circumstances.

The project raised a fundamental issue of the need to collect and validate energy consumption, energy efficiency gains achieved, and hence GHG emission reductions by TVEs or SMEs. The TVE project's mid-term evaluation report suggested that the project needed to quantify the number and impact of the TVE project's self-replications. However, monitoring and evaluating the number and impact of such self-replications would not be simple as there is no solid statistical baseline to compare the self-replications against to see if they are representative of the wider population of TVEs in terms of energy use, production, or product quality. For example, if the self-replications occurred in higher than average specific energy consumption TVEs, then it would call into question the replication potential and impact for the wider population from the pilot projects. The issue raised is very important for the gathering and compilation of high quality national statistics on the energy consumption for industrial enterprises, especially for TVEs and SMEs. In China, there is no energy consumption auditing system for TVEs or SMEs to provide the necessary energy end-use data. The lack of such high-quality energy end use data is likely to present challenges to the successful implementation of the national development plan in regards of energy consumption and energy conservation, and also make it harder to quantify China's contributions to global environmental improvements.

The project also had a positive impact on social development in China. The outcomes of the project contribute to the alleviation of poverty by creating new employment opportunities and improving the livelihoods of rural people, including for rural women. In the process of industrialization and urbanization in China, more and more rural male surplus labor is going to urban areas for work and there will be a need for new forms of local labor to work in rural industries such as TVEs and also make a greater contribution to local rural development. Energy conservation efforts speed up the improvement of working conditions (as shown in the pilot enterprises and replication enterprises' results in the project, but currently without specific statistics to quantify this effect) in TVEs that traditionally operated with very poor working conditions, and thus energy conservation efforts assist TVEs to hire more rural women.

In summary, it is clear that this project has made concrete contributions to the implementation of the national policies on energy conservation, and the development of the energy efficiency aspects of China's "Tenth Five-Year Plan", "Eleventh Five-Year Plan", and the "New Countryside" national development strategies.

6. Market Transformation Context and Results

Coking Sector

Coke is a solid carbon based material primarily used in foundries and steel making that is traditionally derived from the high temperature heating of low-ash, low-sulfur bituminous coal. Traditionally, coking plants are large and heavily polluting industrial plants that are either stand-alone or integrated with steel works. China is a major coke producer and exporter. The TVE project supported the Gaoping Xinggao pilot coking plant in Shanxi Province as a pilot demonstration project. The Xinggao plant has demonstrated the successful use in China of the new clean-type coking technology with heat recovery being used for electricity power production (the clean-coking technology was apparently first demonstrated in the US in 1997). The project has also apparently been the first in the world to extend the use of this technology to successfully use the harder and more carbon intensive anthracite coal instead of the more traditional coking coal which contains more tars and less carbon (bitumen producing = bituminous (coal)).

Seven replication coking plants already using clean-type coking ovens were financially supported by the TVE project and have completed feasibility studies and detailed designs for adding power generation heat recovery plants. However, it would appear that the projected 765,000 tons CO_2/year reductions from heat recovery power generation plants for these seven sites has not yet been realized, nor is it clear exactly if or when these are in fact likely to occur.

It would seem that around 50 clean-type coking plants have been independently (of the TVE project) built in China, with their construction strongly influenced by the success of the Xinggao plant. It is unclear what proportion, if any, currently use heat recovery from coking exhaust gases for power generation. The apparent lack of policy support for simple and fair grid access for export electricity and the self-use of generated electricity would seem to be a key negative factor.

The replication of the heat recovery for power generation technology from clean-type coking plants is lower than it would otherwise have been due to the currently limited construction in China of new coking plant arising from the recent significant coking production over-capacity. This will slow down the formal and self-replication of this technology in the short term. It is probably realistic to assume that these formal replications will eventually take place as part of the wider self-replications assumed to occur once the coking over-capacity is used up from a combination of coking demand growth and retirement of the most polluting existing mechanical oven coking plants. Fair and supportive grid access issues will also need to be addressed.

Concurrent with the coking production overcapacity in China, a high-level policy debate is apparently still underway as to the continued use of traditional mechanical coking plants. On the positive side, mechanical plants enable the recovery of coal chemicals (coal liquids and gases) that are produced from the use of traditional bituminous coal. These coal chemicals replace expensive fuel oil used in industry and add to oil security, which is an issue of considerable focus in China. On the negative side, mechanical plants intrinsically tend to be highly polluting as well as requiring considerable amounts of water. In contrast, the clean-type technology plants run at negative pressure, use less coal to produce the same quantity of coke, and produce essentially no local pollution. The clean-type technology burns up the coal liquids and gases, and can then use the resulting hot coking oven exhaust gas to generate electricity. In Xinggao's case, the use of the locally available and lower local cost anthracite (hard) coal meant that production of significant coal chemicals was not viable in any case. Most new coking plants being built worldwide are now of the clean-type technology. The clean-type technology also supports the use of flue gas cleanup equipment that can remove nearly all of the dust, ash, and eliminate the sulphur emissions that are normally associated with coke production. It is not clear what percentage worldwide use of clean-type coking plants use heat recovery power generation, or what level of steam turbine entry temperature and hence steam turbine efficiency is common.

The Xinggao plant uses a patented technology to produce metallurgical and foundry grade coke from anthracite coal. The plant was built on the site of a bankrupt metal-casting plant, and employed and supported the pensions of the former metal casting plant workers. Xinggao greatly benefited from a TVE project facilitated voluntary agreement with local stakeholders, and was supported by low interest loans and land access assistance from the very supportive local government, which has welcomed new clean industries and closed many polluting local industries. The Xinggao plant received US$100,000 funding from GEF out of the total US$9 million investment required for the 15MW waste heat power plant. The Xinggao plant was designated by the State Economic and Trade Commission (SETC, now incorporated in NDRC) as a key national technical renovation project. The "clean-type" coking oven and waste heat power generation technology has been listed by the Shanxi (the main coke producing province in China) government as the key encouraged technology in the coking industry.

A further clean-type coking plant of Taiyuan Guangyuan Coking Co (also in Shanxi Province) was identified as a suitable (ninth) pilot for the TVE project, was supported with US$100,000 of GEF funding, had a feasibility study successfully undertaken, and had an initial power generation plant design completed. This project has apparently not yet proceeded to construction, partly due to the company's management not considering the wider local pollution control and other benefits of the renovation and partly due to their ability to earn a high return by investing in other areas, such as real estate. Grid access issues are also probably another negative factor. This shows the need for careful screening of proposed pilot project management's engagement in energy efficiency measures, an area where the TVE project was otherwise very successful.

The TVE project's Gaoping Xinggao coking pilot plant has successfully demonstrated (in technical and financial terms) heat recovery power generation for clean-type coking plants in China. In addition, the Xinggao coking pilot plant has no visible pollution from any aspect of its operation when one visits its site. This is because, in addition to the lack of coking oven pollution, the waste heat recovery facilitates the use of desulphurization and ash removal from the coking oven waste gases over when the gases are just discharged at high temperature, as is the normal situation with clean-type coking ovens without waste heat recovery.

Xinggao has also achieved a nearly 20% improvement in power output per level of coking production over its initial design, from a range of heat recovery process refinements. In addition, for the next generation of clean-type technology coking plants, probably around 50% higher electricity output could be achieved for the same capacity with further design, equipment specification and operational improvements, in particular by utilizing higher temperature steam turbines to better utilize the high temperature of the recovered waste heat. This would then give approximately double the electric power output per unit of coke to that originally achieved at Xinggao. However, to obtain this extra output would apparently require an update of the relevant Chinese standard for small boilers and turbines to enable them to operate at higher temperatures, and then would require an upgrading of the Chinese small steam turbine technology used in coking plants. There also seems to be an issue that as the first adopter of the technology Xinggao would understandably have wanted to utilize an affordable and locally supported Chinese steam turbine and generator set to lower its risk. Higher prices for export power would also help in moving to such a higher technological level.

The Gaoping Xinggao clean coking plant has, independently of the TVE project, provided commercial training for students from 14 coking plants from eight provinces in China on the operation of modern clean coking plants. Ten Indian coke making companies have visited Xinggao to study its processes, and three have paid Xinggao to train their staff. There has also been considerable publicity generated by this pilot, and Xinggao clearly has worked hard at generating publicity and providing training on the technology that they have successfully demonstrated, This Xinggao publicity and commercial training seems to have been the single most important factor behind the large and highly significant (but as yet still un-quantified) self-replication potential of this clean-type coking technology, which in turn seems likely to eventually be the single largest energy efficiency, GHG reduction and local pollution reduction impact achieved by the TVE project.

In 2007 Xinggao's GHG reductions are expected to be 105,000 tons CO_2/year from its projected reduced 350,000 tons of coke production, compared to its design 115,000 tons CO_2/year reductions at its rated 400,000 tons a year coking capacity. There are plans to increase the Xinggao coking capacity to 800,000 to 1 million tons/year once the surplus coking capacity in China is used up or sufficient old plants are closed, at which point the CO_2 reductions would be around 230,000 tons/year if the power generation plant used another identical 15MW condensing steam turbine with a 420℃ entry temperature as is currently being used (the coking oven waste gas is 850-1050℃ (depending on coking oven output levels) which is compatible with modern steam turbines which can operate at over 550℃ turbine entry temperature). It is unclear what percentage of the around 50 clean-type coking plants that appear to be in operation in China use "clean-oven" heat recovery to generate electricity, nor is it clear what their steam turbine entry temperatures are, or are proposed to be.

The Xinggao Clean Coking pilot has attracted considerable international attention, with hosted visits for Australian, German, Iranian, Japanese, Ukrainian, and US coking experts. A joint venture is apparently underway between a leading German coking oven design firm and Xinggao to introduce clean-type coking to Brazil, through a 2 million tons/year coking plant using the Xinggao pilot plant technology. So there seems to be a significant Chinese and worldwide market transformation self-replication impact underway from the China TVE project, although this is as yet still unquantified.

A key factor that would support the potential for higher electricity generation output would be the existence of much more realistic (higher) electricity export prices, as well as coking plants being allowed to directly utilize their own generated electricity. At the moment, the local grid for Xinggao apparently insists, as a connection requirement, that 100% of the electricity generated has to be exported and any plant electricity use then needs to be imported from the grid at 2.5 times the price that the local grid pays for the export electricity. This would seem to be an abuse of local grid market power and the exercise of anti-competitive behavior. This is an area where further national policies and enhanced control of local electricity grid connections for small clean Independent Power Producers (IPPs) seems to be indicated.

Xinggao has also demonstrated the economic, technical and social viability of export electricity sales from coking plants. Electricity sales now make up around 8% of Xingao's revenue, in spite of an electricity export price which is less that 40% of the grid electricity supply tariff (as above). There is a strong interest in the TVE project's demonstrated clean-type coking plant heat recovery power generation technology.

Many of the coking plants still used in China are very old, highly inefficient and extremely polluting. Now that a modern clean coking technology has been successfully demonstrated at Xinggao and has already apparently been successfully self-replicated, and given the growing positive policy environment and growing enforcement to remove the oldest and most polluting plants, the enabling environment is very supportive of ongoing market transformation impacts after the end of the TVE project. The ongoing development of capital markets in China also means that coking companies now find it easier to raise funds for technical renovations such as the use of clean-type technology to generate and export electricity from recovered waste heat.

A 25% market share of the clean-type coking technology with electricity generation seems realistic in a, say, 5 year period once the current coking overcapacity no longer overhangs the industry (including from local-policy led closure of the most polluting existing mechanical coking plants), once the policy issue of using clean-type plant instead of mechanical plant is resolved, and once fair access to grids for export power and the ability to utilize self-generated power directly is addressed. Supporting this 25% market share assumption, it is apparently proposed that the Shanxi Provincial government introduce a policy by 30 December 2008 that all clean-type coking plants will have to use waste heat power generation to be allowed to continue operation.

So a realistic self-replication GHG reduction potential of the TVE project's electricity generation from clean-type coking technology in China is probably at least 10 millions tons of CO_2/year, given that China's coke production was 233 million tons in 2005 and that TVEs account for more than 70% of the total output (and 350,000 tons/year of coke output at Xinggao already gives 105,000 tons/year CO2 reductions from the first generation of this technology). This potential could usefully be investigated in more depth alongside quantifying what level of GHG reductions is underway from self-replications, and the degree of attribution that is reasonable to the GEF UNDO-UNIDO-MOA TVE project. In the meantime, a one year attribution of the eventual self-replication CO_2 savings to the TVE project is probably a reasonable estimate, and gives 10 million tons of lifetime CO_2 reductions as attributable to the TVE project.

Cement

China accounts for nearly 50% of world cement production and demand (in 2004 cement production was 934 million tons in China out of 2,130 million tons produced worldwide[1].

Cement manufacture causes significant environmental impacts at all stages of the process. In particular, these include the need for large energy inputs (in China primarily from coal) during cement manufacture, and the release of dust from mining and cement plant operations (the dust production depends on the degree of clean up provided). Cement manufacture contributes about 5% of global anthropogenic CO_2 emissions. Cement is primarily manufactured from limestone to produce clinker which is then ground and mixed with other materials to give Portland or other types of cement. Cement manufacture can also use wastes from other industries, including slag from steel manufacture, fly ash from coal burning, silica fume from silicon and ferrosilicon manufacturing, and recycled concrete from demolition of older structures. The most common use for cement is in concrete with the addition of aggregate (gravel and sand) and water.

In 2003, there were 4,700 cement producing plants in China, primarily serving local markets, although this number is shrinking as smaller plants are closed. In 2003, more than 83 percent came from small producers that average less than 150,000 tons annually, compared with the world average of 600,000 tons a year per producer. These small producers use small output mechanical shaft kilns which have a high energy use per output, whereas more than 90% of output in developed countries is produced by larger capacity modern rotary kilns.

When the TVE project was formulated and designed, the mechanical shaft kiln was the predominant cement making technology being used in China, and hence the early energy efficiency technical renovations were envisaged to be applied to mechanical shaft cement kilns. However, as the TVE project was developed and implemented, there was a parallel shift to the introduction of the lower energy using and higher output new dry process (NDP) rotary shaft kilns in new and retrofit cement plants, a process of cement plant rationalization to fewer and larger cement manufacturing plants, upgrading of shaft kilns (often of less than 1000 tons/day output for a plant with multiple kilns), and replacement of shaft kilns with NDP kilns of 1000-5000 tons/day (there are only three lines in China and seven in the rest of the world that produce over 10,000 tons/day as this 10,000 tpd output is close to the current practical mechanical limit for NDP rotary cement kilns). In addition, when the TVE project was being implemented, 5-stage pre-heater NDP kilns were being developed and introduced in China as it caught up with world best practice in the design of NDP rotary kilns. Such 5-stage pre-heater NDP kilns give a lower pre-heater exit temperature for WHR, and hence are more efficient in terms of cement production, but need to use improved WHR technology compared to the previous 4-stage cyclone pre-heater kilns that were the previously highest technological level cement kilns used in China.

The TVE project's pilot demonstration Zhejiang Shenhe Cement Co. Ltd kiln 5-stage cyclone pre-heater WHR and power generation plant recovers waste heat from the kiln outlet cooler and inlet pre-heater through a waste heat boiler and uses a steam turbine to generate electricity from the otherwise rejected waste heat, with no added fuel being used. Shenhe started producing cement in 1975 using a 100 ton per day (tpd) indigenous technology plant. The plant updated to a 300 tpd mechanical shaft kiln in 1990, and added a 600 tpd shaft kiln in 1995. In 1998 Shenhe was converted to a private company, mostly owned by its former managers. In 2000 Shenhe added a 1000 tpd rotary NDP kiln, and in 2003 a 2500 tpd rotary NDP line was added.

The Shenhe WHR and power generation plant was designed by the Tianjin Cement Industry Design and Research Institute independently from the TVE project. The Shenhe plant was the first

[1] See http://www.indexmundi.com/en/commodities/minerals/cement/cement_t22.html

in China to use a 5 stage cyclone pre-heater at its time of introduction. The Shenhe WHR pilot project cost US$2.5 million, with $100,000 coming from GEF and the rest being funded by Shenhe Cement Co. The first generation cement WHR power generation unit designed in 2004 and as used at Shenhe on its 2500 tpd NDP line achieved 26-28 kWh/ton of clinker and saved nearly 19,994 tons of CO_2/year from replacing electricity from coal fired power plants. The third-generation cement 5 stage cyclone pre-heater with WHR plant designed by the Tianjin Cement Industry Design and Research Institute is expected to produce 35-38 kWh/ton of clinker. A third generation WHR and power generation plant is currently in the process of being installed at the Shenhe 1000 tpd NDP line. This WHR and power generation technology is now being applied to 1000-5000 tpd NDP cement plants.

The formal replications and independent self-replications of the Shenhe project results were greatly assisted by national and local policy support, in particular from NDRC listing the NDP WHR and power generation technology as a key encouraged technology under the 2004 "National Mid-long Term Development Plan for Energy Conservation". Under a new national policy under NDRC decree [2006] 1457 the technology is in principle mandatory in new NDP kilns of over 2,000 tpd. The technology also benefited from strong local policy and practical support from free grid connection and simplified approval processes from the Province of Zhejiang. The Shenhe WHR plant is very profitable as the export electricity is being sold to the grid at 0.5RMB/kWh, which is above the off-peak retail tariff of 0.4 RMB/kWh. Zhejiang province has 247 cement companies which used to have 730 shaft kilns in operation, with 696 apparently being already closed down by March 2007. All Zhejiang's shaft kilns are expected to be phased out by the end of 2007. In March 2007 Zhejiang Province apparently had 81 rotary/NDP kilns in operation, with 29 having WHR installed. Zhejiang plans to introduce WHR recovery to more than the national target of 40% of NDP kilns, which seems realistic given the necessary export power support mechanisms in place. Zhejiang Province produces 100 million tons/year of cement (which is more than that produced in the entire USA). The Shenhe project's successful implementation was assisted by the support of one provincial level LPIC and one city level LPIC. More than 100 cement entrepreneurs have visited the Shenhe plant, as hosting site visits was a pre-condition of obtaining TVE project GEF funding support.

The Tianjin Cement Industry Design and Research Institute apparently accounts for around 70% of cement kiln designs in China and is also apparently involved in around 14 different contracts in other countries including Germany, Pakistan, Turkey, and Vietnam. Once the effectiveness of the Shenhe WHR design was proven, it was replicated in 10 further plants in China under the TVE project. Apparently a number of cement plant design competitors to the Tianjin Cement Industry Design and Research Institute are now also offering 5 stage cyclone pre-heater NDP rotary kilns with WHR power generation designs.

The TVE project also undertook a further pilot demonstration of 16 energy efficiency technical renovations on Hubei Huangshi Lufeng Cement Co's three mechanical shaft kilns with 500,000 tons/year cement annual capacity. Energy efficiency gains of 15% were achieved, giving CO_2 reductions of 22,509 tons/year.

For the TVE project's third cement pilot demonstration, at the Guangdong province's Yingde Baojiang Cement Material Co Ltd, the existing two shaft kilns with a combined Portland cement output of less than 1000 tpd were replaced by a more modern and energy efficient 2500 tpd NDP line, saving 29,581 tons/year of CO_2 over the old shaft kilns, at a similar output level. The Yingde plant now operates at 0.11 kg of coal per kg of cement. This is very impressive as it seems that the world best practice for cement manufacture is 0.10 kg coal used per kg of cement. It does not seem that the generation of electricity from waste heat is common in cement plants in other countries[2].

[2] See http://www.indexmundi.com/en/commodities/minerals/cement/cement_t8.html

Twenty formal replications of the WHR power generation technology were supported by the TVE project, with eight already implemented and one under construction. The calculated CO_2 savings of these nine cement formal replication projects is 494,000 tons/year (out of a total of 1,031,000 tons/year total potential calculated savings for all twenty formal replication projects). The remaining eleven cement plant WHR formal replications of the TVE project should go ahead in due course, with three projects accounting for 129,278 tons/year CO_2 savings seeming to be very promising in terms of replication in the short term.

There are apparently around 600 rotary NDP kilns in operation in China. Around 40 self-replications are apparently known to be underway, with almost certainly more underway that are not known, with some estimates by TVE project sub-contractors that as many as 400 cement WHR power generation self-replications were likely. It is planned that at least 40% of all NDP rotary kilns will adopt the WHR recovery in the next 5 years. There are also apparently self-replications (using the NDP WHR technology demonstrated at Shenhe) underway in 2 cement kiln lines in Turkey, 3 lines in Thailand and one in the USA. Just considering China's NDP WHR impacts (i.e. ignoring the project initiated gains from the shift from shaft kilns to NDP kilns, energy efficiency improvements at shaft kilns, and impacts in other countries), this would suggest self-replication CO_2 savings of 6 million tons of CO_2/year if the average NPD kiln produced 2,500 tpd of clinker and third generation WHR plants were used on 40% of the 600 NDP lines and they produced 35-38 kWh/ton of clinker. If the TVE project was assumed to accelerate the introduction and subsequent market transformation of WHR 5-stage cyclone pre-heater kilns by 18 months over what would have happened in the absence of the project, then lifetime GHG reductions of 10 million tons of CO_2/year could realistically be attributed to the TVE project.

Brick Making

Bricks are estimated to account for around 95% of wall materials used in rural areas in China and 80% overall. This demand for bricks is expected to increase as China's "New Socialist Countryside" policies are implemented to spread the economic gains of China from urban and coastal areas to the countryside - where the majority of people still live in generally small and poor insulation and low quality buildings. There are over 90,000 brick making plants in China making around 850 Billion bricks per year, of which 50% are used in rural areas. Brick making plants serve local markets with low priced and generally low quality products. Brick making accounts for around 70 million tons of coal consumption per year (leading to 170 million tons of CO_2 emission per year), causes considerable local pollution from inefficient brick firing, and causes significant degradation of scarce farmland as fields are dug up for the clay that is the main brick making raw material.

Fired solid clay bricks are a traditional construction material in China, and have been in use worldwide for around 5,000 years[3]. Solid clay bricks are easy to make in inexpensive local plants using surplus rural labor. In addition to their higher energy use and greater degradation of scarce farmland, the use of solid clay brick also causes high winter heating and growing summer building air-conditioning demands from their extremely poor insulation values. This long term increase in energy use in buildings is probably more important for energy use and GHG emissions than their extra energy and GHG emissions from the brick firing. The central government in China is therefore trying to ban the use of solid clay bricks and instead shift brick production to hollow clay bricks with higher and higher perforation rates, as well as bricks made from other materials such as shale rock and industrial wastes – these are expected to account for more than half of construction bricks by 2010. Where hollow clay bricks continue to be produced, the aim is to increase the percentage of perforation to increase insulation, decrease material use, and reduce

[3] See http://en.wikipedia.org/wiki/Brick-making

the coal used for brick firing. The use of highly perforated clay as well as shale and industrial waste derived bricks could approximately halve brick making coal use, and hence halve brick making CO_2 emissions. The use of highly perforated bricks would probably further more than double their energy and hence CO_2 reducing impact from improved insulation values in the buildings built from bricks, as well as reduced brick transport costs and reduced mortar use. These improved insulation and other effects have not been quantified or included in the TVE project's results, which therefore are a significant under-estimate of the impact of the project's full impact in the brick-making sector.

The technologies used in brick making worldwide ranges from older technologies such as Bulls Trench Kiln (BTK) and fixed and movable chimney kilns, to Vertical Shaft Brick Kilns (VSBK, a technology formerly used in China, and now in the process of being introduced to Nepal and Vietnam by GEF funded projects), to the tri-arch Hoffman kiln (the main technology currently being used in China and now being introduced by a subsequent and related GEF project to Bangladesh[4]) to the most advanced tunnel kiln technology as used in developed countries and used in some joint-venture plants in China, but not widely used yet due to its high capital cost.

Common energy efficiency elements in brick making are improved grinding and mixing of raw materials, longer aging of raw materials, increased extruder pressure and vacuum, improved extruder head designs, reduced wastage in raw brick cutting and hence reduced materials reworking, reduced heat loss in the kiln through the use of hollow insulating bricks and insulating finishes inside the kiln, improved kiln extraction fans, electric motor power factor correction, improved waste kiln heat recycling for brick drying (especially in areas of high rainfall duration where air drying is not viable), improved brick stacking, and improved coal feeding and firing practices in the kilns. For brick entrepreneurs the key energy efficiency drivers are improved relations with local officials (particularly important where brick making plant land tenure is not fully certain), and improved brick quality, marketability and sales prices, reduced brick reject rates, and hence improved profitability.

The TVE project undertook pilot demonstration technical renovation projects at two brick making plants of Sichuan (Province) Yongxing Shale Air Brick Co., Ltd and (Shaanxi Province) Xi'an Liucun Hollow Brick Plant (using shale and clay respectively) to demonstrate energy savings and hence GHG reductions in practice. In both cases, a 15-23% reduction in kiln firing coal use, and increase in the perforation rate of hollow bricks was achieved. GHG savings of 4,844 and 3,236 tons CO_2/year were achieved in the pilot demonstration projects respectively. A further 60 brick making plants were supported in their energy efficiency renovations in formal replications by the TVE project, apparently all these have been implemented and are working successfully. These 60 brick formal replications have a combined calculated CO_2 savings of 190,494 tons CO_2/year.

Around 2,000 new brick making plants were established in China in 2006 and most can be expected to have adopted the technologies demonstrated in the TVE project, given the strong promotion from the project for upgraded energy efficiency in brick making TVEs, and the strong partnerships established with the Xi'an Wall Institute which is the leading brick making institute in China. There would also have been a strong self-replication driver coming from the development and marketing of improved brick making machinery by manufacturers, who not only sell brick making machinery in China but also to other countries such as Egypt, Kazakhstan, Malaysia, Mongolia, and Uzbekistan (from just one manufacturer alone), although this effect has apparently not been quantified to date. The TVE project also facilitated self-replication efforts in Bangladesh (with a new GEF project on introducing improved energy efficient Hoffman kilns is now underway) as well as apparently in Kyrgyzstan and Sri Lanka. The TVE project estimates that the introduction of energy efficient Hoffman kilns in China will be advanced by five years over what it would have been in the absence of the project. With an ultimate market penetration of

[4] See http://www.gefonline.org/projectDetails.cfm?projID=1901

25% for the improved energy efficient Hoffman kilns used in brick production in China, this gives CO_2 savings of 170 million tons/year * 15% savings * 25% = 6.4 million tons of CO_2/year. Alternatively, if half of the 2,000 new brick plants built per year adopt the TVE project energy efficiency measures, and they each save 3,000 tons of CO_2/year, this gives 3 million tons of CO_2 saved per year without counting any impact of the project on the retrofitting of existing brick making plants. So it would seem that a realistic incremental lifetime estimate is around 10 million tons of CO_2 saved per year from the TVE project in the brick making TVE sector.

Foundry Sector

China is the world's largest producer of metal castings, with a total output of over 22 million tons/yr from around 26,000 foundries. 60% of the sector's output is from TVEs. Foundry energy use per unit of output in China is twice that of the developed world. GHG emissions from the foundry sector would be expected to be around 10 million tons CO_2/year.

The project selected two metal casting enterprises, Nanjing Moling Foundry Plant and Dalian Jinmei Cast Pipe Plant, as pilot projects to demonstrate in detail the aspects and impacts of energy efficiency retrofits and technology upgrades.

At the larger-scale Nanjing Moling plant, a thorough technical renovation was undertaken that covered improved metal melting, sand resin modeling, the use of a hot-air blast cupola, lost form molding, improved compressed air use, core making, casting, casting cleaning, sand recovery and recycling, heat treatment, power factor correction, and improved casting machining. The investment was US$3.5 million of which the GEF contribution was US$100,000, with further financial support coming from NDRC and provincial and local governments. Achievements of this very successful energy efficiency and technical upgrade project include a nearly 35% energy efficiency gain, CO_2 reductions of 7,647 tons/year, improved product quality, a reduction in casting rejects (down from 15% to 5%), and improved working conditions. The plant also employs a large number of disabled workers. Further worthwhile upgrades in oxygen blowing in the casting cupola, and enhanced monitoring and documentation have been identified. At the Dalian Jinmei Cast Pipe Plant, GHG savings of 381 tons/year of CO_2 reductions were achieved.

Thirty-one replication metal casting enterprises were supported in the formal replication phase of the project in Tianjin, Dalian, Nanjing and Shanxi, and these projects have apparently all been completed and are apparently all operating successfully. The total renovation investment in these thirty-one plants was US$4.5 million, GEF supported the projects with a total contribution of US$465,000, and the projects have apparently achieved an average of 25% energy and GHG savings, for a combined calculated CO_2 savings of 29,483 tons/year.

For the foundry sector, the role of the LPICs has been critical, as most foundries are small and use outdated equipment and techniques, have limited managerial skills and asset bases, have poor working conditions and have high energy use and pollution levels. The wider product technical and management upgrading that comes alongside the energy efficiency improvements will ultimately be a key factor in the survival of individual foundries as the quality of foundry products increases and rationalization starts amongst the oldest, smallest and most backward foundries.

The project seems to have fostered a considerable degree of commitment to energy efficiency amongst the local government and relevant local foundry associations that comprised the project's LPICs. This support seems highly likely to continue after the formal end of the TVE project. There appear to have been a considerable number of self-replications, but it does not seem that this has yet been assessed and quantified. Given the smaller size of the energy and hence CO_2 savings per foundry, and the range and varying mix of energy efficiency measures that need to be adopted, the impact of the TVE project is likely to be gradual. However, even a self replication of say 1000 larger foundries could lead to CO_2 savings of in the order of 1 million tons per year. So while no specific self replication savings can be estimated (due to lack of available estimates of project self-replication spread and speed), the lifetime savings from the foundry sector are likely to be in the 1 million tons of CO_2 range.

7. Key Findings

The evaluation found that the project appears to be based on a generally realistic project design, utilized well-developed project implementation logic, had suitable timescales and used a logical organizational management structure for the context and time for when it was designed.

The project has been implemented in a suitably collaborative, flexible and adaptive way and has successfully overcome a series of major challenges to its original design context in its early implementation phases. The project has been successfully implemented to date in a context where TVEs in China were evolving rapidly with ownership of TVEs moving from collective to private, technologies that often changed completely during the project, state and local administrative rapidly changing management and enforcement of environmental and other desired outcomes, and exposure to competitive forces that meant that many of the proposed pilots had to be changed.

The delays in the project's implementation appear to be reasonable in terms of having been primarily due to external factors over which the project had no control (e.g. the outbreak of SARS) as well as changing policies that could not have been predicted. Specific particularly relevant policy changes include the necessary modifications to the RCF when new revolving funds with no clear ownership structure were no longer allowed, and when the envisaged co-operatively owned PTPMC structure had to be changed to a company structure (Hongyuan) with much clearer ownership and accountability, but necessarily a much less ambitious scope.

The project has comfortably exceeded its expected outputs in terms of energy savings and GHG emission reductions from both the pilot projects and from the formal project replications. If the impacts of the independent replications (those replications that were not directly funded by the project but that are a result of wider project activities) are included, the final impact of the project greatly exceeds the GHG and energy savings envisaged during the duration of the project. The PIC and LPIC support and the efforts and co-operation of the pilot/demonstration TVEs seems to have been a critical element in the significant self-replications achieved to date.

8. Conclusions and Recommendations

(1) **Positive Overall Assessment and Results -** the project evaluators' overall assessment is that the TVE II project focused on appropriate energy use sectors, had a generally sound project design, has been very successfully implemented, has achieved results greatly in excess of those anticipated, and leaves a strong post-project sustainability legacy. In particular: -

- Direct pilot project GHG savings of around 193,192 tons of CO_2/year seem to have been achieved, compared to the project's design target of 85,000 tons of CO_2/year.

- Formal replication project calculated savings of 714,000 tons/yr CO_2 appear to have already been achieved in the 101 projects known to be implemented from the 118 formal replication project TVEs. This figure is expected to increase by between 129,278 and 537,000 tons/year CO_2 savings as the twelve remaining cement plant formal replications are implemented (as seems likely). This is very impressive, given the 1 million tons/yr of CO_2 savings that they were just to be identified in feasibility studies and have detailed designs undertaken, but without having any explicit project link to their implementation, in the original project design.

- **Large Independent or Self-replication Impacts** – lifetime GHG savings directly resulting from the project are estimated to be in the 30 million tons of CO_2/year range, but this has not yet been evaluated and quantified in a systematic way. It is recommended that these independent or self-replications be further quantified as far as is possible as the TVE project is apparently to be used as a UNDP, UNIDO and GEF international best practice case study.

- **Simple Electricity Grid Access a Critical Success Factor** – The rapid uptake of cement waste heat recovery electricity generation, and the lack of uptake of coking waste heat recovery electricity generation, seems to be strongly linked to the promolgation and enforcement of simple and fair technical and financial grid export electricty acess and the ability to use self-generated power directly.

- **Replication Also Achieved in Other Developing Countries But Not Quantified** – the TVE project has attracted considerable interest in a number of developing countries. For example, in brick making, Bangladesh is in the process of adopting the tri-arch Energy Efficient Hoffman kiln proven by the TVE pilot.

- **More Than US$150 million Co-funding Achieved** – The TVE project has achieved US$49 million of co-funding for the eight pilot projects, and around US$100 million of co-funding for the 101 formal replication projects implemented to date. There is clearly a large but as yet un-quantified co-funding level achieved in the self-replication projects in China and in other countries. The more than US$150 million in co-funding known to be achieved is greatly in excess of the US$10.55 million co-funding target.

(2) **Appropriate Project Design and Adjustments** – the project was appropriately designed and its implementation was suitably adjusted for changing circumstances.

(3) **Realistic Project Budgets** – the project budget was realistic for the project outputs and outcomes sought. Co-financing greatly exceeded the project design targets.

(4) **RCF Recommended to be Updated and Continue Post-Project** – the overall intent (outcome) of the RCF was achieved with ABC now showing considerable interest in funding energy efficiency measures in TVEs, and other financial institutions also set to start operating in this area. The specific GEF seed funding project design element was successful in supporting energy efficiency commercial funding. Although only $400,000 of the $1 million GEF component was utilized, such a level of utilization is not unreasonably for new financing mechanisms of this type. It is recommended that the $1 million GEF RCF entrustment loan amount continue to be managed by MoA and utilized post-project as a seed revolving fund (with interest rate charged to reflect loan risks) to support next generation energy efficiency technologies in one or more of the four project TVE sectors in China. A fund such as the RCF can be very useful on an ongoing basis to remove the lack of available finance argument for not implementing energy efficiency, even if the funds are small and are hard to disburse.

(5) **Promising Prospects for Continuation of Hongyuan Co** – in retrospect, the intent to establish a “club-owned” PTPMC co-operative venture to manage project energy efficiency activities, and continue all such activities post-project under one exclusive organizational umbrella, was overly ambitious. However, suitable adjustments were made and the PTPMC co-operative concept was successfully changed to Hongyuan Co, which has operated effectively in place of the proposed PTPMC in terms of managing the project’s energy efficiency activities. In the short term Hongyuan has a suitable learning-by-doing commercial focus. Its long-term prospects are also promising. However, more emphasis would seem to be indicated for its medium term business planning. It is recommended that this be addressed as a matter of some urgency.

9. Lessons learned

(1) **Need for improved focus on project impact modalities** –The project in its design was

intended to select appropriate energy efficient technologies, demonstrate the technologies in eight pilot projects, then trigger their widespread implementation through feasibility studies and detailed designs undertaken in 100 formal replication projects – all to push the energy consuming industrial systems in the huge number of TVE in the four sectors to a higher state of energy efficiency and hence to a lower GHG emissions state. However, the project design did not make it clear what the links were supposed to between implementing the demonstrations, undertaking the formal replication feasibility studies and detailed designs, and the ultimate project goal of fostering mass self-replications in the wider TVE sectors involved. The result was that there was no focus on quantifying the underlying project objective of motivating large numbers of self -replications, and there was no systematic evaluation of the project's self-replication impacts achieved. Therefore, although the TVE project was clearly very successful in adapting and adjusting to changing circumstances and triggering large numbers of self-replications in China, the evaluators ended up having to guess as to a realistic impact of the project and its post-project sustainability. This issue had been raised in the project mid-term evaluation, and although some useful work was undertaken in this area, the impact of the self-replications has not been subsequently fully addressed.

(2) **Electricity Grid Access is a Key Success Factor –** A key factor in the uptake and rapid spread of technologies that involve the export of electricity, or even self use of generated electricity, is for TVE to be able to access the local electricity grid in a simple, fair and transparent manner. This is a wider issue of huge importance to China and other countries as they seek to utilize the enormous renewable energy and waste heat recovery for power generation potentials that are widely distributed in small plants at the local level.

(3) **Need for clear understanding of the socio-economic development of the host country –** The project design under-estimated the positive project impacts that were likely from China's strong socio-economic development and from the change in ownership of TVEs from primarily collective to primarily private – trends that were already well underway when the project was designed. This contributed towards the lack of focus on the likelihood for self-replications to be strongly driven by TVE entrepreneurs' profit motives and increasing competitive pressures. This lack of clear consideration of the underlying and evolving socio-economic situation also contributed to the project design not considering that positive project results would feed back to national, provincial, district and county policy development and implementation that would in turn strongly support the achievement of the project's overall goals. This negatively impacted on the project's implementation and in particular on the monitoring of self-replications.

So, a clear understanding of the socio-economic development of the host country of a GEF project is as important as the details of a project design in terms of the technical environment, capacity building, demonstration and financing mechanisms. This evaluation has placed great importance on socio-economic development aspects. This is because clearly understanding the socio-economic situation is a prerequisite to evaluating the success or otherwise of the project. This understanding is also needed to underpin the estimates developed of project lifetime GHG savings and hence the cost-effectiveness of the GEF funding support of the project. This aspect is also important for GEF host country focal points and GEF itself as they undertake their own evaluations of project outcomes and the means to improve project impacts and effectiveness.

(4) **Need for improved understanding of common barrier removal instruments –** it would be useful for there to be formal GEF guidance as to the experience of such popular barrier removal mechanisms as the use of revolving funds, pilot demonstrations, and enhanced energy efficiency policy implementation. This is because many GEF projects have been implemented with such common barrier removal instruments, and the lessons learned in such projects could very usefully be applied in new project design, implementation and evaluation. For example, in the TVE project the revolving capital fund (RCF) was time consuming to

initiate and did not fully disburse its funds, but yet was highly effective in initiating and leveraging wider funding, which is understood to be common occurrence.

(5) **Replications beyond host country also need to be tracked –** The project has clearly positively impacted on the design of a brick making GEF project in Bangladesh that is now underway, as well as apparently in Kyrgyzstan and Sri Lanka. It is also likely that Chinese brick making equipment manufacturers are selling more energy efficient brick making equipment in countries beyond China. The project has also fostered paid training for Indian coking plant operators in the clean-type coking technology, and may have fostered replications in Australia, Brazil, Germany, Iran, Japan, Ukraine, and the US. The cement waste heat recovery power generation without using extra fuel technology appears to have been replicated in other countries, possibly including Germany, Pakistan, Turkey, and Vietnam. However, none of these replications in other countries seems to have been documented, let alone systematically looked for impact that can reasonably be attributed to the TVE project.

(6) Actual as well as calculated savings need to be tracked – When the evaluators looked closely at the figures, it became clear that where the replication projects had been implemented, what was given as the "actual results" were identical to the "anticipated results" when the projects were fully implemented. For the pilot projects it would seem that the energy and hence GHG savings figures were updated, but the basis of the updating was not fully apparent. For the formal replication projects, it would seem that the energy savings and hence GHG reductions were calculated in the feasibility studies and then not subsequently updated. It is recommended that in future projects actual energy savings be evaluated once the projects are fully implemented and GHG emissions can then be calculated in a transparent manner to add credibility to the results achieved.

Annex A List of Abbreviations

ABC	Agricultural Bank of China
BTK	Bulls Trench Kiln, a 150 year old brick making technology
CO_2	Carbon Dioxide
CTA	Chief Technical Advisor
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GOC	Government of China
LPIC	Local Policy Implementation Committee
MOA	Ministry of Agriculture
MOF	Ministry of Finance
NDP	New Dry Process (for cement clinker production)
NDRC	National Development and Reform Commission
NGO	Non Government Organization
NPD	National Project Director
PIC	Policy Implementation Committee
PMO	Project Management Office
PTPMC	Production Technology and Product Marketing Consortium (Now Hongyuan Cc)
RMB	Chinese Yuan (currency), just less than 8 RMB = 1 US$
RCF	Revolving Capital Fund
SME	Small and Medium-size Enterprises
TVEs	Township-Village Enterprises
UNIDO	United Nations Industry Development Organization
UNDP	United Nations Development Programme
UNV	UN Volunteer
VA	Voluntary Agreement (between government, TVE and relevant industry associations)
VSBK	Vertical Shaft Brick Kiln, the brick making technology used before Hoffman Kilns
WHR	Waste Heat Recovery

Annex B Review Mission Report

1. Final mission agenda

Time		Activities	Place	Participants
Feb 28, Wednesday	20：10	Frank Pool arrives at Beijing（QF191）		
Mar 1, Thursday	9:00 – 11: 00	Meeting with UNDP, UNIDO	UNDP, UNIDO	UNDP, UNIDO, Frank Pool, Gang Wen
	11：00- 12:00	Discussion on evaluation activities	PMO	Frank Pool, Gang Wen, PMO
	13:30-17:00	Briefing	MoA Meeting room	MoF, MoA, UNDP, UNIDO; PMO, Hongyuan Co., ABC; evaluation experts
March 2, Friday	All day	Meeting with concerned parties/agencies	PMO	PMO; Hongyuan Co.; Subcontractors of evaluation on social impact, RCF review and EE; Agricultural Bank of China; subcontractor on LPIC establishment; evaluation experts
March 3 -4, Saturday – Sunday	All day	Review of documents, discussing the framework of the evaluation report	Hotel / Office	Frank Pool, Gang Wen
Mar 5, Monday	All day	Meeting with concerned parties/agencies	PMO	PMO; Hongyuan Co.; Subcontractors of energy efficiency evaluation; Subcontractors of VA review; subcontractor on construction of cement pilot and replication; subcontractor of construction of foundry replication; evaluation experts
March 6, Tuesday	10：50 -12：50	Depart to Hangzhou Visit Shenhe Cement Co., Ltd Meeting with LPIC in Tongxiang City, Zhejiang Province	Tongxiang City, Zhejiang Province	Frank Pool, PMO, local participants
Mar 7, Wednesday	Morning Afternoon	Drive from Tongxiang City to Nanjing, Jiangsu Province Visit Nanjing Moling Foundry, Nanjing	Nanjing, Jiangsu Province	Frank Pool, PMO,

Mar 8, Thursday	Morning	Visit Nanjing Lishui Zhongshan Foundry	Nanjing, Jiangsu Province	Frank Pool, PMO, local participants
	Afternoon	Depart from Nanjing to Xi'an		Frank Pool, PMO,
Mar 9, Friday	All day	Visit Xi'an Liucun Hollow Brick Plant Meeting with LPIC of Xi'an (Baqiao District)	Xi'an, Shaanxi Province	Frank Pool, PMO, local participants
	Afternoon	Gang Wen arrives at Xi'an		
Mar 10, Saturday	All day	Visit Weicheng Zhouling Hollow Brick Plant in Xianyang; Meeting with LPICs of Xianyang	Xianyang, Shaanxi Province	Frank Pool, Gang Wen, PMO, local participants
Mar 11, Sunday	Morning	Visit Xi'an R&D Institute of Wall & Roof Materials	Xi'an, Shaanxi Province	Frank Pool, Gang Wen, PMO, local participants
	Evening	Depart from Xi'an to Beijing		
Mar 12 – 13, Monday – Tuesday	All day	Draft evaluation report； Communication with UNDP Meeting with Gaoping Xinggao Coking Staff	PMO	Frank Pool, Gang Wen
Mar 14, Wednesday	All Day	De-briefing	UNDP	MoF, MoA, UNDP, UNIDO, PMO, Frank Pool, Gang Wen
Mar 15, Thursday	All Day	Meet UNDP to finalize administration matters Frank Pool Depart for Vienna	UNDP	Frank Pool, John Hanawa
Mar 19-22 Monday-Thursday	All Day	Meetings with UNIDO		UNIDO Representatives, Frank Pool

2. Meetings held, location, focus and people met

Time	Location	Focus	People met	
March 1	UNDP Beijing Office	Understandings of UNDP on final evaluation	Kishan Khoday, John Hanawa, and Ma Jian	UNDP Beijing Office
	UNIDO Beijing Office	Understandings of UNIDO on final evaluation	Alessandro Amadio and Ma Jian	UNIDO Beijing Office
	MOA	Coordination for evaluation, evaluation preparation	Gao Shangbin and Cai Li	MOA
			Wang Guiling and PMO staff	TVE project PMO
			Wang Xiwu	PIC Senior Officer of TVE project
			Wang Hai	Hongyuan Co
			Chen Lan	China GEF Office
			John Hanawa	UNDP Beijing Office
			Ma Jian	UNIDO Beijing Office
March 2	PMO	Evaluation meeting with project participants and contract undertakers	Zou Ji and 4 staff	Renmin University
			Zhang Fu	Tianjin Cement Industry Academy
			Hu Bo and another staff	Beijing Huiwenhua Co.
			Wang Hai	Hongyuan Company
			Wang Jiang	ABC
March 5	PMO	Evaluation Meeting	Meng Zhaoli	Tsinghua University
			Jiang Yun	China Energy Conservation Association
			Jia Xiaoli and Lu Shao Yang	Blue Sky Company
			Tian Yishui and another staff	
March 6	Shenhe Cement Company, Tongxiang, Zhejiang Province	Pilot demo in Cement Industry	Wei Song Gen and staff	Zhejiang Shenhe Cement Co. Ltd
		LPIC activities	Sheng Xing Long Chuzhang	TVE/SME Bureau of Zhejiang Province
March 7	Nanjing Moling Foundry, Nanjing, Jiangsu Province	Pilot demo in Foundry Industry	Liang Xin Bao and staff Meng Quig Gui	Nanjing Moling Foundry Nanjing Foundry Association

March 8	Nanjing Lishui Zhongshan Foundry, Yangyang County, Nanjing, Jiangsu Province	Replication in Foundry Industry in Nanjing	Tang Zhixian and staff Meng Quig Gui Song Wenzhong	Nanjing Lishui Zhongshan Foundry Nanjing Foundry Association Jiangsu Metallurgical Design Institute
March 9	Xi'an Liucun Hollow Brick Plant, Xi'an, Shaanxi Province	Pilot demo in Brick Making Industry	Ling Fuhe and staff	Liucun Hollow Brick Plant
	Xi'an R&D Institute of Wall & Roof Materials, Xi'an, Shaanxi Province	Technical support for pilot demo, replication and self-replication	Xiao Hui and staff	Xi'an R&D Institute of Wall & Roof Materials
March 10	Two Brick Plants, Xianyang, Shaanxi Province	Replication in Brick Industry	General Managers and staff of the two Brick Plants	Weicheng Zhouling Hollow Brick Plant, and other replication Hollow Brick Plant
	Local government, Xianyang, Shaanxi Province	LPIC activities and replication in Brick Industry	Vice Mayor and 4 staff	Local government
March 11	Xi'an R&D Institute of Wall & Roof Materials, Xi'an, Shaanxi Province	LPIC activities and replication and self-replication	Zhou Xuan and another staff	Shanxi Xinggao Coking Co. Lt.
March 12	PMO	Meeting with Gaoping Xinggao Coking Plant Staff to discuss clean-type coking plant waste heat recovery technical and economic matters	Hou Kang and another staff	Tianjin TVE Bureau
March 14	UNDP	Evaluation debriefing	UNDP, UNIDO, MOF, MOA, PMO	UNDP
March 19-22	UNIDO	Project review	Enver Khan, Bob Williams, Sergio Miranda da Cruz, Monira Latrech, Sajjad Ajmal	UNIDO

3. Site visits undertaken

Time	Enterprises visited	Location
March 6	Shenhe Cement Co. Ltd	Xinjin County, Chengdu, Sichuan Province
March 7	Nanjing Moling Foundry Co.	Moling Town, Nanjing, Jiangsu Province
March 8	Nanjing Lishui Zhongshan Foundry	Yangyang County, Nanjing, Jiangsu Province
March 9	Liucun Hollow Brick Plant, Xi'an R&D Institute of Wall & Roof Materials	Xi’an, Shaanxi Province
March 10	Weicheng Zhouling Hollow Brick Plant, and other replication Hollow Brick Plant	Xianyang, Shaanxi Province

Annex C Documents Reviewed

The Evaluation Team reviewed the following documents:

(1) Project level documents

- Project Document
- Project Mid-Term Evaluation Report
- PMO report for final evaluation and project summary report
- Proposed Brick Making GEF Project PDF Document, PIF and proposed next steps
- Presentations at International Forum on Energy Efficiency and GHG Reductions in SMEs (TVEs) & Cyclical Agriculture, 16-17 May, Hangzhou

(2) Project contract-level evaluation documents

- Energy Efficient Technologies Implementation Monitoring and Evaluation: final report
- Evaluation Report on Mechanism and Feasibility of Energy Efficiency Voluntary Agreement: final report
- Pilot Project Case Studies: final report
- Statistics of baseline data and achieved project energy savings
- Statistics of replication projects
- Statistics for 42 Project Subcontracts
- Reports of Replication Projects for Energy Efficiency in brick, cement, coking and foundry sectors in Chengdu, Shenyang, Xiangyang and Xi'an
- Xingao Coke Group TVE Project Participation Report
- Shaanxi Xijing Brick-making Equipment Manufacturing Co Ltd company profile
- Entrustment Loan Facility - final report and its 14 annexes
- Establishment and Capacity Building of Local Policy Implementation Committee (LPICs) - Phase I: final report and its 9 Annexes
- Establishment and Capacity Building of Local Policy Implementation Committees (LPICs) - Phase II: final report
- Replication of Regulatory Reform Strengthening Strategy in Countries/Regions for the Establishment and Capacity Building of Local Policy Implementation Committees (LPICs) - Phase III: final report and its 17 annexes
- Replication of Regulatory Reform Strengthening Strategy in Countries/Regions for the Establishment and Capacity Building of Local Policy Implementation Committees (LPICs) - Phase III: training report and its 4 annexes
- Pilot Enterprises Evaluation Reports for brick, cement, coking and foundry sectors
- Promotion materials for project replication, including Perforated Brick Making DVD
- Project Impact Evaluation: final report and sub-reports on PIC and LPIC mechanisms, policy impacts, market impacts and social impacts
- Evaluation of the RCF Mechanism: final report
- Business plan of Hongyuan Company

Annex D **Detailed Project Outputs**

Results for Eight Pilot-Demonstration Projects

No.	Pilot Plant	Plant Profile	Total Annual Energy Use (tce)	CO2 Emissions (tons/year)	Total Investment (10,000 RMB ¥)	GEF Funds (US$)	Energy Use/Unit Product			CO2 Emission Savings (tons/yr)
1	Yongxing Shale Hollow Brick Co. Ltd., Xinjin, Sichuan Province	Raw materials: high quality shale; Products: 16 types in 3 series of high quality shale bricks, including KP1 type perforated bricks with round or rectangular holes, module multiple hole bricks, KF series hollow brick with over 6 holes; Major equipment: one 48-chamber Hoffman kiln, Capacity: 80 million std bricks/year.	9,571.91	23,862.78	260	59,950	Coal: electricity: Combined:	0.90 0.13 1.03	tce/10,000 standard brick tce/10,000 standard brick tce/10,000 standard brick	4,844.06
2	Xi'an Liucun Hollow Brick Plant, Xi'an, Shaanxi	Main product: clay bricks, perforation rate ≥25%. Capacity: 34 million standard bricks/year Major equipment: 3 * 26-chamber Hoffman kilns.	4,191.40	10,449.17	250	60,000	Coal: electricity: Combined:	1.00 0.056 1.06	tce/10,000 std brick tce/10,000 std brick tce/10,000 std brick	3,236.18
3	Dalian Jinmei Cast Pipe Co. Ltd, Dalian	Main products: ductile iron pipe fittings (T- joints, four-way unions, reducing joints, etc. in 20 series) and valves of ø50mm to ø2000mm, and stainless steel precision casting valves. Major equipment: 5 ton cupola; 500 kg capacity electric oven.	562.07	1,401.25	530	60,000	0.091		tce/ton castings	381.27
4	Nanjing Moling Foundry, Nanjing, Jiangsu Province	Products: various kinds of castings, including engine bodies for diesel engines, ductile iron castings for automobiles and civil construction, aluminum alloy castings of air-inlet bent pipes, air-inlet manifold and inlet pipe connections for automobiles.	8,020.99	19,996.32	2,940	100,000	0.374		tce/ton castings	7,646.92

5	Huangshi Lufeng Cement Co. Ltd.	Raw materials: self-supplied limestone and clay, copper slag and cinder available from local market. Products; P.O32.5, P.O42.5 and P.S32.5 cement; Key equipment: 4 Φ3×11M shaft kilns; Annual capacity: over 500,000 tons of P.O32.5, P.O42.5 and P.S32.5 cement.	64,413.31	160,582.38	700	70,000	coal	0.126	tce/ton clinker	22,508.66
							Combined: (cement)	0.117	tce/ton cement	
6	Yingde Baojiang Cement Co. Ltd., Guangdong	Products: Portland cement clinker; Annual capacity: 200,000 tons of Portland cement clinker; Key equipment: two production lines with Φ3×10m shaft kilns	29,563.45	73,701.68	18,800	100,000	coal (clinker):	0.111	tce/ton clinker	29,580.76
							Combined: (clinker)	0.134	tce/ton clinker	
7	Zhejiang Shenhe Cement Co. Ltd	Product: P.O42.5 and P.O32.5 Portland cement; Capacity: 2 million tons of P.O42.5 and P.O32.5 Portland cement; Key equipment: two vertical shaft kilns and two dry-process rotary kilns with capacity of 1,000t/d and 2,500t/day	97,010.72	241,847.73	1,776	99,930	coal (clinker):	0.096	tce/ton clinker	19,993.91
							Combined: (cement)	0.106	tce/ton cement	
8	Shanxi Xinggao Coking Group	Products: foundry coke (2nd grade) and metallurgical coke (1st grade); Key equipment: "Clean Type" coking Ovens; Installed capacity: 400,000 ton/yr. Anticipated 2007 output 350,000 tons			6,700	100,000	1.3 tce/ton coke			114,578.28 (105,000 for 2007)

Results for 118 Formal Replication Projects

Sector	Region	number of TVEs	Anticipated Results		Actual Results	
			Energy Savings (tce/a.)	CO2 emission Reductions (t/a.)	Energy Savings (tce/a.)	CO2 emission Reductions (t/a.)
Cement	Cement 1	10	276,869.39	690,235.39	144,617.71	360,531.95
	Cement 2	10	136,535.21	340,382.29	53,667.19	133,792.30
Coking	Shanxi	7	306,783.00	764,810.02	4,596.00	11,457.83
Foundry	Tianjing	7	902.67	2,250.35	902.67	2,250.35
	Dalian	8	1,790.51	4,463.73	1,790.51	4,463.73
	Nanjing	6	1,587.30	3,957.14	1,587.30	3,957.14
	Shanxi	10	7,545.92	18,811.99	7,545.92	18,811.99
Brick	Xian	15	9,910.09	24,705.85	9,910.09	24,705.85
	Xiangyang	14	14,396.36	35,890.12	14,396.36	35,890.12
	Shenyang	16	14,792.34	36,877.31	14,792.34	36,877.31
	Chengdu	15	37,312.79	93,020.79	37,312.79	93,020.79
Total		**118**	**808,425.58**	**2,015,404.97**	**291,118.87**	**725,759.35**

Annex E

Terms of Reference for the Final Evaluation
UNDP/GEF Project
CPR/99/G31 -"Energy Conservation and
GHG Emissions Reduction in Chinese TVEs"

A. Introduction

Background

China's township and village enterprises (TVEs) are rural, collective economic organizations established at the township or village level. They also include the city branches of township enterprises. TVEs constitute a significant share of Chinese economic production and social welfare while contributing significantly to local and global environmental problems. Emissions of Green House Gases (GHG) from industrial TVEs constitute a major share of China's overall GHG emissions. Their average relative energy consumption is 16% to 60% higher than currently available technologies and they produce low quality products that result in additional energy use downstream. The Global Environment Facility (GEF) funded project, CPR/99/G31 - "Energy Conservation and GHG Emissions Reduction in Chinese TVEs", will reduce GHG emissions from the TVE sector in China by increasing the utilization of energy efficient (EE) technologies and products in the four sub-sectors of brick, cement, metal casting and coking. The project objective is to remove key market, policy, technological, and financial barriers to the production, marketing and utilization of EE technologies and products in the selected sub-sectors.

Specifically, the project objectives include: a) creating institutional mechanisms for barrier removal at the national, county and enterprise level; b) establishing incentives and monitoring systems to strengthen existing regulatory programmes at the county level; c) building technical capacity for energy efficiency and product quality improvement in TVEs; d) creating access to commercial financing for TVE in the four sub-sectors; e) commercialize the financing of TVE energy conservation projects; and f) expanding the application of best practices for local regulatory reform to the national level.

The project has the potential to reduce substantial amounts of CO2 and other pollutants. However, the potential for a nation-wide energy conservation and CO2 reduction in the four sub-sectors represent 1,000 times more than the reductions that will be achieved under this project. This enormous replication potential justifies the establishment of a self-sustaining barrier removal framework that will be operational post-GEF intervention.

The project is executed by UNIDO and implemented by the Chinese Ministry of Agriculture (MOA). UNDP is mainly responsible for monitoring, evaluation, and reporting to the GEF. MOA has appointed a senior official as the National Project Director (NPD). A project management office (PMO), under the supervision of the NPD, has also been established. An international Chief Technical Advisor (CTA) was recruited for the first few years of the project implementation.

To overcome the barriers related to policies, techniques, markets and financing, the project has worked through pilot projects in nine enterprises in the four industry sectors, and duplicating the subsequent pilot project success to at least 100 enterprises in 20 countries. The framework for overcoming the barriers comprised Policy Implementation Committees (PIC) at country and local levels, a Production Technology and Product Marketing Consortium (PTPMC), and a Revolving Capital Fund (RCF). The first step in building the barrier removal framework was for the project to establish barrier removal institutions covering 8 pilot counties. The institutions were designed to show the benefits of barrier removal in general by demonstrating how barriers could be removed in real-world applications in rural China. Then, based on the pilot experiences, the proven successful institutional structures and development approaches were to be replicated, expanded nationally, or absorbed into existing national institutions.

Implementation of the project commenced in early 2001. However, due to a change in policy and regulatory environment coupled with the outbreak of SARS, the project was delayed for more than two years.

B. Final Evaluation

GEF projects with long implementation periods are mandated to conduct a Final evaluation report to confirm the project's development impacts and results. The evaluation is responsive to the GEF Council's decisions on transparency and better access of project information. Following the Mid-Term evaluation that was completed in 2005, the Final evaluation is intended to document the final project impacts and results, identify key lessons learned and best practices and evaluate the overall performance of the project on the recommendations made during the previous evaluation. The Final evaluation is to be conducted or reviewed by independent evaluators not associated with the implementation of the project.

C. Objectives of the Final Evaluation

Under the supervision of the PMO and in cooperation with the UNDP and UNIDO, a project evaluation team which consists of an international consultant and a national consultant will accomplish the following tasks:

a) Review of Project Design and Planning

- Whether the problems the project was supposed to solve were clear and the approach to be used was sound
- Whether immediate objectives and outputs were properly stated and verifiable
- What major changes occurred and the reason for the changes

b) Review of Project Performance

- Timeliness and quality of inputs
- Timeliness and cost-effectiveness of activities undertaken
- Ability of the project to utilize efficiently the inputs available to it
- Quality and quantity of outputs produced
- Achievement of immediate objectives
- What factors might have facilitated or deterred the achievement of project objectives
- Evaluate base line data for energy efficiency and emissions reduction in terms of how they were derived
- Evaluate actual energy efficiency improvements and emissions reduction data in terms of validation.
- Evaluate sustainability of Hongyuan and RCF

c) Review of Project Impacts

- Impact on national energy use and efficiency
- Impacts of the approaches and activities on the four sub-sectors (concrete, brick, coking, and metal casting)
- Achievement of climate change objectives and project outputs in relation to the project inputs, costs and implementation time.
- Cost effectiveness.
- Relevance of the project to national development priorities
- Sustainability of project achievements. The extent to which benefits can be expected to continue beyond the project life.
- Dissemination of project results

- The extent of participation by individuals, groups, institutions, and other stakeholders in the project.

d) Recommendations and Lessons Learned

- Success stories
- Problems in project implementation
- Lessons learned
- Other recommendations

D. Evaluation Criteria

The evaluation team will use, as reference, the Mid-Term evaluation report completed in 2005 as a base for the final evaluation. In general, evaluation practices explore six criteria that are applicable to the project. These six specific evaluation criteria will be utilized to provide all the parties involved on the key results and lessons learned from the project which will be used for information dissemination and future programme planning for UNDP and GEF.

1. Impact: measures both the positive and negative, foreseen and unforeseen, changes to and effects on society caused by this project.
2. Effectiveness: measures the extent to which the project objectives have been achieved or the likelihood that they will be achieved.
3. Efficiency: assesses the outputs in relation to inputs, looking at costs, implementation time, and economic and financial results.
4. Relevance: gauges the degree to which the project at a given time was/is justified within the global and national/local energy and development priorities.
5. Sustainability: measures the extent to which benefits can be expected to continue from the project after GEF assistance has come to an end.
6. Responsiveness: measures the project's ability to respond in an effective and appropriate manner given the change in policy/regulatory environment and the recommendations provided on the Mid-Term evaluation.

E. Methodologies, Frameworks, and Indicators

There are a number of evaluation methodological aspects such as: (a) practices; (b) the use of project logical frameworks; and (c) the development of performance and impact indicators.

A mix of complementary/different methods can be employed, such as (1) desk review of existing documents and materials, (2) implementation surveys, (3) interviews with partners and stakeholders, (4) field visits to selected sites and pilots, with the purpose of verifying the project outputs and the impact of the outputs, and (5) briefing and debriefing sessions with UNDP, UNIDO, and the government (MOA), and (6) qualitative approaches (participatory evaluations and beneficiary assessments). These approaches can be employed separately or together to provide differentially conclusive but complementary evidence on project performance and impact. The methods employed should be determined for the specific evaluation exercise. The evaluation team has certain flexibility to adapt the evaluation methodology to better suit the purpose of the evaluation exercise. For field visits, some PMO staff may accompany the team for logistic arrangements and to help with the coordination with local governments and TVEs.

A standard GEF project is required to use the logical framework approach (LFA). The LFA is also an essential instrument that facilitates results-oriented project implementation and sound monitoring and evaluation. This approach establishes the links between the macro level goal, project level objectives (purposes), specific outputs, and inputs through verifiable indicators and specifications of the assumptions that underlie these relationships.

Evaluation methodologies are dependent on well-developed sets of indicators. These indicators provide the basis for before-and-after analyses and describe the effects (positive and negative) of project interventions, anticipated and unanticipated, intended and unintended. Below is a table to show the indicators for this specific type of GEF Climate Change project, adapted from a GEF M&E working paper. The table also provides the scope of the evaluation.

Indicators for Projects for Energy Efficiency Improvements in Industrial Enterprises (e.g., Township and Village Enterprises - TVEs)			
Projects are to reduce energy consumption in industrial processes, either directly by supporting industrial enterprises to implement a variety of measures such as efficient boilers/kilns/ovens, and energy auditing and management; or indirectly through support and promotion of energy service companies or similar entities carrying out similar activities and functions such as the Hongyuan Company (PTPMC) in the TVE project			
Seven Core Indicators	**Project Level**	**Project Level Examples (for Direct Project Results)**	**Programme/Macro Level (Country-Level) Measurement (Less rigorous than project level indicators)**
1. Energy production or savings and installed capacities	The electric capacity or capacity savings of the measures installed; the energy production or energy savings of measures installed; and/or the number of technologies/measures sold, financed, or directly installed through the project	1. Annual or cumulative energy savings (e.g., MWh, or tce) from energy efficiency investments in industry (TVE sectors), either by TVEs or by energy service companies 2. Electric power capacity (MW) or energy consumption (e.g., coal or coke) reduced through energy efficiency investments 3. Amount of CO_2 emission reduced, by enterprise, by sub-sector etc. 4. Reduced consumption of energy (electric power, coal, coke etc.) per unit of output product (i.e., energy efficiency gain in percentage) 5. Number (percent) of EE measures installed 6. Number of EE projects (pilot and replication etc.) implemented and evaluated	Briefly define the market scope for each specific EE production technology/equipment, production process, and/or engineering service in each sub-sector; as well as the relevance/meaning of the national markets Briefly establish national market baselines and relate trends to expected or targeted replication in project design
2. Technology cost trajectories	The costs of measures directly installed through the project	1. Rates of return achieved from energy efficiency investments in industry 2. Costs of conserved energy (e.g., cents/kWh, cents/tce)	

3. Business and supporting services development	Number of businesses supported and number of personnel receiving training	1. Number of operating energy service companies or other similar companies like the Hongyuan Company offering efficiency improvement equipment or services in target market 2. Number of EE feasibility studies and EE proposals 3. Information network (clearinghouse; newsletters, Internet website, and conferences/workshops) developed 4. Dissemination of results of EE projects 5. Number of demonstration sub-projects of EE measures; [broken out by sector; includes monitoring and verification] 6. Number of energy audits (in particular facilities, or by sector) 7. Guidelines on identifying and developing EE projects 8. Number (percent) of EE measures manufactured by in-country manufacturers 9.Manufacturer investments in/production of EE equipment	Check the existence, and to a less extent, the effectiveness of policies and institutional mechanisms that have a significant effect on the market penetration of targeted technologies/equipment, practices, services, or other EE measures. Collect evidence that direct project interventions are influencing policy and market development trends and related activities at the national level (replication). Broader and brief socioeconomic impacts and changes in social conditions, e.g., employment and gender equality aspects in TVEs etc., as stated in the original design. It should be noted that in UNDP China's Multi-Year Funding Framework (MYFF) 2004-2007, the relevant macro-level outcome/goal, to which UNDP supported interventions are intended to make relevant
4. Financing availability and mechanisms	Subproject financing committed or dispersed	1. Number and dollar volume of ongoing and completed EE sub-project transactions using financing (e.g., amounts borrowed, broken out by sector) 2. Number and dollar volume of ongoing and completed EE sub-projects (total installed costs, broken out by sector) 3. Number of innovative financial and contracting mechanisms such as the RCF (packages) [broken out by sector] 4. Market acceptance of innovative financial and contracting mechanisms such as the RCF (packages) [broken out by sector] 5. Number of commercial financial institutions participating in EE sub-projects 6. Pipeline of EE (portfolios of) sub-projects ready for implementation and financing by commercial parties 7. Revolving fund to support financing of incremental investment costs 8. Number and type of financial incentives offered [broken out by sector] 9. Amount of financing leveraged [broken out by sector] 10. Number of grants issued [broken out by sector]	

5. Policy development	Agencies created or policies developed as a direct result of project activity	1. Existence and evolution of regulatory/contracting frameworks that support energy conservation at enterprise level and support energy service companies (i.e., supporting policies in sub-sectors) 2. Existence and evolution of policies creating incentives for TVE industry to improve energy efficiency 3. Application of Voluntary Agreements 4. Support offices, such as the PMO, PIC and Local PICs, created to coordinate and support institutional and capacity-building activities in EE 5. Offices established for identifying EE opportunities in operations and developing and implementing programmes for EE 6. Number of training programmes for Government and TVE staff, experts, industry personnel, energy managers, and ESCOs 7. Strengthened institutional capabilities (including information management, evaluation, and dissemination) of organizations promoting EE 8. Energy auditing instituted as a regular activity 9. Model energy policy and guidelines 10. Legal, financial, institutional, and regulatory policies and PIC/LPIC action plans instituted to ensure large-scale, sustainable financing of EE investments in TVEs	contribution, is "National policies and frameworks for sustainable energy development strengthened". In this regard, the GEF and UNDP share the same development goals and interventions at the macro-level. It is not necessary to have separate sets of indicators, for GEF and UNDP respectively, concerning measurement of support to national policy development.
6. Awareness and understanding of technologies	Number of participants with increased awareness and understanding, by type of participant, such as energy end users, energy-related businesses, and NGOs	1. Awareness within TVE industry of the benefits of EE investments and of potential contracting approaches with energy service companies or companies like the Hongyuan Co (i.e., performance contracting) 2. Awareness and capability of energy service companies or companies like the Hongyuan Co to make or facilitate profitable investments in TVE industry and sustain a profitable business 3. Level of awareness and understanding of EE technologies, processes, services, and/or actions [broken out by sector] 4. Awareness of business opportunities in EE field 5. Public acceptance of EE measures	

7. Energy consumption, fuel-use patterns and shares, and impacts on end users	For directly supported project beneficiaries	Energy intensities of the four particular industrial sub-sectors, compared with past years and baseline projections	

With reference to the above indicators table, the annual Project Implementation Review (PIR), the original success criteria and the original LogFrame planning matrix, which may be outdated with the changing and dynamic policy environment, the evaluation team can select and define an appropriate set of performance indicators that can be measured and/or made available to the team to reflect the project's outputs and its progress in attaining it objective (project purpose). Considerable data related to the indicators should be made available to the evaluators by the PMO, so that the evaluators can focus more on analysis and recommendations rather than direct data collection. General requirements for the indicators are: operational definitions, baseline and target values, entity and staff who are responsible for measuring and recording, means by which indicators are measured, and the associated key assumptions made.

F. Products expected from the evaluation

The key product expected from this final evaluation is a comprehensive analytical report in English that will include the following contents:

- Executive summary
- Introduction
- Description of the evaluation methodology
- An analysis and update of the indicators with regard to the macro level goal, project level objectives (purposes), specific outputs, and the partnership strategy(s);
- Key findings (including best practice and lessons learned)
- Conclusions and recommendations
- Annexes: TOR, field visits, people interviewed, documents reviewed, etc.

G. Evaluation Team

The evaluation team will consist of two consultants: one international consultant as the team leader and one national consultant. Both consultants should have advanced university degrees and at least seven years of work experience in the field of sustainable energy development, energy conservation and efficiency improvement in industries, associated GHG reduction, as well as sound knowledge about results-based evaluation. The team leader will take the overall responsibility for the quality and timely submission of the evaluation report in English.

Specifically, the international consultant will perform the following tasks:

- Lead and manage the evaluation mission;
- Design the detailed evaluation plan (scope, and methodology, including the indicators, data collection, and analysis);
- Decide the division of labor within the evaluation team;
- Conduct an analysis of the indicators and partnership strategy;
- Draft related parts of the evaluation report; and
- Finalize the whole evaluation report and submit it to UNDP.

One national consultant will perform the following tasks:

- Review documents and provide relevant national context;
- Participate in the design of the evaluation plan;
- Conduct an analysis of the indicators and partnership strategy, and
- Draft related parts of the evaluation report.

H. Implementation Arrangements

To facilitate the outcome evaluation, UNDP, UNIDO, and MOA PMO will provide both substantive and logistical support to the evaluation team.

The UNDP-GEF Regional Coordinator for Climate Change for Asia and the Pacific will also assist the UNDP CO and members of the evaluation team in preparing for the final evaluation of the project. UNIDO, UNDP, and MOA PMO shall provide in advance copies of the necessary documents needed by the evaluators during the evaluation period. Likewise, the PMO shall provide the list of contact persons representing the various stakeholders of the project.

During the evaluation, UNDP China will help identify key partners including UNIDO Programme Manager, former CTA and other stakeholders for interviews by the evaluation team. The interviews may take the form of audio/video conference call, email exchanges, and other means of communication. A total of about two weeks will be required for the evaluation, which are roughly broken down as follows:

Indicative Activity	Rough Timeframe
Desk review of existing documents; Evaluation design and detailed evaluation plan (home based), discussion with UNDP and the PMO	2 days
Mission travel to Beijing, China	
Briefing with UNDP China, UNIDO, MOA, the PMO, finalization of the detailed evaluation plan	1 day
Field visits to four pilot TVE sites, plus visits to four Local PICs, to be determined by the evaluators and the PMO	4.5 days, suggested sites: Hangzhou (Cement), Nanjing (Foundry), Xi'an (Two Brick Plants)
Interviews with partners	2 days
Drafting of the evaluation report	2.5 days
Debriefing with UNDP China, UNIDO, MOA, and the PMO	1 day
Mission to UNIDO HQs in Vienna	4 days
Finalization of the evaluation report	1 days

The following figures indicate the contract amount to be provided by UNDP from the project's evaluation budget.
Remuneration for the team leader: US$600 per work day X 18 work days = US$10,800
Mission travels: international roundtrip air tickets (to Beijing and two-day mission to UNIDO); Domestic air tickets for domestic travel (visits to pilot and replication sites); Daily Subsistence Allowance (DSA) associated with the above international and domestic travels; Limit for terminal allowance for international travel: US$30 X 6 = 180.
Miscellaneous expenses for visa: up to US$200 reimbursable based on the actual costs incurred.
Domestic travel itinerary may be discussed and adjusted following the agreement between the team leader and UNDP according to the specific evaluation plan and design. The mission duration in China is about 2 weeks.

I. Selected documents to be studied by the evaluators

The following documents should be studied by the evaluators:

- UNDP Handbook on Monitoring and Evaluating for Results
- United Nations Development Assistance Framework (UNDAF) for China (2001-2005 and 2006-2010)
- UNDP Country Cooperation Framework (CCF) for China (2001-2005, and 2006-2010)
- UNDP China MYFF 2004-2007
- Project document, PIRs, and reports from project activities and subcontractors
    - GEF M&E Working Paper for Climate Change projects
    - TVE II Brochure
    - Phase II Mid-Term Evaluation, 2005