

**BARRIER REMOVAL FOR THE
WIDESPREAD COMMERCIALIZATION
OF ENERGY-EFFICIENT CFC-FREE
REFRIGERATORS IN CHINA**

Project Number: CPR/98/G31

Final Evaluation
Report

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List of Acronyms and Abbreviations

AQSIQ	Administration of the People's Republic of China for Quality Supervision and Inspection and Quarantine
CCTV	China Central Television
CECP	China Certification Centre for Energy Conservation Products
CFC	Chlorofluorocarbons
CHEAA	China Household Electric Appliance Association
CHEARI	China Household Electric Appliance Research Institute
CNCA	Certification and Accreditation Administration of the People's Republic of China
CNIS	China National Institute of Standardization
COP	Coefficient of Performance
CO ₂	Carbon Dioxide
EEI	Energy Efficiency Index
FECO	Foreign Economic Cooperation Office (of SEPA)
GEF	Global Environment Facility
GHGs	Greenhouse Gases
GWh	Gigawatt-hours (10 ⁶ kWh)
HFC	Hydrofluorocarbons
hp	Horsepower
kWh	Kilowatt-hours
NDRC	National Development and Reform Commission
PMO	Project Management Office
SAIC	State Administration for Industry and Commerce
SALI	State Administration of Light Industry
SARS	Sudden Acute Respiratory Syndrome
SEPA	China State Environmental Protection Agency
SO _x	Sulfur Oxides
TNS	Taylor Nelson Sofres, China (Consultants)
TPR	Tri-partite Review (Meeting)
TWh	Terawatt-hours (10 ⁹ kWh)
UN DESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
WTO	World Trade Organization

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David Von Hippel also offers his gratitude to his Evaluation Mission counterpart Madame Wang Lei, for her deep knowledge of and insight into the refrigeration industry, her hospitality and patience in arranging Mission activities, and her company and hard work during the Mission.

1. EXECUTIVE SUMMARY

The purpose of this document is to report on the results of an Expert Mission commissioned to review the design, conduct, and results of the United Nations Development Programme (UNDP) and Global Environment Facility (GEF) project entitled “Barrier Removal for the Widespread Commercialization of Energy-Efficient CFC-Free Refrigerators in China”, Project Budget Number Project Number: CPR/98/G31 (referred to below as “the Project”). The Evaluation Mission visited project sites in the cities of Beijing, Huangshi, Shunde, and Qingdao over the period from October 9 through 19, 2006. The remainder of this Executive Summary provides an overview of the Energy Efficient Refrigerator Project’s concept and design, describes the project’s implementation and organization, notes the key project results, presents the overall findings of the Evaluation Mission, and provides the authors’ recommendations both as to elements of the Project that might have been improved, as “lessons” for future UNDP and GEF projects, and for follow-up projects that UNDP and other donor agencies might consider supporting.

1.1 Project Concept and Design

The overall goal of the UNDP/GEF project “Barrier Removal for the Widespread Commercialization of Energy-Efficient CFC-Free Refrigerators in China” has been to bring about a significant and ongoing reduction in greenhouse gas emissions from electricity generation by reducing the amount of electricity used annually by household refrigerators in China. The project was designed to incorporate two major elements, each of which involved several different sub-components. The project combines elements of:

- “Technology push”—providing a combination of training and technical resources, plus financial incentives, to induce refrigerator and refrigeration compressor manufacturers to increase the efficiency of the household refrigerators they produce; and
- “Market pull”—to prepare and develop the consumer market, through a combination of standards, labelling, and an information campaign, to accept and purchase in quantity the energy-efficient refrigerators produced.

This is the first China UNDP/GEF project managed by the Foreign Economic Cooperation Office (FECO) of the State Environmental Protection Agency (SEPA) under a national execution modality, and as such the Project broke new ground in the area of UNDP/GEF project management in China.

1.2 Project Implementation and Organization

“**Technical Push**” activities involved in the Project included:

- In-country and overseas training for engineers from manufacturers of refrigerators and refrigerator compressors, and organizing exhibitions and workshops. Starting with an exhibition of existing domestic refrigeration products in 2000, in-country (with international and national experts) and overseas training courses and seminar were held involving staff from compressor and refrigerator manufacturers.

- Compressor manufacturer incentive competitions. 10 compressor manufacturers qualified to bid for incentives in 2000, and bids for the compressor producer incentive program were submitted, and three bid winners selected.
- Refrigerator manufacturer incentive competitions. 16 refrigerator manufacturers submitted bids for, and received, “basic awards” as incentives to design and produce energy-efficient refrigerators. Three manufacturers in 2003 won bids to compete for “Supplemental” and “Principal” Awards.
- Revision of refrigerator energy efficiency standards. New, more stringent standards for residential refrigerators (and freezers) were developed, ultimately approved, and implemented by late 2003.

Recognizing that effective commerce requires both buyers and sellers of goods to be ready to participate at the same time, the Project was designed to address the problem of refrigerator efficiency not only through spurring the development and manufacturing of energy-efficient refrigerators, but also by assuring a market for such units. The “**market pull**” activities included in the Project, and their relationship to each other, are summarized below.

- Education of retailers and retailer incentive program. A program to educate retailers, focusing on the large retail electronics and appliance stores that dominate in major urban markets in China, was planned and carried out.
- Energy-efficiency labelling for key household appliances. A key component of the public education campaign under the project was the development of labels, identifying an appliance as meeting minimum energy efficiency standards and achieving a rating of level 1 (most efficient) to 5 (least efficient), based on a rating system that adjusts for the size of the appliance and other parameters. The administrative process of preparing and authorizing appliance labels was a significant Project undertaking.

Public awareness (media) campaign and related activities. Starting in approximately 2002, and under two sets of contracts, public awareness activities included preparation of TV, radio, and print media pieces, including articles, advertisements, documentaries, posters, and other activities designed to promote the aims of the Project and consumers’ awareness of the environmental and economic benefits of energy-efficiency refrigerators.

- Mass purchase of energy-efficient appliances by Government agencies. This Project element resulted in the inclusion, in late 2004, of about 280 models of energy-efficient refrigerators on the “government purchase list for energy efficiency products” authorized by the State Ministry of Finance (MOF) and NDRC.
- Development of business plan for co-funded refrigerator buyback/recycling program. A business plan was developed, but this sub-project was not funded and did not occur.

1.3 Key Project Results

The project has resulted in an increase of nearly 29 percent in the weighted-average efficiency of household refrigerators produced in China between 1999 and 2005, as well as impressive improvements in refrigeration compressor efficiency. It is likely that the improvements produced by the project will continue to accrue for years to come. Compressor manufacturers involved in the project exceeded virtually all of their production and improvement

goals, and refrigerator manufacturers, with one exception relating to a corporate financial legal situation, did likewise.

The Evaluation Mission estimates that the Project has resulted in the savings of about 11 million tonnes of CO₂ emissions by 2005, and will result in a total of 42 million tonnes of CO₂ emission savings by 2010. Counting the entire savings over the lifetimes of the refrigerators affected by the project, the Evaluation Mission estimates a total of about 170 million tonnes of CO₂ for refrigerators produced through 2005 (savings occurring through 2020) and a total of about 630 million tonnes of CO₂ for refrigerators produced through 2010 (savings occurring through 2025).

The Project resulted in significant lasting capacity building among:

- Manufacturers of refrigeration compressors and refrigerators, including skills gained by technicians and engineers, enhanced research and development capacity, and management skills gained in working within Project guidelines and reporting practices.
- Regulators, including those responsible for setting and enforcing standards for appliances, and those responsible for overseeing the Project.
- Project organizers and managers, who gained considerable experience in operating this significant and complex undertaking.

1.4 Findings of Evaluation Mission

The major findings of the Evaluation Mission are as follows:

The project has been highly effective in reducing greenhouse gas emissions in China by markedly increasing the production and sales of energy-efficient refrigerators and refrigerator compressors. The market for refrigerators is now dominated by units meeting the highest two grade specifications (1 and 2), and refrigerator manufacturers are focused on delivering consistently higher efficiency products. Greenhouse gas savings estimated for the project are presented above, and are highly significant in a national context.

Capacity building activities undertaken by the project, including training for technicians and engineers from compressor and refrigerator manufacturers, training activities focused on appliance retailers, public awareness campaigns, and on-the-job training for Project managers and experts, have been for the most part very effective, and the persistence of capacity gained through the Project in areas of technical capability and project management is highly likely.

With the exception of a very few quite minor issues, Project participants uniformly reported that project organization was very good, with clear structure and communications, transparent project accounting and bidding practices, and good support from project management.

The overall design of the Project was described as very good by all of the participants interviewed by the evaluation mission. In particular, the role of Project Chief Technical Advisor Ray Phillips in defining and structuring the Project in its early phases and throughout implementation was noted as a key factor in Project success.

The roles of UNDP and UN DESA were keys to the success of the Project. UNDP and UNDP Beijing provided overall project guidance, as well as oversight and a managerial framework for SEPA/FECO, working in partnership with UNDP and UN DESA, to use in

structuring its accounting, communications, and other activities related to the Project. UN DESA assisted UNDP in project management activities, and in particular identified and arranged the participation in the Project of international experts involved in technical training, project guidance, and other crucial functions. The involvement of UNDP and GEF were described as a critical component in gaining the attention, acceptance, and respect of project participants ranging from manufacturers to government and quasi-government agencies to individual consumers.

The Project was highly relevant to the needs of the Chinese appliance manufacturing sector in particular, and to the goal of reducing China's greenhouse gas emissions in particular, and the Project's performance was by and large excellent, and produced impressive results in the many areas of the Chinese appliance industry it involved.

The Project has been very successful in reaching and exceeding nearly all of its goals. The only major area where the Project did not perform as intended has been the inability to start a recycling program to safely and permanently retire older, poor-efficiency refrigerators. This remains a priority for further work.

1.5 Recommendations and Potential Follow-up

The Evaluation Mission offers the following recommendations for future UNDP and GEF project activities and for potential follow-up to this Project.

Recommendations related to project processes

- Continue to build capacity to manage programs in China.
- Attempt to minimize management staff turnover in project management.
- Continue to insist on transparency in processes and communications. Clear and open communication has been a very strong element of the Project, and UNDP/GEF's continued insistence on transparency in future projects in China and elsewhere will continue to serve a key capacity-building function.
- Deepen the role of the Project Information Office, and make sure that project materials persist (on the website) after Project is complete
- Continue to involve stakeholders at an early stage of Project planning.

Overarching recommendation for new projects building on results of project

A key impediment to moving forward with programs similar to the Project is lack of funding. Significantly expanded UNDP/GEF funding for China may continue to become less likely as China becomes more affluent, therefore China must begin to look harder at internal sources of funds to support energy efficiency and environmental improvements. A major option for raising a significant amount of money for use in implementing energy efficiency and greenhouse gas emissions reduction projects is to implement a "Public Benefits Charge", collecting a fraction of electricity (and/or gas) revenues for use to help fund future energy efficiency market transformation initiatives.

Specific recommendations for follow-up or new projects related to project elements

- In the future, when organizing training seminar involving engineers, technicians, or other staff from competing companies, be mindful of possible concerns related to potentially

divulging “trade secrets” or industrial “know-how” to competitors.

- Consider going beyond the mass-purchase effort included in the project to actually organizing bulk purchases by government agencies, and by collaborating non-government entities, of the highest efficiency refrigerator products (including for the 2008 Olympics).
- Apply the concepts of the Project—the technology push/market pull—to other appliances, starting with window-mounted, split and possibly commercial air conditioners.
- Apply Project concepts to commercial refrigeration.
- Apply Project concepts to the goal of producing more efficient residential, commercial, and industrial buildings.
- Apply Project concepts to the development and marketing of “next generation” automobiles.
- When designing media ads, try to tie advertisements in more directly with standards/labels, and provide links to more detailed information.
- Consider revising grade designations for freezers (as opposed to combination refrigerator/freezers) to better reflect the fact that freezers operate under different conditions than refrigerator/freezers.
- Consider modifying grade designations for refrigerators to allow for the separation of the very best refrigerators from those that are merely very good, possibly by adding “Grade 1 +” and “Grade 1 ++” ratings.

Continue to seek funding for Appliance recycling programs, as the current typical practice for refrigerator disposal when a new refrigerator is purchased is far from optimal from a greenhouse gas emissions point of view.

1.6 Plan of this Evaluation Report

The remaining sections of this **Evaluation Report** review in more detail:

- The Evaluation Mission’s central priorities (**Section 2**);
- The Project’s concept and design, including a review of the overall goals and methods of the project, and of the Project Document (**Section 3**);
- The Project’s implementation, including the activities carried out, the organizations involved, and the administrative and communications structures put in place to support the activities (**Section 4**);
- The Project’s results, including relevance, efficiency, impacts, and sustainability (**Section 5**);
- The Evaluation Missions findings and assessment regarding the Project (**Section 6**);
- The Evaluation Missions recommendations for follow-up related to the Project and for potential future UNDP and GEF projects (**Section 7**); and
- A summary of key lessons learned through the Project (**Section 8**).

Annexes to this Evaluation Report provide a copy of the initial itinerary of the Evaluation Mission, a summary of the meetings attended and review activities carried out, a listing of the documents reviewed for this Evaluation Report, a printout of the workbook developed to

estimate electricity savings and greenhouse gas impacts of Project activities, and a copy of the Terms of Reference of the International Evaluation Expert.

2. EVALUATION PRIORITIES AND PROCEDURES

The Evaluation of the UNDP/GEF project “Barrier Removal for the Widespread Commercialization of Energy-Efficient CFC-Free Refrigerators in China” has included a combination of home-office review of materials provided by UNDP, UN-DESA, collaborating organizations in China, and Contractors, plus an Evaluation Mission, undertaken by the authors from October 9 through October 19, 2006. The overarching goals of the Mission were to determine whether the Project has achieved its stated objectives, and to identify recommendations that would help UNDP and other project partners learn from the success and shortcomings of the Project.

Specific goals of the Evaluation Mission were to:

- Focus on Project impacts and achievements, both quantitative (such as market penetration of refrigerators and GHG emissions reduction) and qualitative, such as capacity building, noting the degree to which the objectives set out in the original Project Document have been attained.
- Identify points where the project successfully leveraged resources from international donors with national resources, and where it might have done better (or where other projects might do better in the future).
- Review the effectiveness of the National project leadership in carrying out the Project, including noting any impacts on the capabilities of local authorities to undertake similar initiatives in the future..
- Provide recommendations as to how project achievements can be sustained and disseminated to other sectors.
- Identify any problematic issues regarding implementation of the Project.

In addressing these specific evaluation goals, the Evaluation Team has tried to incorporate the general approach to evaluation identified in the Guidelines for Evaluators document provided by UNDP, though some elements of those general guidelines were found to be less germane to the specific review goals above than others, and thus are not emphasized in this Report.

In addition to reviewing written project materials (see the “List of Documents Reviewed for This Report”, presented as an Annex to this document), the Evaluation Mission performed site visits and conducted interviews as follows:

- An overall review of project accomplishments with representatives of key cooperating and management agencies.
- A discussion of Evaluation Mission goals and priorities at UNDP
- Meetings at the China National Institute of Standardization (CNIS) and the China Household Electric Appliance Research Institute (CHEARI)

- A visit to the advertising firm McCann Erickson Guangming.
- Site visits at appliance retail outlets (electronics “superstores”)
- Site visits and interviews with refrigeration equipment manufacturers, including a compressor manufacturer in Huangshi (DongBei) and refrigerator manufacturers in Shunde (Kelon) and Qingdao (Haier).
- A meeting at the National Audit Office

The Annexes to this report provide the Mission itinerary and a summary of meetings attended/activities carried out, and the individuals involved in those events, during the Evaluation Mission.

3. PROJECT CONCEPT AND DESIGN, AND EVALUATION OF PROJECT DOCUMENT

The overall goal of the UNDP/GEF project “Barrier Removal for the Widespread Commercialization of Energy-Efficient CFC-Free Refrigerators in China” has been to bring about a significant and ongoing reduction in greenhouse gas emissions from electricity generation by reducing the amount of electricity used annually by household refrigerators in China. The project was designed to incorporate two major elements, each of which involved several different sub-components. The project combines elements of:

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This is the first UNDP/GEF managed by the Foreign Economic Cooperation Office (FECO) of the State Environmental Protection Agency (SEPA) under a national execution modality, which broke new ground for the management of UNDP/GEF projects in China. UNDP and UNDP Beijing provided overall project guidance, as well as oversight and a managerial framework for SEPA/FECO to use in structuring its accounting, communications, and other activities related to the Project. UN DESA assisted UNDP in project management activities, and in particular identified and arranged the participation in the Project of international experts involved in technical training, project guidance, and other crucial functions.

The remainder of this section of this Evaluation Report provides a brief review of the context of the project, and a summary and review of the Project Document used to guide the implementation of the Project.

3.1 Context of the Project

China’s world-leading economic growth, particularly over the past two decades has markedly improved the quality of life for the majority of its citizens, but has also led to

significant environmental challenges. The main fuel for China's energy sector is coal, and the consumption of coal and other fuels has been a main contributor to often severe local air pollution problems, as well as environmental problems, such as acid precipitation, of significance to the Northeast Asia region and beyond. As consumption of coal and other fuels in China has grown, emissions of carbon dioxide (CO₂), the main greenhouse gas (GHG) species, have increased markedly. China is now the second leading producer of CO₂ from fossil fuels among the world's countries, and based on current trends will overtake the United States to become the leading greenhouse gas emitter by around 2020. The development of the electricity generation sector has been crucial to China's economic growth. Growth in electricity generation capacity and in output has been in the range of 10 percent per year for most of the last two decades, and will reportedly reach 600 GW by the end of 2006¹. Although Chinese power sector planners have been working to increase the volumes of electricity generated through use of less carbon-intensive fuels (natural gas, nuclear energy, hydroelectric, and renewable forms of energy such as wind and solar power), coal remains the fuel for the bulk of China's existing and new generation capacity (including a reported 52.6 GW of the 60 GW of capacity added nationally during the first nine months of 2006). As a consequence, greenhouse gas emissions from the power sector account for approximately a third of overall GHG emissions in China.

Refrigeration has traditionally been the largest single end-use of electricity in the Chinese residential sector. The growing affluence of the Chinese people, and explosive growth in the construction of new housing, has led to large growth in the saturation of refrigerators, first in the major cities, but continuing in the smaller cities and rural areas of the country. Annual sales of refrigerators exceeded 20 million units in China by 2003, and have been growing very rapidly. In 2003, according to CHEAA, China produced over 30% of the world's output of refrigerators². Couples setting up their first homes and existing households purchasing their first refrigerators, combined with households replacing existing refrigerators, have caused the market for refrigerators made in China to increase at an average (exponential) rate of about 16 percent per year over the last several years, as shown in Figure 3-1. As refrigerators have typical useful lives of 10 to 15 years or longer, when an energy-efficient refrigerator is purchased, energy savings are "locked in" well into the future. Conversely, when refrigerators with poor energy efficiency are purchased, higher electricity consumption, and related GHG emissions from the power sector, are also locked in. This Project was designed to seize the opportunity of locking in good refrigerator performance by "pushing" the technology and capacity for the production of energy-efficient refrigerators in China (companies participating in the Project account for about 70 percent of the refrigerators that are produced in China), while at the same time "pulling" demand for energy-efficient refrigeration through a combination of standards, labelling, and a public information campaign.

¹ China State Power Information Network, "China's power generation capacity to exceed 600 mln kw". From <http://www.sp-china.com/news/Powernews/200610310004.htm>. Visited 10/31/06. Based on this figure, generation capacity growth in China has averaged 9.6 percent annual growth from 1990 through 2006. The figure cited for additions of capacity during the first nine months of 2006 also comes from this source.

² China Household Electrical Appliances Association, Assessing the Implementation of Household Appliance Energy Efficiency Standards in China. June 2004.

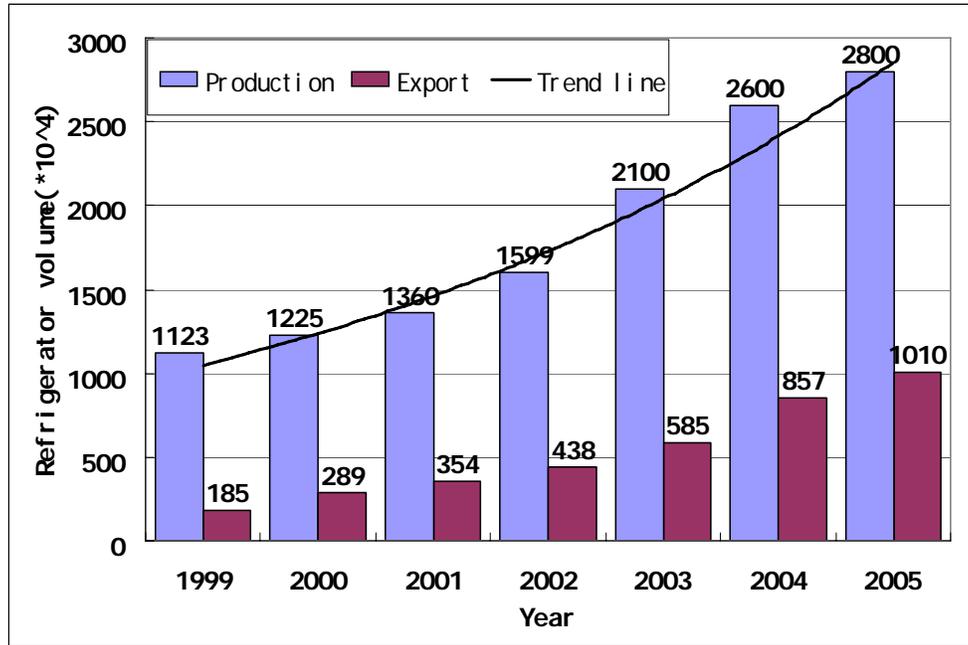


Figure 3-1: China's refrigerator production and exports, 1999 through 2005³

3.2 Project Document--Contents

The Project Document (Project Document, Project Budget Number: CPR/98/G31, Project Title: Barrier Removal for the Widespread Commercialization of Energy-efficient CFC-free Refrigerators in China), prepared for UNDP in approximately 1998-1999, includes the following elements:

- Context**, including a summary description of the pattern of growth of energy use, and related environmental problems, in China, and focusing on the growth of residential refrigerator use as a driver of electricity consumption growth, and thus of growth in GHG emissions. The discussion of context in the Project Document also includes a discussion on China's strategy as it relates to the Project, noting elements such as the government's policy focus on environmental protection in general, greenhouse gas emissions in particular, the electricity sector and the role of household appliances in the growth of electricity demand and in promoting energy efficiency. A subsection on prior and ongoing assistance lists several UNDP projects related to energy efficiency and renewable energy, as well as the US-China Refrigerator project, a Montreal Protocol Fund project, a UNIDO project, and a UNDP project, all of which focused largely on the reduction of the use of CFCs as refrigerants and foam-blowing agents in refrigerator manufacturing, but some of which had elements of energy efficiency improvement as well. An Australian loan to back the conversion of a refrigerator compressor factory to CFC-free status was acknowledged, and the support of the PA/PDF funding for this (the Commercialization of Energy-efficient CFC-free Refrigerators

³ Figure 3-1 from Jiang Feng, China Household Electrical Appliances Association, Push of GEF Project on Chinese energy-saving refrigerator. Presentation made to Evaluation mission on October 9, 2006.

project in providing the background data for and underwriting the detailed planning for the Project was acknowledged. A subsection on the institutional framework for the subsector describes the Chinese organizations involved in the refrigeration industry, including those organizations responsible for planning, coordinating, and regulating the sector.

- The section of the Project Document focusing on **Project Justification** begins with a discussion of the problem to be addressed (described in more detail below), focusing on barriers to implementation of high-efficiency refrigerators in China, then describes the expected end-of-project situation. Subsections describing target beneficiaries, project strategies and implementation arrangements, and reasons for assistance from UNDP follow. “Special considerations” are noted, focusing on the goal of greater involvement of the private sector in the Chinese economy, a target that women should make up 30 percent of training participants under the Project, and noting the opportunities to take advantage of synergies by assisting manufacturers already planning to convert from CFC-based refrigeration to meet the guidelines of the Montreal Protocol. “Coordination arrangements” briefly outlines the roles of SEPA, UNDP, the PMO, and the Chinese Advisory Committee (AC) in the Project. The final subsection, on Counterpart Support Capabilities, describes the organization and capabilities of SEPA’s Foreign Economic Cooperation Office (FECO).
- The **Development Objective** section of the Project Document briefly states that “the development objective of this project is to reduce CO₂ and other greenhouse gas emissions in China by removing barriers to wide spread commercialization of energy-efficient refrigerators in China.”
- The section of the Project Document on **Immediate Objectives, Outputs and Activities** provides considerable detail on the major goals of the project, and the steps to be followed in reaching those goals. Five objectives are listed, several outputs are listed for each objective, and activities—a total of 56 in all—are ascribed to each objective. Further, criteria for success are delineated for each output listed. The objectives and outputs provided by the Project Document are provided below for reference:
 - Immediate Objective 1: Develop capacity to provide a “technology push” for increasing the supply of energy efficient compressors (Outputs: capacity to produce energy-efficient compressors, business plans to increase compressor production, upgraded manufacturing capability)
 - Immediate Objective 2: Develop capacity to provide a “technology push” for increasing the supply of energy efficient refrigerators (Outputs: capacity at refrigerator manufacturers to evaluate options for energy-efficiency improvements plus familiarity with international technology options, select manufacturers to participate in overseas training and in competitive bid process, development of business plans and bid packages by manufacturers)
 - Immediate Objective 3: Establish incentive framework to promote the design, production, consumer acceptance, and increased market sale of high-efficiency refrigerators (Outputs: implementation of new minimum efficiency standards plus capacity for formulation of future standards, financial incentives for manufacturers to design and produce energy-efficient refrigerators, develop capacity to implement mass-purchase program, implementation of refrigerator dealer incentive program, business plan for establishment of pilot refrigerator buy-back/recycling program)

- Immediate Objective 4: Create market conditions of increased consumer demands for energy efficient refrigerators through consumer education, and increase capacity of sales force to promote energy-efficient refrigerator sales (Outputs: Develop nationally-certified energy-efficiency labelling program, produce educational and promotional materials on energy-efficient refrigerators, increase capability of retailers to communicate energy-efficiency criteria to customers)
- Immediate Objective 5: Establish national capacity to promote and manage energy efficiency in the refrigeration sector (Outputs: Establish framework for monitoring and evaluation of project progress and sector development, conduct monitoring of project process and sector development).
- Section E of the Project Document details the **Inputs** expected from the different project participants. These include financial inputs from Chinese enterprises (mostly in the form of investment in production of high-efficiency appliances and components), from National agencies in China (mostly in-kind contributions for staff time, transport, and other expenses), and from UNDP/GEF, including allocations for training, national and international consultants, incentives for manufacturers, travel, equipment, and other costs.
- The section of the Project Document detailing **Risks** identifies and addresses uncertainties that might affect the ability of the Project to achieve its goals.
- A section on **Prior Obligations and Pre-requisitions** notes that manufacturers involved in the project must commit the resources needed to allow them to participate successfully in the project, and notes that the National agencies and organizations involved have fulfilled their budgetary obligations to the project.
- The section of the Project Document on **Project Reviews, Reporting and Evaluation** summarizes the methods, procedures, and indicators to be used in project review.
- The **Legal Context** of the Project is described in reference to Article I of the Standard Basic Assistance Agreement between the Government of the People’s Republic of China and the United Nations Development Programme.
- A section for the Budget of the Project was provided in the Project Document, but the Excel workbook with the Project Budget itself was not initially provided to the Evaluation Mission.
- **Annexes** to the Project Document provide for a Workplan (this was also not initially provided to the Evaluation Mission), a set of Terms of Reference (TORs) for the subcontracts that are part of the Project, a set of TORs for National and International consultants, summaries of the expected overseas training and in-country training activities, a list of the equipment to be purchased under the Project, a description of the incentive programs to be developed and implemented, and a schematic of the project strategy (also not initially provided to the Evaluation Mission).
- Further **Attachments** to the Project Document are entitled “Capacity Building for National Execution”, “Incremental Cost/Benefit Table”, and “Project Planning Matrix”.

3.3 Project Document—Evaluation

Project staff and consultants interviewed by the Evaluation Mission uniformly praised the project

as a whole for being well-conceived, well-organized, and transparent, and that the Project Document has much to do with that assessment.

3.3.1 Problem and technical approach

The Project Document provides a brief but encompassing description of the considerable problem that the Project addresses. Although many volumes can and have been written on the environmental problems associated with growth of energy use in China, the description is appropriate to the purposes of the Project Document. The only minor suggestion that the authors of this Evaluation would like to offer is that a few seminal references (and/or carefully chosen links to web sites) on the general problem might have been cited directly in the text or in footnotes for the use of Project staff who might like to learn more. This same request for guidance to additional background materials pertains to the subsection on host country strategy.

The Project Document effectively describes the problem to be addressed by the Project as a series of nine “key barriers to adoption of energy efficient refrigerators by households” in China. These barriers plus the expected end-of-project situation described by the Project Document, and the list of intended Project beneficiaries, frame the Project objectives. These and related sections of the document are not over-detailed, and provide a good overview to the overall goals of the Project.

3.3.2 Objectives, indicators, and major assumptions

The Project objectives are clearly laid out in the Project Document, and the association of each with component outputs, activities, success criteria, and in some cases the actors (participants) to be involved in each activity, provides useful and systematic guidelines for more detailed Project planning. Summary budgets were identified adequately (though as noted above, the Evaluation Mission has not reviewed a detailed budget document). Major assumptions are addressed in the Project Document are dealt with in reference to “Risks” and to the elements of the Project designed to anticipate and overcome those risks. In retrospect, bearing in mind the results of the Project, at least three types of “Risk” that the Project Document might additionally have identified are:

- Risk of delay in the Project due to slower-than-anticipated official decisionmaking and/or coordination between decisionmaking bodies.
- Risk of delay and/or disruption to the Project due to temporary or ongoing instability in key organizations involved in the Project, particularly considering the often nascent and sometimes not-entirely-transparent nature of Chinese business organizations and institutions.
- Risk that co-funding for a key Project component will not be forthcoming.

These risks, and possibly others, might conceivably have been identified in the Project Document, and addressed in some form, perhaps through contingency arrangements, with such arrangements identified either in the Project Document itself, or perhaps by explicitly noting which organizations responsible for project management and implementation would be designated to prepare and implement contingency plans. The Evaluation Mission recommends that these additional risks be considered in future UNDP/GEF projects that have scope and complexity similar to that found in this Project.

3.3.3 Beneficiaries

The beneficiaries of the Project are clearly defined in the Project Document. The Evaluation Mission did not receive specific information as to which beneficiaries were involved directly in the formulation of the Project, though the level of participation of beneficiaries and the generally smooth operation of the Project suggests that a least key stakeholder must have been consulted to a significant degree. Beneficiaries have had very clear and active involvement in the implementation of the project.

3.3.4 Modalities of execution

The TORs, budgets and workplans (those reviewed by the Evaluation Team), more detailed descriptions of key activities, and other materials provided in the Project Document provided, in the opinion of the authors of this Evaluation, a package of initial guidance to those coordinating and implementing the Project that is as detailed, clear, and forward-looking as can reasonably be expected for a Project of this scope and complexity. The Project Document notes that this is the first Project in which a local institution—FECO of SEPA—takes the lead in managing the major portion of Project activities, and it is clear from the Project Document that FECO-SEPA was carefully briefed and prepared for this role. Roles for other implementing agencies (such as hiring of international consultants and subcontractors) were clearly delineated in the Project Document, and matched well the strengths of those agencies.

4. PROJECT IMPLEMENTATION

In the text below, the main activities included in the Project as originally conceived are noted, and the degrees to which those activities have been implemented effectively and as planned are briefly described. The quality of project monitoring, backstopping, and communications is also addressed.

4.1 Activities

Project activities, apart from overarching management and communication, are divided into “Technical Push” and “Market Pull” activities.

4.1.1 “Technical Push” Activities

Technical “push” activities under the Project were designed to induce Chinese refrigerator manufacturers—and the compressor manufacturers that supply them—to design, manufacture, and offer for sale refrigerators in popular styles and size classes that were significantly more efficient than those on the market at the Project’s inception. Figure 4-1 outlines the relationships between technical push activities⁴.

⁴ Figure 4-1, as well as other information in this section of this Report, are derived from Sun Xuefeng, PMO Manager, Barrier Removal for the Widespread Commercialization of Energy-efficient CFC-free Refrigerators in China, presentation delivered to the Evaluation Mission on Oct. 9, 2006.

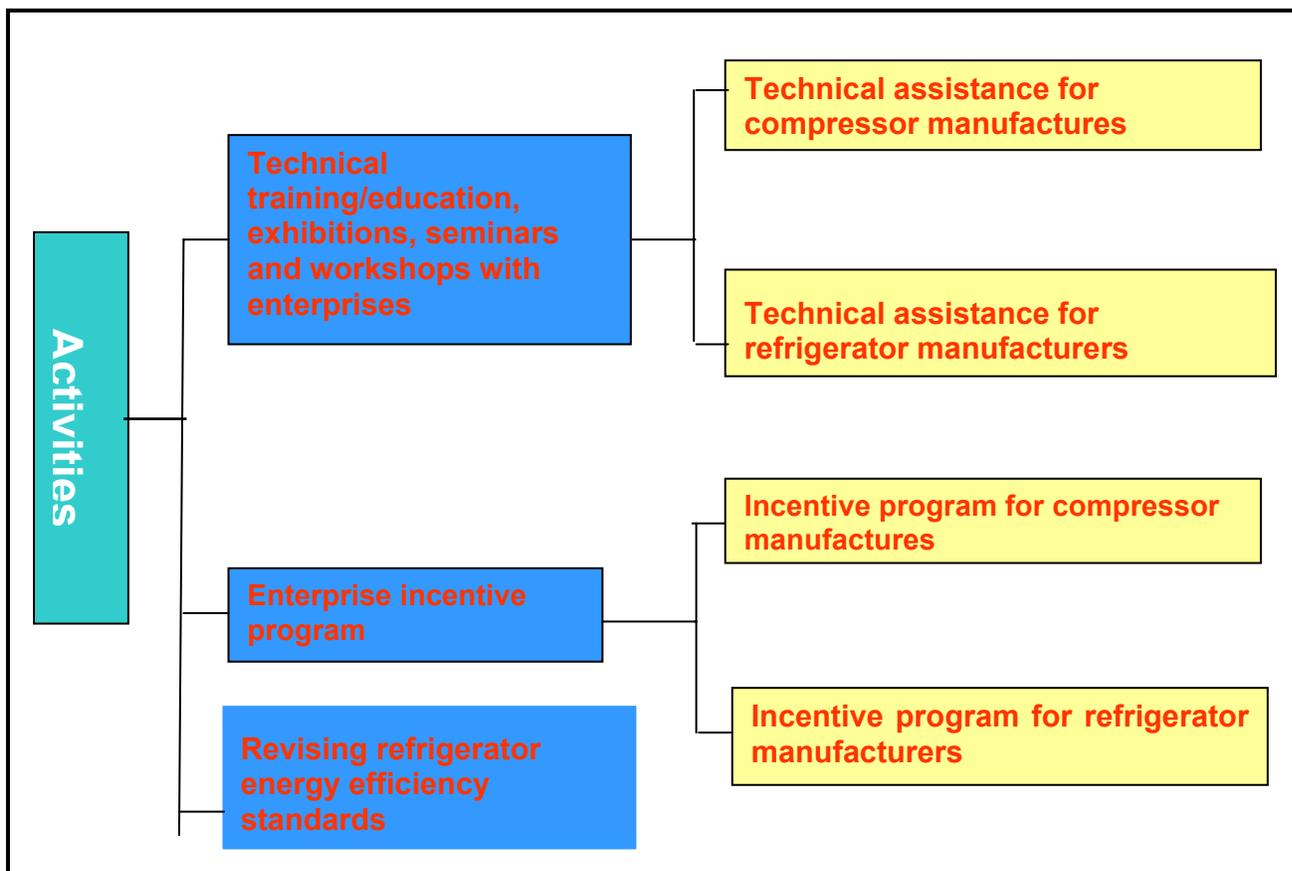


Figure 4-1: Schematic of “Technical Push” Activities

The Technical Push activities involved in the Project, and the degree to which those activities have been successfully implemented, are noted below.

- In-country and overseas training for engineers from manufacturers of refrigerators and refrigerator compressors, and organizing exhibitions and workshops. Starting with an exhibition of existing domestic refrigeration products in 2000, in-country (with international and national experts) and overseas training courses and seminar were held involving staff from compressor and refrigerator manufactures in 2001 and 2002. Though in some cases the number of participants attending a given event was different than in the original project design (often, more participants were included than originally planned), all Project participants interviewed by the Evaluation Mission indicated that these training activities were useful and productive. One group of participants noted that the first refrigerator technology workshop, held at the University of Maryland (US) in September, 2001, was somewhat disorganized⁵, but subsequent workshops at the same venue were reportedly well-organized and well-implemented.

⁵ It is possible that the fact that the initial workshop occurred in part during the immediate aftermath of the “9/11” attacks in the US played a human role in that workshop’s perceived disorganization.

- Compressor manufacturer incentive competitions. 10 compressor manufacturers qualified to bid for incentives in 2000, and bids for the compressor producer incentive program were submitted, and three bid winners selected, in 2002. Following evaluation of production of energy-efficient compressors, a “senior” (\$400,000) and two “junior” (\$50,000) awards were made in 2004. The bid participant interviewed by the Evaluation Mission reported that the incentive program was reportedly carried out in a transparent and fair manner.
- Refrigerator manufacturer incentive competitions. 16 refrigerator manufacturers submitted bids for, and received, “basic awards” as incentives to design and produce energy-efficient refrigerators. These basic awards, totalling \$120,000 per manufacturer for 8 manufacturers, and \$60,000 each for 8 additional manufacturers, were disbursed between 2002 and 2005. Three manufacturers in 2003 won bids to compete for “Supplemental” and “Principal” Awards. Supplemental Awards of \$60,000 each, offered as incentives for the three grantees to do additional development work on energy-efficient refrigerator models, were disbursed to the three companies in 2004 and 2005. The selection of the Principal Award winner was made, and a contract signed, in 2004, with the Kelon refrigerator manufacturing company, though Kelon encountered some difficulties, unrelated to the project, that has kept it from fulfilling all of the terms of the Principal Award⁶. Final notice of the Principal Award recipient is to be made in November, 2006. The overall process of the refrigerator manufacturer incentive activity appears to have proceeded smoothly and has resulted in much-enhanced competition between major manufacturers to produce and promote the purchase of energy-efficient refrigerators.
- Revision of refrigerator energy efficiency standards. A subcontract with the China National Institute for Standardization was awarded in 2001. New, more stringent standards for residential refrigerators (and freezers) and for residential air conditioners were developed, and ultimately approved, and were implemented by late 2003. The standards revision activity was completed to the apparent satisfaction of all organizations involved, and represented a significant step forward in the regulation of the energy efficiency of consumer devices in China.

4.1.2 “Market Pull” Activities

Recognizing that effective commerce requires both buyers and sellers of goods to be ready to participate at the same time, the Project was designed to address the problem of refrigerator efficiency not only through spurring the development and manufacturing of energy-efficient refrigerators, but also by assuring a market for such units. The “market pull” activities included in the Project, and their relationship to each other, are shown in Figure 4-2⁷.

⁶ A Kelon company official was indicted for misuse of company funds in mid-2005, however, and in the resulting investigation the company’s suppliers and bankers suspended shipments of materials and froze company assets, requiring manufacturing to shut down temporarily. By decision taken at the Project’s 2005 TPR meeting, Kelon was allowed to shift the final three months of its production “window” for producing the required number of energy-efficient refrigerators from the original Jun-Aug 2005 period to Jan-Mar 2006, but Kelon was unable to produce the required number of units by the time the extended schedule lapsed (due to continuing difficulties with receiving supplies of materials), though Kelon did meet both the vast bulk of its production target as well all of its other required goals (advertising budget share devoted to energy-efficient products, consumer consciousness raising).

⁷ Figure 4-2 is derived from Sun Xuefeng, PMO Manager, Barrier Removal for the Widespread Commercialization

Summaries of the implementation of these activities are provided below.

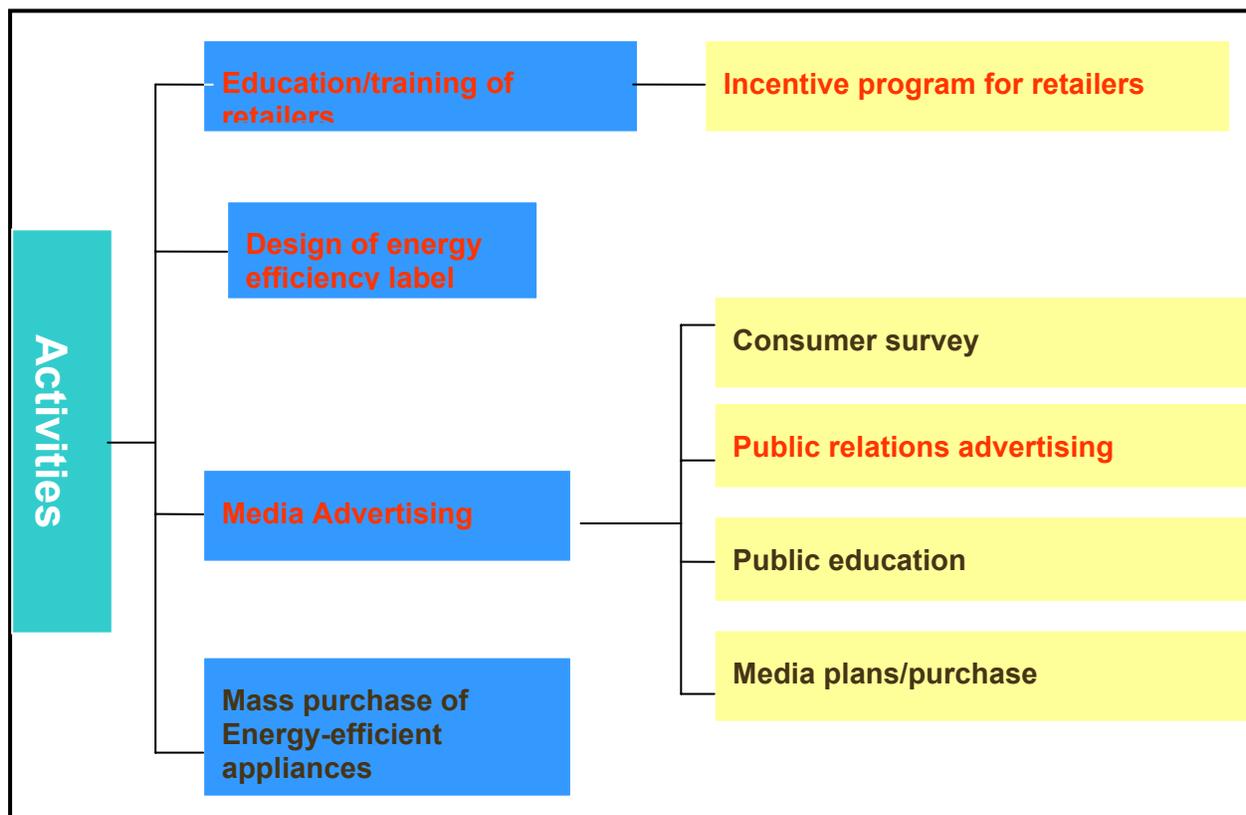


Figure 4-2: Schematic of “Market Pull” Activities

- Education of retailers and retailer incentive program. Detailed planning for a program to educate retailers, focusing on the large retail electronics and appliance stores that dominate in major urban markets in China, was initiated in late 2003. This program included provision of training on the linkages between appliance energy-efficiency, environmental impacts, and consumer electricity bill savings, including discussions of the new refrigerator efficiency standards. The training focused on how to communicate these ideas meaningfully to consumers. Concurrent with the retailer education program, a program of retailer incentives was developed and implemented, resulting in the disbursement of over \$250,000 in project funds to participating retailers, and to refrigerator customers who participated in prize drawings. Customers participated in prize drawings by filling out forms and mailing them to CHEAA. CHEAA staff checked the forms for accuracy, and customers whose forms were found to be complete were entered into a drawing for cash prizes and other awards. The retailer education and incentive activities took place mostly during 2004, with retailer awards under the program presented in early 2005. The retailer education and incentive activities under the Project appear to have been well-implemented and enthusiastically received by

of Energy-efficient CFC-free Refrigerators in China, presentation delivered to the Evaluation Mission on Oct. 9, 2006.

both retailers and the staff of retail stores.

- Energy-efficiency labelling for key household appliances. A key component of the public education campaign under the project was the development of labels, identifying an appliance (refrigerator, refrigerator/freezer, or air conditioner) as meeting minimum energy efficiency standards and achieving a rating of level 1 (most efficient) to 5 (least efficient), based on a rating system that adjusts for the size of the appliance and other parameters. Regulations to support the labelling standard were completed in late 2004 with the support of NDRC, AQSIQ and CNCA, and the labelling system was placed into force in early 2005. This element of the project took somewhat longer than expected to complete. Based on the input received during the Evaluation Mission, this delay seems to have been primarily due to the difficulty involved in achieving consensus between the different government agencies involved on the different aspects of the labelling standards, including whether mandatory certification or voluntary reporting (by manufacturers) would be used to determine grade levels for specific models. With the exception of this delay, the labelling activity was completed to the apparent satisfaction of all parties, and retail outlets report that the labels are very effective in guiding consumers to energy-efficient appliances.
- Public awareness (media) campaign and related activities. Starting in approximately 2002, a public awareness activities coordinated by CHEAA were carried out, including preparation of a 20-minute video promotion piece that was ultimately shown on CCTV, development of media releases for newspapers and magazines in selected urban markets, and radio broadcasts designed to explain and promote the project. Print materials for retailers to distribute to customers, such as “flysheets” touting the environmental benefits of purchasing efficient refrigerators, and “pockets”, featuring the GEF logo and project slogans, for refrigerator brochures and other materials taken home by customers, were also developed and distributed as a part of this campaign. Promotional key-chains, also including project logos and slogans, were also developed and distributed to consumers as a part of the CHEAA effort⁸.

Starting in 2003, additional media activities associated with the public awareness campaign included “before” and “after” consumer awareness surveys, which were used to track consumer understanding of energy efficiency (and thus the results of media campaigns), the development of a public advertising campaign to make consumers aware of the environmental and economic benefits of energy-efficiency refrigerators, and a program of public relations designed to spur newspaper coverage of energy-efficient refrigerators. Consumer awareness surveys were developed and carried out by the firm TNS, first in late 2003, and with a follow-up survey in early 2005 intended to gauge the effectiveness of the public relations campaigns. A contract with McCann-Erickson Guangming Ltd. was signed in early 2003. McCann-Erickson undertook and completed in 2003 a media development and placement plan, and the design of advertising for placement in TV, newspaper, signage (including underground, and bus-stop placements), and other media. Placement of media ads was done through a contract with Zenith Optimedia, signed in 2003. Media ads were aired and placed for approximately one year, from late 2003 through late 2004. CHEAA was subcontracted in 2002 to produce press releases and other materials on the theme of

⁸ China Household Electrical Appliances Association, Barrier Removal for the Widespread Commercialization of Energy-efficient CFC-free Refrigerators in China: Report on the sub-project undertaken by CHEAA. 2006.

refrigerator energy efficiency for use in newspaper articles and broadcast media, resulting in the publication of 240 newspaper articles by the count published in one project report (and 330, including both national and local newspapers, according to another project report), 20 magazine articles, 300 or more articles republished on web sites, and 12 broadcast pieces during 2003⁹. Project participants interviewed by the Evaluation Mission indicated that the Project's public awareness campaign proceeded smoothly.

- Mass purchase of energy-efficient appliances by Government agencies. A subcontract signed with the China Energy Conservation Product Certification Center (CECP, a part of CNIS) and CHEARI led to the inclusion, in late 2004, of about 280 models of energy-efficient refrigerators on the “government purchase list for energy efficiency products” authorized by the State Ministry of Finance (MOF) and NDRC.
- Development of business plan for co-funded refrigerator buyback/recycling program. An additional planned “market push” activity was to prepare a business plan for pilot installation of a program to “buy back” used refrigerators (for example, those no longer needed by buyers of energy-efficient units), recycle components that could be recycled, and dispose of other components properly. Although a proposal for this activity was apparently prepared, the hoped-for (non-UNDP/GEF) co-funding for the project was not ultimately obtained, and the project was not carried out¹⁰. This lack of success represents a significant lost opportunity to permanently remove poor-efficiency, older refrigerators from use in China (and, in some cases, from other countries), and possibly to capture remaining CFC refrigerants in these units for proper disposal. (Please see reference to this program in the “Recommendations” section of this Evaluation Report.)

4.2 Quality of Monitoring, Internal Evaluations, and Project Communications

The monitoring processes related to disbursement of funds, as well as to monitoring of Project progress, were reported by project participants interviewed by the Evaluation Mission to have been clear, and were appreciated as a key means of keeping project elements on track and making sure that funds were spent as intended. Internal evaluation of many different individual project elements took place during the project, in addition to annual reviews (reflected in Annual Project Reports). No problems were identified with any of these processes.

Project communications were also generally reported to be clear, particularly between Project management and other participants, and explicit inclusion of multiple stakeholders in project management and implementation has been much appreciated. For example, inclusion of representatives of refrigerator manufacturers in developing new standards was identified by an interviewee as crucial to assuring that the resulting standards were workable. One interviewee in the refrigeration industry reported occasional difficulty, due primarily to language issues, in communicating with UNDP's international experts during a previous (CFC elimination) refrigeration technology project, and emphasized the importance of the involvement of

⁹ Another project report indicates 17 radio broadcasts related to the project activities and goals were delivered as well (CHEAA 2006 report cited in the footnote above).

¹⁰ As described in UNDP, Annual Project Report (APR) for UNDP/GEF Projects, 2006: Barrier Removal for the Widespread Commercialization of Energy-efficient CFC-free Refrigerators in China, draft report dated June, 2006.

representatives of national appliance-related organizations and national technical experts in this Project as providing valuable go-betweens linking project management, international technical experts, and refrigeration equipment manufacturers. Another participant reported some delays in receiving feed-back on documents submitted to the PMO at SEPA, and wondered whether the several changes of Project Manager at the PMO might have contributed to the delay. In at least one instance, a project participant (subcontractor McCann-Erickson) apparently did not receive information from an earlier consumer survey that could have been of use in designing the public awareness media campaign, although McCann-Erickson doubted that the results would have changed the media approach much. This suggests that there were some minor instances where information flow between project participants was less than ideal, but such occurrences are hardly unexpected in a project of this scope. Still, it represents an indication that there was at least some room for improvement in project communications.

The Evaluation Mission's interview with the Audit Service Center for Foreign Loan and Assistance Projects, Auditing Division II (referred to here as the "Audit Center" for simplicity) indicated that the Audit Center had carefully reviewed the accounts of the project and the reports provided by project participants, and found the accounts to be, with very few exceptions, accurate, complete, and according to UNDP and PMO standards. Communications regarding the project accounts between the Audit Center, the PMO, and other project participants were reported to be smooth and clear. The Audit Center described four minor instances where project participants—manufacturers receiving awards—had not initially used correct accounting procedures, or had not correctly identified purchased equipment as having been underwritten by Project funds. These errors, when brought to the attention of the Project participants in question, were easily and quickly rectified.

The Project Information Center, established early in the Project, had the mandate to collect at least much of the project outputs, and make Project information available on the project web site. Project participants described the Project Information Center as a useful communications tool between project participants, including as a clearinghouse for information. The Project Information Center, supported by CHEAA, collected baseline and continuing data on performance, as well as other technical information related to refrigerators and compressors from participating manufacturers. The Project Information Center also collected data on all parties' sales of refrigerators, and served as a web source of information for project participants and others. The only suggestion offered regarding the Project Information Center was that it could have provided more in the way of technical reference material.

Testing of manufacturers' claims for energy-efficient performance of compressors and refrigerators was carried out by the China Household Electric Appliances Research Institute. These tests included confirmations of pre-project performance of units, carried out starting in 2000, and of improved and, ultimately, award-winning models, carried out through September of 2006. These tests appear to have been implemented smoothly, and the target number of tests specified in the Project Document was exceeded during the project period¹¹.

¹¹ China Household Electric Appliances Research Institute, Testing Mission Report of UNDP/GEF Project Test Agency from 2000 to 2006. Presentation delivered to the Evaluation Mission on October 11th, 2006.

5. PROJECT RESULTS

This section of the Evaluation Report examines the results of the Project, including project relevance and efficiency, project outputs and attainment of milestones/objectives, the attainment of development objective, project effectiveness, capacity building, the estimated impact of the project on electricity use and greenhouse gas emissions in China, and Project sustainability and post-project follow-up by Project participants.

5.1 Relevance

The purpose, approach, and general modalities of execution of the Project were relevant when the Project was formulated, and remain relevant today. The counterpart organizations, starting with SEPA, called upon to manage the Project and to fulfill key roles in the project were well-chosen, and remain central to the issue of influencing refrigerator (and other appliance) efficiency in China, and, through China's exports, to much of the world.

5.2 Efficiency

Project efficiency is interpreted here in two different ways. The first pertains to how well the Project has been managed and implemented. The second pertains to the degree to which the project's efficiency was multiplied by leveraging non-project resources to help accomplish Project aims, notably in the areas of technology development and raising public awareness.

5.2.1 Project management and implementation

Project participants interviewed by the Evaluation Mission have uniformly described the project as being well managed and implemented, with generally clear communications and a transparent and consistent management allowing for efficient project progress. The Evaluation has heard not complaints to date regarding the way that project budgeting, disbursements, or hiring have been carried out. The Evaluation Mission is not equipped with either the data or the background, however, to determine whether funds spent for all service subcontracts under the project have been at suitable cost levels. Where subcontract costs have been cited in project reports, and the Evaluators had sufficient perspective to render an approximate judgement, those costs have seemed reasonable. An area where the international evaluator certainly lacks the expertise to render a judgement of the efficiency of funds spent is in the area of the media advertising development and ad placement for the public awareness campaign. These two subcontracts constituted over one-quarter of total GEF funding for the Project.

5.2.2 Leveraging of donor funds for technology development

The initial Project Document projected a ratio of total project expenditures to UNDP/GEF donor funds of over four to 1 (~USD 40.9 million total funds, of which 9.6 million was to be provided by UNDP/GEF). Despite the fact that \$200,000 in Project co-funding was ultimately not obtained, the projected substantial leveraging of donor funds was achieved, and appears to have been substantially exceeded, largely through the enthusiastic response of the manufacturers (compressor and refrigerator) involved in the Project. Figure 5-1, below, show the project-related investments made by just one participant—Dongbei Huangshi Compressor Company. Here the facilities, research, and market development investments made by the

Company in its line of high-efficiency compressors exceeded the value of the incentive won by the company by a ratio of nearly 20 to one. Several machines used in the production of high-efficiency compressors by Dongbei Huangshi were purchased at least partly using the proceeds of the UNDP/GEF award to the company, and are identified as such with insignia such as the darker green plate at the upper right corner of the picture of the grinding machine shown in Figure 5-2¹². Similarly, investment by Kelon in developing energy-efficient refrigeration products exceeded by more than 50-fold the value of the total awards won by the company (not all of which have been disbursed). Spending on advertising of energy efficient appliances by Kelon alone dwarfed the direct public relations spending by the Project, further indicating the Project's use of leverage in its information campaign. The Haier Corporation reported increases in annual investments related to energy-efficient refrigerators between 2000 and 2006 of about three-fold for human resources investments, eight-fold for development funding, 20-fold for market exploration, and 7-fold for mould-making expenses¹³.

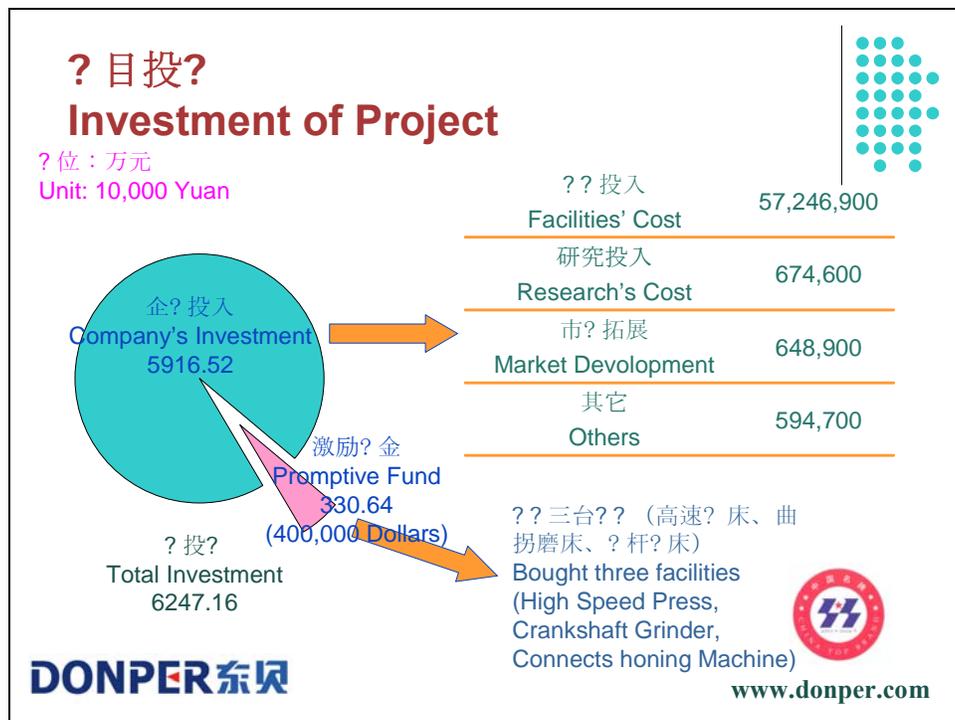


Figure 5-1: Example of leveraging of project funds: Investment in energy-efficient compressor development, marketing, and production facilities by Dongbei Huangshi relative to Project funds received

¹² Figures 5-1, 5-2, and 5-3 through 5-6 are taken from the presentation provided to the authors by Dongbei Huangshi Compressor Company on October 13, 2006.

¹³ Based on data in the presentation provided to the authors by Haier Company on October 18, 2006. A seven-fold increase in mould-making expenses means that investments in mould making for energy-efficient refrigerators by Haier were seven times higher in 2006 than in 2000.



Figure 5-2: Example of production equipment purchased with Project funds: precision machinery from Japan in the Dongbei Huangshi compressor factory. UNDP/GEF label appears under the “MORARA” logo at upper right.

5.2.3 Leveraging of Public Awareness Efforts

Project funds spent on public awareness efforts have been highly leveraged in both magnitude and in duration by the marketing funds spent on energy-efficient refrigerators (and components) by project participants. The Principal award winner among refrigerator manufacturers (Kelon) reports spending 80 percent of its advertising budget in recent years on advertising energy-efficient refrigerators. The Supplemental Award winner among refrigerator manufacturers reports spending up to 96 to 99 percent of its budget for advertising refrigerators during 2005-2006 on advertising energy-efficient models¹⁴.

5.2.4 Leveraging of Project Training Funds

Project training funds were and continue to be substantially leveraged by ongoing and additional training by manufacturers. The manufacturers interviewed by the Evaluation Mission reported that their participation in the Project has encouraged them to press forward with more active and effective programs of training (including external training and bringing both national and international experts to the company). In addition, the staff trained during the Project have uniformly reported working to train co-workers, thus passing on the information and know-how that they received in their own training under the Project.

¹⁴ Although, to place this value in context, only about 2 percent of the refrigerators reported sold domestically by Haier in 2006 failed to meet the energy-efficient definition.

5.3 Outputs of Project—Attainment of Objectives and Milestones

5.3.1 Compressor Efficiency Improvement

The compressor efficiency improvements achieved under the project exceeded both project expectations and, for the vast majority of products included in competitive bids by winning companies, the “bid” levels equalled or exceeded bid values. Compressor efficiencies have continued to improve as a result of the Project, with the most efficient compressor currently produced by Principal Award Winner Project Participant Dongbei Huangshi achieving a COP of 1.95, reportedly a world-leading value. Figure 5-3 shows the degree to which compressor models included in the bid package by Dongbei Huangshi met or exceeded the COP values bid by the company, and Figure 5-4 summarizes high-end improvements in compressor COPs by Dongbei Huangshi under the project¹⁵.

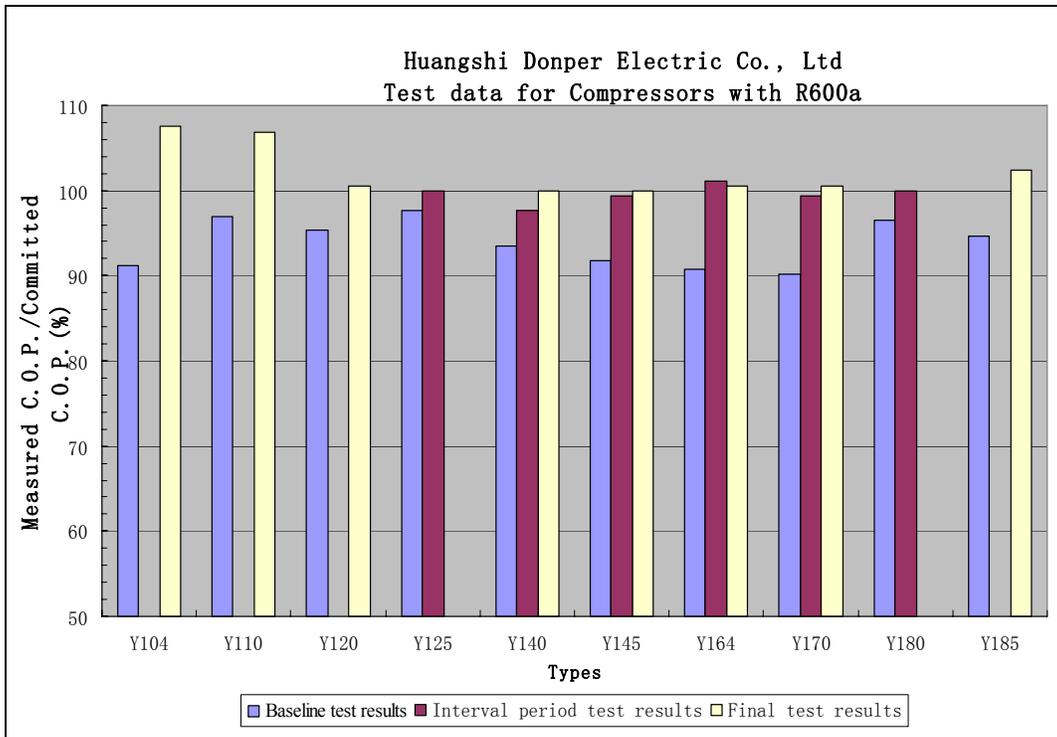


Figure 5-3: COPs of Compressors included in bid package by Dongbei Huangshi. Fraction of “Committed” COP values by baseline and tested compressors are shown.

¹⁵ Figure 5-3 from China Electric Household Appliances Research Institute, Testing Mission Report of UNDP/GEF Project Test Agency from 2000 to 2006.

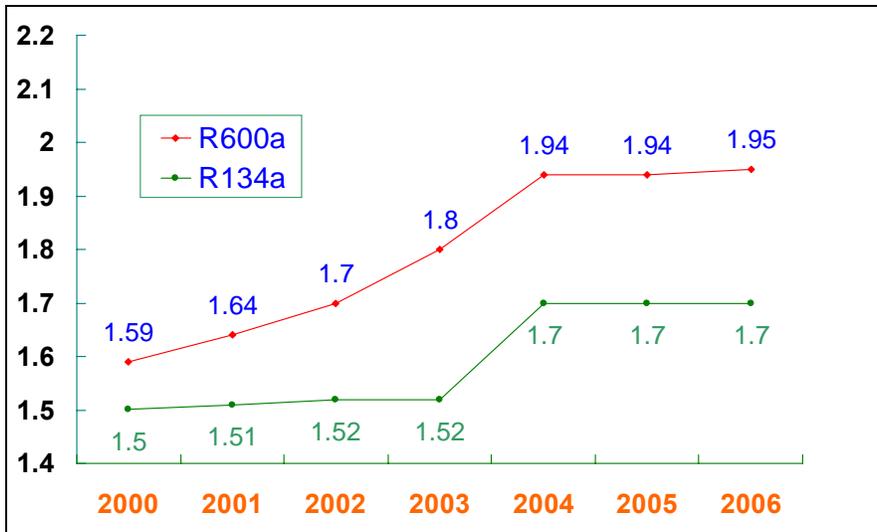


Figure 5-4: Evolution of COPs of highest-efficiency compressors produced by Dongbei Huangshi over time. “R600a” denotes (CFC-free) units using that compound (isobutane) as a refrigerant, while “R134a” denotes compressor using R-134a, a HFC compound.

5.3.2 Sales of energy-efficient compressors

Sales of energy-efficient compressors, as implied by the COP figures above, have vastly exceeded target levels. Figure 5-5 shows the degree to which sales of such compressors have exceeded targets (except for in 2003, due in part to refrigerator makers not yet being ready with the design of refrigerators to accept high-efficiency compressors. Figure 5-6 shows that energy-efficient compressors have rapidly and steadily increased their share of Dongbei Huangshi’s sales.

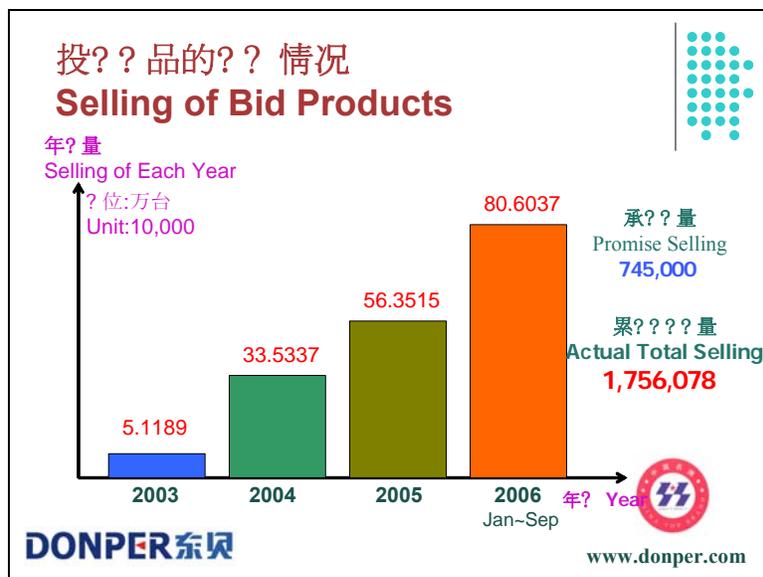


Figure 5-5: Actual sales of high-efficiency compressors versus bid target by the Dongbei Huangshi compressor factory

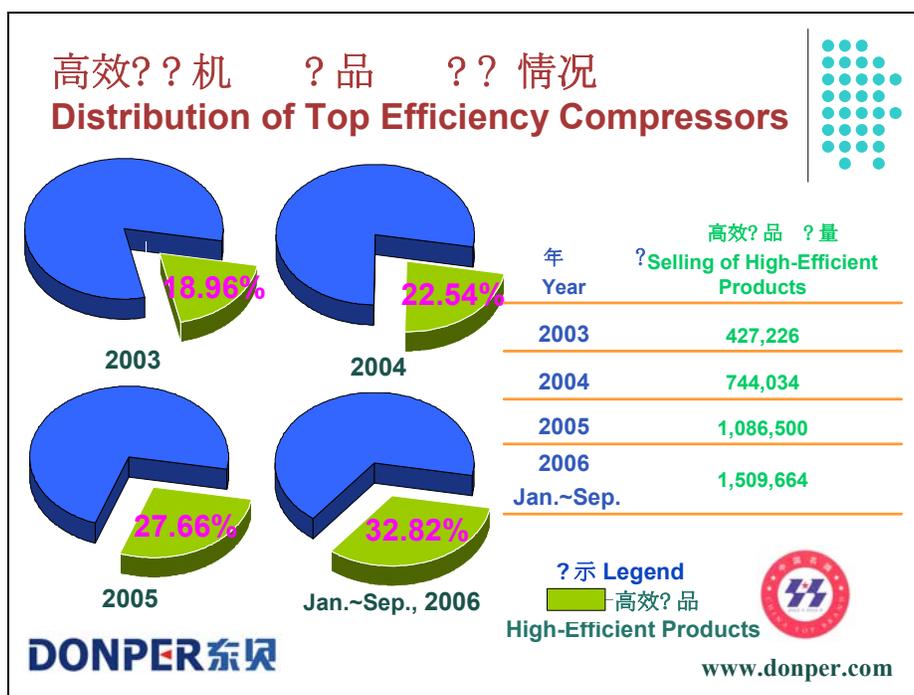


Figure 5-6: Sales of high-efficiency compressors as a fraction of total compressor sales by the Dongbei Huangshi compressor factory.

5.3.3 Refrigerator efficiency improvement

Like compressor efficiency improvement, refrigerator efficiency improvement has exceeded expectations, with models from at least two manufacturers achieving energy coefficient of less than 0.3 (that is, using less than 30 percent of the energy of a similar-sized unit that just meets standards) available by in 2005. Some current models have energy coefficients as low as 0.21, which is a striking improvement from pre-Project conditions. More importantly, there has been a significant shift in the average efficiency of refrigerators produced and sold, as indicated in the tables shown below.

5.3.4 Sales of energy-efficient refrigerators

The top two manufacturers receiving awards under the Project together (ultimately) exceeded targets and goals for both production of energy efficient refrigerator models included in their bids to the project, and for the energy efficiency of those models. For both Kelon and Haider, energy-efficient refrigerator/freezer models have become mainstream top-sellers, and are highly profitable products for the companies. Tables 5-1 and 5-2 show, respectively the energy efficiency and production of the bid models produced by Kelon (totaling about 750,000 units from March 2004 through February 2005), and the sales by year by efficiency category for Haier¹⁶. Table 5-2 shows that Haier's production has shifted over the years to the point where,

¹⁶ Tables 5-1 and 5-2 taken from presentations provided to the Evaluation mission by Kelon and Haier on October

while in 2000 only 35 percent of refrigerators produced met the (current) standards for “Grade 1” units (energy intensity coefficient of 0.55 or less), by 2006 (for the first nine months of the year), 91 percent of Haier’s production met Grade 1 standards.

Refrigerator Incentive Program "Principal Award"									
Bidding Products from March 2004 to February 2005									
English name		GuangDong Kelon Electrical Holdings Co.,Ltd.							
Bid Model #	Type (Model and size)	cubic volume(L)	freezer volume (L)	refrigerator volume (L)	Energy consumption Allowed by Standards (kWh/24h)	Baseline production (*10^4)	March 2004 to February 2005		
							Energy consumption (kWh/24h)	EEI	sales (*10^4)
1	BCD-110	110	36	74	1.03	0	0.67	65.0%	3.66
2	BCD-142	142	50	92	1.13	0	0.68	60.2%	2.40
3	BCD-152	152	50	102	1.15	0	0.69	60.0%	1.08
4	BCD-161	161	60	101	1.18	0	0.55	46.6%	22.42
5	BCD-171	171	60	111	1.2	0	0.58	48.3%	20.24
6	BCD-181	181	75	106	1.26	0	0.67	53.2%	10.16
7	BCD-201	201	75	126	1.29	0	0.69	53.5%	7.39
8	BCD-218	218	64	154	1.3	0	0.79	60.8%	1.35
9	BCD-226	226	62	164	1.31	0	0.7	53.4%	1.14
10	BCD-238	238	64	174	1.34	0	0.79	59.0%	1.02
11	BCD-246	246	62	184	1.35	0	0.69	51.1%	0.54
12	BCD-258	258	85	173	1.42	0	0.82	57.7%	0.13
13	BCD-276	276	85	191	1.46	0	0.88	60.3%	0.93
TOTAL									72.46

Table 5-1: Production of and specification s for “bid” refrigerator models by Kelon, March 2004 through February 2005. “EEI” denotes Energy Efficiency Index.

16 and 18, 2006, respectively.

Energy-efficiency coefficient η (GB12021.2-2003)	Production Quantity (Unit)						
	2000	2001	2002	2003	2004	2005	2006 Jan.-Sep. 2006
1.0< η	130232	9175	36015	0	0	0	0
0.9< η =1.0	289025	261277	246382	30768	0	0	0
0.8< η =0.9	94915	122909	258545	228830	139645	0	0
0.7< η =0.8	494219	382267	340057	416312	209467	112401	33318
0.65< η =0.7	107228	38931	63331	95911	160591	149868	64638
0.6< η =0.65	115884	192514	479826	677631	768046	19558	199910
0.55< η =0.6	211461	176685	350075	758529	986980	824272	333184
0.5< η =0.55	377451	445425	724202	724568	1024612	1298942	1199463
0.4< η =0.5	360407	609664	235374	382652	2226625	3297090	3198568
0.3< η =0.4	26496	93548	44206	86348	907691	1139331	1034870
0.2< η =0.3	0	0	0	8967	558579	651925	599731
η Minimum	0.33	0.33	0.33	0.26	0.22	0.22	0.21
Total Sales	2207318	2332395	2778013	3410516	6982236	7493387	6663682
Sales $\eta > .55$	65%	51%	64%	65%	32%	15%	9%
Sales $\eta = .55$	35%	49%	36%	35%	68%	85%	91%

Table 5-2: Production of refrigerators versus energy efficiency coefficient for the Haier Company, 2000 - 2006

5.3.5 Standards and label development

Refrigerator, freezer, and air conditioner standards successfully developed, paving the way (among agencies that must collaborate to produce and approve standards) for effective standards development in the future (for appliances and beyond). Energy labels developed, and the point-of-sale information materials that have accompanied label introduction, have been effective tools for communicating energy efficiency concepts to consumers, as well as being effectively used (and well-understood) by retailers. Figure 5-7 provides a sample of the labels (here, uncharacteristically, for a refrigerator not meeting the “grade 1” or “grade 2” criteria) that are used to help consumers to distinguish more-energy-efficient from less-energy-efficient appliances. The labelling system, and the appliance efficiency grading system on which it is based, is clear and understandable. Some recommendations on how the labelling system might be upgraded for better use with freezers, and to better communicate the superior energy efficiency of the very best refrigerators, are provided in section 7, below. Table 5-3 shows the correlation between energy efficiency coefficients and Grade levels for refrigerators and freezers, based on current standards and certification levels.



Figure 5-7: Example of refrigerator energy label

Fraction of Maximum Electricity Consumption	
$\eta \leq 55\%$	1
$55\% < \eta \leq 65\%$	2
$65\% < \eta \leq 80\%$	3
$80\% < \eta \leq 90\%$	4
$90\% < \eta \leq 100\%$	5

Table 5-3: Designations of grade levels for refrigerator energy label. Here η is the percentage of the energy consumption of a refrigerator of equivalent size just meeting standards.

5.3.6 Raising of public awareness of link between energy efficiency and environmental impacts

Anecdotal evidence—in the form of verbal retailer reports, and reports of the timing of

increased sales of energy-efficient-refrigerators by manufacturers as they related to the timing of the Project's public awareness campaign, suggest that the Project's media campaign was effective in raising consumer consciousness about the linkage between refrigerator purchase, the environment, and energy/economic savings. The Project's media campaign included work in 2002 coordinated by CHEAA to prepare a video on the Project that was shown on CCTV, prepare of press releases resulting in hundreds of newspaper and magazine articles, preparation of radio broadcasts related to the Project, retailer training and sales contests to introduce the market to the environmental and economic benefits of energy-efficient refrigerators, customer drawings for prizes, and give-aways of promotional literature and key chains with the Project's message and logo at appliance points of sale. Based on the assessment of CHEAA, these media efforts resulted in an increase in awareness of the benefits of energy-efficient refrigerators on behalf of the buying public¹⁷.

TNS, the firm retained to assess, via a survey of about 1600 households in five cities, the Project's 2003 media campaign (with advertisements designed by McCann Erickson Guangming Ltd.), included the following among its main conclusions from the survey:

“Unlike in 2003, when ‘environmentally friendly refrigerators’ was mentioned by people, the first concept came to them was ‘energy-efficiency’, ‘CFC-free’ could only be the second. The correlation level between ‘energy saving’, ‘economic use’ and ‘environmentally friendly refrigerators’ had been increased.”¹⁸

Other empirical evidence collected by TNS, however, seems to indicate that the impact of the media campaign was in some cases mixed. For example, the survey showed a significant increase in the fraction of respondents who said that they realized that purchasing an energy-efficient refrigerator was good for the environment, but other some metrics denoting the reach and success of the 2003 media campaign were practically unchanged, or went up or down only slightly. It is clear that the 2003 media campaign had a net positive effect on consumer attitudes. The TNS report, does, however, offer some useful ideas as to how the 2003 media campaign might be improved, some of which are echoed in section 7 of this Evaluation Report.

Examples of print media ads prepared by McCann Erickson are provided in Figure 5-8

¹⁷ China Household Electrical Appliances Association, Barrier Removal for the Widespread Commercialization of Energy-efficient CFC-free Refrigerators in China: Report on the sub-project undertaken by CHEAA. 2006.

¹⁸ TNS Consultants (individual authors, Chirantan Ray, Dilys Du, Jason Xie, Shawn Wang), CONSUMER AWARENESS TRACKING ENERGY EFFICIENT REFRIDGERATORS IN CHINA: Report Post-campaign Survey. Prepared for: United Nations (UN) & State Environmental Protection Administration China (SEPA), Jan. 2005, Job #: 10995.



Figure 5-8: Examples of print advertisements prepared for the Project by McCann Erickson Guangming, Ltd.

Based on a summary by CHEAA’s of the subproject managed by CHEAA (see reference above), the Project Information Center’s web offerings, including a collection of the data on energy-efficient refrigerators submitted by manufacturers, has been useful in compiling data needed to evaluate the project, and in providing information to project participants. The Evaluation Mission has not yet been able, however, to access an English version of the Project Information Center website to make a direct assessment of the current offerings there.

5.4 Development Objectives

5.4.1 Impact on government policies

The Project has had a significant impact on government policies, including the direct impact of getting standards and labels implemented, and indirect impact of setting up pathways and connections for more effective energy-efficiency policy development in the future. Both these direct and indirect impacts are extremely important. Without the Project, and the involvement of UNDP/GEF in the Project, it is likely that the crucial connections across agencies between upper-level policymakers in the relevant organizations, mid-level staff responsible for designing and implementing standards and testing, and appliance manufacturers (who provided input so as to assure that standards could in fact be practically implemented) would not have been established as quickly and firmly. It is expected that the organizational connections

developed under the project will make future standards and labelling programs for additional classes of appliances in China, and perhaps for other types of energy-using devices (ranging from electronics to commercial buildings) quicker and easier to develop and implement. Further, the positive publicity for energy efficiency generated through and by the Project is also likely to provide policymakers with a greater impetus to develop and implement standards for new devices. The ultimate impacts on China's greenhouse gas emissions of these types of changes in the way that government policy is made is difficult, of course, to estimate quantitatively, because the impacts can be quite far-reaching. To provide just one example, if nationwide standards for residential building energy performance are brought into being, as a result of the Project, two years earlier than they would have been without the policymaking capacity developed under the project, the net annual savings would very likely be in the range of tens of millions of tonnes of CO₂-equivalent per year.

5.4.2 Gender Issues

At the National level, women have clearly played key, and often pivotal, roles in this Project. Women have been heavily involved in management and administration of the project through positions in SEPA and the PMO, and have been central to the work of most of the organizations, including government/quasi-government and commercial (manufacturers, retailers) visited by the Evaluation Team. Women have also been active as trainees in both in-country and overseas technical courses, although the Evaluation Mission does not have sufficient information to definitively ascertain that the Project Document goal that 30 percent of trainees be women have been specifically met, though anecdotal information suggests that actual participation by women trainees has been close to half that value (15 percent). As in most countries, more engineers tend to be men than women, but women engineers are not uncommon in China, and a clear effort has been made by the Project to actively recruit women for positions in training events.

The Evaluation Mission has not yet reviewed documentation that would allow us to conclude that gender balance has been a priority in the selection of international consultants—it seems that most if not all international consultants have been male—but a significant fraction of national consultants (including one of the members of this Evaluation Mission) participating in the Project are female.

5.5 Effectiveness

The Project has been highly effective in reaching its main goals—namely, getting much higher-efficiency refrigerators into the hands of Chinese consumers. The average energy intensity of new refrigerators sold dropped by nearly 29 percent between the Project's inception in 1999 and the end of 2005. In the process, the Project has transformed the Chinese refrigerator industry, making energy-efficiency a central (and profitable) goal of refrigerator design for manufacturers.

5.6 Capacity Building

5.6.1 Capacity building in government and quasi-governmental institutions

The Project has built significant capacity for Project formulation and management among

the government institutions, led by SEPA, that have been involved in the Project. Capacity has also been built in organizations like CNIS and CHEARI that are involved in appliance testing, and formulation of standards and labels, as well as in organizations like CHEAA, involved in information gathering and public outreach.

5.6.2 Capacity building in commercial enterprises

The Project has most definitely built capacity within commercial enterprises through its technical training activities, as well as through the processes required of enterprises as they complied with Project rules and regulations. This capacity building includes (but is not limited to):

- Capacity among compressor manufacturers to develop staff with internal and external training, and to plan and carry out research and development efforts, get new products into production quickly, and market new energy-efficient products..
- Capacity among refrigerator manufacturers to develop staff with internal and external training, and to plan and carry out research and development efforts on new refrigeration products, to get new products into production quickly, and market new energy-efficient products.
- Capacity among appliance retailers and their sales staff to incorporate energy-savings and environmental elements in their appeals to customers, and to understand and make clear to customer the meanings of appliance standards and labels.

Connections between the different project participants that have been built under the Project are also important elements of built capacity. Connections across both the upper levels of the involved institutions (governmental, quasi-governmental, and commercial institutions) and across the mid-levels (division managers, engineers, and other technical experts) within these organizations will serve China well in the future.

The evaluation mission was unable to determine whether the capacity built by the Project (and capacity-building trends started by the Project) among manufacturers spilled over into the manufacture of other types of appliances (beyond refrigerators and freezers). In the case of Dongbei Huangshi, for example, the company does not (yet) make compressors for markets other than refrigeration, though the Project has certainly helped to improve the company's capacity to make compressors for some non-residential markets. At Kelon and Haier, the air conditioning research and development divisions, for example, seem to be largely separate from the refrigeration divisions, so an effort on the part of upper management of those companies will be needed to extend the capacity-building benefits of the Project to other divisions so as to improve the energy-efficiency of other appliances and equipment produced by Kelon and Haier.

5.7 Impact on Electricity Use and Greenhouse Gas Emissions in China

Several calculations of GHG emissions savings appear in different documents related to the Project, and not all agree. The Evaluation Mission has not yet reviewed the bases for all of these estimates, but offers the following general overview of calculation procedures, and a rough, initial estimate of CO₂ emissions savings.

The calculation of electricity use and greenhouse gas impacts of the Project requires the estimation of several parameters, which we will define as:

N, the number of refrigerators sold that have been improved relative to what would have occurred in the absence of the project

Delta-kWh, the electrical energy saved per year, on average, for the N refrigerators (Delta-E may vary by year)

EF, the average Emission Factor that can be expected in terms of CO₂ per kWh generated (note that this is a composite that includes assumptions about fuel mix and efficiency of the electricity generation avoided by the use of more efficient refrigerators. Embedded in the emission factor is also an assumption about which generation units are likely to be avoided (not run, or run less) if power needs are reduced due to energy-efficiency measures. An EF of 1.5 kg of CO₂ per kWh of electricity generated is used in the Project Document, and will also be used here at present (though in fact this value will change, if slowly, over time, as the types of generation capacity in China shift).

L, the average lifetime, in years, of the energy-efficient refrigerators purchased. This may be modelled as a point value, or a distribution.

Note that N and Delta-kWh are paired, and must be defined consistently. If N is the total number of refrigerators sold in China over a given period, Delta-kWh is then the average improvement in refrigerator efficiency over the entire stock of refrigerators sold. If N is used only to count sales of energy-efficient refrigerators, then Delta-kWh is the increment between the energy intensity of the likely average refrigerator purchased in a given year, and the energy intensity of an average energy-efficient unit. There is also a choice made in deciding how many years of data to include in N. When can the effects of the Project be said to have begun? When should they be considered to end? First-order assumptions have been made for all of these parameters by the Evaluation Mission, and have been included in an Excel workbook used to calculate electricity and emissions savings from the Project. A printout of this workbook can be found as an Attachment to this Report. Note that the emissions calculated do not include the greenhouse impacts of non-CO₂ gases, of which methane is the most important for this calculation. Including these gases would increase Project GHG emissions savings somewhat (perhaps a few percent).

5.7.1 Quantitative impact on electricity consumption and generation in China

Based on the assumptions described in the box below, and with refrigerator improvement trends as shown in Figure 5-9, the Evaluation Mission estimates that by 2005, the Project has resulted in the savings of 9.4 TWh of annual electricity generation (measured at the power plant) annually from the improvement in efficiency of new refrigerators produced in China. By 2010, projected cumulative annual savings from refrigerators purchased through that year are estimated at 36 TWh, meaning that the Project will have replaced, by that time, the need for approximately 10 600 MW coal-fired power plants. These estimates take into account savings both in China and from exported units. It should be kept in mind that any calculation of energy (and greenhouse gas emission) savings from a Project such as this one, which has focused on changing the patterns of an industry and a market, have uncertainties associated with them, perhaps the greatest of which is uncertainty as to what efficiency trends in the refrigerator market would have been in the absence of the Project. A brief discussion of areas of uncertainty in the calculation of Project-related savings is provided in section 5.7.3, below.

REFRIGERATOR ENERGY USE

Estimated kWh/day per unit energy index, for ~200-liter model: 1.29 (Unit just meeting standards)
 Assumed efficiency in absence of project 79.40% in 1999, declining at an average (linear) rate of 0.50% per year even in the absence of the Project.
 Improvements in efficiency assumed to continue at 2% as a result of the Project (post-Project conditions)
 Average refrigerator lifetime 15 years
 Average rate of sales growth, 1999 to 2005 16.45%/yr
 Assumed average rate of sales growth, 2006-2010 13.00%/yr (slightly lower than recent experience, as urban markets become saturated)
 Assume that losses in transmission and distribution are 10% of generation (will be higher in rural areas), so savings at generator will be higher by a factor of 1.11 than end-use savings.

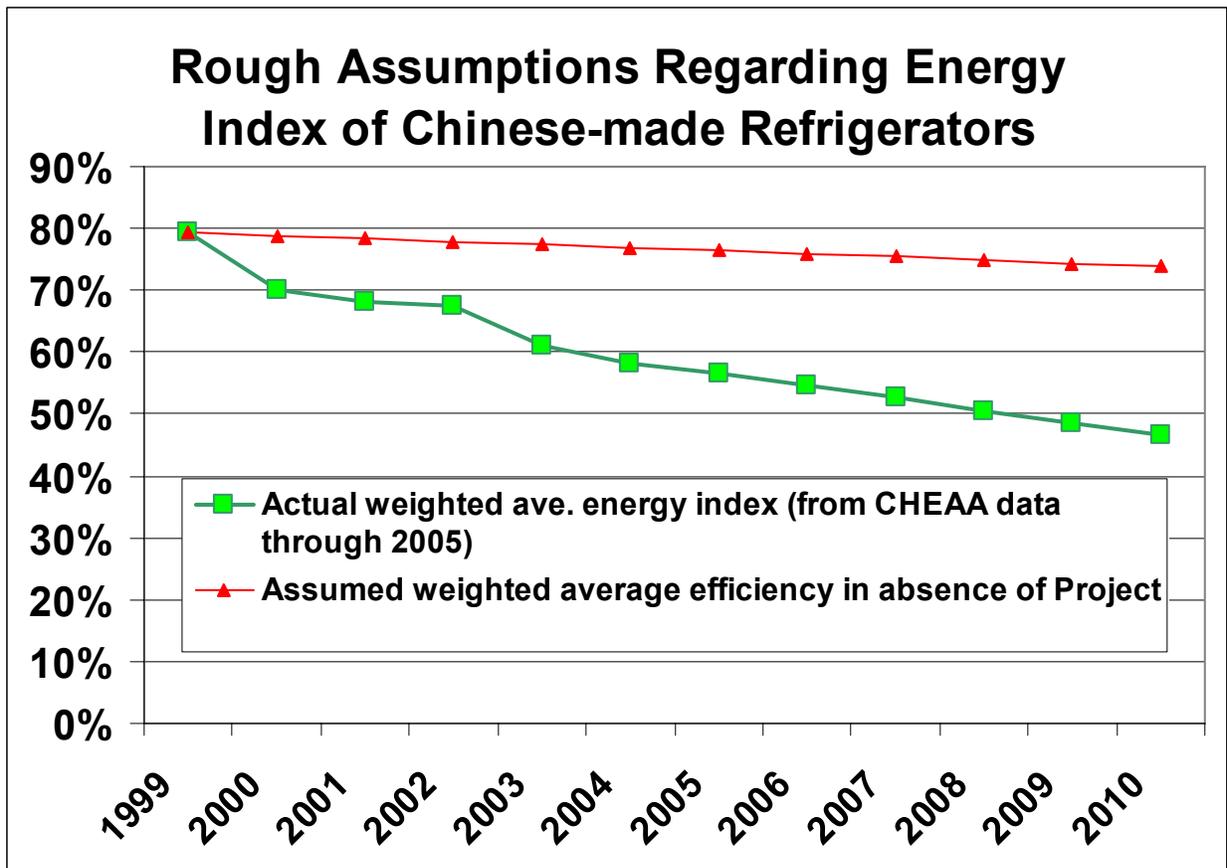


Figure 5-9: Estimates of average refrigerator energy index with and without the Project

5.7.2 Quantitative impact on greenhouse gas and other pollutant emissions in China

The Evaluation Mission estimates that the Project has resulted in the savings of about 11 million tonnes of CO₂ emissions by 2005, and will result in a total of 42 million tonnes of CO₂ emission savings by 2010. Counting the entire savings over the lifetimes of the refrigerators affected by the project, the Evaluation Mission estimates a total of about 170 million tonnes of CO₂ for refrigerators produced through 2005 (savings occurring through 2020) and a total of about 630 million tonnes of CO₂ for refrigerators produced through 2010 (savings occurring through 2025). In addition, the Evaluation Mission estimates that the Project has resulted in the

savings of about 77 thousand tonnes of sulphur oxide emissions by 2005, and will result in a total of nearly 300 thousand tonnes of SO₂ emission savings by 2010. Figure 5-10 shows the trend in cumulative (not lifetime) CO₂ and TWh savings estimated for the Project through 2010.

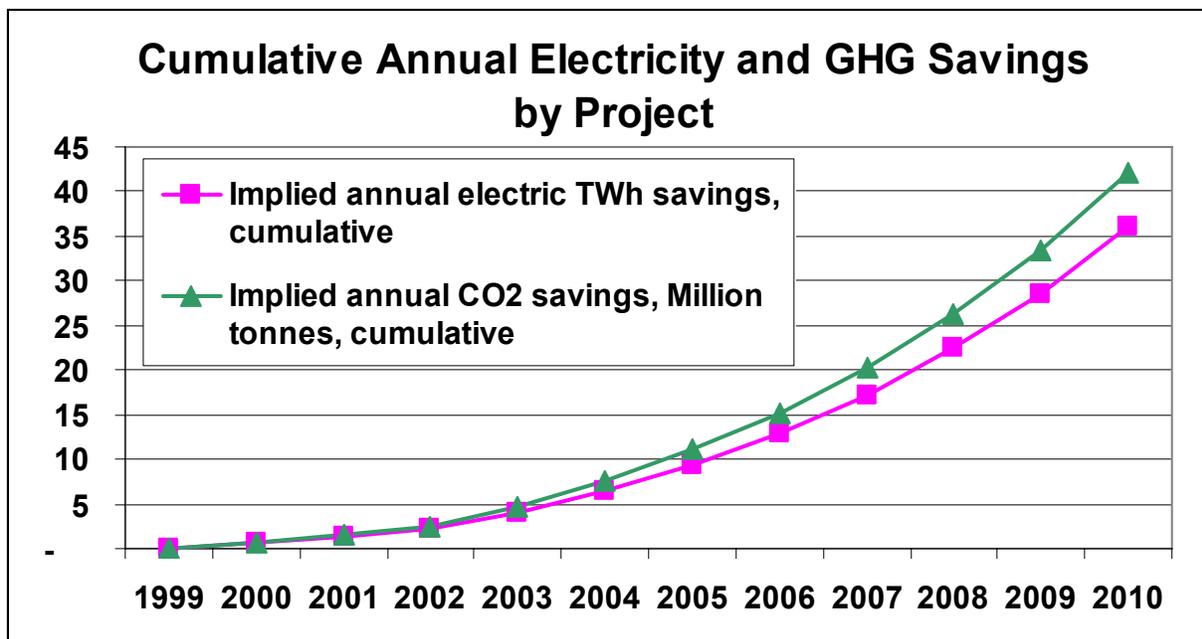


Figure 5-10: Estimates of cumulative CO₂ emissions and electricity generation savings resulting from the Project

5.7.3 Uncertainties in the estimation of project results

Key uncertainties in the calculations above, or other factors that could affect these calculations, include:

- The potential savings from recycling of old refrigerators (and proper disposal of any CFCs). Increased recycling of old refrigerators and proper CFC disposal would increase the savings achieved through the Project, but if it can be argued that improved efficiency and reduced cost of new refrigerators have allowed a significant number of families to retain and continue to operate their old refrigerators as second units, Project savings would be lower overall.
- Identification of the trend in refrigerator efficiency in the absence of the Project. Indications are that the efficiencies of new refrigerators produced in China were rising (energy intensities were falling) in the years before the implementation of the Project¹⁹, though CHEAA staff suggested that the capacity-building associated with the formulation of the Project was a significant factor in the process of efficiency improvement of Chinese refrigerators in the late 1990s. Alternatively, it can be argued that as Chinese manufacturers sought global markets for their products, they would have been obliged to increase their products' efficiencies to be

¹⁹ China Household Electrical Appliances Association, Video presentation: "Green Life Starts from the Selection of Refrigerators".

competitive. If refrigerator efficiency would have increased at 1 percent annually in the absence of the project, TWh savings (and related emissions savings) through the Project would be reduced by somewhat less than 20 percent, relative to the estimate shown above (with savings reaching approximately 30 TWh per year, rather than 36 TWh per year, by 2010).

- Future (post-Project) trends in refrigerator efficiency. A continuing improvement along the lines of that experienced in the past few years has been assumed in the calculation shown. Given that the highest efficiency refrigerators are also reportedly among the highest selling models, and that the cost differential between higher-efficiency and lower-efficiency units with similar feature has been dwindling, this assumption seems reasonable, but it is possible that physical and technological limits will ultimately reduce the rate of efficiency improvement.
- Changes in the efficiency of power generation. If the average generation that is “backed off” (used less) as a result of refrigerator efficiency improvements is a newer unit, with higher efficiency than the assumed 380 grams of coal equivalent/kWh, savings in greenhouse gas emissions would be lower than those shown above.
- Changes in the use of emissions control equipment (largely for SO₂, but perhaps eventually for CO₂). Increased use of SO₂ scrubbers, and possibly eventually CO₂ capture, would reduce the net emissions of those pollutants. Some increase in the average rate of capture of SO₂ from power plants is likely by 2010, though the significant implementation of CO₂ capture during that time frame is not.
- Averages of coal heat, carbon, and sulphur contents. These are unlikely to change too much, but more selective mining and possibly expanded use of coal cleaning could result in a modest reduction in CO₂ emissions savings, and a somewhat larger reduction in SO₂ emissions savings.
- Potential increases in the average size (and thus energy consumption) of refrigerators used in China and exported by Chinese companies. Project participants felt that a substantial shift to significantly larger refrigerators in China was somewhat unlikely due to the limited space in most Chinese homes for refrigerators. New, larger dwellings being built in China, however, may well allow the use of larger refrigerators²⁰, which would use somewhat more energy than smaller refrigerators (though energy use is likely to rise more slowly than volume for similarly-equipped units).

5.8 Sustainability and Post-project Follow-up by Project Participants

Project sustainability, and the prospects of post-project follow-up are the subject of this section, including sustainability of refrigerator standards, the persistence of the electricity and greenhouse gas emissions savings produced under the project, the persistence of human capacity improvements, the persistence of human capacity improvements achieved under the project, the sustainability of the pattern of refrigeration technology improvement begun under the project, and the extension of Project success to improving the efficiency of other appliances.

²⁰ Indeed, to the extent that new houses are built in suburbs further from stores, the frequency of shopping trips may fall, necessitating the use of larger refrigerators.

5.8.1 Sustainability of refrigerator standards

Based on the Evaluation Mission's interview at CNIS, it seems clear that the improvement of refrigerator standards will continue, as an administrative process is in place for periodic revision and updating of standards.

5.8.2 Persistence of electricity and greenhouse gas savings

The Persistence of electricity savings and directly related greenhouse gas emissions savings brought about by the Project seems highly likely to persist, if for no other reason because of the commercial imperative for refrigerator manufacturers to maintain increasingly high standards of energy efficiency in order to be competitive in the domestic and, increasingly, global markets. Another factor that suggests that savings will persist is that the increment between the price between high-efficiency and lower-efficiency units has been declining, and now, for equivalent models, seems to be only a few hundred Yuan (on a refrigerator with a price of 2500 to 4500 Yuan) in many manufacturer's product line. A price increment low enough to assure consumer payback on the extra investment in a high-efficiency unit in just a few years (and/or low enough to be negligible to most consumers) helps greatly to ensure persistence of the purchase of energy-efficient refrigerators.

The extent to which savings remain high, and the results of the Project can be built upon, will depend in part on ongoing efforts at maintaining and increasing public awareness of energy efficiency and its connection to the environment, on the implementation of refrigerator recycling programs to get poor-efficiency old refrigerators (and the CFCs they contain) out of the national stocks. Overall, the groundwork for continuations of improvements in refrigeration efficiency in China seems to have been well-established by the Project.

5.8.3 Persistence of human capacity improvements

At each of the venues visited by the Evaluation Team, including government agencies, manufacturing concerns, and quasi-governmental organizations such as CHEARI, those interviewed by the uniformly reported good retention of engineers and other staff trained during the course of the project. Among compressor and refrigerator manufacturers, there have been reports of some movement of trained engineers among different firms, but the trained staff have remained in the refrigeration industry in China, and as a consequence, continue to apply what they have learned in seminars, study tours, and other project activities to the design of energy-efficient refrigerators for the Chinese domestic and export markets.

Compressor Manufacturer

Specifically, at the Dongbei Huangshi compressor facility, all of the staff trained both on-site and on study tours remain with the firm, though some are now in supervisory positions in part due to the experience and expertise gained as being involved in Project training activities. Although Dongbei Huangshi had a relatively active program of staff training prior to the Project, Dongbei Huangshi officials reported that as a result of the project their own training procedures—including sending staff to special research institutes and inviting foreign and domestic experts in the compressor and refrigeration sector to visit Dongbei Huangshi—have become more effective due to the contacts with technical experts gained during the Project.

Similarly, Dongbei Huangshi also reported that participation in the Project has

significantly improved their Research and Development R&D process, both through the tools and training provided by the Project, through better access to national and international experts in refrigeration technology acquired as a result of the Project, and through changes in the organization of their R&D effort made in order to take advantage of Project training offerings. One change cited in particular by Dongbei Huangshi officials was that the theoretical background in compressor mechanics and thermodynamics provided to the company's engineers through the Project training activities has allowed the R&D staff to design compressors to be more efficient from a theoretical standpoint, rather than simply testing new compressor options empirically. This ability has dramatically increased the speed of compressor technology innovation at the company.

Refrigerator Manufacturers

Like Dongbei Huangshi, each of the Refrigerator manufacturers visited appear to be very much on course to continue the trends in improvement in development and production (and thus sales) of refrigerators of increasingly higher efficiency. Both Kelon and Haier report significant improvements in their research and development programs, as well as internal and external staff training (see above) that seem likely to prevail, in no small part because energy-efficient models have become mainstream top-sellers for the companies, and are highly profitable. Management at both companies seem committed to continuing efficiency improvements through development of human resources, as noted above.

5.8.4 Sustainability of pattern of refrigeration technology improvement

The manufacturing companies interviewed by the Evaluation Mission report deep and ongoing commitment to sustaining and enhancing the technology improvements spurred by the Project. This commitment is reflected in part by the ongoing training and R&D commitments described above, as well as the plans noted below for increasing production of high-efficiency appliance components by compressor manufacturers, and energy-efficient appliances by refrigerator manufacturers. The fact that efficient units apparently are also reportedly high-profit units further increases manufacturer's already strong incentives to continue to pursue energy-efficiency, as does Chinese producers increasing presence in and goals for participation in the appliance export market.

Compressor Manufacturer

Dongbei Compressor Company reports a plan to increase the proportion of its compressors that are energy efficient models to 45 percent in 2007, up from just under a third in the first three quarters of 2006, and from 19 percent in 2003 (see Figure 5-6). In the process, Dongbei will phase out some of its less-efficient compressor product lines. Dongbei also plans to expand its line of energy-efficient compressors to the 3 hp size (from the roughly 1/10 to 1/5 hp sizes used in the most common sizes of household refrigerators). While Dongbei has no fixed timetable for expanding its line of energy-efficient compressors—the timetable will depend on the development of demand for the compressors in the refrigeration industry—when produced the larger energy-efficient compressors will extend the energy-saving impacts of the Project into the large household and commercial refrigeration product lines.

Refrigerator Manufacturers

Refrigerator manufacturers are also highly likely, given the patterns of efficiency

improvement noted in section 5.3 of this Evaluation Report, to continue to improve their models. The availability of improved compressors will help, but these companies are also driven by competitive (with each other, with other companies in China, and with companies from outside China in the global marketplace) pressures that will keep them working to achieve higher efficiency in their products. As the segment of the Chinese market that wants larger refrigerators grows, and as Chinese producers seek to produce refrigerators appropriate for other markets (such as refrigerators for the North American markets, which are 2 to 3 times the volume of average Chinese units), efficiency innovations are and should continue to spread to a wider range of products.

Both Kelon and Haier produce considerable amounts of commercial refrigerators and freezers. Based on what the Evaluation Mission has observed and been told, the imperative for efficiency improvement in these units—some of which are quite small—has not yet been as high as for the (admittedly larger) residential market. Some innovations from the residential market will undoubtedly carry over to the commercial markets, but an initial initiative in this area may be helpful (see section 7, below).

5.8.5 Extension of Project success to improving the efficiency of other appliances

The Project has laid the groundwork for development of efficiency standards for other appliances (beyond the current set—refrigerators, freezers, and domestic window-mounted and “split” air conditioners), and those organizations interviewed by the Evaluation Mission that would likely be involved in such standard-setting indicate that processes are underway or in the planning stages for several additional domestic appliances to be covered by standards and labels in the future. The contacts between the different organizations that must be involved in setting standards and criteria for labelling that have been formed under the Project will be significant in increasing the efficiency and speed with which such standards can be developed and approved. Encouraging the inclusion of many stakeholders in such discussions—including manufacturers’ representatives—has also been an important Project focus that will lead to more rapid Standards development in the future.

In the absence of another effort like the Project for appliances outside of the domestic refrigeration area, there is likely to be some improvement in efficiency as a result of the project, but how much is difficult to say. Refrigerator manufacturers interviewed by the Evaluation Mission generally reported that, for example, the air conditioning units of their companies were substantially separate, in both R&D and manufacturing, from their refrigerator divisions, and refrigeration compressor manufacturer Dongbei Huangshi does not presently make compressors for uses outside the refrigeration market. The appliance manufacturers interviewed indicate an awareness of the benefits of increased efficiency throughout their product lines, but the Evaluation Mission is unable to determine whether this awareness is strong enough to encourage substantial efficiency improvement in other appliances absent standards, labelling, and/or other strong inducements.

6. CONCLUSIONS

The overall conclusion of this evaluation is that the project has been extremely effective in achieving its primary goals, namely providing Chinese refrigerator manufacturers (and compressor manufacturers) with the capacity to produce household refrigerators that not only meet, but exceed the highest international standards, and changing consumer behaviour so as to put those refrigerators in the hands of Chinese consumers.

6.1 Findings

The findings presented in detail in Section 5 of this Report are summarized here.

6.1.1 Effectiveness of the Project in reducing GHG emissions in China

The project has been highly effective in reducing greenhouse gas emissions in China by markedly increasing the production and sales of energy-efficient refrigerators and refrigerator compressors. The average energy intensity of new refrigerators sold in China has decreased by nearly 29 percent between the Project's inception in 1999 and the end of 2005, the market for refrigerators is now dominated by units meeting the highest two grade specifications (1 and 2), and refrigerator manufacturers are focused on delivering consistently higher efficiency products. The ultimate greenhouse gas savings achieved under the project is a function of the inputs to the estimate of those savings, many of which are somewhat uncertain, but a "central" estimate made by the Evaluation Mission suggests that the savings of the project from 1999 to 2005, calculated over the lifetimes of the refrigerators affected by the Project (sold in China and elsewhere) were approximately 170 million tonnes of CO₂, and probable savings through 2010 will be about 630 tonnes of CO₂. These lifetime savings will accrue over the period 1999 through 2025.

6.1.2 Effectiveness of Project capacity building activities

Capacity building activities undertaken by the project, including training for technicians and engineers from compressor and refrigerator manufacturers, training activities focused on appliance retailers, public awareness campaigns, and on-the-job training for Project managers and experts, have been for the most part very effective, and the persistence of capacity gained through the Project in areas of technical capability and project management is highly likely. International organizations, led by UNDP and UN DESA, have, in partnership with SEPA/FECO, played key roles in arranging and implementing effective capacity building in both technical and managerial areas. Without this international input and expertise, it is likely that the Project would not have been as effective in meeting either its emissions reduction or capacity-building goals.

6.1.3 Effectiveness of Project organization

With the exception of a very few quite minor issues, Project participants uniformly reported that project organization was very good, with clear structure and communications, transparent project accounting and bidding practices, and good support from project management. The overall design of the Project was described as very good by all of the participants interviewed by the evaluation mission. In particular, the role of Project Chief Technical Advisor Ray Phillips in defining and structuring the Project in its early phases and throughout

implementation was noted as a key factor in Project success.

6.2 Assessment

6.2.1 Relevance

The Project was highly relevant to the needs of the Chinese appliance manufacturing sector in particular, and to the goal of reducing China's greenhouse gas emissions in particular. The "market pull" element of the Project was an innovative and crucial addition, providing refrigerator manufacturers with the confidence to build models for a market for efficient products that, at the beginning of the Project, did not really exist in China. Given the increasing market orientation of the Chinese economy, the "market pull" approach was and continues to be highly relevant, and this approach should be used in future Projects, where applicable, in China and elsewhere. The input of international advertising firms in designing marketing approaches was an important input to the Project.

6.2.2 Performance

The Project performance was by and large excellent, and produced impressive results in the many areas of the Chinese appliance industry it involved.

6.2.3 Success

The Project has been very successful in reaching and exceeding nearly all of its goals. The only major area where the Project did not perform as intended has been the inability to start a recycling program to safely and permanently retire older, poor-efficiency refrigerators. This remains a priority for further work (as noted below).

7. RECOMMENDATIONS

The Evaluation Mission presents summary recommendation in three general areas: recommendations related to project processes, overarching recommendations for new projects building on the results of the Project, and specific recommendations for follow-up or new projects related to Project elements.

7.1 Recommendations Related to Project Processes

The Evaluation Mission's recommendations related to Project management processes include the following:

- Continue to build capacity to manage programs in China. This Project has broken ground as one of the first, if not the first, major UNDP assistance project to be largely managed by a Chinese agency. SEPA's PMO for this Project has learned a great deal from the process, and this experience should be built upon.
- Attempt to minimize management staff turnover in project management. A measure of the success of the Project has been that PMO project managers have been much in demand for other positions. This is good for China, but can cause some temporary difficulties in project communications. In this project, difficulties related to leadership transitions have generally

been minimized by effective communication, but maintaining continuity of leadership in project management should continue to be a goal for future projects.

- Continue to insist on transparency in processes and communications. Transparency is a concept that is not always native to project management, but it serves projects well, and provides confidence to both project participants and project funders. Maintaining the transparency of project activities should continue to be a high priority. Clear and open communication has been a very strong element of the Project, and UNDP/GEF's continued insistence on transparency in future projects in China and elsewhere will continue to serve a key capacity-building function.
- Deepen the role of the Project Information Office, and make sure that project materials persist (on the website) after Project is Complete. For this Project in particular, the website maintained by the Project Information Office, and the Office's data collection, assembly, and dissemination efforts, should be continued into the future. This may require ongoing funding from manufacturers, SEPA, or others.
- Continue to involve stakeholders at an early stage of Project planning. Involving stakeholder in Project planning from the early stages contributed greatly to the effectiveness of this Project, and should be a model for design and implementation of future projects.

7.2 Overarching Recommendations for New Projects Building on Results of Project

A key impediment to moving forward with programs similar to the Project (examples are provided in section 7.3, below) is lack of funding. It is the Evaluators' working assumption (though we would like to be proven wrong) that significantly expanded UNDP/GEF funding for China will become less likely as China becomes more affluent in the longer-term, therefore, though China is slated to receive increased UNDP/GEF funding in the next several years, China must begin to look harder at internal sources of funds to support energy efficiency and environmental improvements in the future.

A major option for raising a significant amount of money for use in implementing energy efficiency and greenhouse gas emissions reduction projects is to implement a "Public Benefits Charge", collecting a fraction of electricity (and/or gas) revenues for use for energy efficiency, to help fund future market transformation initiatives of this type. Many states in the United States, and other nations around the world, have adopted or are considering this type of arrangement, where on the order of a fraction of a percent to 1 to 3 percent of utility revenues are collected, placed in a fund and disbursed to subsidize projects with public benefits—benefits to the environment, to energy efficiency, or to society as a whole (such as support for research and development, or assistance to low-income residents with their utility bills). One percent of utility revenues, if collected in China, would result in a fund sufficient to underwrite many of the project ideas noted below. This fund could be managed by an agency in China, with expertise from the UNDP and its related organisations used to help with key capacity building areas, including bringing in technical, policy, and other experts, as needed, from abroad.

7.3 Specific Recommendations for Follow-up or New Projects Related to Project Elements

Specific recommendations by the Evaluation Mission regarding follow-up or new project options that are related to Project elements include (presented in no specific order of importance):

- In the future, when organizing training seminar involving engineers, technicians, or other staff from competing companies, be mindful of the fact that trainees may be unwilling to bring up more than the most general concerns in front of their colleagues from other companies. The reason for this reluctance is that trainees fear divulging trade secrets, industrial “know how”, or innovations in progress. During the Evaluation Mission’s visit to a compressor manufacturer, staff who had attended two group training session noted that during the first such session, trainees were invited to offer questions and comments as a single group, but no-one offered any comments. In a second training, however, the question and answer portions of the training were organized by company group, resulting in lively and productive interactions with trainers. When possible, UNDP/GEF should therefore use the latter model when designing training sessions for representatives of commercial organizations.
- Consider going beyond the mass-purchase effort included in the project—the placement of energy-efficient refrigeration products on the government list of products approved for purchase—to actually organizing bulk purchases by government agencies, and by collaborating non-government entities, of the highest efficiency refrigerator products. Possibilities that come to mind here include the bulk purchase of refrigerators and freezers for public housing, military quarters, government-owned lodging facilities, and, most notably, housing units being built for the 2008 Beijing Olympics. Manufacturers could compete on a combination of both price and energy efficiency to obtain bulk contracts from government and related agencies.
- Apply the concepts of the Project—the technology push/market pull— to other appliances, starting with window-mounted, split and possibly commercial air conditioners. Air conditioning was noted by many project participants as a crucial area for reduction of both electric energy consumption and electricity demand (peak power) reduction, and for the reduction of the environmental impacts associated with supplies of both electric energy and peak power.
- Apply Project concepts to commercial refrigeration. This could include program elements such as working with major buyers of commercial refrigeration equipment (soft-drink and ice-cream manufacturers, for example) to get their buy-in on improving commercial refrigeration units, and possibly to organize bulk purchases of high-efficiency units (for example, for vendors gearing up for tourism associated with the Beijing Olympics. At present, commercial refrigeration has not received the same level of development attention as residential refrigeration, though many of the technical problems are the same²¹.

²¹ Though some differ, of course—commercial refrigeration uses more glass doors, for example. Marketing priorities also differ, as refrigeration may be a smaller part of a stores’ operating expenses than refrigerator electricity use is of a household’s budget.

- Apply Project concepts to the goal of producing more efficient buildings. China is undergoing a building boom, particularly in urban areas, that may in fact be unprecedented in any nation on earth. As the lifetime of a building is typically 30 or more years, and often 40 to 60 or more years, making a building—residential, commercial/institutional, or industrial—energy efficient to begin with “locks in” energy savings for a very long time. Conversely, failing to implement energy efficiency measures when a building is in the construction phase results in a significant lost opportunity to reduce energy use and its associated costs and pollutant emissions. A combination of a “green buildings” incentive program for, for example, major residential and commercial building developers, coupled with the introduction of national building energy efficiency standards, would accelerate the penetration of energy-efficient buildings in the stock of new Chinese buildings. Once again, the upcoming Beijing Olympics, and the application of green building technologies to some of the many new structures to be built for that event, may provide a high-profile way to launch building energy efficiency standards.
- Apply Project concepts to the development and marketing of “next generation” automobiles, that is, electric and hybrid vehicles with efficiencies 2 to 3 times those of current vehicles on the Chinese market. This type of effort would, admittedly, cost perhaps 100 times as much as the refrigerator efficiency project evaluated here, but the stakes are very high, both in terms of possible savings in oil imports (China is fast becoming one of the largest importers of crude oil and oil products) and in terms of China’s competitiveness in the global auto market.
- When designing media ads, try to tie advertisements in more directly with standards/labels (for example, use a “Grade 1” logo in ads, show the China Energy Label), and include a website address where substantive information can be found such as sample calculations of annual household savings of money (and kWh and CO₂ emissions). The Evaluation Mission understands the need to appeal to very basic notions of priorities and value, but having additional, more detailed information referenced would be helpful.
- Consider revising grade designations for freezers (as opposed to combination refrigerator/freezers) to better reflect the fact that freezers operate at similar temperatures to the freezer compartments of combination units, and as a consequence, at lower average temperatures than refrigerator/freezers. This change would provide consumers with a better sense of which freezers are more efficient than others. At present, virtually all freezers are shown on the grading label as grade 4 or 5, because the grades are set up for refrigerator/freezer combination units.
- Consider modifying grade designations for refrigerators to allow for the separation of the very best refrigerators from those that are merely very good. For example, some of the best refrigerators on the market in China today in the most popular 200 litre (approximately) size have energy efficiency coefficients of 0.28 and less, meaning that they are labelled “Grade 1”, and properly designating them among the most energy-efficient models. Refrigerators with energy efficiency coefficient nearly twice as high (up to 0.55), however, use about 100 percent more electricity than the most efficient models, and also are labelled “Grade 1”. Modifying the grade designation to, for example, add a “Grade 1 +” and “Grade 1 ++” rating would provide consumers with additional information to choose highest efficiency units.
- Continue to seek funding for Appliance recycling programs. As noted in the STAP

Technical Review to the Project Document²²:

“The removal from the market of the old models raises several issues. If they are to be destroyed then there should be a recycling facility in place to recover the CFC 12 from the compressor and, at least some, of the CFC 11 from the foam to prevent these ozone depleting gases being emitted to the atmosphere. The best environmental option may be to refurbish these older units.”

The current practice, when a family purchases a new refrigerator in China (and if the old unit is operable), is typically to keep the second unit and use it in the home (if space allows), to give the unit to a friend or relative, or to sell the unit to a second-hand appliance vendor or an individual. In some cases, used Chinese refrigerators are exported to other Asian countries, or used refrigerators from urban China find their way to rural China. If a refrigerator is no longer working, it might be used for parts, or might simply be disposed of. When refrigerators remain in use, the benefits of early retirement of poor-efficiency models (and their replacement by high efficiency models) are lost. In addition, many older refrigerators contain CFCs that will ultimately leak to the atmosphere (affecting both climate and the ozone layer) if not properly removed from the refrigerant system and disposed of. CFCs are also present in the foam products used in older refrigerators. For all of these reasons, a refrigerator recycling program should be started in China, first on a pilot scale, but followed quickly by a scale suitable to cover major urban areas. Part of the costs may be covered by the value of recycled metals (especially, for example, copper, the price of which has risen two-fold and more in the last year) from the units traded in. Other materials, such as plastics, may also be recycled. Costs of the recycling program beyond the value of recycled materials should properly be covered by funds such as public benefit funds (see above), or a recycling fee paid by appliance purchasers (or manufacturers) on each unit purchased (or produced). Fee-based support for the program, from a manufacturer’s perspective, may seem somewhat unwelcome, but removing more old refrigerators from use, which a recycling program would do, should boost sales of new refrigerators.

8. LESSONS LEARNED

A number of lessons learned specific to project elements or operation are incorporated implicitly and explicitly into the recommendations provided in Section 7, above, and will not be repeated here. Key overarching lessons learned through this project include.

- An integrated approach to problem has been crucial to Project success. This includes not only the excellent “technology push/market pull” concept, but, for example, the support for technical improvements among both compressor and refrigerator manufacturers.
- The importance of SEPA and UNDP/GEF certification and awards to manufacturers cannot be understated. Manufacturers feel that consumers are extremely aware of, and inclined to place great faith in, the endorsements of national and international institutions, and will adjust their buying habits accordingly.

²² Global Environment Facility, [Annex 3: STAP Technical Review](http://www.gefweb.org/wprogram/mar98/undp/china/cfcfinl3.pdf) [to Project Document, dated ~1998]. Available as <http://www.gefweb.org/wprogram/mar98/undp/china/cfcfinl3.pdf>.

- The importance of the involvement of UNDP and GEF in this project was not so much related to the money provided by the international funding agencies—though that was an important input in leveraging co-funding from manufacturers and others—but in that UNDP/GEF have the attention and ear of high government officials responsible for authorizing major initiatives in China, and without the influence provided by UNDP/GEF on those decisionmakers, the project would not have been implemented (or, at least, not in its ultimate form).
- Finding the right International Experts to provide training and other functions on this Project has been a key to the Project success. The work of UNDP and UN DESA in making these and other Project arrangements has been a crucial component of the Project.
- The need to build in flexibility to Project processes to allow project management to flexibly respond to changing situations. This may mean offering managers choices, through the project document, at key decision points, based on the managers' assessments of project process. Or it may involve trying to anticipate difficulties, and offering explicit alternatives or contingencies in the Project document for specific eventualities. This project has faced a few such situations (the temporary difficulties—resolved in November 2006—with awarding the Principal Award to refrigerator manufacturers, the lack of recycling program funding), and though it is not clear that these events could or should have been anticipated, they underscore the need for some built-in flexibility in project management.

ANNEXES TO EVALUATION REPORT

Initial Schedule of Project Evaluation Mission

Date	Time	Activity	Attendee	Venue
October 9 Monday	forenoon 9:00- 12:00	<p>The meeting which project managers, project experts and assessment experts will attend</p> <p>The project managers and project experts introduce the project implementation and its objectives' achievement, the results and effect of the project</p> <p>The project managers and project experts communicate with the assessment experts.</p>	<p>SEPA representatives</p> <p>Assessment experts, project experts</p> <p>UNDP representatives</p>	The office of SEPA
October 9 Monday	afternoon 2:30-5:00	<p>Visiting UNDP</p> <p>Comparing the notes about the implementation, objectives and achievements of the energy-saving project refrigerator of GEF</p>	<p>UNDP</p> <p>Assessment experts</p>	UNDP
October 10 Tuesday	Forenoon 9:00- 12:00	<p>Visiting energy standardization commission</p> <p>Introducing the sub-project and its achievements taken by energy standardization commission</p> <p>The effect between the project and standard and label</p>	<p>The energy standardization commission;</p> <p>Assessment experts;</p> <p>(SEPA UNDP)</p>	The office of energy standardization commission
October 10 Tuesday	Afternoon 2:30-5:00	<p>Visiting</p> <p>McCANN-ERICKSON</p>	<p>McCANN-ERICKSON</p> <p>GUANGMING</p>	The office of McCANN-ERICKSON

Date	Time	Activity	Attendee	Venue
		GUANGMING Ltd. introducing the sub-project taken by McCANN-ERICKSON GUANGMING Ltd. and its achievements	Ltd.; Assessment experts; SEPA; UNDP	GUANGMING Ltd.
October 11 Wednesday	Forenoon 9:00-12:00	Visiting the China Household electrical Appliances Research Institute Introducing the implementation of sub-project taken by them, and the project effect assessed by using monitoring data	the China Household electrical Appliances Research Institute; assessment experts; SEPA; UNDP	The office of the China Household electrical Appliances Research Institute
October 11 Wednesday	Afternoon 2:30-5:00	Investigating Beijing Market to know about the impact of the project on refrigerator market and consumers	assessment experts	Beijing
October 12 Thursday	Forenoon 9:00-12:00	Visiting the National Audit Office to know about the project's auditing [THIS VISIT POSTPONED TO OCTOBER 19]	Assessment experts; SEPA	The office of National Audit Office
October 12 Thursday	afternoon	Beijing-Wuhan (The Scheduled flight 15: 35CA1365) Wuhan - Huangshi (automobile)	Assessment experts	
October 13 Friday	The whole day	Visiting the awarded compressor company- Huangshi Donper To know about the process of energy-saving products developed by the company; To know about the project	Assessment experts Huangshi Donper	Huangshi Donper

Date	Time	Activity	Attendee	Venue
		effect through analyzing the variation of compressor development, technology level and market supply		
October 14 Saturday	forenoon	Huangshi-Wuhan (automobile) Wuhan-Guangzhou (The scheduled flight Am12:50MU2473)	Assessment experts	
October 15 Sunday	The whole day	Break time	Assessment experts	
October 16 Monday	The whole day	Visiting Kelon, to know about the company's process about participation in award and the works about energy-saving refrigerator development and market pushing	Assessment experts; UNDESA Li Shaoyi [MR. LI WAS UNABLE TO ATTEND]	The office of Kelon in Shunde, Guangdong
October 17 Tuesday	forenoon	Shunde-Guangzhou (automobile) Guangzhou-Qingdao (the scheduled flight 12:50MU5258)	Assessment experts	Guangzhou
October 17 Tuesday	afternoon	Visiting Haier, To know about the company's work on energy-saving refrigerator development and market pushing	Assessment experts	The office of Haier
October 18 Monday	forenoon	Visiting Haier, To know about the company's work on energy-saving refrigerator development and market	Assessment experts	The office of Haier

Date	Time	Activity	Attendee	Venue
		pushing		
October 18 Monday	afternoon	Qingdao-Beijing (the scheduled flight 15:15ca1570 or 18:05ca4655)	Assessment experts	
October 19 Thursday	forenoon 9:00	The workshop on summarizing	Assessment experts; SEPA UNDP Project experts	The office of SEPA
October 20 Friday		return	The international assessment experts	

Summary of Meetings Attended and Site Visits Carried out by Evaluation Team

October 9, 2006

9:00 a.m. - 12:00 p.m.

Meeting Purpose: Project managers and project experts communicate with the assessment experts

Location: Foreign Economic Cooperation Office (FECO), State Environmental Protection Administration (SEPA), Room 620, Xianfeng Office Building, No.277, Zhaodengyu Road, Xicheng District, Beijing

Participants:

Dr.David Von Hippel, Evaluation Expert

Ms.Wang Lei, Evaluation Expert

Ms. Xie Hong, FECO of SEPA, the Translator

Dr.He Ping, UNDP

Dr. Sun Xuefeng, Director Division IV of FECO of SEPA, The Project Manager.

Mr. Liu Fuzhong, Deputy President of China Household Electrical Appliances Association(CHEAA), Senior Engineer The Evaluation Expert of the Project.

Ms. Jiang Feng, Secretary General of CHEAA, Senior Engineer Professor, the Project Coordinator.

Mr. Zhong Shunhe, Consultant of China Household Electric Appliances Research Institute (CHEARI), Professor, the Domestic expert of the Project.

Dr. Li Hongqi, Professor ,College of Environmental &Energy Engineering, Beijing University of Technology, the Compressor expert of the Project,

Mr. Qi Bing, CHEARI, Scientific Promotion Department Director, Professor, the Refrigerator expert of the Project.

Mr. Chen Jianhong, China National Institute of Standardization, Sub-Institute of Resource and Environment Standardization, Professor, the expert of the Project.

Mr. Yue Zhenjiang, the media expert of the Project.

Mr. Wang Wei, FECO of SEPA, Official of the Project.

Mr, Dou Yanwei, CHEAA

Meeting Process:

- 1.Introduction of the participants by Dr. Sun Xuefeng,
2. Dr. David Von Hippel introduced the purpose and content of the evaluation and expressed the

willingness to hear from the ideas and information from related parties.

3. Dr. Sun Xuefeng gave a general introduction of the implementation of the project:

Barrier Removal for the Widespread Commercialization of Energy-efficient CFC-free Refrigerators in China.

4. Ms. Jiang Feng gave a presentation on the influence on domestic appliances in China from the implementation of the project. “*Push of GEF Project on Chinese energy-saving refrigerator*”

5. The other participants gave supplementary comments on Madam Jiang Feng’s presentation.

6. Q&A

October 9, 2006

2:30 - 4:00 p.m.

Location: Visiting UNDP CHINA, No.2, Liangmahe Nan Road, Beijing

Participants:

Dr. He Ping, UNDP China

Dr. David Von Hippel, Evaluation Expert

Ms. Wang Lei, Evaluation Expert

Mr. Dou Yanwei, CHEAA

Meeting Process:

Comparing notes about the implementation, objectives and achievements of the energy-saving project refrigerator of GEF

October 10, 2006

9:30 - 12:00 a.m.

Location: Visiting China National Institute of Standardization, No.4 Zhichun Road, Haidian District, Beijing

Participants:

Mr. Cheng Jianhong, China National Institute of Standardization, Sub-Institute of Resource and Environment Standardization, Professor, the expert of the Project.

Dr. David Von Hippel, Evaluation Expert

Ms. Wang Lei, Evaluation Expert

Ms. Xie Hong, FECO of SEPA, Translator

Mr. Dou Yanwei, CHEAA

Meeting Process:

1、 Dr. David Von Hippel introduced the purpose and content of the evaluation and expressed

the willingness to hear from the ideas and information from related parties.

2、 Mr. Cheng Jianhong, China National Institute of Standardization, Sub-Institute of Resource and Environment Standardization, Professor, the expert of the Project:

Energy efficiency standards and labels for China's household refrigerators

3、 Q&A

October 10, 2006

2:30 - 4:00 p.m.

Location: Visiting McCann Erickson Guangming Ltd., 9th Floor, Zhaowei Building, No.14, Jiuxianqiao Road, Zhaoyang District, Beijing

Participants:

Don W Norris, McCann Worldgroup Managing Director

Tomaz Mok, McCann Erickson EVP Director of Professional Services

Mr. Yue Zhenjiang, media expert of the Project.

Dr. David Von Hippel, Evaluation Expert

Ms. Wang Lei, Evaluation Expert

Mr. Dou Yanwei, CHEAA

Meeting Process:

1. Dr. David Von Hippel introduced the purpose and content of the evaluation and expressed the willingness to hear from the ideas and information from related parties.

2. Tomaz Mok, McCann Erickson EVP Director of Professional Services, delivered a presentation entitled:

CHINA Consumer Education Campaign for Energy Efficient Refrigerator

3、 Q&A

October 11, 2006

9:10-12:00 a.m.

Location: Visiting CHEARI, No.29 Xia Xie Street, Xuan Wu District, Beijing,

Participants:

Mr. Jia Yong Jiang, Deputy Director of CHEARI

Ms. Gong Bin, Director's Assistant, CHEARI

Mr. Zhong Shunhe, Consultant to CHEARI, Professor, the expert of the Project.

Mr. Qi Bing, CHEARI, Scientific Promotion Department Director, Professor, refrigeration expert of the Project

Ms. Mao Zhonghua, CHEARI, Scientific Promotion Department, Engineer.

Dr. David Von Hippel, Evaluation Expert

Ms. Wang Lei, Evaluation Expert

Mr. Dou Yanwei, CHEAA

Meeting Process:

1. Welcoming remarks by Mr. Jia Yong Jiang
2. Dr. David Von Hippel introduced the purpose and content of the evaluation and expressed willingness to hear ideas and information from related parties.
3. Mr. Zhong Shunhe, Consultant of CHEARI, Professor, the expert of the Project, presented “*GEF Technical Training*”
4. Mr. Qi Bing, CHEARI, Scientific Promotion Department Director, Professor, the refrigeration expert of the Project, presented “*Testing Mission Report of UNDP/GEF Project Test Agency*”
5. Q&A
6. Visit the Testing Laboratory

October 11, 2006

2:00-3:30 p.m.

Investigating Beijing Appliance Markets to know about the impact of the project on the refrigerator market, refrigerator vendors, and consumers

Location:

Da Zhong Electrical Appliances “Multiple Shop”, Niu Jie Location

Participants:

Dr. David Von Hippel, Evaluation Expert

Ms. Wang Lei, Evaluation Expert

Mr. Zhong Shunhe, Consultant to CHEARI, Professor, Project Expert

Mr. Dou Yanwei, CHEAA

October 11, 2006

3:50-5:00 p.m.

Investigating Beijing Appliance Markets to know about the impact of the project on the refrigerator market, refrigerator vendors, and consumers

Location:

Da Zhong Electrical Appliances “Multiple Shop”, Ci Qikou Location

Participants:

Dr. David Von Hippel, Evaluation Expert

Ms. Wang Lei, Evaluation Expert

Mr. Dou Yanwei, CHEAA

October 12, 2006

Travel day, Beijing to Wuhan by air, Wuhan to Huangshi by car

October 13, 2006

9:00 a.m.-1:00 p.m.

Location: Visiting Huangshi Donper Electrical Appliance Co., Ltd. (Donper)

No, 5 Wuhuang Road, Tieshan, Huangshi City, Hubei

Participants:

Mr. Yang Baichang, Board Chairman, Huangshi Donper Mech-Electrical Group Co., Ltd.,
Huangshi Donper Electrical Appliance Co., Ltd, Economics Master

Mr. Cao Lijian, General Manager Assistant\General Engineer of Donper, Senior Engineer

Mr. Deng Chengwu, General Manager Vice-General Manager of Donper

Mr. Yan Wei, Vice-Manager of Marketing Office, Donper

Mr. Wang Xinnan, R&D Department Director, Donper

Ms. Peng Peilan, R&D Department Director, Donper

Mr. Sun Jiyong, R&D Department Vice-Director, Donper

Mr. Lin Yinkun, Manufacture Department Director, Donper

Ms. Zhang Wenfang, Financing Department Director, Donper

Mr. Luo Bin, Equipment Department Director, Donper

Dr.David Von Hippel, Evaluation Expert

Ms. Wang Lei, Evaluation Expert

Ms. Xie Hong, FECO of SEPA, Translator

Meeting Process:

1. Mr. Yang Baichang, Board Chairman, Huangshi Donper Mech-Electrical Group Co., Ltd,
Huangshi: Welcome remark to the evaluation team and general introduction of the operation and
daily work in Dongpei.

2. Dr. David Von Hippel introduced the purpose and content of the evaluation and expressed
willingness to hear ideas and information from related parties.

3. Mr. Deng Chengwu, General Manager Vice-General Manager of Donper presented:
Self Evaluating Report of Huangshi Dongbei Electrical Appliance Co., Ltd.
4. Q&A
5. Visit factory work line.

October 14 and 15, 2006

Travel days, with visits to scenic areas: Wuhan to Guangzhou by air, Guangzhou to Shunde by car

October 16, 2006

9:00 a.m. - 12:30 p.m., 2:00-4:00p.m.

Location: Visiting Guangdong Kelon Electrical Holdings Co., Ltd (Kelon), No.8 Ronggang Road, Ronggui, Shunde, Foshan, Guangdong, PRC.

Participants:

Mr. Yutao Su, President, Kelon

Ms. Fan Wei, Engineer Manager, Technical Management Section, R&D Centre, Kelon

Mr. Pan Jian, R&D Department Technology Development, Kelon

Ms. Li Juying, R&D Centre, Kelon

Dr. David Von Hippel, Evaluation Expert

Ms. Wang Lei, Evaluation Expert

Ms. Xie Hong, FECO of SEPA, Translator

Meeting Process:

1. Mr. Yutao Su, President, Kelon: Welcome speech to the evaluation team.
2. Dr. David Von Hippel introduced the purpose and content of the evaluation and expressed willingness to hear ideas and information from related parties.
3. Ms. Fan Wei, Engineer, Manager, Technical Management Section, R&D Centre, Kelon, presented: *Summary of the Project Implementation.*
4. Q&A
5. Visit the factory work line and related facilities.

October 17, 2006

Morning: Travel, Shunde to Guangzhou by car, Guangzhou to Qingdao by air

4:30 - 6:00 p.m.

Location: Visiting Haier Group, Haier Industry Park, No.1 Haier Road, Hi-tech zone, Qingdao,

China

Participants:

Dr. David Von Hippel, Evaluation Expert

Ms. Wang Lei, Evaluation Expert

Ms. Xie Hong, FECO of SEPA, the Translator

Mr. Dongning Wang, Refrigerator R& D Department Manager, Haier Refrigerator Co., Ltd
General Engineer, Senior Engineer

Mr. Chen Weijia, Haier Group Beijing Chief Representative

Miss Zhu Wenyin, Item Manager, Refrigerator R& D Dept, Qingdao Haier Joint Stock Co., Ltd

Meeting Process:

Visit the products exhibits of Haier Group

October 18, 2006

10:00 a.m. - 12:30 p.m.

(Travel: 8:00-10:00 a.m. from Qingdao to Huangdao by bus)

Location: Visiting Haier No.2 Refrigerator Division, Haier Industry Park, Qingdao Economic
Tech Department zone (Huangdao of Qingdao) Qingdao, China

Participants:

Mr. Dongning Wang, Refrigerator R& D Department Manager, Haier Refrigerator Co., Ltd
General Engineer, Senior Engineer

Mr. Chen Weijia, Haier Group Beijing Chief Representative

Miss Zhu Wenyin, Item Manager, Refrigerator R& D Dept, Qingdao Haier Joint Stock Co., Ltd

Mr. Yang Jun, Haier No.2 Refrigerator Division Cause ,Department Manager of Order
Fulfillment Center

Dr. David Von Hippel, Evaluation Expert

Ms. Wang Lei, Evaluation Expert

Ms. Xie Hong, FECO of SEPA, the Translator

Meeting Process:

1. Dr. David Von Hippel introduced the purpose and content of the evaluation and expressed willingness to hear ideas and information from related parties.
2. Mr. Dongning Wang, Refrigerator R& D Department Manager, Haier Refrigerator Co., Ltd General Engineer, Senior Engineer, presented: *Project on UNDP/GEF Barrier Removal for the Widespread Commercialization of Energy-efficient CFC-free Refrigerators in China.*
3. Q&A

4. Visit factory work line

Afternoon: Travel, Qingdao to Beijing by air

October 19, 2006

9:00 a.m. - 10:00 a.m.

Location: Visiting Audit Service Center for Foreign Loan and Assistance Projects, China National Audit Office, Room 901, No.4 Zhongguancun South Avenue, Beijing

Participants:

Ms. Xin Feng, Deputy Director of Auditing Division II, ACCA, CICPA

Mr. Yu Yong, chief manager of the project, Auditing Division II

Dr. David Von Hippel, Evaluation Expert

Ms. Wang Lei, Evaluation Expert

Mr. Zhong Shunhe. (serving as Translator)

Meeting Process:

1. Dr. David Von Hippel introduced the purpose and content of the evaluation and expressed willingness to hear ideas and information from related parties.
2. Ms. Xin Feng introduced the project's auditing process, including the audit criteria, objectives, methods and scope, then described the audit contents, suggestions for the project following the audit, and some problems found during the audit.
3. Q&A
4. Ms. Xin Feng noted that the external evaluation is very useful and necessary, and hope to know whether all the UNDP projects have the external evaluation process or not and hope that National Audit Office could get the external evaluation report. She thinks it will be very useful for the final audit process in the next year if her office receives the external evaluation report.

October 19, 2006

2:00 - 5:00 p.m.

Evaluation Summary Meeting

Location: Foreign Economic Cooperation Office (FECO), State Environmental Protection Administration, Room 620, Xianfeng Office Building, No.277, Zhaodengyu Road, Xicheng District, Beijing

Participants:

Dr. David Von Hippel, Evaluation Expert

Ms. Wang Lei, Evaluation Expert

Dr. Sun Xuefeng, Director Division IV of FECO, SEPA; the Project Manager.

Mr. Liu Fuzhong, Deputy President of China Household Electrical Appliances Association (CHEAA), Senior Engineer, The Evaluation Expert of the Project.

Ms. Jiang Feng, Secretary General of CHEAA, Senior Engineer, Professor, the Project Coordinator.

Mr. Zhong Shunhe, Consultant to China Household Electric Appliances Research Institute (CHEARI), Professor, the Domestic expert of the Project.

Dr. Li Hongqi, Professor, College of Environmental & Energy Engineering, Beijing University of Technology, the Compressor expert of the Project,

Mr. Qi Bing, CHEARI, Scientific Promotion Department Director, Professor, the Refrigeration expert of the Project.

Mr. Chen Jianhong, China National Institute of Standardization, Sub-Institute of Resource and Environment Standardization, Professor, expert of the Project.

Mr. Yue Zhenjiang, media expert of the Project.

Mr. Wang Wei, FECO of SEPA, Official of the Project.

Meeting Process:

1. Dr. David Von Hippel presented *PRELIMINARY RESULTS OF EVALUATION OF UNDP/GEF PROJECT “Barrier Removal For The Widespread Commercialization Of Energy-efficient CFC-free Refrigerators in China”*
2. Mr. Wang Wei, expressed his agreements with Dr. David and thanks again for the cooperation of each visited enterprise.
3. Dr. Sun Xuefeng thanked the evaluation experts for their sharing of evaluation results and suggestions with PMO and project experts, and expressed that the PMO will review the evaluation report and use it to help the PMO continue to improve future projects.

List of Project Documentation Reviewed

[LIST NOT YET COMPLETE]

United Nations Development Programme (UNDP), Project of the Government of The People's Republic of China: Project Document, Project Budget Number: CPR/98/G31/A/1G/99, Project Title: Barrier Removal for the Widespread Commercialization of Energy-efficient CFC-free Refrigerators in China (Project Document). Date unspecified on the document, but presumably 1999.

Huangshi Dongbei Electrical Appliance C., Ltd., Barrier Removal for the Widespread Commercialization of Energy-efficient CFC-free Refrigerators in China: Self Evaluating Report. October, 2006.

China National Institute of Standardization, Energy efficiency standards and labels for China's household refrigerators. Presentation delivered to the Evaluation Mission on October 10, 2006

UNDP, Annual Project Report (APR) for UNDP/GEF Projects, 2006; Barrier Removal for the Widespread Commercialization of Energy-efficient CFC-free Refrigerators in China. Draft report dated June, 2006)

Sun Xuefeng, PMO Manager, Barrier Removal for the Widespread Commercialization of Energy-efficient CFC-free Refrigerators in China. Presentation delivered to the Evaluation Mission on Oct. 9, 2006.

China Electric Household Appliances Research Institute, Testing Mission Report of UNDP/GEF Project Test Agency from 2000 to 2006. Presentation delivered to the Evaluation Mission on October 11th, 2006.

TNS Consultants (individual authors, Chirantan Ray, Dilys Du, Jason Xie, Shawn Wang), CONSUMER AWARENESS TRACKING ENERGY EFFICIENT REFRIDGERATORS IN CHINA: Report Post-campaign Survey. Prepared for: United Nations (UN) & State Environmental Protection Administration China (SEPA), Jan. 2005, Job #: 10995.

China Household Electrical Appliances Association, Barrier Removal for the Widespread Commercialization of Energy-efficient CFC-free Refrigerators in China: Report on the sub-project undertaken by CHEAA. 2006.

Project Management Division VI, Foreign Economic Cooperation Office, China State Environmental Protection Administration, Successful Eco-Procurement Example - China Energy Efficient Refrigerator Project. 2006.

[Document presumably prepared by PMO/SEPA and UN-DESA in some combination, and apparently based on the document above], Case Study of the China Energy Efficient Refrigerator Project. No date provided, but presumably 2006. Available as http://www.un.org/esa/sustdev/csd/casestudies/e3_c3_China.pdf.

Phillips, Ray, China CFC-Free Energy-Efficient Refrigerator Project. Presented at the IEA-India Workshop on Energy Efficiency Standards and Labelling, Bangalore, India, October 13-14, 2004. Available as <http://www.iea.org/textbase/work/2004/bangalore/philips.pdf>.

Guangdong Kelon Co. Ltd, Project Report on UNDP/GEF Barrier Removal for the Widespread Commercialization of Energy-efficient and CFC-free Refrigerators in China. Presentation made to Evaluation mission on October 16, 2006.

Qingdao Haier Joint Stock Co., LTD., Project Report on UNDP/GEF Barrier Removal for the Widespread Commercialization of Energy-efficient CFC-free Refrigerators in China. Presentation made to Evaluation mission on October 18, 2006.

Global Environment Facility, Annex 3: STAP Technical Review [to Project Document, dated ~1998]. Available as <http://www.gefweb.org/wprogram/mar98/undp/china/cfcfinl3.pdf>.

China Household Electrical Appliances Association, Assessing the Implementation of Household Appliance Energy Efficiency Standards in China. June 2004. Available as http://www.efchina.org/documents/CHEEA_appliance_energy_efficiency_standards_implementation.pdf.

Jiang Feng, China Household Electrical Appliances Association, Push of GEF Project on Chinese energy-saving refrigerator. Presentation made to Evaluation mission on October 9, 2006.

McCann Erickson Guangming (Beijing Office), CHINA Consumer Education Campaign for Energy Efficient Refrigerator. Presentation made to Evaluation mission on Oct 10, 2006.

China Household Electrical Appliances Association, Video presentation: “Green Life Starts from the Selection of Refrigerators”. Date approximately 2002.

Printout of Workbook Used to Estimate Electricity and Greenhouse Gas Savings Achieved by Project

ESTIMATES OF GHG SAVINGS FROM UNDP/GEF REFRIGERATOR EFFICIENCY PROJECT (1999-2006)

Prepared by: David Von Hippel (Project Evaluation Expert)
 Date Prepared: 10/30/2006

Areas shaded blue represent calculated figures

EMISSION FACTORS

Emission factor: 1.5 kg CO₂/kWh (from Project Document)
Check of emission factor (based on values from author's files and other sources)
 Average efficiency of coal-fired electricity production, 2003: 380 gce/kWh
 From <http://www.sp-china.com/environmental/a.html>
 Average energy content of raw chinese coal: 0.7143 tce/tonne coal
 Average carbon content of raw chinese coal: 60%
 Conversion constant: 29.2 GJ/tce
 Emission factor: 92.6 kg CO₂/GJ Coal input (based on IPCC)
 Emission factor (calculated from carbon content): 105.48 kg CO₂/GJ Coal input
 Implied GJ coal/kWh output: 0.0111
 Implied emission factor: 1.03 kg CO₂/kWh with IPCC emission factor, or
 1.17 kg CO₂/kWh with emission factor calculated from carbon content

Both of these are lower than the figure in the Project Document, which may be based on lower-efficiency power plants. Assuming that losses in transmission and distribution are 10% of generation (will be higher in rural areas), a total emission factor (CO₂ saved per end-use kWh saved) The emission factor calculated base on carbon content is used in the calculations below.

For sulfur oxide emissions, assuming an average sulfur content of 1.10% by weight for Chinese coal, and that sulfur removal results in the capture of 30% of sulfur in coal (as a national average), an average emission factor can be calculated as 0.74 kg SO₂/GJ Coal input, which implies 0.008 kg SO₂/kWh electricity output.

REFRIGERATOR ENERGY USE

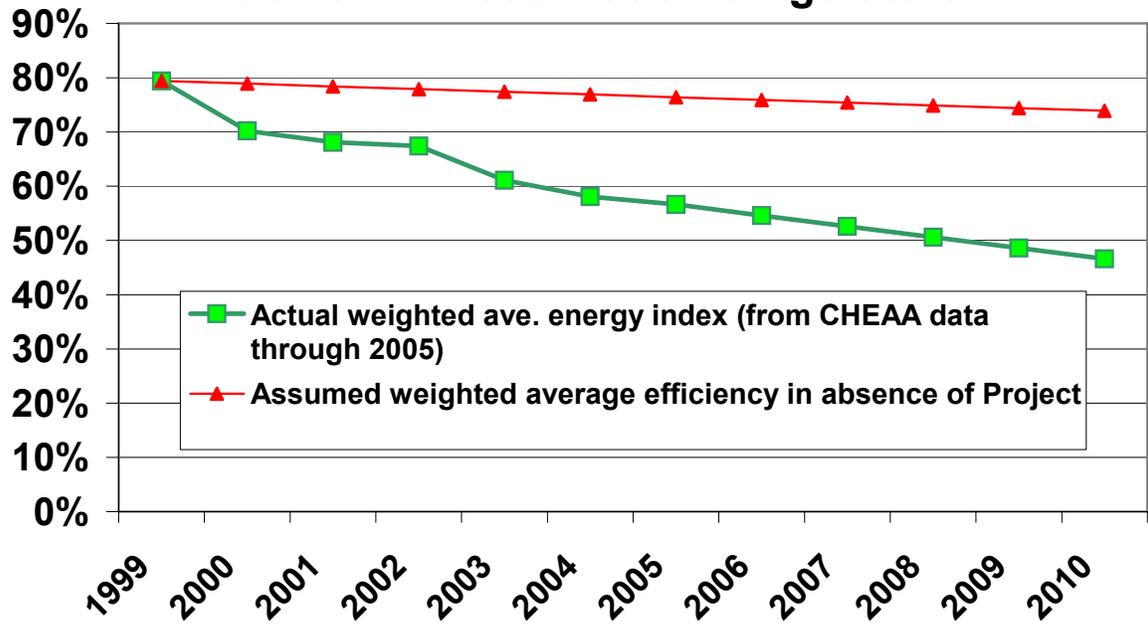
Estimated kWh/day per unit energy index, for ~200-liter model: 1.29 (Unit just meeting standards)
 Assumed efficiency in absence of project 79.40% in 1999, declining at an average (linear) rate of 0.50% per year even in the absence of the Project.
 Improvements in efficiency assumed to continue at 2% as a result of the Project (post-Project conditions)
 Average refrigerator lifetime: 15 years
 Average rate of sales growth, 1999 to 2005: 16.45%/yr
 Assumed average rate of sales growth, 2006-2010: 13.00%/yr (slightly lower than recent experience, as urban markets become saturated)
 Assume that losses in transmission and distribution are 10% of generation (will be higher in rural areas), so savings at generator will be higher by a factor of 1.11 than end-use savings.

Year	Actual weighted ave. energy index (from CHEAA data through 2005)	Assumed weighted average efficiency in absence of Project	Average unit energy savings at end-use, kWh/yr	Total Refrigerator Sales by Chinese Companies (domestic and imports) (million)
1999	79.40%	79.40%	-	11.23
2000	70.20%	78.90%	41.09	12.25
2001	68.10%	78.40%	48.65	13.60
2002	67.40%	77.90%	49.60	15.99
2003	61.10%	77.40%	76.99	21.00
2004	58.10%	76.90%	88.80	26.00
2005	56.60%	76.40%	93.53	28.00
2006	54.600%	75.90%	100.61	31.64
2007	52.600%	75.40%	107.70	35.75
2008	50.600%	74.90%	114.78	40.40
2009	48.600%	74.40%	121.87	45.65
2010	46.600%	73.90%	128.95	51.59
Year	Implied annual GWh electricity generation savings for each year's output	Implied annual electric GWh generation savings, cumulative	Implied GWh electricity generation savings, lifetime , for each year's output	Implied lifetime electric generation GWh savings, cumulative
1999	-	-	-	-
2000	559	559	8,390	8,390
2001	735	1,295	11,028	19,418
2002	881	2,176	13,218	32,636
2003	1,797	3,972	26,948	59,583
2004	2,565	6,538	38,481	98,064
2005	2,910	9,447	43,645	141,710
2006	3,537	12,984	53,056	194,765
2007	4,278	17,263	64,175	258,940
2008	5,153	22,415	77,289	336,229
2009	6,182	28,597	92,727	428,956
2010	7,392	35,989	110,874	539,830

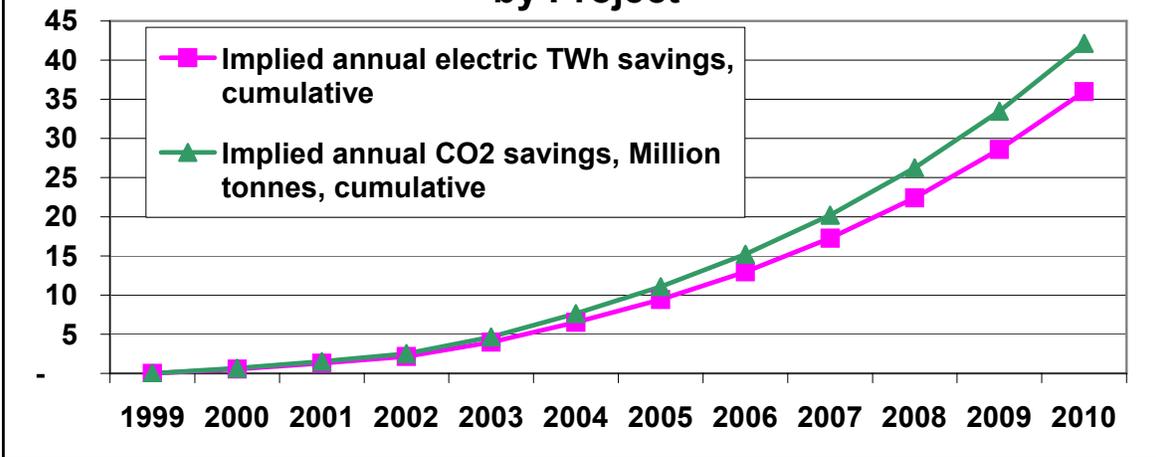
Year	Implied annual CO ₂ savings, Million tonnes, for each year's output		Implied lifetime CO ₂ savings, Million tonnes, for each year's output	
	Implied annual CO ₂ savings, Million tonnes, for each year's output	Implied annual CO ₂ savings, Million tonnes, cumulative	Implied lifetime CO ₂ savings, Million tonnes, for each year's output	Implied lifetime CO ₂ savings, Million tonnes, cumulative
1999	-	-	-	-
2000	0.65	0.7	9.82	9.82
2001	0.86	1.5	12.91	22.73
2002	1.03	2.5	15.47	38.20
2003	2.10	4.6	31.54	69.74
2004	3.00	7.7	45.04	114.77
2005	3.41	11.1	51.08	165.85
2006	4.14	15.2	62.10	227.95
2007	5.01	20.2	75.11	303.06
2008	6.03	26.2	90.46	393.51
2009	7.24	33.5	108.53	502.04
2010	8.65	42.1	129.76	631.80

Year	Implied annual SO ₂ savings, Million tonnes, for each year's output		Implied lifetime SO ₂ savings, Million tonnes, for each year's output	
	Implied annual SO ₂ savings, Million tonnes, for each year's output	Implied annual SO ₂ savings, Million tonnes, cumulative	Implied lifetime SO ₂ savings, Million tonnes, for each year's output	Implied lifetime SO ₂ savings, Million tonnes, cumulative
1999	-	-	-	-
2000	0.005	0.005	0.069	0.069
2001	0.006	0.011	0.090	0.159
2002	0.007	0.018	0.108	0.267
2003	0.015	0.033	0.221	0.488
2004	0.021	0.054	0.315	0.803
2005	0.024	0.077	0.358	1.161
2006	0.029	0.106	0.435	1.596
2007	0.035	0.141	0.526	2.121
2008	0.042	0.184	0.633	2.755
2009	0.051	0.234	0.760	3.514
2010	0.061	0.295	0.908	4.423

Rough Assumptions Regarding Energy Index of Chinese-made Refrigerators



Cumulative Annual Electricity and GHG Savings by Project



Terms of Reference for International Evaluation Consultant

Project No. and Title:	UNDP/GEF CPR/98/G31-Barrier Removal for the Widespread Commercialization of Energy Efficient CFC-Free Refrigerators in China
Job Title:	International evaluation consultant
Duration of the Contract:	Four weeks (two weeks in China) during April 15 to June 15, 2006
Location of services:	Beijing and two other cities in China, and home office

Background

With rapid economic growth and living-standard improvement in China, production of household refrigerators has increased considerably over the last decade, rising from 4.63 million units in 1990 to over 10 million per year since 2000, and in 2004, the number reached to 30.33 million units. Refrigerators are always on, and therefore consumer significant amounts of electricity and Chinese refrigerators have historically been significantly less efficient than refrigerators in developed countries. With the support from the Global Environment Facility, the Government of China and the United Nations Development Programme (UNDP) jointly developed the project “Barrier Removal for the Widespread Commercialization of Energy Efficient EFC-Free Refrigerators in China” (CPR/98/G31).

The project was the first GEF UNDP project nationally executed by China. The project has been executed by the State Environmental Protection Administration (SEPA), with daily implementation by the Project Management Office (PMO).

The project has aimed at promoting the manufacture and wide use of energy-efficient refrigerators by removing technical, market, commercial, information and other barriers to increased market penetration of the technologies and products. The activities developed for the project can be generally grouped into those providing a “technology push” to increase the supply of energy efficient refrigerators, and those providing “demand pull” to raise retailer and consumer understanding of the benefits of energy efficient refrigerators in China.

The project is coming to an end in 2006 (most project activities were completed in 2004, with only a few activities remaining in 2005/6). In order to fulfill UNDP and GEF requirements, the project is conducting an external/independent evaluation during the period of April 15 1 to June 15, 2006.

The purpose of the evaluation is to perform an in-depth assessment to see whether the project has successfully accomplished its objectives in terms of its approaches, activities and outcomes according to the agreed upon Project Document and to evaluate the impacts and sustainability of project outcomes. The findings of the evaluation will be utilized by the Chinese Government, UNDP, the GEF, and other GEF Implementing Agencies and member countries to help guide future projects in the areas of energy efficiency and market transformation.

The project should be evaluated based on the logical framework (“logframe”) included with the

project document, and in annual Project Implementation Reports (PIRs), copies of which are attached.

Scope of Services

Under the supervision of PMO and in cooperation with the UNDP and UNDESA, 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

- 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

c) Review of Project Impacts

- Impact on national energy use and efficiency (due to changes in consumer behaviour, availability of new EE refrigerators and compressors in stores, ability of retailers to more effectively market EE refrigerators, etc).
- Impacts of the approaches and activities on China's refrigeration sector.
- Achievement of climate change objectives and project outputs in relation to the project inputs, cost and implementation time.
- Cost effectiveness.
- Relevance of the project to national development priorities
- Sustainability of project achievements. The extent to which benefits will 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

The international consultant will be the Team Leader and responsible for drafting the evaluation

report, the national consultant will assist the international consultant in providing the baseline assessment, inputs on national policies and strategies, and in collecting information and commenting on the evaluation prepared by the international consultant.

Qualifications

The consultant will have as many as possible of the following qualifications:

- Project development, implementation, and evaluation experience;
- Familiarity with energy efficiency issues;
- Expertise with economic analysis, spreadsheet analysis and related social and technical issues;
- Good communications and writing skills in English;
- Knowledge of international energy efficiency programs;
- Knowledge of energy efficiency programs and projects in China;
- Knowledge of market transformation projects and programs;
- Knowledge of GEF projects and project requirements;
- Knowledge of UNDP projects and project requirements;
- Familiarity with appliance/white goods and/or other consumer goods sectors;
- Professional experience in working in China and with Chinese counterparts.,

Output

The consultant will prepare an evaluation report presenting evaluation results for the project, and recommendations for future similar projects. The report should be submitted to UNDP, PMO/SEPA and UNDESA within six weeks from the date when the consultant contract was awarded. The document should be submitted in electronic format.

Duration of the Contract

Four work weeks, including travel time are required. The consultant will travel to Beijing, China and two other cities locations within China. The consultant will meet with government officials, project participants, and other stakeholders in order to evaluate the project's implementation and impact. The travel schedule and locations visited will be developed in conjunction with UNDP, PMO/SEPA and UNDESA.

Procedures

Interested and qualified consultants are invited to make a proposal describing:

- The name and CV of the applicant;
- The proposed methodology, including approach, scoping, indicators, instruments.

Payment Schedule

30% of the total amount due the consultant will be paid upon signature of the contract for

mobilization. The remaining 70% is payable upon acceptance by UNDP, SEPA and UNDESA of the evaluation report in its final form.

Attachments

- *Project Document*
- *Logistical Framework*
- *Project Implementation Reports (PIRs)*