# Case Study of the China Energy Efficient Refrigerator Project

The China Energy Efficient (EE) refrigerator project was the fifth key GEF Environment Change project. The project has received GEF grants totaling US$9,860,000, leveraged by over $31 million in other funding.[1] The project was approved by the GEF in July 1999 and began in Dec. 1999. Project implementation will last 6 years. It is expected that the project will be completed in Dec. 2005.

The project's Implementing Agency is UNDP. The domestic Executing Agency is the China State Environment Protection Administration (SEPA), which has assigned SEPA's Foreign Economic Cooperation Office (FECO) to manage execution of the project. The United Nations Department for Economic and Social Affairs (UNDESA) is supporting the project as the International Cooperating Agency.

## 1 Project Background

From 1980 to 1995, residential power use rose from three percent to twelve percent of total electricity consumption, growing at an annual rate of 16.3 percent. This growth has been driven by an explosive increase in household appliance use, as household income has risen. Within the residential sector, it is estimated that refrigerators alone, now found in 70% of urban households, account for approximately half of all residential electricity consumption. In 1992, there were a total of 39 million refrigerators in service, an increase from only 4 million in 1985 (38% average annual growth). According to calculation, at current levels of power consumption and production levels, refrigerators produced in China over the next decade will require an additional 601 billion kWh of energy over their expected lifetimes, This would necessitate an estimated increase in an annual power generation capacity of 5,700 MW, equivalent to an annual average of 60 million tons of additional $CO_2$ emissions. Excessive energy consumption by refrigerators has become an issue extremely need to be solved. It is clear that additional power generation capacity required will be significantly higher in the future several and several ten years. In 1995, electricity production was responsible for one-third of China's $CO_2$ emissions. The demonstrated that refrigerators were slated to use considerable quantities of electricity and to contribute significantly to $CO_2$ emissions.

Prior to the China Refrigerator Project, Chinese refrigerators were significantly less energy efficient than those produced in the European Union, United States, or Japan (e.g., the average refrigerator in China consumed up to 2.5kWh/year per liter of volume compared to 1.5kWh/year in Europe). There was a clear need to strengthen capacity in China to manufacture and utilize energy efficient refrigerators. Domestic research demonstrated that the energy consumption by refrigerators in china could reduce by as much as 40%. However, there were many barriers for the widespread commercialization of energy

[1] Project funding consisted of $243,000 in GEF Project Preparation and Development Facility (PDF) funding and $9,617,000 full project funding.

efficient refrigerators in China.

The China Refrigerator project was developed in order to address this problem. The project began in 1989 as a bilateral cooperation project between the US Environmental Protection Agency (USEPA) and China State Environmental Protection Administration (SEPA). From 1989-1995, work was conducted in the areas of CFC substitutes research, energy efficient design options, prototype development, safety testing, and field testing. A chlorofluorocarbon (CFC) replacement demonstration was funded through Montreal Protocol Fund ($3.5 million) received in two parts in June 1993 and March 1995.

Initial GEF project development funding of $243,000 was received in March 1997 from the GEF's Project Preparation and Development Facility (PDF). GEF approved full project funding of $9.6 million for market transformation in June 1998. The Project Document was approved July 1999. The project was formally launched at an inception meeting in December 1999.

A key factor in ensuring the success of a comprehensive market transformation project is to carefully plan and coordinate activities, and to ensure that all stakeholders are involved in both project planning and execution. This was particularly true with the China Refrigerator Project, which benefited greatly from active stakeholder involvement in development and implementation of the project. Please see the attached text box for a list of key stakeholders.

## 2 Project goals

The China Refrigerator Project's goal

**Project Participants**

Chinese refrigerator and compressor manufacturers

China State Environmental Protection Administration (SEPA)-- National Executing Agency, project Advisory Committee (AC) member

United Nations Development Programme (UNDP)-- GEF Implementing Agency, AC member

China Ministry of Finance (MOF) – GEF Country Focal Point, AC member

SEPA Foreign Economic Cooperation Office-- National Implementing Agency and home of Project Management Office (PMO)

United Nations Department for Economic and Social Affairs (UNDESA)-- International Cooperating Agency

China National Development and Reform Commission (NDRC) – chief energy efficiency regulatory body, AC member

China State General Administration for Quality Supervision, Inspection, and Quarantine (AQSIQ) – issues energy efficiency and other product standards, AC member

China National Institute of Standardization (CNIS) – provides market assessment, technology review, and economic analysis support to AQSIQ in energy use standard development, and was lead participant in GEF project standards and labeling work

China State Administration of Internal Trade (SAIT) – oversees retail sector; AC member

China Household Electric Appliance Association (CHEAA) – lead participant in variety of project activities; liaison to industry; maintains project Information Center and website

China Household Electric Appliance Research Institute (CHEARI) – helped develop demo project prototype, provides project technical support and product testing capability

China Certification Center for Energy Conservation Products (CECP) – responsible for China's endorsement level and will manage information label; key participant in mass procurement program

Collaborative labeling and Appliance Standards Program (CLASP) – key participant in standards and labeling work

University of Maryland Center for Environmental Energy Engineering (UMd CEEE) – intensive long-term refrigerator design training location

National and international experts and contractors hired to support implementation of the project

was to reduce energy consumption through promotion of improved refrigerator energy efficiency, contributing to protection of the global environment by reducing carbon dioxide and other greenhouse gas (GHG) emissions caused by household refrigerator energy use in China. An additional project goal was to take advantage of product and production line modifications through the CFC phase-out to introduce energy efficiency modifications.

It is estimated that in the ten years following implementation of the project, refrigerators in China can reduce electricity consumption by about 120 billion kWh. If this electricity is all from coal, this will save 7.175 million tons of coal, resulting in emissions reductions of 143 million tons of $CO_2$. In addition to this significant global environmental benefit, corresponding reductions of $SO_2$ emissions and other local pollutants will lead to significant improvement of local environmental quality.

# 3 Project barriers

During project development, nine barriers were identified to adoption of energy efficient refrigerators by households. These barriers were:

- Lack of awareness of the lifecycle economic benefits of high-efficiency refrigerators
- Lack of reliable, comparative information available to consumers about specific models.
- Manufacturer uncertainty about market demand for high-efficiency models
- Manufacturer uncertainty about cost-effectiveness of high-efficiency models
- Lack of expertise in energy efficient refrigerator design.
- Higher-efficiency compressors are not available domestically.
- Dealer reluctance to stock or promote high-efficiency models
- Lack of an appliance recycling program.
- Lax efficiency standards.

Each of these barriers will be discussed below.

## *3.1 Lack of awareness of the lifecycle economic benefits of high-efficiency refrigerators*

Refrigerator purchasers in China, as consumers elsewhere throughout the world, were highly sensitive to the first-costs of their purchases and, inappropriately preferred models with low purchase prices and higher electricity costs because they did not fully appreciate that total lifecycle costs, including electricity, can be much lower for high-efficiency models.

## *3.2 Lack of reliable, comparative information available to consumers about specific models*

Even where consumers wanted to purchase models with low lifecycle costs, they were unable to make comparisons between models because energy efficiency labels did not exist to provide this information in a consistent and easy-to-understand way.

### *3.3 Manufacturer uncertainty about market demand for high-efficiency models*

Manufacturers had access to few, if any, market research studies or data about the potential demand for high-efficiency models in the Chinese market, partly because historically low electricity prices and little emphasis on energy efficiency in the Chinese economy left both producers and consumers uninterested in energy efficient products.

### *3.4 Manufacturer uncertainty about cost-effectiveness of high-efficiency models*

Manufacturers were also uncertain about the costs of developing and producing high-efficiency models, and about the price premium in the marketplace that high-efficiency models might command. Therefore, manufacturers were reluctant to commit the resources to develop and produce high-efficiency models.

### *3.5 Lack of expertise in energy efficient refrigerator design*

The majority of Chinese manufacturers lacked the engineering and design expertise to develop new energy efficient refrigerator models or modify existing designs to make them more energy efficient. As a result, manufacturer did not cultivate the skills and staff necessary for energy efficient refrigerator design. Second, most domestic manufacturers had relied heavily on imported or licensed technology and were therefore at a further disadvantage in developing new energy efficient product designs. Finally, many domestic manufacturers (and particularly second tier ones) relied on a limited and unchanging product line for their sales, and therefore had extremely limited experience in product design and redesign. For these reasons, many manufacturers were uncertain of their ability to implement energy-efficiency measures without targeted training to impart the necessary skill sets.

### *3.6 Higher-efficiency compressors were not available domestically*

In order for a Chinese refrigerator manufacturer to design and produce a high-efficiency refrigerator, a higher-efficiency compressor must be utilized. Prior to the project, such compressors were not available in China, and the higher cost of imported high-efficiency compressors was a strong disincentive for domestic refrigerator manufacturers.

### *3.7 Dealer reluctance to stock or promote high-efficiency models*

Uncertainty about consumer demand, the need to educate their sales force, and fear of reduced sales due to higher prices on the shelves made dealers reluctant to stock high-efficiency models. Surveys conducted during project development also indicated that sales staff were unfamiliar with the benefits of energy efficiency and unable to provide consumers with reliable information.

### *3.8 Lack of an appliance recycling program*

As China’s refrigerator market matures, an increasing proportion of purchases involve replacement of an old refrigerator. Unlike most developed countries, where most old appliances are scrapped or recycled, market research indicates that many new buyers in China kept their old refrigerators. Continued use of these old refrigerators risked offsetting many of the efficiency gains from the purchase of new refrigerators.

### *3.9 Lax efficiency standards*

China's previous refrigerator efficiency standards, promulgated in the 1980s, were established in view of the needs of hundreds of small refrigerator producers. They allowed production of a large number of highly inefficient refrigerators and provided manufacturers no incentive to companies to increase the energy efficiency of their models.

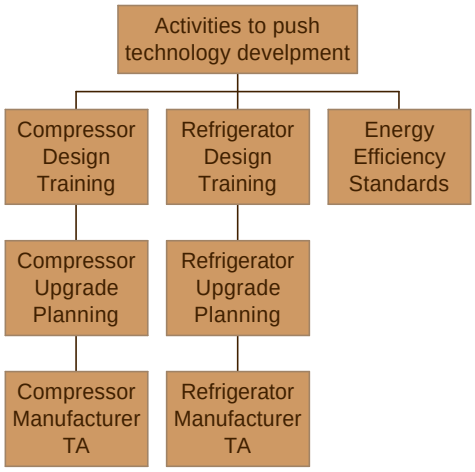
## 4 Project activities

A series of coordinated project activities were developed in order to eliminate or reduce these barriers so that a long-term, sustained transformation of China's refrigerator market could be accomplished. These activities can by grouped into two categories: (1) those providing a "technology push" to increase the supply of energy efficient refrigerators, including technical training, technical assistance, study tours, incentive program for refrigerator and compressor manufacturers, and revision of the national energy consumption standard, and (2) those providing "demand pull" to increase demand for energy efficient refrigerators by increasing retailer and consumer understanding of the benefits of energy efficiency and energy efficient refrigerators.

### *4.1 Technology Push*

The project's "Technology Push" activities were focused at manufacturers: the "supply side" of the market transformation equation.

First, given that an energy efficient compressor is an integral component of energy efficient refrigerators, the project included a range of activities aimed at compressor manufacturers. Through international design training, business planning, technical assistance and technology transfer, the project assisted compressor manufacturers in upgrading their products. Training provided manufacturers with the ability to design more efficient compressors, and an incentive program provided them with the incentive and the incremental cost funding to make and sell them




Simultaneously, focused training activities aimed at the refrigerator manufacturers increased their capacity to design and manufacturer energy efficient refrigerators. Computer design modeling, international technology training, tours and exhibitions, and intensive energy efficient design training provided refrigerator manufacturers with the tools to create new energy efficient model designs. To provide them with the incentives and incremental cost funding to implement efficiency gains, manufacturers competed in a bidding process for incentive program awards designed to both raise average efficiency levels for all manufacturers and promote development of super-efficient models.

The project also strengthened energy efficiency standards with two rounds of standards revisions during both the PDF and GEF stages of the project. National standards setting organizations and staff were also provided with assistance and training in the analytical tools to determine new efficiency standards in order build national capacity for future standard revision.

### *4.2 Demand-pull*

The project's demand-pull activities included a number of programs designed to reduce barriers to consumer and dealer acceptance of energy efficient refrigerators. It was discovered during the market survey conducted during the PDF phase of the project that there was no longer a big difference between most products in terms of basic product functions. Instead, other criteria were becoming increasingly important. The project's consumer awareness goal therefore became making energy efficiency one of these key factors.


To generate demand and increase consumers' understanding on the benefits of high-efficiency refrigerator, a Consumer Education Campaign was be designed, using TV, outdoor advertising, magazine ads, and other media. Consumers were also targeted at retail locations with relevant educational and informational material. To complement this Campaign, a public relations campaign was implemented in order to broadly educate the public on the benefits of energy efficiency. In addition, a nationally certified energy label was developed in order to provide comparable information across models to allow consumers easily identify energy efficient refrigerators.

Through the retail education activity, retail staff were trained in the promotion of energy efficiency, and a retail incentive program was implemented to encourage stores and salespeople to further promote energy efficient refrigerators in key target markets of China. A mass purchasing program was designed and launched to promote purchase of energy efficient appliances by large scale purchasers, particularly government agencies. Finally, a proposal has been developed and third party international funding is being sought for a recycle/buyback program providing financial incentives to consumers to return old refrigerators on the purchase of a new energy efficient ones will be developed.[2] The project has also provided technical assistance to the National Development and Reform Commission (NDRC) in its development of new nationwide regulations for appliance recycling.

Please see the table below for a list of project activities and budget for each activity.

[2] No GEF funding was sought for the appliance recycling program, which was designed as a parallel activity to be funded with third party international funding.

| Activity | GEF | Co-financing | Total |
|---|---|---|---|
| 1. Compressor Factory Technical Assistance | $352,500 | $1,579,500 | $1,932,000 |
| 2. Refrigerator Factory Technical Assistance | $1,503,090 | $24,265,000 | $25,768,090 |
| 3. Incentive Programs | $3,595,000 | $660,000 | $4,255,000 |
| 4. Consumer Education Program | $2,984,940 | $4,450,000 | $7,434,940 |
| 5. Project Management, Monitoring and Evaluation | $1,181,470 | $335,000 | $1,516,470 |
| Total | $9,617,000 | $31,289,500 | $40,906,500 |

# 5 Key Project Results

### *5.1 Overall energy efficiency gains*

The China Refrigerator Project has achieved significant results in a variety of areas. First and foremost, the number of manufacturers producing energy efficient refrigerators and the number of energy efficient refrigerator models produced has significantly increased as a result of the project. As an intermediate indicator, annual production of energy efficient refrigerators[3] went from about 1 million in 1999 to 10.7 million in 2004 and over 14 million in the 12 months ending in June 2005. The average refrigerator energy index[4] has improved from 0.794 in 1999 to 0.572 as of June 2005, for a gain of 28%. Production of super-efficient refrigerators (those at least 60% more efficient than the energy efficiency standard) has increased from 400 units in 1999 to 3.3 million during the 12 months ending in June 2005. There are currently 256 models of domestically manufactured energy efficient refrigerators on the market which meet the energy efficiency requirement of grade 1 of the National Standard for refrigerator energy consumption (superior to European grade A).

The project's original target was to promote sales of 20 million energy efficient refrigerators over a 10 year impact period during and following the project after the project has achieved market transformation. Based on average efficiency gains of 40% relative to the baseline, each energy efficient refrigerator sold results in $CO_2$ emissions reductions of 5 tons over its lifetime, for total target estimated emissions reductions of 100 million tons $CO_2$ equivalent.[5] Based on sales of energy efficient refrigerators (all of which *at least* 40% more efficient than the energy use standard, indicating that the average energy savings for those refrigerators is even greater) or 11.7 million units between 2000 and 2004, it appears that the project goal will be not only met, but also significantly exceeded. If current sales levels of over 5 million energy efficient refrigerators per year continue, emissions reductions due to market transformation achieved by the project could reach or exceed 250 million tons $CO_2$. Emissions reduction cost

[3] Unless otherwise noted, "energy efficient refrigerators" referred to here are those in the top two grades as defined by the new energy efficiency standard, consisting of refrigerators that are at least 40% more efficient than the standard. Production refers to production by refrigerator manufacturers participating in the project.

[4] Average refrigerator energy use relative to the standard, so 0.572 in June 2005 means that on average, refrigerators used 57% of the energy allowed by the standard.

[5] Energy savings of 220 kWh/year per refrigerator = 5 tons $CO_2$ equivalent emissions reductions.

effectiveness will likely reach less than $0.05/ton $CO_2$.[6]

### *5.2 Technical Assistance*

Under the technical assistance program, engineers from 8 Chinese compressor manufacturers participated in design training workshops, study tours, and expert technical assistance. Engineers from 16 participating refrigerator manufacturers received training in international technology options, and modeling of energy-efficiency measures, expert technical assistance, and in-depth international design training. As shown in the table below, the project provided almost five thousand person-days of training.

| # | Description | Dates | Staff trained | Person-days training |
|---|---|---|---|---|
| 1 | In Country Compressor Training Program (1) | 2000.12.7 -12 | 29 | 174 |
| 2 | In Country Compressor Training Program (2) | 2001.7.16 -21 | 29 | 174 |
| 3 | Overseas compressor study tour (1) | 2000.7.22-31 | 7 | 7 |
| 4 | Overseas compressor study tour (2) | 2001.9.8-20 | 8 | 104 |
| 5 | TA for compressor manufacturers (1) | 2001.7.8-18 | 54 | 149 |
| 6 | TA for compressor manufacturers (2) | 2002.11.2-24 | 60 | 276 |
| 7 | ERA Design Modeling Training | 2000.9.10 -20 | 38 | 418 |
| 8 | Overseas Training on Refrigerator Options for Refrigerator Manufacturer Engineering Staff | 2001.1.8-17 | 38 | 380 |
| 9 | In-country Intensive Refrigerator Design Training | 2001.6.3-24 | 23 | 506 |
| 10 | First Group of Refrigerator Factories Overseas Training of intensive design in University of Maryland | 2001.9.4-12.4 | 7 | 63 |
| 11 | Second Group of Refrigerator Factories Overseas Training of intensive design in University of Maryland | 2001.12.4-2002.3.4 | 6 | 546 |
| 12 | Third Group of Refrigerator Factories Overseas Training of intensive design in University of Maryland | 2002.3.8-2002.6.8 | 7 | 651 |
| 13 | Forth Group of Refrigerator Factories Overseas Training of intensive design in University of Maryland | 2002.6.8-2002.9.8 | 7 | 651 |
| 14 | TA for refrigerator manufacturers (1)[7] | 2001.12.3-21 | 110 | 348 |

[6] Emissions reductions and energy savings are calculated as 40% lower energy use for approximately 20% of the projected market (2 million refrigerators/year) for 10 year project impact period at the conclusion of and following the project and with for an assumed 15 year average product life. 40% average efficiency gain for approximately 20% of annual production represents average fleet-wide efficiency gain of 8%. Actual efficiency improvement achieved 1999-2004 more than three times that amount, in addition to which greater numbers of energy efficient refrigerators than projected are being sold.

| # | Description | Dates | Staff trained | Person-days training |
|---|---|---|---|---|
| 15 | TA for refrigerator manufacturers (2) | 2002.5.14-6.2 | 58 | 232 |
| 16 | TA for refrigerator manufacturers (3) | 2002.11.12-30 | 64 | 243 |
| TOTAL | | | 545 | 4,922 |

### *5.3 Energy Efficiency Standards Revision*

China's refrigerator energy efficiency standard was introduced in 1989 (along with standards for washers, air conditioners, fans, rice cookers, TVs, radios, and irons). It was revised in 1999 (effective date 1 Jan. 2000) with support from the GEF during the project's PDF phase. The project also supported a second revision in 2003 (GB 12021.2-2003, test standard GB/T 8059.2-1995 = ISO 8187). This revision includes 10-15% energy savings relative to the 1999 standard, with an additional 10% savings scheduled to take effect in 2007.

| 1999 categories | M | N |
|---|---|---|
| Refrigerator, no-star compartment | 0.233 | 245 |
| Refrigerator, 1-star compartment | 0.643 | 191 |
| Refrigerator, 2-star compartment | 0.45 | 245 |
| Refrigerator, 3-star compartment | 0.657 | 235 |
| Refrigerator/Freezer | 0.777 | 303 |
| Chest frozen food cooler | 0.558 | 200 |
| Chest food freezer | 0.597 | 216 |
| Upright frozen food cooler | 0.624 | 223 |
| Upright food freezer | 0.519 | 315 |

Allowable energy use (EU) is calculated:

$$EU = M*AV + N$$

where AV is Adjusted Volume, M the volume factor, and N a constant. Adjusted volume is calculated:

$$AV = FVAF * FR + FF$$

where FVAF (Freezer volume adjustment factor) is 2.15, FR is freezer volume, and FF is fresh food compartment volume.

| 2003 categories | M | N |
|---|---|---|
| Refrigerator, no-star compartment | 0.221 | 233 |
| Refrigerator, 1-star compartment | 0.611 | 181 |
| Refrigerator, 2-star compartment | 0.428 | 233 |
| Refrigerator, 3-star compartment | 0.624 | 223 |
| Refrigerator/Freezer | 0.697 | 272 |
| Frozen food cooler | 0.53 | 190 |
| Food freezer | 0.567 | 205 |

[7] Manufacturer technical assistance consisted of individual visits to 4-6 factories per trip, with calculation of person-days takes into account by dividing by the number of factories visited.

The key variables are volume factor M and constant N, which determine allowable energy use. The 2003 standard (right) reduced the number of categories from 9 in the 1999 standard (left) to 7 by eliminating the distinction between chest and upright coolers/freezers. For almost all categories, both variables were reduced, as shown in the attached tables.

**Refrigerator standard change 1999-2003**

| Description | M | N |
|---|---|---|
| Refrigerator, no-star compartment | -5% | -5% |
| Refrigerator, 1-star compartment | -5% | -5% |
| Refrigerator, 2-star compartment | -5% | -5% |
| Refrigerator, 3-star compartment | -5% | -5% |
| Refrigerator/Freezer | -10% | -10% |
| Chest frozen food cooler | -5% | -5% |
| Chest food freezer | -5% | -5% |
| Upright frozen food cooler | -15% | -15% |
| Upright food freezer | 9% | -35% |

### *5.4 Labeling*

The GEF energy efficiency labeling program is part of a joint effort funded by the GEF, the Energy Foundation, the UN Foundation, and the Collaborative Labeling and Appliance Standards Program (CLASP).[8] The GEF project's original intention was to include both endorsement and information label components, since both label types make different and important contributions to energy efficiency promotion. However, GEF funds for labeling were limited and China already had an energy efficiency endorsement label, so the decision was made to focus GEF support on development of the information label.


| | |
|---|---|
| ?= 55% | 1 |
| 55%<?=65% | 2 |
| 65%<?=80% | 3 |
| 80%<?= 90% | 4 |
| 90%<?= 100% | 5 |

Graphic design and market testing of the new information label were completed and a workshop held in March 2003 to announce and evaluate design options. The draft plan for management of the labeling program was completed at the end of 2003. Regulations to create the energy efficiency label were approved in 13 August 2004 and took effect on 1 March 2005.Refrigerators are the first product to use the label, which will then be applied to other products as well, thus expanding the scope of its impact.

As shown by the graphic, the information label is similar to the EU label, but with a number instead of letter scale. As shown in the table, energy use allowance for each label category is expressed as a percentage of the energy use standard.

[8] Labeling funding $145,000 GEF funding, $178,000 others.

### *5.5 Consumer Education Program*

The Consumer Education Program's purpose was to make consumers both aware of the advantages of energy efficient refrigerators and more willing to purchase them. The program's budget was approximately $3 million, a significant portion of the GEF project budget and the first time that the GEF funded a program of this nature and scope.

| Activity | Contractor | Budget |
|---|---|---|
| Creative Content Design | McCann-Erickson Guangming | $343,090 |
| Media Purchase | Zenith Media | $2,357,476 |
| Public Relations | CHEAA | $180,700 |
| Consumer Awareness Tracking | Taylor Nelson Sofres Consultants | $79,530 |
| Int'l Marketing Expert | Burson-Marsteller | $28,613 |
| TOTAL | | $2,989,409 |

Separate contracts for creative content development, media placement, public relations, and consumer surveys were competitively bid and contracted. A list of contractors and budgets for individual program activities is shown in the attached table.


The advertising campaign began in Nov. 2003 and was one year long. It included newspaper and magazine ads, outdoor advertising, in-store advertising, and two TV ad pulses (Nov-Dec 2003 and June 2004 respectively ) timed to coincide with peak buying seasons. The campaign featured the unified dual message that energy efficient refrigerators protect the environment and save money, with imagery and themes to link those savings to the consumer's everyday life and protection of the environment.

In addition to GEF funds, participating refrigerator manufacturers were required to invest 10% of their advertising budget in promoting energy efficient products. An expert group site visit to participating manufacturers found that manufacturers met or exceeded this requirement.

### *5.6 Refrigerator Manufacturer Incentive Program*

For the Refrigerator Manufacturer Incentive Program, basic awards of US$60,000 or $120,000 (depending on manufacturer size) were awarded to each of the 16 participating manufacturers (exceeding the project's original target of 12 participants) to cover incremental costs of project participation for each manufacturer: (1) participation in all training and technical transfer programs, (2) increasing average energy efficiency at least 10%, (3) development of at least one new, top-rated energy efficient product, and (4) investing at least 10% of the refrigerator advertising budget in energy efficient products. All participants met or exceeded (some significantly) these requirements.

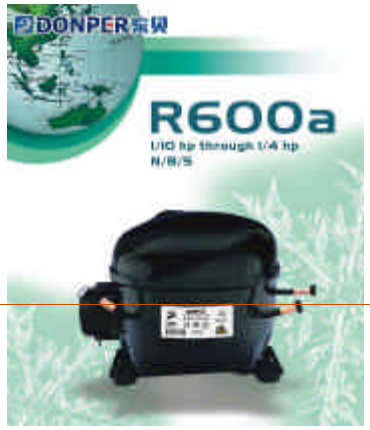
The refrigerator principal award was a total award of $US 1 million (including the basic award) awarded to the manufacturer who commits to and achieves the greatest total energy savings (relative to the energy efficiency standard) over a 12 month period for a single new energy efficient model refrigerator-freezer. The winner, Kelon, committed to produce and sell one million super-efficient

refrigerators during the contest period. The model proposed, the BCD-209, uses only 0.42 kWh/day (67% lower than the energy use standard), making it one of the most energy efficient refrigerators in the world. During the first 6 months of the contest sales period, Kelon has produced and sold 442K super efficient fridges, making it on track for meeting its sales goal.[9]

The refrigerator principal award was carefully timed to follow the technical training, and allow for large-scale production and sales of new, energy efficient refrigerators to benefit from the simultaneous consumer education campaign and issuance of the energy efficiency label. However, intense competition between leading manufacturers over the principal award resulted in a political battle, which (along with concerns related to the amount of money involved) delayed finalization of the award contract for several months and reduced some of these benefits.

Three Supplemental awards of US$60,000 each were also awarded to manufacturers that committed to and achieved the greatest energy savings relative to their base year energy efficiency. The three supplemental award recipients (Haier, Xinfei, and Kelon) are moving towards completing them.

### *5.7 Compressor Manufacturer Incentive Program*




The Compressor Manufacturer Incentive Program consisted of two awards of $400,000 and $100,000 respectively to the manufacturers that committed to develop and commercialize the most energy efficient compressor technologies (awards could be split in the event of a tie). For both the principal and secondary awards, proposals will be evaluated and scored as follows:

*(COP of* compressor *– baseline COP of 1.4) multiplied by the Potential market for compressor(s) of that size range*

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Potential awardees for the secondary award received an efficiency bonus of 0.05 if the substitute refrigerant technology proposed differs from the one proposed by the principal award winner in order to encourage development of compressors using a variety of refrigerants.

Three winning manufacturers were selected and committed to develop new lines of more energy efficient compressors. Huangshi Dongbei won the $400,000 main prize with a package of 18 highly efficient compressors. Wanbao and Jiaxipera split the secondary prize. Based on site visits and data collected from the bid winners, manufacturer commitments to increase compressor EE have been met or

[9] In order to account for shipments of energy efficient refrigerators to retailers that have not yet been sold to final consumers, Kelon and the backup award recipients will receive up to a 15% credit for the delta between wholesale and final consumer sales, such that if Kelon meets its 1 million unit target for sales to retailers, up to 150,000 refrigerators may still be in retailer hands and not yet sold to final consumers. In order to encourage further promotion by Kelon of energy efficient refrigerators and long term sales gains, Kelon may receive another 5% sales credit if at least 50% of their advertising during the promotional period is energy efficiency related, and another 5% if consumer awareness is raised by at least 10% points during that period.

exceeded. According to independent test results, Huangshi's top model reached COP 1.9; Wanbao's and Jiaxipera's top models reached 1.8 and 1.76 respectively, compared to average efficiency of COP 1.0 in 2000 for all compressor company project participants. All three of the bid winners have met commercialization goals, with significant sales by Jiaxipera and Huangshi (331,000 and 755,000 high efficiency units respectively).

### *5.8 Retailer Incentive Program*

Through the Retailer Incentive Program, cash payments of over $250,000 were awarded on a competitive basis to winning stores and individual salespeople, with additional funding of about $200,000 for program administration, an Award Workshop, retailer education, purchaser awards, and in-store consumer education materials.

In addition to the retailer and salesperson awards, the Retailer Incentive Program also included a lottery-style award for purchasers. This award was designed to give purchasers and additional incentive to buy energy efficient refrigerators, and to collect additional information (a total of 12,892 information forms were submitted). The table below shows the number and amounts of these awards.

| **Store awards** | **Number** | **Amount** | **Total** |
|---|---|---|---|
| First prize | 1 | $25,000 | $25,000 |
| Second prize | 5 | $10,000 | $50,000 |
| Third prize | 10 | $2,000 | $20,000 |
| Honorable mentions | 20 | $1,000 | $20,000 |
| Total/average | 36 | $3,194 | $115,000 |
| **Salesperson awards** | **Number** | **Amount** | **Total** |
| First prize | 1 | $10,000 | $10,000 |
| Second prize | 5 | $5,000 | $25,000 |
| Third prize | 25 | $2,500 | $62,500 |
| Honorable mentions | 50 | $100 | $5,000 |
| Total/average | 81 | $1,265 | $102,500 |
| **Purchaser awards**[10] | **Number** | **Amount** | **Total** |
| First prize | 1 | $10,000 | $10,000 |
| Second prize | 10 | $1,000 | $10,000 |
| Third prize | 50 | $100 | $5,000 |
| Subtotal | 61 | $410 | $25,000 |
| Honorable mentions | 1000 | $10 | $10,000 |
| Total/average | 1061 | $33 | $35,000 |

A total of 57 top nationwide retailers were recruited to participate in the program, all of whom signed contracts committing themselves to achieve program goals. A sales data collection system was established and in-store ad materials were sent to each retailer. Retailer education was completed in April 2004 (200 salespeople received training by project staff). The Retailer Incentive Program contest was conducted May 1 through October 31, 2004, after which the Awards Workshop was held to issue incentive funding awards. The first place retailer award was won by the Shanghai Commercial Center. The first place salesperson award was won by Ma Haiming from Beijing.

Participating stores and salespeople achieved sales of over 35,000 top rated energy efficient refrigerators. While this amount is small relative to total nationwide refrigerator sales, the program was able to achieve a per refrigerator incentive cost (approximately $7 per refrigerator) that was significantly

[10] Based on Chinese government regulations, the first and second prize amounts were not approved and had to be reduced to RMBY 5,000 (~$600) each. The number of awards was increased from 11 to 33 in order to keep the total budget the same.

lower than that achieved in comparable rebate programs in other countries.

# 6 Project Management and Monitoring

In addition to technical and substantive project activities, the China Refrigerator Project established a structure to monitor achievement of project results and manage project activities. An Information Center was established (managed under subcontract by CHEAA) to collect product and other technical and financial data from participating manufacturers. A Testing Center was established at the China Household Electric Appliance Research Institute (CHEARI) to perform scheduled and random testing of new refrigerators and compressors in order to provide independent test results confirming efficiency gains. A project website (www.r-gefchina.org.cn/news/en/admin.asp) was constructed and managed by CHEAA in order to provide project and product related information to project participants and the public.

Through its participation in the project, the project management abilities of project executor SEPA FECO, the Project Management Office (PMO), and its subcontractors has grown steadily, and good, productive relations have been established among national and international experts and other project stakeholders. The principal structure for interaction among project stakeholders is the Advisory Committee (AC), which includes representatives from all relevant government agencies and NGOs, and which has been invaluable in providing management, guidance, and coordination for the project.

PMO staff has also benefited by taking the lead in conjunction with national and international experts in organizing and implementing technical training workshops, as well as participation in project management related training specifically undertaken to familiarize key PMO staff with project management techniques and practices (e.g., Microsoft Project).

# 7 Stakeholder Involvement

SEPA and FECO have also worked closely with representatives of the key government agencies involved in the appliance sector in order to ensure the success and sustainability of project activities, in particular the China National Development and Reform Commission (NDRC), the China State General Administration for Quality Supervision, Inspection, and Quarantine (AQSIQ), the China National Institute of Standardization (CNIS), the China Certification Center for Energy Conservation Products (CECP), and others.

Most importantly, the project has been successful in working with its most important stakeholders: refrigerator and compressor manufacturers. The strong interest that manufacturers showed in the project and sustained commitments they made in order to participate is evidence of this success. A total of 16 refrigerator manufacturers (four more than the 12 originally targeted) and 12 compressor manufacturers (double the six originally targeted) requested participation in the project, and made the necessary commitments to participate. In addition to meeting or exceeding their commitment to develop new , energy efficient products, these manufacturers also invested significant resources in undertaking and completing project activities. Through 2004, participating manufacturers invested co-financing of over US$ 100 million in conjunction with their participation in project activities. This figure is far more than the committed

coordinate funds ($30 million) estimated in the Project Document. Why did these manufacturers, which are profit-seeking entities, participate to this extent? Because the project was designed in order to incentivize and leverage this participation, and ultimately because manufacturers were convinced (in no small part by project organizers and the technical and marketing research conducted during the project's PDF phase) that participation the energy efficiency market transformation program was in their own interest, and vital to their competitive positions, this strong level of manufacturer involvement therefore represents both a major success indicator and as a major leverage of GEF funds, a significant success in itself.

# 8 Experience and Lessons Learned

The China Refrigerator Project provides a variety of beneficial experience and lessons learned for future implementation of other projects.

First, during the process of project implementation, the PMO has paid great attention to cooperation and establishment of good relations with other government agencies, NGOs, and UNDP, which has greatly benefited project implementation. The PMO has also coordinated closely with other key project stakeholders, particularly refrigerator and compressor manufacturers and government agencies relevant to the appliance sector (see discussion under Section 7 above on Stakeholder Involvement).

The successful implementation of the China Refrigerator Project has shown that project design is very important. As a market transformation project, the project included many more activities and was significantly more complex than the traditional single activity project, but it was therefore able to achieve larger and more sustainable gains. Additionally, the key to success for a comprehensive market transformation project is to carefully coordinate related activities. This requires strong and constant communications with project participants, as well as ongoing monitoring of the progress of project activities, needs, and requirements. Based on this ongoing monitoring, the PMO has in some cases had to modify originally planned activities in order to ensure coordination with other activities, or to take participant views into account. The PMO believes that this approach has greatly increased the project's implementation efficiency and effectiveness.

The market development of energy efficient refrigerator products includes two aspects: "pushing" efficient refrigerator production and "pulling" efficient refrigerator sales. In order to promote market development, the project adopted a wide variety of voluntary, mandatory, and capacity building measures. The combination of these measures created the condition for long-term, sustainable transformation of the market in favor of energy efficient compressors and refrigerators.

Finally, it is also crucial to conduct international exchange and cooperation. Many countries have significant experience with energy efficient compressors and refrigerators. Through international exchange, research, and cooperation, China was able to draw on that experience, jump start progress in China, and avoid mistakes by organizing a series of international and domestic workshops, study tours and training programs.

# 9 Information Sources

General project information is available at the China Refrigerator project website www.r-gefchina.org.cn/news/en/admin.asp. The demonstration project technical report *Sino – US CFC-Free Super-Efficient Refrigerator Project Progress Report: Prototype Design & Testing, Summer 1997* and technical information regarding the prototype are available at www.epa.gov/appdstar/appd or from the project organizers. Copies of the project proposal, Project Document, and periodical status reports are available at www.gefweb.org.