PROJECT BRIEF

1. Identifiers:

Project Number:	
Project Name:	Thailand: Building Chiller Replacement Program
Duration:	3-7 years
Implementing Agency:	World Bank
Executing Agency:	Electricity Generating Authority of Thailand
Requesting Country or Countries:	Thailand
Eligibility:	Thailand ratified FCCC on 12/28/1994
GEF Focal Area:	Climate Change
GEF Programming Framework:	Operational Program 5

2. Summary:

The project seeks to remove barriers preventing the widespread replacement of low energy efficiency building chillers with highly energy efficient non-CFC chillers in Thailand. This will address two global problems at the same time: Global warming and stratospheric ozone layer depletion. In view of these dual benefits joint GEF - Multilateral Fund financing is proposed to address perceived risks associated with chiller replacements under tropical conditions, to cover increased initial transaction costs and to resolve access to credit problems. It is expected that a contingent, interest free GEF/MF loan of $5 million will remove these barriers and leverage about $85 million in World Bank and commercial co-financing to transform Thailand's Chiller market from low efficiency CFC chillers to climate and ozone friendly models. Thus the project will enable the replacement of at least 440 chillers, abating about 1,400 kt in carbon emissions and phasing-out 220 tons of CFC.

3. Costs and Financing (Million US):

GEF:	-Project	US$ 2.5 million
	- PDF:	US$ -
	Subtotal GEF:	US$ 2.5 million
Co-financing:	-IA or private:	US$ 25.0 (for phase 2)
	-Multilateral Fund:	US$ 2.5 million
	-Reinvestments: (revolving fund)	US$ 60.5 million
	Subtotal Co-Financing:	US$ 88.0 million
Total Project Cost:		**US$ 90.5 million**

4. Associated Financing (Million US$) --

5. Operational Focal Point endorsement:

Name: Orapin Wongchumpit Title: Director, International Environmental Affairs Division

Organization: Office of Environmental Policy and Planning Date: 8/17/98

6. IA Contact: Robin Broadfield, Sr. Regional Coordinator
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A: Project Development Objective

1. Project development objective and key performance indicators (see Annex 1):

The proposed project aims at removing barriers preventing widespread replacement of low energy efficiency building chillers with new high efficiency non-CFC chillers in Thailand. Under this program, approximately 444 chillers or at least one-third of the existing CFC chillers will be replaced with high efficiency non-CFC chillers.

Key performance indicators are the following:

- number of building owners participating in the chiller replacement program;
- reduction of electricity consumption and associated abatement of carbon dioxide emissions as a result of the installation of new high energy efficiency chillers;
- reduction of CFC emissions as a result of the early retirement of existing CFC chillers with high leakage rates;
- reduction of CFC demand for servicing in the chiller sector in Thailand as CFC installed in the replaced or retired CFC chillers will be recycled and reused for servicing the remaining fleet of existing chillers until the end of their useful life.

2. Project Global objectives and key performance indicators (see Annex 1):

The project's global objectives are: (a) to remove barriers to the widespread adoption of new higher energy efficient non-CFC chillers (GEF/MLF); (b) to reduce greenhouse gas emissions by replacing inefficient CFC chillers with higher energy efficiency non-CFC chillers (GEF); and (c) to reduce emissions of ozone layer depleting substances (MLF); The key performance indicators are:

- KWh electricity consumption and associated CO2 emissions avoided (tons);
- CFC emissions avoided (tons);
- Systems refrigerant leakage rate reduced, refrigerant refill in kg per year;
- number of high efficiency non-CFC chillers installed.

B: Strategic Context

1a. Sector-related Country Assistance Strategy (CAS) goal supported by the project (see Annex 1):

CAS document number: 18002-TH Date of latest CAS discussion: June 16, 1998

Thailand's macro-economic crisis has plunged the economy into severe recession since mid-1997. This threatens the gains of high economic growth over the past decade and dominates the attention of the Thai Government. The World Bank's Country Assistance Strategy (CAS), agreed upon in June 1998, visualizes a number of short term stabilization measures for the economy primarily through prudent monetary policies. Over the medium term, the CAS seeks to consolidate the nascent economic stability and generate sustainable recovery through a number of medium term measures. Renewing competitiveness of the Thai economy is the cornerstone of the Bank's medium-term strategy. Removing infrastructure bottlenecks is one of the four interventions proposed by the CAS for renewing competitiveness of the Thai economy. The CAS emphasizes that energy is in short supply (para. 48) and that the economic crisis threatens the financial viability of EGAT which is facing serious difficulty in meeting its investment requirements (para. 50). The CAS considers balancing environmental concerns with the valid need to provide electricity inexpensively and reliably as pivotal to recovery of the electricity sector. The proposed project will release peak capacity, save energy and generate long term financial savings for EGAT and will therefore

contributes to the fulfillment of all the concerns highlighted in the CAS for the electricity sector. The project is also supportive of the goal of the CAS of ensuring quality of life through protecting the environment.

b. GEF Operational Strategy/program objective addressed by the project:

The proposed project is consistent with GEF Operational Program 5: removal of barriers to energy efficiency and energy conservation. The purpose of OP 5 is to support seemingly profitable energy efficiency / conservation efforts that are not realized because of the existence of initial transaction cost, perceived risk information and other barriers. OP 5 financing will be utilized to cover increased initial transaction costs and to address perceived incremental risks in national efforts to sustainably removing of such barriers. The specific barriers targeted by the project are detailed in Section B 3.

As a secondary benefit, the project will also lead to a reduction in CFC-11 and CFC-12 emissions - gases with a very high ozone depletion and global warming potentials.

The project is fully complementary to and builds on the Demand Side Energy Project sponsored by the GEF during its pilot phase.

2. Main sector issues and Government strategy:

Despite of the economic downturn which Thailand has been experiencing since 1997, peak power demand for fiscal year 1997 was recorded at 14,506,300 kilowatts (kW), a nine percent increase from the previous year. At the end of fiscal year 1997, the total electricity generating capacity of the Electricity Generating Authority of Thailand (EGAT) was 14,686,898 kW. Although the growth of electricity demand in the near future is anticipated to be less than the growth rate experienced in the previous years, the economic crisis has restrained Thailand's ability to expand its power generating facilities. This highlights the importance of immediate implementation of energy conservation measures.

In 1992, the Government approved legislation establishing the Energy Conservation Promotion Act, which increased the commitment and resources necessary to implement a comprehensive energy efficiency program. The Act (a) formalized the responsibilities of the Department of Energy Development and Promotion (DEDP) as the lead implementation agency for energy conservation; (b) gave DEDP the authority to issue voluntary building energy codes and appliance efficiency standards; (c) identified a class of large energy users as "controlled facilities" and required that they hire energy managers, conduct energy studies and develop energy conservation plans, or face large financial penalties; and (d) established the Energy Conservation Promotion Fund (ECF), financed through taxes on refinery products. The ECF will fund energy conservation, renewable energy and co-generation projects as well as support training, technical assistance, promotion, monitoring and evaluation, research and demonstration, technology transfer, and related activities that improve environmental conditions.

To implement the Energy Conservation Promotion Act, the Ministry of Science, Technology and Environment issued a Ministerial Order in 1995 establishing energy consumption standards for building air-conditioning systems (centrifugal chillers) for both existing systems and new installations. Depending on the cooling capacity, energy consumption of all existing centrifugal chillers shall not exceed 0.8 - 0.9 kW per refrigerated ton, and 0.67 - 0.75 kW per refrigerated ton for new installations.

3. Sector issues to be addressed by the project and strategic choices:

The chiller sector in Thailand has grown dramatically in the past decade due to the large amount of

construction that has taken place as the Thai economy has grown. Building chillers of a wide variety exist in Thailand, but most are centrifugal and utilize CFC-11 as a refrigerant. Second most popular for cooling for large buildings is CFC-12 (approximately 3-5 percent of all chillers). Chillers in Thailand are supplied by up to seven manufacturers, but five account for the majority of production -- Carrier, Daikin, McQuay, Trane, and York.

It is estimated that there are currently just under 1,500 CFC chillers operating in Thailand. More than 80% of existing CFC chillers are in Bangkok. About 3 – 5% of the existing CFC chillers are running with CFC-12, while the remaining 95% are running with CFC-11. All of these were installed in 1993 or earlier, as CFC chillers have not been available in Thailand since 1993. The majority of these chillers are approximately 5 - 7 years old, and the average cooling capacity of chillers currently in operation is between 400 and 500 tons. However, to achieve the highest energy savings this project will also address the replacement of CFC chillers that are older than 5 – 7 years as well. While newer centrifugal chillers are consuming less energy, but those installed before 1993 were found to consume significantly more, approximately 0.8 - 1.0 kW per refrigerated tons.

This proposed project will give priority to CFC chillers as retirement of these units would render benefits to both CFC and CO2 emission reduction. Only high efficiency non-CFC chillers with rated energy consumption of not more than 0.63 kW per refrigerated tons will be installed under this program. The project will explore all technology alternatives available and support only those replacement options that promise the least impact on global warming that is technically feasible, environmentally sound and economically viable. Total equivalent warming impact (TEWI)-based market reviews conducted so far indicate that the carbon dioxide and ODP reduction targets indicated in Annex 2 will be achievable, even if refrigerant replacements with remaining GWP, such as HFC 134a, would have to be used because of the lack alternatives. The new chillers to be installed under this program would have the least TEWI feasible under current conditions. The final selection of the refrigerant type for each CFC chiller to be replaced will be made after thorough case by case assessments are done. This project will be implemented in close consultation with the equipment suppliers and building owners.

Barriers to early retirement of existing CFC centrifugal chillers:

- High up-front costs and lack of access to commercial credit.
- Unfamiliarity with the technology / perceived technology risk under tropical conditions. The technology is new to Thailand and there is no track record to demonstrate that the envisaged energy savings would indeed materialize.
- Lack of capacity to service and maintain the systems. While EGAT has substantial experience in demand-side-management, its staff does not have the experience and training to competently install and service the proposed chillers, and monitor and evaluate the performance and impact of the program.

The main barrier removal activities proposed under the project are:

- Set up an energy servicing company (ESCO) type arrangement under which EGAT would maintain ownership of the chillers and charge consumers for energy services. This would allow consumers to spread the high up-front costs over the lifetime of the technology.
- Provide funding in form of an interest-free loan to set up a revolving fund for the implementation of a first series of 24 chillers to demonstrate the economics and technical / institutional feasibility of the proposed arrangements. For administrative and logistical purposes, the replacement of the first 24 units will be undertaken in Bangkok. 90% of financial savings achieved through reduced energy consumption would flow back into a revolving fund administered by EGAT. If this demonstration

phase confirms the win/win nature of investments in highly efficient non-CFC chillers, initial resources plus additional $25 million which EGAT would be committed to borrow from either IBRD or other sources (local commercial banks), will be used for replacing an additional 420 chillers.

- Seek agreements with chiller suppliers to provide service and maintenance, as well as sufficient training and technical assistance, as needed. (At present, routine maintenance is not common for most old chillers.)

C: Project Description Summary

1. Project components (see Annex 1):

Component	Category	Indicative Costs (US$M)	% of Total	Bank-financing (US$M)	% of Bank-financing
Project management and monitoring (EGAT) • Identifying potential chillers to be replaced; • Establishing energy consumption baseline for each potential chiller; • Disseminating information on high efficiency chillers in Thailand; • Monitoring energy consumption of new chillers.	Impl. Support	1.5*	2	0	0
Global Components (first phase)					
Demonstration – Installation of 24 chillers (GEF)	Physical	2.5**	3	0	0
Installation of 24 chillers (MLF)		2.5***	3	0	0
Second Phase**** -- Installation of 420 Chillers	Physical	84.0*****	92	25	28
	Total	90.5	100	25	28

* For both demonstration and phase II. About 7% of the savings returned to the revolving fund would be used to cover this cost.

** GEF's approval is sought subject to subsequent approval by the Multilateral Fund.

*** At the meeting of the Executive Committee of the Multilateral Fund in July 1998, the World Bank was invited to submit this chiller replacement project based on the proposed 50/50 contribution from the MLF and GEF. The revised proposal will be resubmitted to the Executive Committee of the MLF in November 1998 or March 1999.

**** Pending an evaluation of the demonstration phase and confirmation the win/win assumption.

***** While the total cost is US$84 million and the loan provided from IBRD is US$25 million, the remaining balance of US$59 million will be covered by the savings returned to the revolving fund.

2. Key policy and institutional reforms to be sought:

EGAT institutional capacity to manage and implement innovative energy efficiency financing

programs would be improved sustainably .

3. Benefits and target population:

Consumers will benefit from lower electricity bills, while enjoying the same level of service. According to experience gained in OECD countries it is estimated that energy needs may be about one third lower for the new systems. At least 10% of these savings will be passed on to consumers. The balance will be used by EGAT to reinvest in more chillers and to finance transaction costs. EGAT would also benefit from a reduced need to provide new generation capacity.

The project will yield global environmental benefits with respect to both climate change and ozone layer depletion. It will lead to individually verifiable abatement of 76,000 tons of carbon equivalent (tC) of greenhouse gas emissions initially (24 systems replaced), and ultimately 1.4 million tons of carbon equivalent (mtC) when the entire program (444 systems) is implemented. About 220 tons of CFCs (ODP weighted) will be withdrawn (12 tons through the initial project).

4. Institutional and implementation arrangements:

The overall project will be implemented by the Demand-Side Management Organization (DSMO) of the Electricity Generating Authority of Thailand (EGAT) which is responsible for the generation and transmission of electricity in Thailand. EGAT operates as a bulk supplier of electricity, relying on the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA) for retail distribution, except to a few large consumers. EGAT has the legal mandate and authority to pursue all facets of demand-side management (DSM). This proposed chiller replacement project is also part of EGAT's overall DSM program.

This project will be overseen by the DSM sub-committee comprised of EGAT, MEA, PEA, National Energy Policy Office (NEPO), Fiscal Policy Office (FPO), Department of Energy Development and Promotion (DEDP), Energy Conservation Center of Thailand (ECCT), National Institute of Development Administration (NIDA), and Energy Research Institute (ERI). Project performance and the energy savings achieved may be independently verified as necessary. A detailed M & E plan, including specific auditing provisions, will be prepared prior to CEO endorsement.

D: Project Rationale

1. Project alternatives considered and reasons for rejection:

Main barriers to the replacement of existing chillers with high efficiency non-CFC chillers are the high up front costs and lack of access to commercial credit, and perceived technology risk under tropical conditions. Although the project will pay off by itself through savings gained from lower energy consumption of new high efficiency chillers, it is unlikely that this project will be undertaken by any enterprises as commercial credit is not available. High interest rates currently imposed on local commercial loans make the project become unattractive. Moreover, there is no documented evidence to assure building owners that the savings claimed by chiller manufacturers would be attainable under the climate conditions in Thailand.

Providing a line of credit to building owners will not be sufficient to attract building owners to undertake this project. There is a need to have an agency like EGAT which does not have any interest in selling new chillers to act as an intermediary between building owners and chiller suppliers. Moreover, EGAT through

its on-going DSM program could help establish baseline energy consumption of the existing systems as well as monitor energy consumption of the new chillers. The experience gained from this project would then be documented and disseminated to other building owners.

Once the demonstration project is proven to be successful, the initial support from GEF and MLF plus additional resources raised from commercial banks or IBRD will be invested to purchase another 420 chillers. With the blends of interest-free loans from GEF/MLF and commercial loans, the average interest rate will be lower which will help accelerate payback period of the investment. As this project is designed to have EGAT be an owner of new chillers for about 10 - 15 years before they could be transferred to building owners, building owners do not need to raise the required up front capital.

2. Major related projects financed by the Bank and/or other development agencies (completed, ongoing and planned):

Sector issue	Project	Latest Supervision (Form 590) Ratings (Bank-financed projects only)	
		Implementation Progress (IP)	Development Objective (DO)
Bank-financed Demand-side management	Promotion of Electricity Energy Efficiency	S	U*

IP/DO Ratings: HS (Highly Satisfactory), S (Satisfactory), U (Unsatisfactory), HU (Highly Unsatisfactory)

* Despite satisfactory performance to date, the recent financial crisis has created uncertainty that the project will be able to meet its global objectives. The lack of available financing has slowed the implementation progress of several key DSM programs, such as the Green Building and Industrial Cost Reduction Programs. In addition, the uncertainty among the private sector caused by the crisis has dampened interest in EGAT's Industrial ESCO program, which will be critical in catalyzing private sector participation in the power sector in Thailand, a key objective of this project. For these reasons the DO-rating has recently been changed to U.

3. Lessons learned and reflected in proposed project design:

The lack of available financing under the current financial crisis in Thailand has slowed the implementation progress of several key areas in the on-going project. However, whereas economic developments came as a surprise for the DSM program, the new macroeconomic environment can already be factored into the design of this project, so as to avoid the difficulties currently experienced in the DSM project, and mitigate exchange rate risks. Moreover, the capital required for financing this project will largely come from savings gained from lower electricity consumption of new high efficiency non-CFC chillers. Building owners participating in this program are required to surrender 90% of savings from their electricity bills to EGAT. These savings will be deposited in the revolving fund which will be established under this project, and be reinvested in more new chillers as well as be used to servicing loans received from GEF/MLF and IBRD or other commercial sources.

As EGAT is already working as the implementing agency for the on-going World Bank/GEF

funded project, EGAT already has extensive experience with regard to the World Bank's requirements. The DSMO is already familiar with the World Bank's policies and guidelines on procurement and disbursement. Therefore, it is expected that project implementation should proceed as planned. Nevertheless, during the demonstration phase EGAT will promote participation of foreign energy service companies (ESCO) with the expectation that this foreign ESCO will play a much more active role in the second phase of this project, if necessary.

4. Indications of borrower commitment and ownership:

The Government and beneficiary's commitment to improve energy utilization is very high. This is shown by the Government action in enacting the Energy Conservation Promotion Act and related ministerial orders which explicitly specify energy consumption standards for major equipment and appliances. EGAT which is the beneficiary of this proposed project has already had a DSM office established. This office is now implementing the on-going World Bank/GEF financed *Promotion of Electricity Energy Efficiency Project*. Although the project will not complete until December 1999, the achievement obtained thus far indicates that the project successfully meets all the objectives.

Borrower commitment is shown by the fact that EGAT agrees to take responsibility on any losses unrelated to the (externally verified) performance of the new chillers (e.g. management deficiencies). Moreover, there is another financial incentive for EGAT in that energy savings achieved from this project would help EGAT defer additional investment in new power plants. The average cost of investment in new power plants is about $1.25 per watt.

5. Value added of Bank and Global support in this project:

Bank and GEF/MLF support will accelerate early adoption of high efficiency non-CFC chillers. This project will assist Thailand in meeting its obligations under the Montreal Protocol to reduce and eventually eliminate the use of ozone depleting substances. As a result of savings gained from replacing inefficient chillers with high efficiency units, competitiveness of the private sector will be strengthened. The support from the Bank and GEF/MLF for this project will also help open up energy servicing market in Thailand.

E: Issues Requiring Special Attention

As the savings claimed by chiller manufacturers have not been documented in Thailand so far, it is obvious that the beneficiary is confronting technology risk as well. This technology uncertainty is another factor that could undermine EGAT's ability to pay back the loans. Therefore, there is a need to provide contingency financing in form of guarantee on any currency loss for the whole duration of the project, while a guarantee on technology risk would be provided, , for the demonstration phase of the project. This coverage is essentially provided through the proposed, innovative structuring of GEF/MLF support.

3. Technical

The project will explore all technology alternatives available and support only those replacement options that promise the least impact on global warming that is technically feasible and

economically viable. Total equivalent warming impact (TEWI)-based market reviews indicate that the carbon dioxide and ODP reduction targets will be achievable, even if refrigerant replacements with remaining GWP, such as HFC 134a, would have to be used because of the lack alternatives. The new chillers to be installed under this program would have the least TEWI feasible under current conditions. The final selection of the refrigerant type for each CFC chiller to be replaced will be made after thorough case by case assessments are done.

4. Institutional

As outlined above, EGAT has extensive experience in the implementation of energy efficiency projects. The project will further strengthen EGATs capacities to design and implement innovative demand side energy conservation programs.

5. Social

The project will have positive economic impact on consumers, because at least 10% of the financial savings achieved through energy conservation would be passed on to them.

6. Environmental

a. Environmental issues: None
b. Environmental category: B

7. Participatory Approach:

a. Primary beneficiaries and other affected groups: EGAT, households in buildings selected under the program

b. Other key stakeholders: consumer groups, chiller suppliers

F: Sustainability and Risks

1. Sustainability:

Apart from the perceived technological risk that prevents widespread replacement of inefficient CFC chillers with high efficiency units, lack of access to capital to meet the high up front costs is another factor that has to be overcome. By placing ownership of new chillers acquired under this program with EGAT, this financial barrier to the building owners could be overcome. Long-term sustainability of this project depends on the effectiveness of the new high energy efficient chillers, maintenance quality, and the effectiveness of the established system to collect benefits from energy savings back to the revolving fund. If all these factors are achieved, private ESCO may decide to pursue this business on their own, which will relieve the burden off from EGAT as well as to increase competition in this market not only in Thailand but also in other countries in this region. A preliminary analysis confirms economic viability of the proposed scheme for the second phase of the project.

2. Critical Risks (reflecting assumptions in the fourth column of Annex 1):

Risk	Risk Rating	Risk Minimization Measure
Annex 1, cell "from Outputs to Objective"		
Installation and maintenance carried out according to industry standards.	M	Only chillers that meet international standards will be used in this project. Maintenance quality of chiller suppliers will be used as one of the criteria for the selection of the machines installed under this program.
Lower operating cost due to higher energy efficiency of new systems.	M	Chiller operators will be trained to properly monitor the performance of the chillers.
Barriers to widespread replacement of existing chillers with high energy efficient systems are removed.	M	Experience and achievement gained from this project will be disseminated to building owners, professional association, industry associations and academic institutions.
Annex 1, cell "from Components to Outputs"		
Savings from the lower operating costs of new chillers are enough to pay off the investment costs.	N	Prior to the equipment installation, EGAT, through its DSM Office, will monitor the energy consumption of the air-conditioning systems to establish baseline energy consumption data.
Building owners are satisfied with the new technology and accept the financing scheme proposed under this program	M	New chillers meet the local regulation pertaining to energy consumption standards for centrifugal chillers.
No significant change in foreign exchange rate.	S	Guarantee on currency risk is provided to this program.
Overall Risk Rating	M	

Risk Rating - H (High Risk), S (Substantial Risk), M (Modest Risk), N (Negligible or Low Risk)

ANNEX 1

PROJECT DESIGN SUMMARY

THAILAND: BUILDING CHILLER REPLACEMENT PROGRAM TO REDUCE THE USAGE OF CFC-11 AND CFC-12 IN CHILLER SERVICING

Narrative Summary	Key Performance Indicators	Monitoring and Evaluation	Critical Assumptions
a. *Sector-related CAS Goal:* Renewing competitiveness in the production and servicing sector. b. *GEF Operational Program*: Promotion of the adoption of high efficiency non-CFC chillers by removing barriers and reducing implementation costs.	1. Lower electricity costs to the participating enterprises. 2. Avoided emissions of CO_2 by 1.39 mtC over the 17 year period.	1. Project implementation reports and sector statistics. 2. As above.	(Goal to Bank Mission) 1. Improved energy conservation.
Project Development Objective: Removing barriers preventing widespread replacement of low energy efficiency building chillers with high efficiency non-CFC chillers.	1. Number of building chillers being replaced beyond this program 2. Improved energy efficiency of the new building chillers (0.63 kW per refrigerated tons). 3. Reduction of annual CFC demand in the chiller sector (22.2 ODP tons). 4. Quantity of CFC recovered from dismantled CFC chillers (170 ODP tons).	1. Project implementation reports. 2. As above. 3. Project monitoring survey. 4. Project implementation reports.	1. High efficiency non-CFC chillers installed and maintained according to industry standard. 2. Continued support and interest from concerned agencies and industry for reduction of CFC and CO_2 emissions in the building chiller sector.
Outputs: 1. 24 units of new high efficiency non-CFC chillers in operation during the demonstration phase of the project. 2. Evaluation of the	1. 24 units installed by 1999. 2. Evaluation process	1. Semi-annual implementation reports and 590s. 2. Evaluation report.	1. Installation and maintenance carried out according to industry standards. 2. Lower operating cost due to higher energy

demonstration phase. 3. Additional 420 units of new high efficiency non-CFC chillers installed and in operation.	completed by 2001. 3. 420 units installed by 2009.	 3. Semi-annual implementation reports and 590s.	efficiency of new systems. 3. Barriers to widespread replacement of existing chillers with high energy efficient systems are removed.
Project Components/Sub-components: (see Annex 2 for project description) 1. Demonstration Phase 2. Second Phase 3. Project Management and Performance Monitoring	Inputs: (budget for each component) $ 5 million $84 million $1.5 million		1. Savings from the lower operating costs of new chillers are enough to pay off the investment costs. 2. Building owners are satisfied with the new technology and accept the financing scheme proposed under this program. 3. No significant change in foreign exchange rate.

ANNEX II

INCREMENTAL COST ANALYSIS

THAILAND: BUILDING CHILLER REPLACEMENT PROGRAM

Broad Development Goals and Baseline

1. The chiller sector in Thailand has grown dramatically in the past decade due to the large amount of construction that has taken place as the Thai economy has grown. Building chillers of a wide variety are used, but most systems installed before 1993 utilize CFC-11 as a refrigerant. Some 3-5 percent of chillers -- mostly installed in large buildings -- use CFC-12. It is estimated that just under 1,500 CFC systems are currently in operation. CFC chillers have not been available in Thailand since 1993, and since that time CFC-free systems have been installed in new buildings. These systems are more energy efficient, as well as more ozone-friendly, than CFC chillers, but they do not constitute international state-of-the-art. Chillers are supplied by seven manufacturers, with five accounting for the majority of production.

The majority of the CFC chillers are 5-7 years old, and their average cooling capacity is 400 - 500 tons. (The focus of the project may be on chillers of above average age). Power requirements are 0.9 kW/ton, which implies an energy consumption of almost 2,000 MWh per year (assuming a running time of 12 hrs/day). This is about 30% percent more than state-of-the art technology. While the chillers have a remaining technical lifetime of almost 20 years on average, their replacement with modern systems would thus pay back within a few years.

The Electricity Generating Authority of Thailand (EGAT) has substantial experience and a good track-record in exploiting such 'win-win' energy conservation measures (acquired, *inter alia*, through the GEF-funded *Promotion of Electricity Energy Efficiency Project*). However, in the chiller sector, the following barriers prevent the exploitation of this opportunity:

- Unfamiliarity with the latest technology / perceived technology risk under tropical conditions. The technology is new to Thailand and there is no track record to demonstrate that the envisaged energy savings would indeed materialize.
- High up-front costs and lack of access to commercial credit. Due to lack of demonstration, commercial loans for the implementation of the project are not readily available.
- Lack of capacity to service and maintain the systems. While EGAT has substantial experience in demand-side-management, its staff does not have the experience and training to competently install and service the proposed chillers, and monitor and evaluate the program.

Absent external support to remove these barriers, it is likely that the currently installed chillers would remain in service for the rest of their technical lifetime, at which point they would be replaced by the type of systems that have been installed in Thailand since the ban on CFC-11 and CFC-12 in 1993.

Global Environmental Objective

The objective of this project is the creation of a market for high-energy efficiency chillers in Thailand. The project itself would initially seek to replace 24 chillers on a pilot basis and to demonstrate the economics and feasibility of the technology. The larger-scale program following a successful demonstration would lead to the replacement of about 30% of the remaining CFC chillers – or 444 systems in total. It is expected that the demonstration effect of the program and the experience gained would in turn lead to the more wide-spread use of energy efficient chillers in the chiller market as a whole. This latter effect has not been quantified, however.

In addition to the market transformation benefits sought in accordance with the objective of Operational Program 5, the project would lead to a significant direct reduction in greenhouse gas emissions. By replacing CFC chillers with systems that are 30% more efficient, the CO2 emissions associated with air conditioning can be reduced by the same amount – or about 130 tC per system and year. The energy efficiency benefits of the project are shown in Table 1.

Table 1: Carbon abatement benefit from energy savings

Parameter	*Value*
Average cooling capacity of chiller (tons)	500
Average consumption, baseline chiller (kW/t)	0.90
Energy consumption, alternative (kW/t)	0.63
Estimated operating time (hrs/day)	12
Estimated remaining lifetime (yrs)	17
Carbon intensity of Thai power sector (kgC/kWh)	0.22
Energy savings per chiller and year (MWh)	591.3
Carbon savings per chiller and year (tC)	130.1
Direct carbon savings (24 systems – ktC)	53.1
Carbon savings, program (444 systems – ktC)	981.9

Equally significant are the greenhouse gas (GHG) reduction benefits that would occur from a decrease in leakage rates and the replacement of CFCs with substitute refrigerants that have a lower global warming potential, as shown in Table 2. Energy efficiency and leakage effects combined, the project would lead to direct GHG emission reductions of 76.4 ktC equivalent, and programmatic benefits of 1413.6 ktC equivalent.

Table 2: Climate change benefit from refrigerant substitution

Parameter	*Value*
Average global warming potential, baseline*	4,225
Leakage rate, baseline (% per year)	10.0
Global warming potential, alternative**	153
Leakage rate, alternative (% per year)	2.0
Direct GHG savings (24 systems – ktC)	23.3
GHG savings, program (444 systems – ktC)	431.7

* Assuming 95% of systems are using CFC-11 (global warming potential 4,000) and 5% are using CFC-12 (global warming potential 8,500).

** Assuming HCFC-123 (global warming potential 93) and HFC-134a (global warming potential 1,300) would replace CFC-11 and CFC-12, respectively.

GEF Alternative

The proposed project would seek to remove the barriers that prevent the wider use of high-energy efficiency chillers in Thailand. The project would focus on the replacement of remaining CFC chillers, for two reasons:

- Replacing CFC chillers yields higher and more immediate energy efficiency gains, and is therefore better suited to demonstrate the economic benefits of the technology;
- Replacing CFC chillers yields extra global environmental benefits by replacing substances that are highly damaging to the ozone layer and have a global warming potential several times higher than that of their substitutes.

However, it is expected that the demonstration benefits from, and experience gained in, the replacement program would ultimately also spill over to the market for newly installed systems.

The main barrier removal activities proposed under the *Chiller Replacement Program* are:

- Set up an ESCO type arrangement under which EGAT would maintain ownership of the chillers and charge consumers for energy services. This would allow consumers to spread the high up-front costs over the lifetime of the technology.
- Provide contingent funding for the implementation of a first series of 24 chillers to demonstrate the economics and technical / institutional feasibility of the proposed arrangements. 90% of energy savings would flow back into a revolving fund administered by EGAT.
- Seek agreements with chiller suppliers to provide service and maintenance, as well as sufficient training and technical assistance, as needed.

Since the project yields both ozone layer and climate change benefits, it is proposed that the incremental cost of these activities be shared by GEF and the Multilateral Fund to the Montreal Protocol. The project is described in more detail in Section C of the project concept document.

Scope of the Analysis

The focus of the project is on the replacement of CFC chillers. Consequently the system boundary of the analysis is restricted to the market for this particular type of chiller – of which some 1,500 units are still in use.

Costs

The incremental cost of this project are the costs of removing the barriers that prevent the realization of what would otherwise be a win-win opportunity. It is judged that most barriers can be removed through a demonstration package involving the replacement of 24 chillers which – if successful – would trigger a larger scale replacement program. Included in the package would be a maintenance contract with the supplier to assure adequate servicing of the new equipment and to build capacity in the country to take over these tasks in due course. Information barriers would be removed through a marketing and public awareness program. The estimated cost of individual project components are shown in Table 3.

Table 3: Project costs

Item	*Cost ($)*
Investment costs (per chiller)	
Chiller	150,000
Installation and site preparation	35,000
Maintenance contract	15, 000
Procurement / shipping / insurance	5,000
Total	*205,000*
Overhead costs (annual)	
Program marketing and public awareness	24,000
Accounting	4,000
Evaluation (equipment monitoring and reporting)	32,000
Total	*60,000*

Over a 7-year time horizon, project costs would add up to a present value of about $5.2 million, of which $0.3 million are transaction costs ($1.5 million over the entire program). It can be expected that these extra costs would be roughly offset by savings in electricity costs in the order of perhaps $40,000 per chiller and year, worth $5.2 million over 7 years – which would make replacement a win-win opportunity.

However, these savings are uncertain and there is a strong perception among stakeholders that they may not materialize. In addition, there are some incremental transaction costs. To remove this barrier and cover the (perceived) incremental risks a *7-year, interest free loan* over $5 million would be provided, the repayment of which would be subject to project success (measured as realized energy savings). The combination of concessionality and conditional repayment allows to simultaneously compensate for, and cover incremental risk as well as incremental transaction costs.

The incremental cost analysis can thus be summarize as shown in Table 3. The expected cash flows are shown in Table 4.

Table 3: Incremental Cost Matrix

	Baseline	**Alternative**	**Increment**
Domestic Benefit	1,500 chillers in operation	1,500 chillers in operation	0
Global Environment Benefit	*Direct:* 176.9 ktC (energy) 23.5 ktC (leakage) *sector wide:* 3,273.2 ktC (energy) 434.9 ktC (leakage)	*Direct:* 123.8 ktC (energy) 0.2 ktC (leakage) *sector wide:* 2,291.1 ktC (energy) 3.2 ktC (leakage)	*Direct:* 53.1+23.3 = 76.4 ktC *sector wide:* 981.9+431.7 = 1,413.6 ktC
Costs ($ million) Capital costs Electricity costs Marketing, evaluation ***Total***	 0.0 17.0 0.0 ***17.0***	 4.9 11.8 - 16.8* 0.3 ***17.1 - 23.0***	 4.9 -5.2 – -0.2 0.3 ***0.0 - 5.0***

* depending on project success. It is expected that close-to-full efficiency gains will be realized.

Process of Agreement

The parameters and assumptions used in the incremental cost analysis are based on information collected as part of project preparation. The proposed approach and financing modalities have been discussed and agreed with EGAT. The analysis will be refined at project appraisal, as necessary, and will be formally agreed with Thai authorities in the course of project negotiations. A cost-sharing arrangement with the MLF is sought, because the project will generate dual benefits in terms of CFC substitution and GHG abatement. An initial concept has been discussed with the Multilateral Fund at the July 1998 meeting of the MLF Executive Committee, where positive feedback was received. It is planned to formally submit the project to the MLF Executive Committee as soon as possible after its inclusion in the GEF work program.

Table 4
Cash Flow Analysis by Month Assuming Program Extension (In Baht, Unless Otherwise Noted)

Month	Balance Owed	Program Repayments	Program Admin Costs	Funds Available	New Units (#)	Cum. Units (#)	Cum. Units Repaid (#)	Total Units Currently Being Repaid (#)	Monthly Payments Due	Monthly Payments Received	
0				207,900,000	0	0	0	0	0		
6	0	0	203,441	17,565,913	0	24	0	24	3,756,630	3,756,630	
12	0	0	203,441	40,230,958	0	24	0	24	3,756,630	3,756,630	
18	0	0	203,441	64,053,130	0	24	0	24	3,756,630	3,756,630	
24	0	0	203,441	89,091,502	0	24	0	24	3,756,630	3,756,630	
30	0	0	203,441	115,408,166	0	24	0	24	3,756,630	3,756,630	
36	0	0	203,441	143,068,383	0	24	0	24	3,756,630	3,756,630	
42	0	0	203,441	14,574,854	1	44	0	44	6,712,604	6,712,604	
48	1,050,000,000	0	203,441	13,334,316	1	49	0	49	7,490,492	7,490,492	
54	1,114,596,158	0	203,441	33,798,624	3	184	0	184	28,182,313	28,182,313	
60	1,183,166,282	0	203,441	38,971,622	4	205	0	205	31,293,865	31,293,865	
66	1,255,954,849	0	203,441	38,235,859	4	228	0	228	34,872,150	34,872,150	
72	1,333,221,381	0	203,441	42,501,940	4	253	0	253	38,761,590	38,761,590	
78	1,415,241,361	0	203,441	45,577,184	5	282	0	282	43,117,763	43,117,763	
84	1,502,307,223	0	203,441	50,261,612	5	313	0	313	47,940,668	47,940,668	
90	1,594,729,389	0	203,441	59,579,169	6	348	0	348	53,230,307	53,230,307	
96	1,692,837,382	0	203,441	22,449,820	2	363	0	363	56,186,281	56,186,281	Repayment = 207,900,000
102	1,796,980,992	0	203,441	63,124,910	7	404	0	404	61,787,075	61,787,075	
108	1,907,531,533	0	203,441	73,862,135	8	449	0	449	68,632,489	68,632,489	
114	2,024,883,161	0	203,441	76,696,734	8	499	0	499	76,411,369	76,411,369	
120	2,149,454,278	0	203,441	85,127,851	9	555	0	555	84,968,137	84,968,137	
126	2,122,985,104	25,797,064	203,441	377,078,710	0	555	0	555	86,368,335	86,368,335	
132	2,094,887,542	25,797,064	203,441	766,167,160	0	555	0	555	86,368,335	86,368,335	
138	2,065,061,415	25,797,064	203,441	1,175,119,866	0	555	0	555	86,368,335	86,368,335	
144	2,033,400,379	25,797,064	203,441	1,604,950,961	0	555	0	555	86,368,335	86,368,335	
150	1,999,791,552	25,797,064	203,441	2,056,726,359	0	555	0	555	86,368,335	86,368,335	
156	1,964,115,105	25,797,064	203,441	2,531,566,387	0	555	0	555	86,368,335	86,368,335	
162	1,926,243,837	25,797,064	203,441	3,030,648,572	0	555	0	555	86,368,335	86,368,335	
168	1,886,042,724	25,797,064	203,441	3,555,210,556	0	555	0	555	86,368,335	86,368,335	
174	1,843,368,431	25,797,064	203,441	4,106,553,168	0	555	0	555	86,368,335	86,368,335	
180	1,798,068,810	25,797,064	203,441	4,686,043,646	0	555	0	555	86,368,335	86,368,335	

186	1,749,982,350	25,797,064	203,441	5,279,903,637	0	555	24	531	82,611,706	82,611,706
192	1,698,937,603	25,797,064	203,441	5,896,282,937	0	555	24	531	82,611,706	82,611,706
198	1,644,752,575	25,797,064	203,441	6,544,130,442	0	555	24	531	82,611,706	82,611,706
204	1,587,234,076	25,797,064	203,441	7,225,052,709	0	555	24	531	82,611,706	82,611,706
210	1,526,177,031	25,797,064	203,441	7,940,738,313	0	555	24	531	82,611,706	82,611,706
216	1,461,363,747	25,797,064	203,441	8,692,962,039	0	555	24	531	82,611,706	82,611,706
222	1,392,563,140	25,797,064	203,441	9,472,408,996	0	555	44	511	79,655,731	79,655,731
228	1,319,529,910	25,797,064	203,441	10,282,515,932	0	555	49	506	78,877,843	78,877,843
234	1,242,003,664	25,797,064	203,441	11,083,565,230	0	555	184	371	58,186,022	58,186,022
240	1,159,707,992	25,797,064	203,441	11,838,734,258	0	555	205	350	55,074,470	55,074,470
246	1,072,349,477	25,797,064	203,441	12,612,291,149	0	555	228	327	51,496,186	51,496,186
252	979,616,654	25,797,064	203,441	13,402,792,476	0	555	253	302	47,606,746	47,606,746
258	881,178,893	25,797,064	203,441	14,208,722,494	0	555	282	273	43,250,573	43,250,573
264	776,685,227	25,797,064	203,441	15,028,006,849	0	555	313	242	38,427,667	38,427,667
270	665,763,094	25,797,064	203,441	15,858,315,006	0	555	348	207	33,138,029	33,138,029
276	548,017,015	25,797,064	203,441	16,699,681,346	0	555	363	192	30,182,054	30,182,054
282	423,027,180	25,797,064	203,441	17,565,780,392	0	555	404	151	24,581,261	24,581,261
288	290,347,951	25,797,064	203,441	18,437,046,085	0	555	449	106	17,735,846	17,735,846
294	149,506,276	25,797,064	203,441	19,308,495,291	0	555	499	56	9,956,966	9,956,966
300	0	25,797,064	203,441	20,175,209,560	0	555	555	0	1,400,198	1,400,198
301	0	0	203,441	20,344,533,063	0	555	555	0	0	0

ANNEX 3
TECHNICAL REVIEW
THAILAND
BUILDING CHILLER REPLACEMENT PROGRAM

STAP REVIEW

Several discussions with the STAP reviewers have taken place and it is expected that this dialogue will continue. The specific comments raised in their review were taken into account as follows.

- **More precise definition of the chillers replaced in the demonstration project.** Chillers will be carefully selected – from an initial short list, as suggested -- to maximize benefits and demonstration effects. While the detailed list will be worked out during project preparation, important selection criteria are likely to include age, leakage rate, efficiency, location, current service arrangements, etc.

- **Age of replaced chillers.** As outlined above, the age of chillers is likely to be one of the criteria to select pilot phase chillers. If project objectives are best reached by replacing older chillers this will be done. In terms of the analysis underlying the proposal, it was assumed that chillers have a remaining lifetime of 17 years, which implies an average age of perhaps 8 years (see incremental cost analysis).

- **More information on project cash flows.** Such a table has been added in the incremental cost annex.

- **Refrigerant content of replaced chillers.** The data used in the analysis – 1 kg of refrigerant per ton – is based on information provided by EGAT and chiller suppliers. Using the values suggested by the STAP reviewers would reduce global environmental benefits by about 25%. This would not affect the eligibility of the proposal under Operational Program 5.

- **30% efficiency gains is an overestimate.** The estimate is based on reliable data from private sector suppliers and EGAT. The figure will be confirmed during preparation, but evidently the ultimate size of the efficiency gains is a major project risk and the key reason why GEF support is needed.

- **Position of the Multilateral Fund.** As stated in the proposal, the Bank has received positive feedback on the proposal at the last meeting of the Executive Committee of the MLF. It is suggested that inclusion in the GEF work program be subject to a positive funding decision by the MLF, and that the project be officially submitted to the MLF as soon as possible after (conditional) inclusion in the GEF work program.

- **Why the 1997 – 1998 chillers do not constitute the international state of the art?** Annex 2 of the document mentioned that CFC-free systems have been installed in new buildings after

1993. These systems are more energy efficient, as well as more ozone-friendly, than CFC chillers, but they do not constitute international state-of-the art. Most new CFC-free chillers were installed in Thailand during the period from 1990 – 1996. Since 1997, after the economic crisis took place, the number of new installations reduced dramatically. Chiller manufacturers inform that during the last few years, a new chiller design has been focusing on achieving highest energy efficiency at part load, instead of maximum efficiency at full load. Chillers are running at part load most of the time. Moreover, most CFC-free chillers were installed in new buildings, not as a replacement to the existing unit. Therefore, there is no baseline energy consumption for evaluating the savings gained from replacing old chillers with new ones.

- **Who currently services the chillers? How would the new service agreement differ?** For chillers, routine maintenance is not a common practice. Chillers will be attended to only when they break down. Chiller suppliers and independent contractors are providing repair work to installed chillers in Thailand. The new service agreement will require that chiller suppliers provide routine maintenance as recommended by the manufacturers.