ARAB REPUBLIC OF EGYPT
2G-SOLAR THERMAL (GEF)

GEF Project Brief

Middle East and North Africa Region
MNSIF

Date: February 5, 2004
Sector Manager: Francoise Clottes
Country Director: Mahmood A. Ayub
Project ID: P050567
Focal Area: C - Climate change

Team Leader: Anna Bjerde
Sector(s): Renewable energy (50%), Power (50%)
Theme(s): Other environment and natural resources management (P), Access to urban services for the poor (P), Infrastructure services for private sector development (S)

Project Financing Data

[ ] Loan [ ] Credit [X] Grant [ ] Guarantee [ ] Other:

For Loans/Credits/Others:
Amount (US$m): 49.8

Financing Plan (US$m): Source	Local	Foreign	Total
BORROWER/RECIPIENT	25.00	0.00	25.00
GLOBAL ENVIRONMENT FACILITY	0.00	49.80	49.80
FOREIGN SOURCES (UNIDENTIFIED)	0.00	72.20	72.20
Total:	25.00	122.00	147.00

Borrower/Recipient: GOVT. OF EGYPT
Responsible agency: NREA - NEW AND RENEWABLE ENERGY AUTHORITY
Note: The GEF Grant would be disbursed as an up-front payment to contribute to the financing of the project.
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Estimated Disbursements (Bank FY/US$m):

FY	2006	2007	2008	2009	2010	2011	2012	2013	
Annual									
Cumulative									

Project implementation period: 3 years construction (2006-2008); 5 years operations and maintenance contract (2009-2013)

Note: The Government of Egypt has entered into advanced discussions on the financing of the non-solar part of the plant with the European Investment Bank (EIB) and the Japanese Bank for Investment and Cooperation (JBIC) in March 2004. A more specific financing plan is expected to be in place by May 2004 and firmed up no later than September 2004.

Expected effectiveness date: 05/01/2006 **Expected closing date:** 05/01/2013

A. Project Development Objective

1. Project development objective: (see Annex 1)

National Development Objective. The national development objective of the project is to support the development of clean energy in Egypt, in this case solar, as a way to lower CO_2 emissions in energy generation. Furthermore, the project will add much needed capacity to the power grid, which currently operates at a very low capacity reserve margin.

Global Environment Objective. The global environment objective is to contribute to improving the economic attractiveness of solar thermal technology globally. The project will create global learning effects that will contribute to a reduction in costs for the technology over the long-term.

The objectives will be achieved by demonstrating the technical and commercial viability and environmental benefits of a solar thermal hybrid plant selling power through a Power Purchase Agreement (PPA) to the national power utility, the Egyptian Electricity Holding Company (EEHC).

It is important to note upfront that this project's design has changed during preparation in two key ways: (i) the project was originally conceived to be bid out under the arrangements of an Independent Power Producer (IPP) but is now proceeding under an EPC/O&M arrangement due the general down turn in investor appetite in IPPs and the prohibitive regulations on private sector infrastructure participation in Egypt following the recent devaluation of the Egyptian currency (see more about this under section 3.2 Strategic Choices); and (ii) the project size has been increased from about 127 MW to 151 MW based on a review of the plant's optimal size. Furthermore, the project has been under preparation for a relatively long period, but in that context, it needs to be noted that the project was scheduled for submission to the May 2002 WP inclusion Council meeting but removed at the request of the GEF due to lack of funding at that time. A project preparation time-table has been agreed to which includes the following key milestones:

- Issuance of RfP — October, 2004
- Closing date for bid submissions — End January, 2005
- Negotiations with lowest bidder — September, 2005
- Bank Appraisal — October, 2005
- GEF CEO Endorsement — November, 2005
- Bank Board — November/December 2005

2. Key performance indicators: (see Annex 1)

Key performance indicators for the national development objective of the project will be:

- Total electricity generated from renewables (GWh/year)
- Total renewables capacity (MW)
- Emissions reduced (tons/year)
- Solar output as a percentage of total energy produced by the hybrid plant

For the global environment objective, the performance indicator will be based on evaluating the long-term cost reductions resulting from the project and will include:

- Cost of solar thermal power (¢/kWh and $/kW)

B. Strategic Context

1. Sector-related Country Assistance Strategy (CAS) goal supported by the project: (see Annex 1)
Document number: 22163-EGT **Date of latest CAS discussion:** March 7, 2001

The CAS emphasizes the need for interventions which support higher and sustained growth through improved macroeconomic stability and infrastructure for greater competitiveness. It also focuses on interventions with a major indirect poverty reduction impact, which promote broad based growth and the development of poor areas.

The CAS specifically refers to the proposed project for its potential to contribute to these objectives, as it will provide for investment in the country's energy infrastructure. The project will also introduce at a larger scale the use of solar energy to help meet the current energy demand in Egypt, therefore contributing to lower emissions through the resulting decrease in the usage of fossil fuels. In addition, the project will indirectly assist in further developing the Kureimat area through increased opportunities for employment and tourism.

1a. Global Operational strategy/Program objective addressed by the project:

The proposed Project addresses the Global Environmental Facility's (GEF) Operational Program 7 (OP7): reducing the long-term cost of low greenhouse gas-emitting technologies. It is one of four projects planned by GEF as part of the benchmarking phase of the solar thermal area of the program.

OP7 aims to accelerate market penetration of several large-scale backstop technologies, such as solar thermal power, that are constrained by high capital costs and high commercial risks. The strategy is to identify projects that address national priorities, and then finance the incremental costs of investments, capacity building and other activities that reduce market barriers. For solar thermal power, it is generally agreed that significant cost reductions and eventual commercial acceptance can only begin to occur with the implementation of several demonstration projects in carefully selected countries and sites. A Cost Reduction Study for Solar Thermal Power Plants (Enermodal Engineering, May 1999) was commissioned in collaboration with the GEF Secretariat to determine the viability of long-term cost reductions for solar thermal. The study concluded that a phased approach should be adopted, in which four projects would benchmark the costs and provide an initial opportunity for cost reduction. The targets for cost reduction were solar electricity generation costs in the range of 10-11 US¢/kWh and a capital cost of solar fields of about $2,000/kW.

Egypt is a particularly good candidate to host a solar thermal project with GEF support for three reasons. First, the Government of Egypt is serious about materializing its renewable energy potential and has set a target in which renewable energy sources are expected to account for 3 percent of installed capacity by 2010 (about 600MWe-800MWe). Second, all the necessary resources are present, namely: high insolation; gas for co-firing; electricity network to interconnect to; adequate cooling water supplies; and vacant land for which there is little alternative use. Third, the Egyptian power system is currently operating at a very low reserve margin (3%) and the proposed project is included in the Least-Cost Expansion Plan, expected to come on stream in 2008.

Although stand-alone solar thermal plants have been operating for the last 15 years or so in California, their integration with a combined cycle gas turbine (CCGT) or similar plant – denominated Integrated Solar Combined Cycle (ISCC), the preferred choice for a hybrid – has never been demonstrated. Such integration is important commercially, since it enables continuous operation (of the hybrid) regardless of solar radiation conditions and offers higher efficiencies than other hybrid options. The proposed project is in effect a proof-of-concept installation that will help reduce the perceived technical and commercial risks of the technology, with respect to the optimal configuration, system control and other design issues.

The share of generation attributed to solar measured by energy delivered (solar share) is expected to be about 6.6 percent. The solar proportion – the generating capacity of the solar field as a proportion of the total plant size – is expected to be about 20 percent. The total plant size is relatively small due to a number of factors:

- From a systems aspect, a larger system will present a greater design and operational challenge, and higher technical risk.
- From the cost aspect, a trade-off has to be made between either having a high solar component that has larger demonstration impact and costs more, or a low solar component with a relatively smaller demonstration effect and more manageable incremental cost.
- From a financing perspective, a larger plant would require larger external financing to be borne by NREA, and the agency's capacity to absorb large-scale debt is limited.

- From the solar system viewpoint, the modularity of the technology means that even this smaller system is relevant to future, larger projects. Along with the others, the proposed project will contribute to providing cost reduction manufacturing opportunities to the solar thermal industry in the long-term.

2. Main sector issues and Government strategy:

In 2002, about 95 percent of the population was served by the electricity grid in Egypt. Of a total demand of 83 TWh on the interconnected system, 78 percent was met by thermal plants (of which 90 percent was supplied from natural gas and 10 percent heavy oil), 19 percent was met by large hydro plants (principally the High Dam and Aswan 1&2), and electricity from Independent Power Producers (IPPs), including wind, accounted for 3 percent. The system is interconnected with Libya, Jordan and Syria and there are plans for other interconnections in the future. There is about 564MW of isolated capacity installed mainly in the Canal zone, Alexandria and Middle and Upper Egypt which supply a total of 278 GWh. Current available capacity is around 15,836MW and peak load is 15,343MW, leaving a reserve margin of only 3 percent, which is significantly lower than the internationally advisable margin of 15 percent. The proposed project is a critical contribution to the needed capacity in Egypt to meet the growing demand for electricity. It is included in the country's least cost expansion plan and expected to be operational in 2008.

Egypt has a rapidly expanding economy that is based on the availability of reliable and low cost electric power. The rate of growth of electricity demand in Egypt has exceeded 6.5 percent per year over the past 10 years and is expected to remain in the 6-7 percent range over the next 10 years. Peak demand is expected to rise to 20,372MW by 2008. In recent years, three private sector generation projects have been implemented in Egypt adding a capacity of 1,950MW to the national grid. While the Government strategy was very much to continue to award contracts to private investors in order to meet the need for additional capacity, the recent drop in the Egyptian pound to major foreign currencies has resulted in a significant financial burden on EEHC, since many of its loans are denominated in foreign currency as are the PPAs with the IPPs. As a result, the Government has adopted a new policy for private infrastructure projects (referred to as "the new BOOT regulations"), which put the entire foreign exchange risk on the investor by requiring that PPAs be denominated in local currency. The new regulations have caused private interest in infrastructure in Egypt to evaporate. Accordingly, most new generation projects are expected to be financed by loans and grants.

Electricity tariffs in Egypt remain uniform across all distribution companies. The weighted average tariff is piaster 12.8/kWh (US$0.02/kWh). There are significant cross subsidies in the tariffs, and thus for most consumer groups the tariffs are either substantially below or above marginal cost. For the two key consumer groups, households and the agriculture sector, tariffs are estimated to be half of the marginal cost. Until now, subsidized tariffs have remained an obstacle for large-scale private sector involvement, especially in the distribution business and also for the development of large scale commercial renewable energy operations. However, the Government of Egypt recently announced its intention to gradually increase tariffs to allow for better cost recovery and reflection of true cost of electricity service delivery.

Government Strategy

In line with the Egyptian structural adjustment policy, the power sector, operating under the direction of the Ministry of Electricity and Energy (MEE), was unbundled and reorganized in 2001. Power operations are organized under EEHC and include five generation companies, seven regional distribution companies and a single transmission company which retains responsibility for the 500kV, 220kV and 132kV transmission backbone, dispatching, planning for new power and transmission projects and for the purchase of power produced by IPPs. A regulatory board has been established, chaired by the Minister of Electricity, with

representatives from EEHC, other ministries and consumers.

Egypt is fortunate in that it has abundant reserves of low-cost natural gas, which enables it to manage a steady gas-to-power strategy, leaving its diminishing oil reserves for other uses or for export. Present plans thus entail largely gas-fired plants, including an expansion of the 1,250MW El-Kureimat gas-fired steam generating plant and a new 750MWe combined-cycle plant also at Kureimat. In addition, several wind projects are under implementation, and are expected to increase wind capacity from about 63MWe to over 400MWe. The Government of Egypt had contemplated developing many of these projects through private sector Build Own Operate Transfer (BOOT), Build Own Operate (BOO), and Build Own Transfer (BOT) arrangements. However, due to the new BOOT regulations and the reduced private sector appetite for power projects in general globally, these projects are anticipated to be financed by loans and grants from international financing institutions, such as the Arab Funds and European Investment Bank (EIB), and through bilateral donor assistance. Nevertheless, the Government hopes to return to private sector participation in the generation of power and may also contemplate selling minority equity stakes in the distribution companies. In the longer term, such companies may also be able to raise financing from local debt markets, though at present the lack of development of the markets and the likely lack of creditworthiness of the distribution companies may hold back such plans.

The Government of Egypt has a target of meeting 3 percent of its primary energy needs from renewable energy sources by the year 2010. The New and Renewable Energy Authority (NREA), which was established under the MEE in 1986, has responsibility for implementing the government's strategy and develop renewable resources in Egypt. Most of NREA's activities have been in the research and development field; however, since 2001, when the first wind farm was installed with NREA as executing agency, its activities have increasingly turned to the production of green energy. In 2003, about 80 percent of NREA's revenues were attributable to electricity sales from 63MW of installed wind capacity at Zafarana through PPAs with EEHC.

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

3.1 Sector Issues Addressed

The project will contribute to the goal of having 3 percent of total installed capacity from renewable energy by 2010. The capacity of the solar field is estimated to be 30MWe; therefore representing 5 percent of the renewable capacity in 2010 if 600MWe is achieved. The project will also contribute to the critical need for overall system capacity increase in Egypt.

Furthermore, the project will contribute to strengthening the implementing agency, NREA. A study is about to be commissioned under the GEF preparatory grant in support of wind in Egypt to review institutional options for NREA now that its main activities have evolved from research and development to production and sales of electricity from renewable sources. The study will be completed by the end of 2004, its findings will be discussed with the government and NREA during project appraisal, and an action plan for the restructuring of NREA and ensuring is financial and operational viability will be agreed to and incorporated into the solar thermal project design.

3.2 Strategic Choices

This project, along with the other three projects under the umbrella of support from the GEF OP7, was originally designed as a private sector project, whereby the solar-thermal power plant would be constructed through an IPP, and the global environment externality (i.e., the solar field) would be financed by a grant

from the GEF. In mid-2002, the MEE, through NREA, proposed a change to the project's concept as a result of the policy change within the Government of Egypt on foreign currency exposure related to private sector investment projects. As stated earlier, the new regulations caused private interest in infrastructure in Egypt to evaporate. To confirm the lack of private sector interest, independent consultants carried out a survey of investors who had previously expressed interest in developing the solar-thermal project as an IPP. In this survey, 31 investors were contacted to register their interest to invest in an IPP-style project under the current BOOT regulations. Only one company filled out the requested questionnaire; another 21 responded by stating that they were either not interested in general or not interested under the current BOOT regulations; three were no longer in existence, and six responded that they would be interested in principle, but did not fill out the questionnaire and thus were not considered serious.

As a result, NREA proposed a change in the project concept from an IPP to an Engineer Procure Construct (EPC) approach that includes an O&M contract with the same entity for a period of 5 years. This is the same arrangement envisaged for the solar thermal power projects under preparation in India and Morocco and possibly Mexico. The Government of Egypt has entered into advanced discussions on the financing of the non-solar part of the plant with EIB and the Japanese Bank for Investment and Cooperation (JBIC) in March 2004. Under such scheme of borrowing from EIB or JBIC, the currency risk would rest with the Government as the sovereign borrower of the funds. A financing plan is expected to be in place by May 2004 and firmed up no later than October 2004, when the bidding documents will be ready to be submitted to pre-qualified firms for the EPC cum O&M contract. It is also likey that a small share of the financing of the project will be met by a loan from the IBRD.

Although a private sector project was the preferred strategic choice, a case could be made that public financing of the first solar thermal project will be at lower cost and with a greater degree of certainty, since the private sector would demand a premium for the greater risks associated with integrating the new technology.

Another important choice is to find a way that best supports the GEF program goal by ensuring a sufficient demonstration impact and operational learning experience with a corresponding impact on the solar thermal industry and its business opportunities. This has resulted in two decisions: (i) to include in the O&M contract an incentive structure (including a penalty) to maximize the solar output during the contract validity period; and (ii) to ensure the continuation of the incentive structure in the PPA contract between NREA and EEHC. The specifics in the O&M contract and PPA that will ensure the appropriate incentive structure will be worked out during project preparation.

C. Project Description Summary

1. Project components (see Annex 2 for a detailed description and Annex 3 for a detailed cost breakdown):

The project components are summarized in the table below. Estimates are preliminary and based on the recent Conceptual Design Study (January 2004) carried out by NREA and its consultants, Fichtner Solar. The technical, economic and financial data are estimate values and subject to finalization at appraisal when the winning bid has been identified.

Component	Indicative Costs (US$M)	% of Total	Bank financing (US$M)	% of Bank financing	GEF financing (US$M)	% of GEF financing
1. Design, Construction and Operation of an Integrated Solar Combined Cycle Power Plant.	140.00	95.2	0.00	0.0	47.30	95.0

2. Technical Assistance to NREA	7.00	4.8	0.00	0.0	2.50	5.0
Total Project Costs	147.00	100.0	0.00	0.0	49.80	100.0
Total Financing Required	147.00	100.0	0.00	0.0	49.80	100.0

The proposed project will finance the construction of an Integrated Solar Combined Cycle (ISCC) power plant under an EPC (engineering, procurement, construction) arrangement with a 5-year O&M (operation and maintenance) contract, to be located in Kureimat, about 95 km south of Cairo, on the eastern side of the river Nile. The main innovation of an ISCC plant is the integration of steam generated by solar energy into a combined cycle power plant, which will require a larger steam turbine to generate electrical energy from the additional solar-generated steam.

The plant will be of about 151MWe (at 20°C) capacity combining a conventional fossil fuel portion of about 121MWe and an input from solar sources of about 30MWe. When own consumption of 5.3MWe is deducted, the net overall plant capacity becomes 145.7MWe. The total net energy produced by the plant is expected to be 984 GWh per year, which includes the solar contribution of 64.5 GWh per year. This corresponds to a solar share of 6.6 percent of the total annual energy produced by the plant operating at a full load.

The technology for the solar field is expected to be parabolic trough with a capacity of about 200 GWh per year (thermal) of solar heat plus all the associated balance of plant equipment. The primary fuel for the conventional fossil fuel portion is expected to be natural gas supplied at the site by Egyptian General Petroleum Corporation.

The total investment cost is estimated to be US$147 million, which includes equipment (US$127 million), the O&M contract cost (US$13 million) and technical assistance costs related to project preparation such as site preparation and consulting services for project management (US$7 million). The local cost is estimated to be 20 percent of the total investment cost.

2. Key policy and institutional reforms supported by the project:

The project will contribute to the achievement of the GOE's goal to increase the share of renewable energy in its total installed capacity, and will also serve to crystallize the new role of NREA as an independent producer of green electricity and enhance its performance through institutional reform.

3. Benefits and target population:

The main benefits associated with the domestic objectives of the project are: (i) provision of modern infrastructure by efficient private suppliers and contractors for the 5-year O&M contract; (ii) increased generation capacity derived from renewable resources which has the potential to reduce the level of local and regional pollution; (iii) increased capacity to develop large-scale innovative renewable projects; and (iv) position Egypt as a potential source of expertise and equipment in future solar thermal power projects internationally.

The main global benefits of the project are: (i) the demonstration of operational viability of hybrid solar thermal power generation in Egypt; (ii) contribution to accelerated market penetration of large-scale backstop power generation technologies; and (iii) reduction of greenhouse gas emissions from power generation. The incremental physical benefits of the project over a conventional CCGT are expected to be: increased renewable electricity production (about 65GWh per year) and reduced carbon emissions (about

1.1 million tons over the lifetime of the project). Benefits of local and regional pollutant reduction – specifically oxides of sulfur and nitrogen and particulate matter – have not yet been estimated but will be calculated at appraisal.

As a demonstration project designed to create an initial market for an environmentally benign technology, the beneficiaries of the project are many:

- NREA, whose staff will obtain expertise in the preparation and execution of a novel power system;

- Planners, policy makers and regulators in the energy sector who will benefit from the technical assistance to be carried out as part of the project;
- Local industry that will be well positioned to provide a large fraction of the non-specialized materials and equipment;
- The local scientific, educational and environmental community, which will benefit from plant visits and from specialized workshops to discuss the technology and its future benefits to the environment; and
- The general public which will consume the electricity produced by the hybrid plant.

The benefits are expected to accrue mainly to:

- *Kureimat and the surrounding area*, which will benefit from additional economic development, increased investment, additional employment, and increased tax revenue;
- The *renewable energy industry*, including manufacturers, developers, and support service companies, which will benefit from the increased economic activity generated;
- The *Egyptian public* will benefit from a cleaner environment; and
- The *power sector* will gain from diversifying its generation mix and in gaining experience in operating the technology on a large scale. In the longer term this should lead to opportunities, alongside developers and manufacturers, to export these skills to other countries.

4. Institutional and implementation arrangements:

The construction and operation of the ISCC power plant will be implemented by an EPC cum O&M arrangements to be secured through international competitive bidding. The project will be executed by NREA and overseen by MEE. A Project Steering Committee (PSC) will be formed to ensure that the broader project objectives are met, especially those dealing with capacity building, replication, information dissemination and public awareness. The PSC is expected to have members from other interested government ministries in addition to MEE and the Egyptian Environmental Affairs Agency, the GEF, the International Finance Institutions providing loans to the project, and possibly an interested NGO.

NREA will have the responsibility for overall project management and for these purposes it will establish a project implementation unit (PIU). The PIU will benefit from the assistance of an implementation consultant during the construction years, whose responsibilities will be, among others, to assist the agency in reviewing the detailed designs and specifications as well as help in the preparation and negotiation of the Power Purchase Agreement to be signed with EEHC.

During the construction but mainly in the O&M period, close coordination between the EPC contractor and the PIU will be essential to ensure knowledge from the EPC contractor is transferred to NREA's staff, specially with regards to the plant's operation, so that NREA can take over the plant's management after the 5 year O&M contract expires. This is important given NREA's relatively recent experience in managing and operating projects. The PIU will include the personnel required to be stationed at the power

plant with the primary task of collecting and evaluating operating data, interacting with the contractor/operator, and verifying invoices submitted from the contractor/operator to NREA.

The World Bank will supervise and monitor the implementation of the activities through regional and specialized staff as required.

D. Project Rationale

1. Project alternatives considered and reasons for rejection:

An early study carried out by the Energy Sector Management Assistance Program (ESMAP: a joint program of the World Bank and UNDP) identified the two most promising large scale renewable energy options for Egypt to be wind and solar thermal. Since the early 1990s, Egypt has been developing wind farms on an increasing scale and has under construction or commissioned some 400MWe of capacity operating under quasi-commercial conditions. GEF preparation grants (PDF Block B and C) have been awarded to Egypt and activities are currently under way under this grant to identify a project which would assist in the removal of barriers to commercial development of the wind market.

Given both wind and solar's potential as backstopping supply technologies, the Government is ready to guarantee financing for projects that result in a larger contribution of renewable energy to the energy mix in Egypt.

Although there are, broadly, three solar thermal technologies: the parabolic trough; the central receiver, and the parabolic dish Stirling system, the parabolic trough is the most technically and commercially proven option. The Government of Egypt, through the MEE, is very committed to the proposed project and has stressed its preference for a commercially proven technology. As such, it has been decided that the project design be based on the parabolic trough technology. Bidders will be free to choose a parabolic trough design that best suits the project requirements based on a list of acceptable designs to be discussed with interested bidders during the pre-qualification process. The bidding documents will specify the values of the technical parameters to be within a certain range from the ones of the baseline design, including the physical area required which corresponds to 1,000 x 1,125 meters and allows bidders to have an open choice when it comes to parabolic trough designs, which vary slightly in size. Bidders will be requested to provide their own design within the specified range in order to best fit the bid evaluation criteria. It has also been decided to exclude thermal storage as this technology has not yet been commercially proven on a large scale.

Notwithstanding the solar thermal technology choice, the other challenge of integration of a solar thermal system with a fossil unit such as a CCGT has not yet been demonstrated, but is considered a promising configuration. The Egypt project is proposed to employ this configuration, with the solar thermal component operated as an intermediate and peak load plant. The operational experience gained from this plant will clearly be useful for future plants, not only in Egypt but also in other countries. One reason is that the final design has many aspects in common with other solar thermal hybrid designs but differ in the details, which will allow future plants to be further optimized based on different experiences.

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

Table 3 below indicates the major relevant projects from Bank and non-Bank development agencies. The Bank has not been involved in lending operations in the energy sector in Egypt in recent years; however, it has continued a dialogue, collaborated and provided technical assistance on the preparation of this project.

Sector Issue	Project	Latest Supervision (PSR) Ratings (Bank-financed projects only)	
		Implementation Progress (IP)	Development Objective (DO)
Bank-financed			
Power Generation	Kureimat Power Project (1992)	S	U
Solar Thermal Power Development	India: Solar Thermal Power Project (Bank/KfW)		
Solar Thermal Power Development	Mexico: Hybrid Solar Thermal Power Plant		
Solar Thermal Power Development	Morocco: Solar Based Thermal Power Plant		
Clean Energy Development	Egypt: Private Sector Wind Energy Development Program		
Other development agencies			
Power Development	Walidia Thermal Power Station (JBIC)		
Power Development	Abou-Zaabal Substation (JBIC)		
Private Sector Power	Port Said and Suez East (IFC)		
Clean Energy Development	KfW-sponsored Wind Farm		
Clean Energy Development	Danida-sponsored Wind Farm		
Power Development	Sidi Krir Transmission and Substation Project (JBIC)		
Clean Energy Development	JBIC-sponsored Wind Farm		
Clean Energy Development	Spanish-sponsored Wind Farm		

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

3. Lessons learned and reflected in the project design:

Power Sector Development in Egypt

NREA has gained significant experience in designing and implementing wind energy projects with international loan and grant financing. Important lessons drawn from this experience include the importance of a transparent and well-managed competitive bidding process. Another important lesson from the development of the wind projects is that they have attracted the major international suppliers of wind technology, demonstrating the interest and comfort of major suppliers with business transactions in Egypt.

Furthermore, through the development of these projects, NREA has operated under PPAs with the national utility and has gained significant experience in structuring and negotiating such agreements. This experience will be very useful in the propopsed solar thermal project, in which a power purchase agreement will need to be put in place as well as a gas purchase agreement.

Solar Thermal Power Plant Development Worldwide

No large scale solar thermal power plants have been built in developing countries to date. GEF-supported projects are now in preparation in India, Mexico and Morocco. The most significant solar thermal installations are in California where 354MW of parabolic troughs, with back-up gas fired steam boilers

have been generating electricity and selling it to the utility for about 15 years.

To meet the cost reduction objective of the project, it is necessary to move beyond the trough/backup boiler design upon which the California plant is based. The purpose is to permit higher thermal efficiencies, improve the dispatchability of the plant and to encourage greater competition in the design and supply of equipment. Such a plant would be more attractive to utilities, thus increasing the market size. For this reason the project includes the following features: (i) bidders will be allowed freedom to choose among manufacturers for the parabolic trough designs and the gas-fired power equipment (ii) price competition will be key, to ensure that low-cost components are used, wherever possible locally manufactured; and (iii) the contractor will have incentives to maximize output from the solar field, which will bring about a focus on O&M costs, thus bringing down life-cycle costs.

4. Indications of borrower and recipient commitment and ownership:

Ministry of Electricity and Energy, EEHC and NREA have all shown significant commitment to the project. The Ministry has requested financing for the project from major lenders active in the power sector in Egypt, EEHC has included the project in its least-cost expansion plan and anticipates it to be operational in 2008 to meet the country's demand for increased capacity and NREA is working on specifying the technical design of the proposed plant together with its consultant, Fichtner Solar. While the preparatory studies are receiving incremental financial support from the GEF, there is a significant commitment of both financial and human resources from all three institutions.

Furthermore, at the national level, the Ministry of International Cooperation and Foreign Affairs and the Ministry of Environment have all been briefed on the project and have given their support and where necessary have issued the required approvals.

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

Because of its current direct involvement in investment and advisory services across many sectors in Egypt, its past experience in the power sector combined with knowledge of renewables investment, including solar thermal power, the Bank, with the assistance of GEF, has a comparative advantage. The proposed project involves the development of a proven but unusual technology through an EPC arrangement which will be followed by a 5-year O&M contract to ensure proper operation and maintenance and maximum output by the solar field. The project will be among the first of its kind in the world.

Bank involvement will help attract strong bidders through the use of transparent and competitive procurement processes. Bank and GEF staff have acquired valuable experience in the past years in developing projects for the commercial exploitation of large-scale grid-connected renewable energy technologies, such as the wind farm projects in India and China. Furthermore, the Bank's experience in developing similar solar thermal power projects in India, Mexico and Morocco will facilitate preparation and implementation of this project. GEF financial commitment to the project is essential. Solar thermal power plants are not yet competitive because of high capital costs and incomplete learning resulting from the low level of deployment globally. Hence GEF support through the proposed grant will avoid Egypt having to bear the incremental costs of the project and help bring down the long-term costs of the technology.

E. Summary Project Analysis (Detailed assessments are in the project file, see Annex 8)

1. Economic (see Annex 4):

● Cost benefit NPV=US$ million; ERR = % (see Annex 4)
○ Cost effectiveness
○ Incremental Cost
○ Other (specify)

The feasibility study prepared by Lahmeyer in 2000 and the updated conceptual design study by Fichtner Solar in January 2004, have provided estimates of the economic costs of hybrid solar thermal variants and their baseline equivalent CCGTs, including the economic least cost plant size, its dispatch into the power system, possible technology variants, and cost estimates.

Preliminary Cost-Benefit Analysis of the Program

A preliminary cost benefit analysis of the project suggests that for a total capacity of 151MWe, and introducing a 6.6 percent solar contribution, the installed cost of the plant will be about $147 million. The net present value (NPV) of fuel, O&M costs and consumables will be about $305 million over the 25-year lifetime. The O&M costs in economic terms assume an economic cost of natural gas of US$3.5/mmbtu as compared to the actual cost (referred to as the financial cost) of US$0.70/mmbtu. To calculate the benefits, the average electricity tariff has been assumed to be US$0.04/kWh in economic terms. Based on these assumptions, the estimated rate of return of the project is 4.8 percent without the GEF grant and 10.4 percent with it.

Results of the full cost-benefit analysis will be completed by appraisal and will include other benefits not mentioned in Table 1 below, in particular the local and regional environmental benefits resulting from lower emissions of sulfur and nitrogen oxides, and of particulates.

Table 1: Preliminary Cost-Benefit Analysis Summary

Parameter	NPV (US$ million)
Costs:	
Capital	146.7
O&M	33.7
Fuel	270.6
Consumable	1.2
Total	452.2
Benefits:	
Electricity	422.5
GEF grant	49.8
Total	472.3
EIRR without GEF grant	4.8%
EIRR with GEF grant	10.4%

Incremental Cost Analysis

An initial simplified incremental cost analysis based on intertemporal comparisons of the baseline and likely plant is included in Annex 3. The results indicate that for a total capacity of 151MWe, introducing a 6.6 percent solar contribution will increase the installed cost of the plant from about US$91 million for a conventional CCGT to about US$146.7 million for the hybrid. There will be an increase in the net present value (NPV) of O&M costs of about US$13.4 over the 25-year lifetime, partially offset by the reduced fuel consumption and consumables the NPV of which will be US$18.8 million and US$0.2 million less respectively over 25 years. Therefore, the estimated incremental cost for 30MWe of solar capacity is about US$49.8 million. Table 2 below has the results in more detail.

Table 2. Incremental Results and Costs of the project over the Baseline

	PV* (discounted)	Capital	Recurrent (annual)
	(Million US$ unless otherwise stated)		
Baseline (CCGT):			
Capital costs	91.3	91	
Fuel costs	289.4		24.56
O&M costs	20.3		1.69
Consumables	1.5		0.10
Total	402.5	91	26.35
Levelized electricity costs (¢/kWh)	3.73		
Alternative (ISCC):			
Capital costs	146.7	147	
Fuel costs	270.6		22.98
O&M costs	33.7		2.87
Consumables	1.3		0.10
Total	452.3	147	25.95
Levelized electricity costs (¢/kWh)	4.17		
Increment:			
Incremental capital cost	55.4		
Incremental fuel cost	(-18.8)		(-1.58)
Incremental O&M cost	13.4		1.18
Incremental consumables cost	(-0.2)		0
Total incremental cost	49.8		(-0.4)
Incremental levelized cost (¢/kWh)	0.43		

* Discounted at 6% above inflation, which is assumed at 4% (total discount rate 10%) over the 25 year plant life

Finalization of costs and analysis

Final costs as proposed in the winning bid will not be known until after it has been selected, at which point it will also be possible to determine conclusively the incremental cost of the plant. Both cost benefit and incremental cost analyses for the GEF grant will be carried out on the winning bid. The proposed approach to determining the final incremental cost will be based on differential runs of the system planning model in use by NREA/EEHC. The first 'baseline' run will optimize the system for least cost expansion while the second will constrain the model to using the winning bidder's plant: the cost difference between the two will be the incremental cost for GEF purposes.

2. Financial (see Annex 4 and Annex 5):

NPV=US$ million; FRR = % (see Annex 4)

A preliminary analysis of the impact of the project on NREA's financial position has been conducted and will be finalized during appraisal, when the project financial NPV and IRR will be calculated. The debt servicing related to loans to be obtained to finance the proposed project will be NREA's responsibility, with no financial assistance expected from the government. However, the government will provide a guarantee for the loan to be taken by NREA.

At the moment NREA is capable of covering its operating expenses due to the large grant components in the financing of its wind farm projects and some government assistance with debt servicing. As progress is being made on the financial arrangements to be put in place to finance the proposed project, a detailed analysis will be done on the agency's ability to meet debt payment obligations including the new loan to be taken under the proposed project. A PPA will be put in place under the project that will ensure NREA is paid a tariff that covers its cost. Revenue projections prepared by NREA show strong growth in the years to come as the large wind - and the proposed - projects are implemented. Furthermore, the Government is considering paying NREA a credit for the reduction in domestic gas consumption due to increased share of renewable power in the power production mix based on the increased price that the displaced gas can be exported at.

Fiscal Impact:

Fiscal impact issues will be looked at in detail during appraisal but is expected to be positive as a result of the reduced usage of natural gas in the ISCC plant, which can be exported by the government at higher value than if sold within Egypt. The magnitude of these issues will be analyzed in detail during the forthcoming preparation and appraisal.

3. Technical:

The main technical issue to be addressed is the specification of the performance required from the plant in terms of its capacity, output, fuel consumption and efficiency and how these are to be divided between the conventional and solar portions of the plant. In addition to minimum qualifications for the solar trough technology, these performance specifications will ensure effective integration of the steam systems for the solar field and the gas-fired combined cycle plant. The contractor selection process will review plant designs to ensure that the plant will operate effectively in all modes. In particular, integration and control of the system should be flexible enough to allow the solar contribution to be consistently maximized, while under other circumstances allow power to be efficiently generated on natural gas only (e.g., during night time or if the solar field is not operational). Creating an incentive structure to maximize solar output from the field for the whole life of the plant and a bid evaluation mechanism which is transparent but does not inadvertently introduce a bias for or against a particular technology or cause bidders to 'game' the

evaluation is a significant task.

The framework of contracts – which will regulate the operation of the plant over its lifetime – will include incentives to operate the plant to produce a minimum contribution of energy from the plant (both solar and fossil) and to keep a minimum capacity available. They will also include the fuel supply arrangements, and power purchase covering issues such as pass-through of natural gas costs.

The bid evaluation criteria and the determination of the levelized electricity cost (LEC) will be included in the bidding documents under preparation and will be assessed during preparation of the project.

4. Institutional:

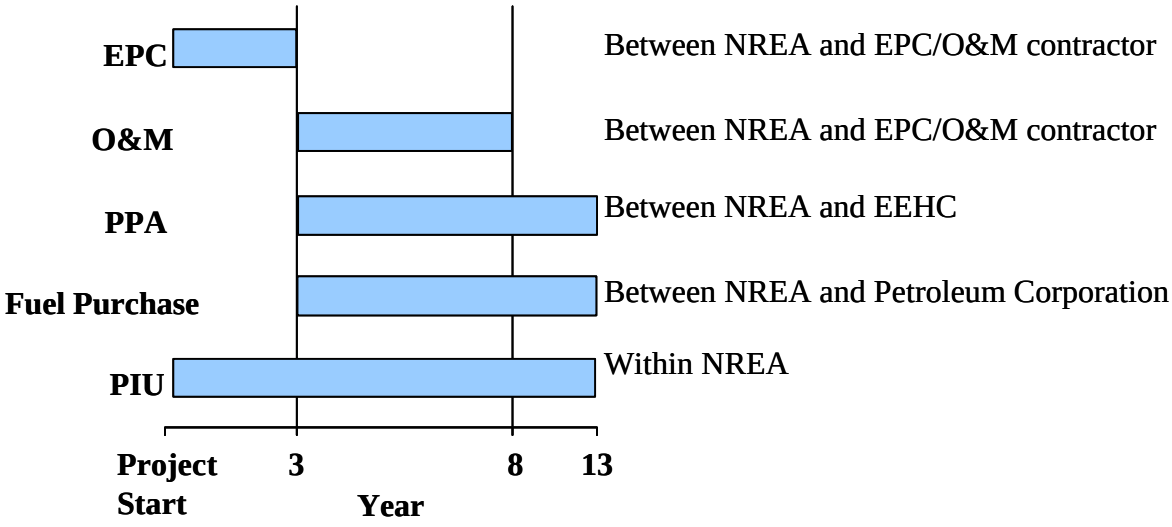
Contractual Arrangements

The contractors/suppliers for the EPC cum O&M arrangements will be selected through competitive bidding will be internationally reputable and with broad experience in similar arrangements. The contractors/suppliers will be responsible to undertake the engineering, procurement and construction of the power plant and operate it for 5 years.

Contractual clauses regarding power output from the solar-based power plant component will be incorporated in the O&M contract between NREA and the contractor/supplier as well as in the PPA between NREA and EEHC in order to maximize the solar output. The contracts for the O&M and the PPA will be for 5 and 10 years respectively. Therefore, the power plant will be operated by the contractor/supplier during the first 5 years from commissioning. For operation and maintenance, the contractor/supplier will receive a monthly or quarterly basic remuneration. There will be penalties in case of not meeting the required generation output, the required heat production from the solar field, or exceeding the fuel consumption. During these 5 years, NREA should gain the necessary experience to take over the plant.

It is most likely that the GEF grant will be partitioned into an investment and an operating portion, detailed arrangements on the proportions and disbursement schedule of both partitions will be discussed during preparation and finalized at appraisal. Ensuring that the necessary controls are in place to monitor performance and ensuring prompt payment of the grant to the operators will be important considerations for the project's implementation plan. Several options will be explored, including the holding of the O&M part of the GEF grant as an offshore escrow account, for release to the operator on the authority of a third party monitor. In the latter case, selection criteria for the third party monitor and triggers for releasing funds to the operator will be developed before appraisal.

The chart below illustrates, in a simplified format, the arrangements that need to be in place throughout project implementation.



4.1 Executing agencies:

The project will be executed by NREA and overseen by MEE. NREA will supervise the contractor/supplier during the 3 years of construction and 5 years of operation and maintenance with the support of an implementation consultant. For these purposes NREA will establish a project implementation unit.

4.2 Project management:

Although NREA's staff are competent and have gained very relevant project management experience though the operation of wind farms in Zafarana, and PPAs in place between NREA and EEHC, a project implementation unit (PIU) will be established to minimize project implementation risks. Consulting services for project management during the EPC cum O&M contract period and support to NREA's PIU will be in place before the start of implementation. These services would include assistance to NREA in the preparation of the PPA that the agency will sign with EEHC, as well as for the fuel purchase agreement.

4.3 Procurement issues:

The contractor/supplier will be chosen through an international competitive bidding process, in which bidders will be given the maximum freedom of choice to meet the plant specifications from the technological and financial points of view. The solar field will be of the proven parabolic trough type, where 2 types of design are available (Euro-trough and LS-3). The ISCC plant configuration will be optimized during the bidding process and will only become definite when the winning bidder is selected. The bid documents will be flexible and allow a range of power output in order to have sufficient competition. The bidders will be allowed to offer gas turbines of their choice (different or not from the baseline design) which fits best the evaluation criteria. This open approach will help ensure that optimum technology at least cost is employed.

There are several critical procurement issues that are essential to achieving the project objectives. The bidding will be carried out according to World Bank Procurement Guidelines to ensure that reputable contractors/suppliers are selected on a competitive basis. In particular:

- Pre-qualification will ensure that only appropriately qualified contractors/suppliers are invited to bid, and will be based on (i) experience and past performance on similar contracts; (ii) capabilities

with respect to personnel, equipment design, construction, manufacturing and operation facilities; and (iii) financial position;

- Evaluation of the EPC cum O&M bids and the determination of the Levelized Electricity Cost (LEC) will be based on: (i) the investment costs (USD); (ii) generation (kWh/a); (iii) solar generation (kWh/a); (iv) O&M costs (USD/a); (v) fuel consumption (Btu/a); and (vi) technical aspects including the technology type, the mode of operation of the plant, the heat rate of the combined cycle and solar elements, and the guaranteed availability of the unit; and (vii) organizational aspects including the adequacy of the approach, the organization of the works and the exceptions to any of the bidding document that may be proposed;
- The bidding will be based on performance specifications through the EPC cum O&M contracts to ensure that the bidders have the option to offer innovative solutions to meet performance requirements. For example, this will include the requirement to operate at the maximum capacity of the plant during night time or when the solar field is not operational.

Bid evaluation criteria are still under development. In principle they will be designed to ensure that bid is awarded to the contractor/supplier offering the lowest price for the output of the power plant while meeting minimum availability, output and capacity requirements from the solar and fossil sides. Procurement capacity assessment of NREA will be carried out during project preparation. One contract combining the solar field and combined cycle plant will be the basis for procurement. The Standard Bank document: Supply and Installation of Plant and Equipment - two stage bidding procedures will be used for the EPC cum O&M contract. It should be noted that a Country Procurement Assessment Report has been recently finalized in Egypt (the report is dated December 19, 2003).

4.4 Financial management issues:

The proposed GEF grant will be made to the Government of Egypt to be on-granted to NREA. NREA will also be responsible for the financing of the local cost and repayment of the loan which will finance the foreign cost related to the conventional part of the plant. This loan will be guaranteed by the Government of Egypt. Financial analysis is underway to ensure the financial capability of NREA and will be completed at appraisal. Cost recovery of the power produced under this project will be ensured through the PPA between NREA and EEHC.

There is no Country Financial Accountability Assessment prepared to date for Egypt. A financial management assessment of NREA will be carried out during project preparation, and based on its findings measures for improving the financial management system will be identified and implemented.

5. Environmental: Environmental Category: B (Partial Assessment)

5.1 Summarize the steps undertaken for environmental assessment and EMP preparation (including consultation and disclosure) and the significant issues and their treatment emerging from this analysis.

An initial scoping study on environmental impacts was undertaken as part of the feasibility study prepared by Lahmeyer in 2000. It reported that the environmental impact of the project is expected to be minimal as (i) the site is currently unused desert without cultural or environmental restraints; (ii) it is close to the existing much larger gas-fired power plant at Kureimat for which major infrastructure (gas supply and electricity evacuation) has already been furnished and (iii) the plant will utilize natural gas.

In November 2003, NREA commissioned a comprehensive EIA following the guidelines for EIAs in OP 4.01, for which the Bank reviewed and cleared the terms of reference (TOR). The EIA includes an assessments of air quality, water resources, noise, ecology, hydrology, traffic, land use and visual impact,

and archaeology. The EIA will also establish a detailed environmental management and monitoring program to be followed by the selected contractor during plant operation. This will be enforced through appropriate contractual clauses, which will be included in the corresponding agreements. In addition, the specific environmental hazards relating to the solar thermal portion of the plant to be investigated include the evaluation of quantity and quality of water required by the project for cooling purposes, the heat transfer fluid, and any cultural heritage, resettlement or social issues (the site is unused desert area without cultural, social or environmental restraints thus neither cultural heritage nor resettlement issues are expected to arise).

The environmental impact of the plant, both at the local and regional/global levels, will be minimal as the plant will utilize solar and natural gas. The use of solar power does not produce any pollutants. The combustion of natural gas leads to the lowest level of CO_2 emissions of any fossil fuel. In addition, the combustion of natural gas does not entail SOx emissions and has significantly lower emissions of NOx than other fuels. The heat transfer oil might leak and contaminate the soil. However, appropriate treatment of contaminated soil has been included in the design of the project. No other adverse environmental impacts, including on groundwater, are foreseen. Equally, no resettlement is foreseen and no adverse social impacts are expected. The project may, on the contrary, impact poverty positively by adding to the power capacity of Egypt. This is needed given the very low reserve margin that the system is currently operating on. The GEF component will ensure that the poor are not adversely affected, as the project will not impact on the current tariff levels in place.

5.2 What are the main features of the EMP and are they adequate?

The final EIA report is expected to be completed by April 15, 2004, the main features of the EMP will be discussed in this section when the report findings become available.

5.3 For Category A and B projects, timeline and status of EA:

Date of receipt of final draft: April 15, 2004

The EIA is currently underway. A draft report will be submitted to the Bank for review by April 15, 2004. The review is being undertaken based on World Bank guidelines, specifically OP 4.01 (Environmental Assessment) and OP 4.11 (cultural heritage). However, given that the area is a deserted with no cultural property per se on the site, it is doubtful that there will be any issues related to cultural heritage. The final determination on this matter will be made by the final EIA. The proposed date for “in-country” disclosure of the assessment is September 24, 2004.

5.4 How have stakeholders been consulted at the stage of (a) environmental screening and (b) draft EA report on the environmental impacts and proposed environment management plan? Describe mechanisms of consultation that were used and which groups were consulted?

Consultations have been undertaken in the areas surrounding the site. The outcome of these consultations show wide-spread support for the project as it is anticipated to lead to job opportunities and also possible economic activity through tourism.

5.5 What mechanisms have been established to monitor and evaluate the impact of the project on the environment? Do the indicators reflect the objectives and results of the EMP?

The O&M contract will ensure that the operator properly implements and monitors the mitigating measures to be identified in the EIA. Subsequent to the O&M contract, NREA will be responsible for continuing the monitoring and evaluation in accordance with the measures in the O&M contract. This will be enforced by the legal framework in Egypt for environmental requirements in relation to power plants. These regulations

are in line with Bank guidelines.

6. Social:

6.1 Summarize key social issues relevant to the project objectives, and specify the project's social development outcomes.

The proposed project is to be developed on a vacant site close to the existing Kureimat gas-fired power plant. The land for the proposed site for the plant in Kureimat owned by NREA where there are no existing residents nor any economic activity taking place. The site is several kilometers from the town of Kureimat, and a separate residential area set aside for the employees of the existing power plant exists about 2 kilometers from the proposed project site.

It is expected that during construction of the plant there will be significant influx of workers into the area, both skilled and unskilled. The residential complex that accommodates workers for the existing power plant has vacant apartments which have been earmarked for workers of the proposed plant, therefore disruption due to the influx of workers is expected to be minimal.

The expected social development outcome of the project is to minimize the impact on the consumers from the implementation of a more expensive power plant through the contribution of the GEF grant whilst contributing to additional job opportunities for the inhabitants around the Kureimat project area.

6.2 Participatory Approach: How are key stakeholders participating in the project?

Key stakeholders from relevant branches of government and the private sector (as landowners around the site) have been consulted. Further consultations will be carried out during the permitting process.

6.3 How does the project involve consultations or collaboration with NGOs or other civil society organizations?

Consultations have been carried out which show strong support for the project, which is expected to lead to new job opportunities.

6.4 What institutional arrangements have been provided to ensure the project achieves its social development outcomes?

The project will not lead to an increase in the consumer tariffs due to the GEF grant which will off-set the additional cost due to the solar field.

6.5 How will the project monitor performance in terms of social development outcomes?

A PPA will be put in place between NREA and EEHC which will specify the cost/kWh for electricity from the proposed plant. The negotiated price is expected to be in line with EEHC's own cost of generation.

7. Safeguard Policies:

7.1 Are any of the following safeguard policies triggered by the project?

Policy	Triggered
Environmental Assessment (OP 4.01, BP 4.01, GP 4.01)	● Yes ○ No
Natural Habitats (OP 4.04, BP 4.04, GP 4.04)	○ Yes ● No
Forestry (OP 4.36, GP 4.36)	○ Yes ● No
Pest Management (OP 4.09)	○ Yes ● No
Cultural Property (OPN 11.03)	○ Yes ○ No
Indigenous Peoples (OD 4.20)	○ Yes ● No
Involuntary Resettlement (OP/BP 4.12)	○ Yes ● No
Safety of Dams (OP 4.37, BP 4.37)	○ Yes ● No
Projects in International Waters (OP 7.50, BP 7.50, GP 7.50)	○ Yes ● No
Projects in Disputed Areas (OP 7.60, BP 7.60, GP 7.60)*	○ Yes ● No

7.2 Describe provisions made by the project to ensure compliance with applicable safeguard policies.

OP 4.01 applies to the project and is used as a guideline for the EIA currently underway. Although no other safeguards are triggered by the project, it was agreed at the stage of the Integrated Safeguards Data Sheet that the applicability of OPN 11.03 would be determined by the EIA.

F. Sustainability and Risks

1. Sustainability:

The higher capital cost of the hybrid plant will be offset by the proposed GEF incremental cost grant, and as a result, increases in consumer tariffs will not be required for cost recovery. The integration of the solar field with a CCGT ensures that the hybrid will provide the required electricity contribution to the system regardless of solar radiation conditions. For these reasons, the hybrid power plant is expected to operate sustainably as an integral part of the Egyptian power system. The incentive structure for the EPC cum O&M will ensure optimal design for integration of the solar thermal with the gas-fired plant and maximize solar output from the plant when in operation. Dissemination of information about this demonstration project will contribute to future replication in other countries and to refining the GEF strategy regarding this technology.

Although, the project does not directly address market distortions due to electricity and gas pricing, the institutional options study for NREA which aims at a financially and operationally viable renewable entity will highlight the issues to the government and make some proposals to address them. In addition, the government is currently working towards identifying and implementing a comprehensive regulatory framework for the energy sector (including renewables), for which the Bank has received a request to support through a Public-Private Infrastructure Advisory Facility (PPIAF) grant. Thirdly, the government realizes that the electricity tariff policies are not sustainable due to the significant financial losses that EEHC is currently incurring and has announced its intention to gradually phase out subsidies.

1a. Replicability:

The general approach adopted by the project is highly replicable within Egypt, regionally and globally. An early study carried out by the Energy Sector Management Assistance Program (ESMAP: a joint program of the World Bank and UNDP) suggested that sites with ready access to gas supply, electricity evacuation

and water infrastructure would be capable of supporting 5-10GW of solar thermal plant in Egypt alone. High insolation sites are available across much of the region, though many lack the necessary infrastructure at this time. Worldwide there are suitable sites and, unlike other renewable technologies, solar thermal hybrid plants are inherently at utility scale.

The main barriers to further replication are costs and the associated learning needs, the overcoming of which this project is expected to address by providing cost reduction and operation information and disseminating it throughout the solar thermal community. Further grant support will be required for subsequent plants, as it is unlikely that this one alone (or even combined with the three others being prepared) will bring costs down to levels that are competitive with conventional power plants.

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

Risk	Risk Rating	Risk Mitigation Measure
From Outputs to Objective		
Continued commitment to innovative approaches to clean energy production (especially renewables) not maintained	M	Letter of policy from GoE, continued engagement with GoE
Level playing field between renewable and other sources of energy in Egypt not established/maintained	S	Thorough analysis at appraisal. Long term agreements between EEHC and NREA established
No further solar thermal capacity is built in Egypt/worldwide	S	Maintain contact with developers, understand their needs, continued engagement with GEF
From Components to Outputs		
Technological or design problems encountered	S	Ensure only credible suppliers/contractors are allowed to bid.
Suppliers/Contractors not willing to bid for project with solar element	S	Early engagement with potential developers (under way) and ensuring that developer can recover additional costs/ cover additional risks. Monitor other solar thermal projects.
No incentive to maximize solar contribution	M	Ensure incentives are included in contractual arrangements
Institutional or managerial problems	S	Upfront agreements between GoE and sponsor
Sectoral issues including tariffs, gas pricing not resolved	S	Upfront agreements between GoE, NREA and EEHC
Insufficient implementation capacity at NREA	M	Build capacity during preparation and implementation and during O&M period
Overall Risk Rating	S	Close monitoring of sector environment. Ensure security package is well-constructed.

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

Timing and Relationship to Other Solar Thermal Projects

The project was initiated within the Bank in October 1997 with the approval of the Project Concept Document (PCD) and a feasibility study, partly financed by a PDF Block B grant was approved in August 1998. A PDF Block C grant was awarded in January 2001 to cover part of the costs incurred by NREA in

preparing the project under IPP arrangements.

The change in the Government of Egypt's policy on foreign currency exposure related to private sector investment projects caused private interest in infrastructure to evaporate and prompted a request from the Government to change the project's concept to be publicly financed about one and a half year ago. After the lack of private sector interest was confirmed, a change in the project mode from an IPP to an EPC/O&M approach was approved, which is the same arrangement currently being pursued by the other solar thermal projects in India and Morocco and most likely Mexico. A consulting firm financed under a PDF Block C grant was recruited to update the feasibility study, prepare technical specifications and assist with the bidding process. The consultant has already delivered an update to the feasibility study and draft technical specifications. To date, disbursements of the PDF Block C grant stand at 10 percent and another 50 percent is expected to be disbursed by December 31, 2004.

There is a risk that further delay will occur, particularly in relation to issuing bid documents. To minimize this risk, during pre-appraisal a detailed schedule of activities was agreed upon with NREA, in which the pre-qualification documents are expected to be issued by April 2004 and the bid documents should be issued on October 1, 2004. Subsequent delays are less likely since they are less under the control of the Government of Egypt. Nevertheless, one further point of delay may occur for the approval of the GEF grant by the Government which will not be possible until the project has been approved by the board of directors of the World Bank. Steps will be taken to mitigate this risk by processing the grant approval in parallel with the bidding process to the extent possible.

The proposed project has not been significantly slower in development compared with the other three GEF-sponsored solar thermal projects. Outline details of these other projects are set out in the table below.

Comparative Details of Other Solar Thermal Projects

	India	**México**	**Morocco**
GEF Council Submission date	April 1996	December 1999	May 1999
GEF Grant size (US$ million)	45	39.2 - 49.4	49.5
Project structure	Public sector owned, turnkey construction with 5 year O&M contract	Public sector owned, build-transfer contract.	Public sector owned, turnkey construction with 5 year O&M contract
Project size (MW): Conventional Solar Total	 105 35 140	 270 30 300	 ~170 30-35 ~200
Recent progress	Main fuel changed to natural gas. Gas supply agreement pending. RFP issued and deadline extended 4 times.	Issues related to differences between World Bank and Government's procurement procedures resolved.	Completion of conceptual and financial modeling.
Next major step and timing	New deadline for bids established for June 2004.	RFP to be issued by CFE.	Pre-qualify by April 2004 and issue RFP to sponsors by October 2004.

Significant delays have been experienced by the four operations, namely due to the complex nature of the projects, and specificities related to each country. In India, the main cause for delay is a result of the many extensions granted for bid submission requested by the private sector. In Mexico the main issues are related to a discrepancy between government and procurement rules. For Morocco and Egypt the major hurdle to overcome is finalizing the project financing and maintaining the procurement schedule. These two issues are closely linked as the RfP can not be issued without a firm financing plan.

There is some risk that the requests for proposals for the projects will be bunched together and thus create a short burst of high demand for solar thermal products and services. Such an outcome may have the opposite effect of that intended in that the high demand may result in high prices. On the current showing, there is a potential for two bunches of two projects each (India and Mexico, followed by Egypt and Morocco). The India/Mexico bunch is unlikely to be as severe as may it appear at first because of the different project structures. The Egypt and Morocco teams are currently operating in an environment of coordination and information sharing. If bunching should emerge, it is likely that an agreement can be reached on delaying the RFP of one of the projects. However, given the complexity of these projects it is unlikely that they will be commissioned at the same time given the government's different procedures and schedules for approval of financing for such complex projects.

3. Possible Controversial Aspects:

No controversial aspects have been identified at this stage.

G. Main Conditions

1. Effectiveness Conditions

- Egyptian Government approval and ratification of grant and loan agreements
- Legal opinion from Egyptian Government issued

2. Other [classify according to covenant types used in the Legal Agreements.]

Conditions for Appraisal/Negotiations

- Bids received and evaluated by NREA

Conditions for Bank Board approval

- Draft Contract prepared and negotiated

Legal Covenants (to be determined at appraisal but likely to include):

- Project Management Consultant in place
- Contract signed with EPC/O&M contractor

H. Readiness for Implementation

☐ 1. a) The engineering design documents for the first year's activities are complete and ready for the start of project implementation.
☒ 1. b) Not applicable.

☐ 2. The procurement documents for the first year's activities are complete and ready for the start of project implementation.
☐ 3. The Project Implementation Plan has been appraised and found to be realistic and of satisfactory quality.
☐ 4. The following items are lacking and are discussed under loan conditions (Section G):

I. Compliance with Bank Policies

☒ 1. This project complies with all applicable Bank policies.
☐ 2. The following exceptions to Bank policies are recommended for approval. The project complies with all other applicable Bank policies.

Anna Bjerde	Francoise Clottes	Mahmood A. Ayub
Team Leader	**Sector Manager**	**Country Director**

Annex 1: Project Design Summary

ARAB REPUBLIC OF EGYPT: 2G-SOLAR THERMAL (GEF)

Hierarchy of Objectives	Key Performance Indicators	Data Collection Strategy	Critical Assumptions
Sector-related CAS Goal: Improved energy infrastructure for greater sector competitiveness and higher sustained growth.	**Sector Indicators:**	**Sector/ country reports:** GoE annual reports on economy and on infrastructure, energy sectors	**(from Goal to Bank Mission)** GoE's continued commitment to reforming the energy sector.
GEF Operational Program: To reduce the long-term costs of low greenhouse gas-emitting energy technologies	**Outcome / Impact Indicators:** Costs of solar thermal power: below 10-11 ¢/kWh and $2,000/kW by 2010		Learning curve effects result in reduced investment and operating costs
Global Objective: 1. Increase the use of renewable energy sources in Egypt and help reduce the long-term costs of low greenhouse emitting energy technologies.	**Outcome / Impact Indicators:** 1.1 Total electricity generated from renewable sources in GWh/a – [baseline – 214GWh/a] 1.2 Total renewable capacity in MW [baseline – 68MW] 1.3 Emissions reduced (tons/a): • CO_2 [baseline – 117 tons/a] • NO_x [baseline – X tons/a] • SO_x [baseline – X tons/a] • Particulates [baseline – X tons/a]	**Project reports:** Reports from NREA and Sector Regulator Solar thermal power plant reports	**(from Objective to Goal)** Continued reform and development of power sector by Egyptian authorities Continued institutional support and interest in renewable sources in Egypt Sufficient stability in fuel prices and no significant drop in conventional power plant prices Initial GEF support for solar thermal power supplemented in later stages by other funding regimes At least 3 other solar thermal power plant come forward in current round of GEF support Benchmark costs are within acceptable range for further development Other sources of funding become available outside GEF

Hierarchy of Objectives	Key Performance Indicators	Data Collection Strategy	Critical Assumptions
Output from each Component:	**Output Indicators:**	**Project reports:**	**(from Outputs to Objective)**
1. Demonstrated operational viability of solar thermal power generation in Egypt	1.1 Production of 984 GWh of electricity, of which 64.5 GWh is 'solar' from plant with total gross capacity of 151MW	Progress reports World Bank project supervision reports	Continued commitment to innovative approaches to clean energy production (especially renewables)
2. Improved local capacity to plan, finance and implement a complex power project	2.1 PIU is established and able to successfully follow-up on project implementation. At least 50% of operations staff are local		Level playing field established/maintained between renewable and other sources of energy in Egypt
3. Reduced emissions compared with CCGT	3.1 Approximately 1.1 million tC avoided over 25 years.		Further solar thermal capacity is planned in Egypt and worldwide
4. Costs of solar thermal power plant benchmarked	4.1 Plant costs below 10-11 c/kWh and $2,000/kW		
Project Components / Sub-components:	**Inputs: (budget for each component)**	**Project reports:**	**(from Components to Outputs)**
1. Design, construction and operation of a 151MW solar fossil hybrid power plant to be implemented under an EPC/O&M contract. Details to be left to bidders but with the following specified: ● A solar thermal field of about 30MWth and producing about 6.6% of total output energy ● A fossil fuel element (probably CCGT) using natural gas	GEF grant of $49.8 million for incremental cost combined with local counterpart financing of about $97.2 for baseline fossil plant costs.	Progress reports. World Bank supervision and disbursement reports, activity completion reports.	No major technological or design problems ('first of a kind') issues Sufficient interest from bidders to undertake the construction and O&M for an ISCC plant. Incentives are put in place to maximize 'solar contribution' No institutional or managerial problems. Sufficient implementation capacity at NREA
2. Institutional support to project implementation: ● Survey/assistance to local equipment suppliers/contractors. Monitoring/evaluation and dissemination. ● Institutional support to possible restructuring of NREA and staff training.	$3 million, of which $1.05 million from GEF sources		

Annex 2: Detailed Project Description
ARAB REPUBLIC OF EGYPT: 2G-SOLAR THERMAL (GEF)

By Component:

Project Component 1 - US$140.00 million

Design, Construction and Operation of an Integrated Solar Combined Cycle Power Plant

The gross capacity of the Integrated Solar Combined Cycle (ISCC) plant will be about 151 MWe (at 20°C) and will most likely comprise of gas turbine(s), a steam turbine, and a parabolic trough solar field with a capacity of about 200 GWh per year (thermal) of solar heat plus all associated balance of plant equipment. The total net energy produced by the plant would be 984 GWh per year, which includes the solar contribution of 64.5 GWh per year. This corresponds to a solar share of 6.6 percent of the total annual energy produced by the plant operating at a full load. An ISCC with cooling tower and without storage is anticipated to be the preferred choice within the technical design options. The primary fuel for the gas turbine will be natural gas supplied at the site by Egyptian General Petroleum Corporation.

Following the construction, a 5-year O&M contract will be put in place which will ensure proper operation of the newly constructed plant. The O&M contract will be extended to the same firm in charge of the construction of the plant.

Project Component 2 - US$7.00 million

Technical Assistance to NREA

This component will finance technical assistance costs related to project preparation such as site preparation and consulting services for project management, including technical assistance and capacity-building activities for NREA, as well as support for replication of the plant in Egypt and worldwide. These activities will include:

Training of NREA and regulatory staff in solar thermal power plant operations, with particular respect to dispatching and integration into the power system;

- Survey/assistance to local equipment suppliers/contractors to establish what components may be provided locally and to inform such suppliers of the opportunity future projects may present;
- Monitoring/evaluation and dissemination of performance results from the project both domestically and internationally, as a way to support future replication;
- Consulting services for project management and support to NREA's project implementation unit (PIU); and
- Institutional restructuring of NREA.

The replication support will include an online gateway for interested developers around the world. The gateway will provide passive information on operational and, to the extent possible, financial performance and details of contact information, potential for site visits and so on. On a more active level, some dissemination will be supported, including: (i) participation in international fora, such as those sponsored by the International Energy Agency's SolarPACES working group (a group of national parties interested in solar thermal power); (ii) relevant industry associations; and (iii) other countries piloting solar thermal power plants worldwide. The replication support will be the responsibility of NREA.

An additional US$1.05 million have already been provided as grant financing from GEF for project preparation purposes.

Additional GEF Annex 3: Incremental Cost Analysis
ARAB REPUBLIC OF EGYPT: 2G-SOLAR THERMAL (GEF)

Baseline

An analysis of Egypt's system expansion plan, fuel supply and availability, and potential candidate plants suggests that the least-cost baseline course of action will be the commissioning of further gas-fired combined cycle capacity. The baseline plant is therefore assumed to be a combined cycle gas turbine (CCGT) fueled with natural gas capable of producing the same output as the proposed GEF alternative.

GEF Alternative

The plant will be of about 151MWe capacity combining a conventional fossil fuel portion of about 121MWe and an input from solar sources of about 30MWe. When own consumption of 5.3MWe is deducted, the net overall plant capacity becomes 145.7MWe. The total net energy produced by the plant is expected to be 984 GWh per year, which includes the solar contribution of 64.5 GWh per year. This corresponds to a solar share of 6.6 percent of the total annual energy produced by the plant operating at a full load. The technology for the solar field is expected to be parabolic trough with a capacity of about 200 GWh per year (thermal) of solar heat plus all the associated balance of plant equipment.

In the Egyptian context, Kureimat is a least cost site with excellent levels of solar insolation of 2,431 kWh/m2/year at a latitude of 30°,[1] direct access to natural gas,[2] water supplies[3] and direct access to the national electricity grid.[4] The proposed project is based on a feasibility study and a conceptual design report financed by the GEF, which assess the technical and economic feasibility of solar thermal technology in Egypt and specify the design of the ISCC power plant at Kureimat. It is anticipated that the proposed solar power station will have the characteristics shown in Table 1 below.

Table 1:Characteristics of the Proposed Solar Thermal Plant

	Value
Parameter	Integrated Solar Thermal
Gross Plant Capacity (MWe)	151
of which Solar Field (MWe)	30
Electricity Output (GWh/yr)	984
Solar Share (proportion of total energy output)	6.6%
Investment/Total Installed Cost (US$ million)	147
Levelized Electricity costs w/o grant (Us¢/kWh)	4.2

The technical, economic and financial data are estimate values and subject to finalization at appraisal when the winning bid has been selected. Power plant capacity and the relative proportion of the fossil and solar components are indicative and based on the results of the feasibility and draft conceptual design report study. Plant configuration will be optimized during the bidding process and will only become definite when the winning bidder is selected and the contractual framework (the security package) negotiated. This open

approach will help ensure that optimum technology at least cost is employed.

Scope of the Analysis

System Boundary

The analysis is based on the direct comparison of the proposed solar thermal plant with the least-cost conventional solution in the same annual output. It is recognized that the introduction of solar-thermal capacity to the national grid might require further adjustments in the system expansion plan, not least because the proposed plant is relatively small compared to the conventional power stations that might be built in the baseline. These system-wide effects are ignored in the current analysis. While they could be captured in a broader study of the entire system expansion plan, a simple plant-by-plant comparison was preferred, for the following reasons:

- The Egyptian power system is growing relatively fast. Relative to this expansion and the overall size of the system, the proposed addition is relatively minor and can be absorbed without major repercussions;
- There is a trade off between spatial and temporal system boundary: A plant-by-plant comparison ignores systemic effects, but allows the analysis of the entire plant lifetime. A system expansion analysis, on the other hand, has a wide spatial system boundary, but usually covers no more than 10-15 years of plant life. In the current context – where systemic effects are assumed to be small, and the time horizon of the expansion plan is relatively short – covering the entire plant life was considered more important.

An earlier sensitivity run of the system expansion plan performed by EEHC with and without a solar thermal / fossil fuel hybrid plant resulted in incremental costs in the same range as calculated in the plant-by-plant comparison.

Additional Domestic Benefits

The GEF alternative will result in some improvements in domestic air quality, but these additional domestic benefits are marginal. Egypt has a separate program targeted at local air pollution, especially in the urban areas where it is worst.

This project will position Egypt as a world leader in the commercialization of solar thermal technology and as a potential source of goods and services for future solar thermal power projects both domestically and abroad, particularly in the high insolation region in which it finds itself.

Input Costs

Capital Costs

At about US$3,248/kW, solar thermal power generation without combined cycle entails substantially higher capital investment than the baseline CCGT, which costs about US$ 603/kW. The suggested ISCC costs US$840/kW, whereby the solar field and its ancillary equipment alone entails capital costs of US$1,717/kW. The size of the solar field is 226,630 m2 and is estimated to cost US$ 176/m2.

These costs are within the same band as other solar thermal plants now under preparation and are consistent with earlier estimates. In the GEF PDF Block C application, costs were estimated for the solar field of $1,897/kW, average plant costs for a hybrid at $894/kW and a likely cost of solar electricity of 9.5 US¢/kWh. For a volumetric central receiver, costs were estimated at $902/kW with the solar field at

$2,137/kW and solar electricity at 10.2 US¢/kWh. The Mexico plant, which is the most recent example presented to the GEF Council, estimated costs to be in the range of $1,650-$2,000/kW for the solar field, average plant costs of $586/kW (for a much smaller solar proportion) and solar electricity costs of $8.9 US¢/kWh.

Recurrent Costs

The main recurrent cost elements concern operations and maintenance (O&M) and fuel purchases. Good O&M data for solar thermal power are available from the 354MWe of plant that has been operating in California since the 1980s. Over the years, operators have succeeded in substantially reducing O&M costs by increasing the efficiency and lifetime of components, improving the effectiveness of the solar field, power block interface and other measures. As a result, the typical O&M costs for a solar field have come down to about 1.3 US¢/kWh, compared with about 0.3 US¢/kWh for a typical CCGT. The higher O&M costs of the solar field are partially offset by savings in fuel costs. The economic cost of natural gas in Egypt is estimated to be US$ 3.5per million BTU, which translates into levelized electricity costs of 4.17 US¢/kWh for the integrated plant.

Key Assumptions

Key assumptions are summarized in Table 2 below.

Table 2: Key assumptions

Parameter	Value
Technical:	
Plant lifetime	25 years
Total Plant Capacity (net at 20°C)	146MWe
Fossil capacity (net at 20°C)	120MWe
Solar capacity (net at 20°C)	28MWe
Incremental solar efficiency	39%
GT capacity factor	85%
GT efficiency	32.65%
ST efficiency	34.92%
Overall efficiency	67.57%
Economic:	
ISCC	$840/kW
CCGT	$610/kW
Solar field	$1,717/kW
Economic cost of gas	$3.5/mmBTU
Gas cost escalation (annual)	1%
O&M cost escalation (annual)	1%
Consumables escalation (annual)	1%
ISCC fossil part fixed O&M costs	$1,270,000
ISCC solar field part fixed O&M	$990,000
ISCC variable O&M costs	0.05¢/kWh
CCGT fixed O&M costs	$1,140,202
CCGT variable O&M costs	0.05¢/kWh
Discount rate (after inflation)*	6%

* Inflation is estimated to be 4 percent per year.

Incremental Costs

Using the data presented above, the incremental cost of the project is estimated to be $49.8 million, as presented in Table 3 below. The robustness of the result was tested in an extensive sensitivity analysis illustrated in Table 4. The most significant factors affecting incremental cost are: assumed natural gas fuel costs, unit investment costs; and discount rate.

Table 3: Investment, O&M and Incremental Costs

	PV* (discounted)	Capital	Recurrent (annual)
	(Million US$ unless otherwise stated)		
Baseline (CCGT):			
Capital costs	91.3	91	
Fuel costs	289.4		24.56
O&M costs	20.3		1.69
Consumables	1.5		0.10
Total	402.5	91	26.35
Levelized electricity costs (¢/kWh)	3.73		
Alternative (ISCC):			
Capital costs	146.7	147	
Fuel costs	270.6		22.98
O&M costs	33.7		2.87
Consumables	1.3		0.10
Total	452.3	147	25.95
Levelized electricity costs (¢/kWh)	4.17		
Increment:			
Incremental capital cost	55.4		
Incremental fuel cost	(-18.8)		(-1.58)
Incremental O&M cost	13.4		1.18
Incremental consumables cost	(-0.2)		0
Total incremental cost	49.8		(-0.4)
Incremental levelized cost (¢/kWh)	0.43		

* Discounted at 6% above inflation, which is assumed at 4% (total discount rate 10%) over the 25 year plant life

Table 4 –Sensitivity Analysis for ISCC

	Variations	LEC ISCC (US$/MWh)	LEC CCGT (US$/MWh)	LEC for solar portion (US$/MWh)	Grant (=incremental costs) (million US$)
Fuel Costs	4	45.3	41.3	103.3	46.9
	3.5	41.7	37.3	103.3	49.8
	3	38.0	33.4	103.3	52.8
	2.5	34.3	29.5	103.3	55.8
Cost Estimate	+15%	43.6	38.5	115.5	58.2
	Base case	41.7	37.3	103.3	49.8
	-15%	39.8	36.2	91.1	41.5
Discount Rate	5%	43.0	38.1	112.4	50.5
	6%	41.7	37.3	103.3	49.8
	7%	40.5	36.6	94.8	49.1
Note: LEC stands for levelized electricity costs. The base case is highlighted in grey.					

Incremental Cost Matrix

The results of the incremental cost analysis are summarized in the incremental cost matrix in Table 5.

Table 5: Incremental Cost Matrix

	Baseline	Alternative	Increment
Domestic Benefits **a) physical**	984 GWh per year of electricity	984 GWh per year of electricity (919.5 GWh are generated through the combustion of gas, and 64.5 GWh are produced through the solar field).	Nil
b) programmatic	Limited NREA/EEHC institutional capacity to develop complex private renewables-based generation projects	Demonstrated practical viability of utility-based solar thermal technology Participation in planning, preliminary design of technical and financial requirements, preparation of bidding documents for hybrid plant	Reduction of perceived risks in renewables-based power; gain in operational experience Up to 20 NREA/EEHC Staff at various levels trained in solar/hybrid technology
	Limited regulatory capacity for renewables	Regulatory staff training in solar thermal	Solar thermal regulatory capacity
Global Benefits **a) environmental**	16.14 million tons of CO_2 emitted over 25 years.	15.78 tons of CO_2 emitted over 25 years.	1.1 million tons of CO_2 abated over 25 years of project.
b) programmatic	No hybrid solar thermal power plants in utility operation; high risk perceived by investors	30MWe solar thermal capacity. Demonstration effect/combining impact with similar plants in other countries	30 MWe of solar thermal capacity More countries and investors globally willing to consider STP hybrid options
	Solar thermal industry dormant with little future prospects; costs high	Revived interest/market opportunities for solar thermal industry	Creation of new opportunities for STP industry as a result of cost reductions
Incremental Costs (see table 3)			US$49.8 million

Process of Agreement

The technical and economic data used in the Project Brief have been drawn largely from a draft Conceptual Design Report for the planned ISCC in Egypt carried out by Fichtner Solar in January 2004. The estimates of incremental cost are based on this source. The results of this report were discussed extensively with the Egyptian authorities during the pre-appraisal mission in early February 2004. The study, a planned workshop and further consultations are the basis on which bidding documents, which further specify the details of the project, are to be prepared. A detailed anticipated timeline for the project as well as timing for the preparation of bidding documents and bidding process is attached in the back to office report dated February 9, 2004.

Refined data will become available when the bidding process is complete, when the exact specifications and costs of the winning proposal will be known. Following that, final agreement on the technical, economic, financial, environmental and social aspects of the project will be possible between all the parties. The method by which the final incremental cost will be determined and agreed has been outlined earlier in this annex.

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[1] - A site of 1,900 kWh/m2/year is generally qualified as sufficient for solar thermal technology (IEA, 2003). The data for solar insolation are derived by weighted linear interpolation from two measurement sites at Giza (2,110 kWh/m2/year) and Asyut (2,752 kWh/m2/year).

[2] - The natural gas pipeline crosses the site allocated for the plant in the northern part of the site.

[3] - The river Nile is located a on average 3 km to the west of the site. There is also groundwater available onsite. However, the quality of the groundwater needs to be determined.

[4] - The electricity will be fed into a 220 kV transmission line, which is located on the south-western boundary of the future plant site.

Additional GEF Annex 4: STAP Roster Technical Review and Project Team's Response
ARAB REPUBLIC OF EGYPT: 2G-SOLAR THERMAL (GEF)

Independent Technical Review

Reviewer: Mr. Pascal DeLaquil
President
Clean Energy Commercialization, LLC
Annapolis, MD - USA

1. Introduction

This project will assist the Government of Egypt, through its relevant agencies the Egyptian Electricity Holding Company (EEHC) and New and Renewable Energy Authority (NREA), to procure and benefit from a hybrid solar thermal power plant through an Engineer Procure and Construct (EPC) contract with a 5-year operation and maintenance (O&M) contract. A similar project was proposed in early 2002 using an independent power producer approach. However, the Government of Egypt changed its policy on foreign currency exposure related to private sector investment projects, and this caused private interest in infrastructure projects (in general) to evaporate. Therefore, based on a request from the Government, the project's concept was changed to a publicly financed approach.

Selection of the EPC/O&M contractor will be through an international bidding process, and details of the selected plant design are expected to vary slightly, but based on the conceptual design study by Fichtner Solar, the project is expected to comprise an Integrated Solar Combined Cycle (ISCC) plant configuration with a total capacity of about 151 MW and a solar thermal component of about 30 MW. On an annual basis, the solar field will contribute about 6.6% of the total energy produced by the plant. The EPC/O&M contractors will be able to optimize their design through choice of proven solar trough technologies, turbine generator equipment, and degree of local content, as long as the proposed design meets the performance specifications from the Government of Egypt.

2. GEF Context

The proposed project addresses GEF Operational Program 7 (OP7): reducing the long-term cost of low greenhouse gas-emitting technologies. OP7 aims to accelerate market penetration of several large-scale backstop technologies that are constrained by high capital costs and high commercial risks. The strategy is to identify projects that address national priorities and then finance the incremental costs of investments, capacity building and other activities that reduce market barriers and perceived risks by investors.

Based on the technical success of the 354 MW of solar thermal power plants still operating in California after more than 15 years, this technology can be considered an important large-scale non-carbon emitting backstop technology. Many of these plants currently operate at solar outputs that exceed their initial design specifications. However, current costs for this technology are high, and significant cost reductions for this technology can only begin to occur with the implementation of new projects. The proposed project is one of four similar projects demonstration (the others being in India, Mexico and Morocco) which have been sponsored by GEF as part its program to accelerate cost reduction and commercial adoption of large-scale non-carbon emitting generation technologies.

3. Key Issues

3.1 Project Approach

The switch to from a private sector to a public sector financing approach has specific advantages and disadvantages. The key disadvantage is that it may not be sustainability over the long-term because of changing government policy and the public sector's limited access to capital. However, in the near-term, the proposed EPC/O&M contract approach for this project preserves many of the important features of the private sector approach. Namely, the choice of technology and its associated risks will be borne by the contractor during construction and the initial five year operating period, and that entity will be in the best position to manage those risks. Second, the contract will contain appropriate incentives for maximizing the utilization of the solar field over the long term. Third, the contractor and key suppliers will be positioned to capture of technology and organizational learning effects that are essential to achieving long-term cost reductions.

The fact that the main activities of NREA are evolving from research and development to production and sales of electricity from renewable sources is a potentially powerful, but risky development. It provides a strong governmental drive to realize the social and environmental benefits of renewables (as long as the policy remains strong), but it also means that significantly more capacity building will be required in support of this project.

Specifically, it is stated that this project will benefit from a study that is about to be commissioned under a GEF preparatory grant to review institutional options for NREA in support of wind projects. The aim is for the study to identify an action plan that can be included in the implementation of the solar-thermal project. What is the timing of this study in relation to the project? Will the results be available in time to impact this project?

Regarding consulting services for project management during the EPC/O&M contract period, the Project Brief reads as if the contractor will be responsible for project management rather than being tasked to support the project implementation unit (PIU) within NREA in their role as the project manager and implementing agency. For effective capacity building, the PIU should lead the project management team, and while the contractor may perform all the project management activities, PIU members will need to be involved both for training purposes and to be able to recommend documents for approval to NREA and EEHC management.

This would seem appropriate given that the Project Document states (on Page 10) that NREA has gained significant experience in designing and implementing wind energy projects with international loan and grant financing. However, ISCC plants are significantly more complex than wind farms, and having the project management and support contractor on board before the start of implementation is critical.

Another important project feature is the decision to include an incentive/penalty structure in the O&M contract that will act to maximize the solar output, and to ensure the continuation of the incentive structure in the PPA contract between NREA and EEHC. This will help achieve the GEF program goal by promoting an effectively operated demonstration and ensuring sufficient learning experience within the solar thermal industry.

A single contract encompassing the ISCC plant is the proper basis for procurement. Use of the World Bank Procurement Guidelines and the Bank's standard two-stage bidding procedures should ensure that a reputable contractor is selected in an open and transparent manner.

This reviewer agrees that a public financing of the first solar thermal project can be done at lower cost and with a greater degree of certainty, since the private sector would demand a premium for assuming both the

technical and financial risks of the project. In the proposed public sector approach, the contractor continues to assume the technical risks, but NREA and the Government of Egypt are assuming the financial project risks.

The institutional and implementation arrangement for the project is clear from the level of the NREA and below. However, above the NREA, it only states that the project will be overseen by MEE. This reviewer believes that a Project Steering Committee (PSC) is needed to ensure that the broader project objectives are met, especially those dealing with capacity building, replication, information dissemination and public awareness. The PSC should have members from other interested government ministries in addition to MEE, the GEF and the IFIs providing loans to the project. In addition, an interested NGO should be invited onto the PSC.

3.2 Scientific and Technical Soundness

Solar thermal power plants that raise steam to generate power have been successfully operating for over 15 years. The basic concept of the ISCC (integrating a solar thermal steam generating field with a natural gas combined cycle power plant) is sound and has been extensively studied. While such a project has yet to be implemented, a project following this concept should be completely feasible, as the technical basis for such an integrated system is quite straightforward.

Details of the technical and economic effectiveness of the power plant will depend on the design and equipment choices of the selected bidder. Therefore, this review is based on the conceptual design identified in the Project Brief, and it seeks to identify the most important technical issues that will to be addressed during the implementation of the project.

The size of the solar thermal field at about 30 MW is sufficiently large to provide relevant operating experience and contribute to the re-establishment of manufacturing capacity for critical solar field components that will help lead to lower costs in the future.

The project document states that "two types of solar parabolic trough designs are available: Euro-trough and LS-3." In fact, other potential designs do exist. Does the project intend to limit bidders to these two types of trough designs because they are more technically proven? Some experts believe that the LS-2 collector is a more reliable design than the LS-3 collector. Will that design be allowed?

The project document correctly states the need for proven technology, and the intention to pre-qualify all bidders. It is therefore recommended that a list of acceptable solar trough designs be developed and reviewed with potential bidders during the pre-qualification process. In the prequalification discussions, the project should be open to other solar trough designs, provided that the potential bidder is able to demonstrate an acceptable level of development.

Page 9 states that "To enable both existing types to compete for the project, the physical size of the solar field will be scaled to fit the requirements of both designs corresponding to a size of 1,000 x 1,125 meters." This is unclear. I believe that what is meant is that the physical area for the solar field will be fixed at 1,000 x 1,125 meters, and the bidders will be allowed to optimize the output of their solar field within this space limitation. If this is the correct interpretation, then the text should be clarified.

This reviewer supports the decision to exclude thermal storage from the project design, as this technology has not been adequately developed for solar trough systems and because storage adds little value to a hybrid plant.

The Project Brief states that NREA is working together with Fichtner Solar to develop the performance specifications of the proposed plant. In addition to minimum qualifications for the solar trough technology, these performance specifications must ensure effective integration of the steam systems for the solar field

and the gas-fired combined cycle plant. The contractor selection process should also review plant designs to ensure that the plant will operate effectively in all modes. In particular, integration and control of the system should be flexible enough to allow the solar contribution to be consistently maximized, while under other circumstances allow power to be efficiently generated on natural gas only (e.g. during nighttime or if the solar field is not operational).

3.3 Adequacy of the Financing Mechanism

Page 13 states that a preliminary analysis of the impact of the project on NREA's financial position has been conducted and will be finalized during appraisal. What was the result of this preliminary analysis? Given the cost and performance of the conceptual design, and assuming the current financial prices for gas and electricity, does the project have a positive cash flow? The incremental costs analysis in the Project Brief is based on the economic prices for gas and electricity, and it does not provide any insight into whether this project approach is at all sustainable. A preliminary financial analysis would indicate whether and by how much the GOE may need to subsidize the NREA for operation of this plant.

Page 15 states: "Ensuring that the necessary controls are in place to monitor performance and ensuring prompt payment of the grant to the operators will be important considerations for the project's implementation plan." This implies that the GEF grant will be partitioned into an investment portion and an operating portion. This project feature is specified nowhere in the Project Brief that this reviewer could find. It should be properly introduced and clarified.

If a portion of the GEF grant is used to support the O&M contract during the first 5-year period, how will NREA be able to assume responsibility for O&M in the second 5-year period?

3.4 Identification of Global Environmental Benefits

The project's principal global environment objective is to contribute to improving the economic attractiveness of solar thermal technology globally. The project will create global learning effects that will lead to a reduction in costs for the technology over the long term. Globally, solar thermal power plants have the potential to provide a significant proportion of new electricity generating capacity in the next century on a non-carbon emitting basis if this project, and the others within the program, are successful in reducing the technology's costs and risks to a competitive level. Major markets exist for this technology in other high sunlight regions of the world.

3.5 Fit with GEF Goals

The project has a good fit with the GEF Operational Program #7. The plant itself will have lower CO2 emissions than a fossil-based plant of the same annual output. More importantly, it will help revitalize the solar thermal industry, and it will facilitate the technological and organizational learning that are critical to achieving long-term cost reductions.

3.6 Regional Context

The project is a good fit to Egypt's growing electricity demand, its growing commitment to renewable energy power project development, its excellent solar resource and its current availability of natural gas.

3.7 Replicability

This project, and its companions in Mexico, India and Morocco, is not likely to result in immediate cost-competitiveness for solar thermal power plants. The study Cost Reduction Study for Solar Thermal Power Plants, Enermodal Engineering, May 1999 commissioned in collaboration with the GEF Secretariat to determine the viability of long term cost reductions for solar thermal technology concluded that a phased approach should be adopted. These four projects represent the first of three phases, and they will provide an initial opportunity for cost reduction. In the assessment of this reviewer, the targets for cost reduction of solar electricity in the range of 10-11 US¢/kWh and a capital cost of solar fields of about $2,000/kW by 2010 are quite achievable. Meeting these targets would create very important opportunities for replication of this project, not only in Egypt, but also throughout the Mediterranean Region, South Asia, and other parts of the world with similar climates. The need for future GEF buydown will most strongly depend on the cost of conventional power and the valuation (if any) of environmental externalities.

3.8 Sustainability

The public sector financing approach being proposed for this project will establish the contractual arrangements necessary for the first 10 years of plant operation. Beyond that period, a new PPA will be required, but given that the investment costs will have been written down, the marginal operating costs for the plant should be attractive. For potential follow-on projects, the project is not designed to address the government policies that distort the market prices for gas and electricity.

From the GEF perspective, the main sustainability issue will be to ensure that the plant is operated in a manner that maximizes the output from its solar field throughout the lifetime of the plant so as to maximize the technology learning and cost reduction benefits.

4. Secondary Issues

4.1 Linkages to Other Focal Areas

No comment.

4.2 Linkages to Other Programs

As already mentioned, this project has linkages to other similar projects in Mexico, India and Morocco, and it forms part of the GEF program on Greenhouse Gas Reduction.

4.3 Degree of Involvement of Stakeholders

According to the Project Brief, there is a high degree of involvement of the key government stakeholders, especially EEHC and NREA. Early engagement with potential developers is stated to be underway to ensure a willingness to submit bids. Given that the new financing approach will remove significant financial risks from the bidders, it can be expected that interest among potential developers will be high.

4.4 Capacity Building Aspects

The proposed project contains specific elements of capacity building that will involve EEHC and NREA staff. These are necessary and appropriate. In addition, successful implementation of the project will provide needed capacity building within the international solar thermal power plant manufacturing sector.

4.5 Innovativeness

No comment.

5. Conclusion

This reviewer's overall assessment is that the project is technically feasible, that the proposed approach to project development is sound, and that the project has significant long-term potential to meet GEF goals.

Issue and Bank Project Team Response	Reference in Project Brief
Project Approach	
The fact that the main activities of NREA are evolving from research and development to production and sales of electricity from renewable sources is a potentially powerful, but risky development. It provides a strong governmental drive to realize the social and environmental benefits of renewables (as long as the policy remains strong), but it also means that significantly more capacity building will be required in support of this project. Specifically, it is stated that this project will benefit from a study that is about to be commissioned under a GEF preparatory grant to review institutional options for NREA in support of wind projects. The aim is for the study to identify an action plan that can be included in the implementation of the solar-thermal project. What is the timing of this study in relation to the project? Will the results be available in time to impact this project? *Having NREA as an implementing agency for this complex project is a riskier proposition. However, NREA's further development as a producer of renewable energy sources is an important step in making concrete the Government's commitments to renewable energy.* *The institutional options study for NREA will be launched in the next six weeks, and its findings will be available to the project team by the end of 2004. These findings will be discussed with the Government and NREA during project Appraisal, and an Action Plan for the restructuring of NREA and ensuring its financial and operational viability will be agreed to and incorporated in the project design* *Additional information on timing and linkages with project design have been added to the project brief.*	Section B 3.1
Regarding consulting services for project management during the EPC/O&M contract period, the Project Brief reads as if the contractor will be responsible for project management rather than being tasked to support the project implementation unit (PIU) within NREA in their role as the project manager and implementing agency. For effective capacity building, the PIU should lead the project management team, and while the contractor may perform all the project management activities, PIU members will need to be involved both for training purposes and to be able to recommend documents for approval to NREA and EEHC management. This would seem appropriate given that the Project Document states (on Page 10) that NREA has gained significant experience in designing and implementing wind energy projects with international loan and grant financing. However, ISCC plants are significantly more complex than wind farms, and having the project management and support contractor on board before the start of implementation is critical. *The EPC/O&M contractor will have the overall responsibility for the construction of the plant and the subsequent O&M contract, for which project management of*	

construction-related activities are an implicit feature. However, it is the PIU that will take the lead in managing the project, and it will benefit from technical assistance financed by the project to be provided by a consultant during the construction period. The consultant will provide assistance with activities such as reviewing the detailed designs and specifications as well as the drafting and negotiation of the PPA. During the construction but mainly in the O&M period, close coordination between the EPC contractor and the PIU will be essential to ensure knowledge from the EPC contractor is transferred to NREA's staff specially with regards to the plant's operation, so that NREA can take over plant's management after the 5 year O&M contract expires. This is important given NREA's lack of experience in managing and operating complex projects, such as an ISCC (NREA has gained very relevant experience managing wind farms). *Distinction of roles and responsibilities concerning project management have been clarified in the Project Brief.* The institutional and implementation arrangement for the project is clear from the level of the NREA and below. However, above the NREA, it only states that the project will be overseen by MEE. This reviewer believes that a Project Steering Committee (PSC) is needed to ensure that the broader project objectives are met, especially those dealing with capacity building, replication, information dissemination and public awareness. The PSC should have members from other interested government ministries in addition to MEE, the GEF and the IFIs providing loans to the project. In addition, an interested NGO should be invited onto the PSC. *The project team agrees and the suggestion is reflected in the brief. The PSC will be discussed with the government during up-coming missions and will reach a final agreement regarding its composition and function during project Appraisal.* *The Project Brief has been updated to reflect the above.*	Section C 4 Section C 4
Scientific and technical soundness	
The project document states that "two types of solar parabolic trough designs are available: Euro-trough and LS-3." In fact, other potential designs do exist. Does the project intend to limit bidders to these two types of trough designs because they are more technically proven? Some experts believe that the LS-2 collector is a more reliable design than the LS-3 collector. Will that design be allowed? *The bidding documents will be open and bidders will be free to choose the design that best suits the project requirements. The bidding documents will specify the values of the technical parameters to be within a certain range from the ones of the baseline design. Bidders will be requested to provide their own design within the specified range in order to best fit the bid evaluation criteria.* *The project brief has been amended to reflect that bidding will be open all parabolic trough designs available in the market.* The project document correctly states the need for proven technology, and the	Section D 1

intention to pre-qualify all bidders. It is therefore recommended that a list of acceptable solar trough designs be developed and reviewed with potential bidders during the pre-qualification process. In the prequalification discussions, the project should be open to other solar trough designs, provided that the potential bidder is able to demonstrate an acceptable level of development. *The project team agrees with the suggestion and will raise the issue with NREA for inclusion in the pre-qualification process currently under way.* Page 9 states that "To enable both existing types to compete for the project, the physical size of the solar field will be scaled to fit the requirements of both designs corresponding to a size of 1,000 x 1,125 meters." This is unclear. I believe that what is meant is that the physical area for the solar field will be fixed at 1,000 x 1,125 meters, and the bidders will be allowed to optimize the output of their solar field within this space limitation. If this is the correct interpretation, then the text should be clarified. *The technical specifications have estimated the requirement of a physical area corresponding to 1,000 x 1,225, thus allowing bidders to have an open choice when it comes to parabolic trough designs, which vary slightly in size.* *The statement in the Project Brief has been clarified to reflect the above.*	Section D 1
The Project Brief states that NREA is working together with Fichtner Solar to develop the performance specifications of the proposed plant. In addition to minimum qualifications for the solar trough technology, these performance specifications must ensure effective integration of the steam systems for the solar field and the gas-fired combined cycle plant. The contractor selection process should also review plant designs to ensure that the plant will operate effectively in all modes. In particular, integration and control of the system should be flexible enough to allow the solar contribution to be consistently maximized, while under other circumstances allow power to be efficiently generated on natural gas only (e.g., during nighttime or if the solar field is not operational). *The project team agrees, these performance specifications have been added to the project brief.*	Section E 3
Adequacy of the Financing Mechanism	
Page 13 states that a preliminary analysis of the impact of the project on NREA's financial position has been conducted and will be finalized during appraisal. What was the result of this preliminary analysis? Given the cost and performance of the conceptual design, and assuming the current financial prices for gas and electricity, does the project have a positive cash flow? The incremental costs analysis in the Project Brief is based on the economic prices for gas and electricity, and it does not provide any insight into whether this project approach is at all sustainable. A preliminary financial analysis would indicate whether and by how much the GOE may need to subsidize the NREA for operation of this plant.	

It is too early to say what NREA's future financial performance will be given that the analysis is not yet finalized and the financing arrangements are not yet in place. To date NREA manages to cover its operating expenses due to the large grant components in the financing of its wind farm projects and some government assistance with debt servicing. For the proposed project, the PPA to be put in place between NREA and EEHC will need to ensure cost recovery through the negotiated electricity tariff. If a tariff that cant ensure cost recovery is not agreed upon, mechanisms will have to be put in place to ensure that the agency receives appropriate subsidies from the government to recover its costs. In addition, the Government of Egypt is currently reviewing how NREA could benefit from some share of increased revenue from increased gas export sales attributable to the reduced domestic gas consumption as a result of the renewable energy projects. Page 15 states: "Ensuring that the necessary controls are in place to monitor performance and ensuring prompt payment of the grant to the operators will be important considerations for the project's implementation plan." This implies that the GEF grant will be partitioned into an investment portion and an operating portion. This project feature is specified nowhere in the Project Brief that this reviewer could find. It should be properly introduced and clarified. *The project team agrees, the Project Brief has been modified to reflect the comments provided above.* If a portion of the GEF grant is used to support the O&M contract during the first 5-year period, how will NREA be able to assume responsibility for O&M in the second 5-year period? *This issue will be discussed with the government during Appraisal. Most likely the PPA will include a clause that provides for tariff adjustments to ensure cost recovery for NREA. Alternatively, targeted government subsidies to finance O&M for the plant may be put in place.*	Section E 4
Replicability	
This project, and its companions in Mexico, India and Morocco, is not likely to result in immediate cost-competitiveness for solar thermal power plants. The study Cost Reduction Study for Solar Thermal Power Plants, Enermodal Engineering, May 1999 commissioned in collaboration with the GEF Secretariat to determine the viability of long term cost reductions for solar thermal technology concluded that a phased approach should be adopted. These four projects represent the first of three phases, and they will provide an initial opportunity for cost reduction. In the assessment of this reviewer, the targets for cost reduction of solar electricity in the range of 10-11 US¢/kWh and a capital cost of solar fields of about $2,000/kW by 2010 are quite achievable. Meeting these targets would create very important opportunities for replication of this project, not only in Egypt, but also throughout the Mediterranean Region, South Asia, and other parts of the world with similar climates. The need for future GEF buydown will most strongly depend on the cost of conventional power and the valuation (if any) of environmental externalities.	

Agreed. The contribution of this project to the program is discussed.	
Sustainability	
The public sector financing approach being proposed for this project will establish the contractual arrangements necessary for the first 10 years of plant operation. Beyond that period, a new PPA will be required, but given that the investment costs will have been written down, the marginal operating costs for the plant should be attractive. For potential follow-on projects, the project is not designed to address the government policies that distort the market prices for gas and electricity. *Agreed. The project does not directly address market distortions due to electricity and gas pricing. However, the institutional options study for NREA which aims at a financially and operationally viable renewable entity will highlight the issues to the government and make some proposals to address them. In addition, the government is currently working towards identifying and implementing a comprehensive regulatory framework for the energy sector (including renewables), for which the Bank may be involved through a grant from the Public-Private Infrastructure Advisory Facility (PPIAF). Thirdly, the government realizes that the electricity tariff policies are not sustainable due to the significant financial losses that EEHC is currently incurring, in part due to the devaluation of the Egyptian pound.* *The project brief has been amended to make the above points more clear.* From the GEF perspective, the main sustainability issue will be to ensure that the plant is operated in a manner that maximizes the output from its solar field throughout the lifetime of the plant so as to maximize the technology learning and cost reduction benefits. *Agreed. Initially this will be ensured through clauses in the O&M contract. Discussions are currently being held on incentives to be put in place for NREA to ensure the maximized output from the solar field for the period that goes beyond the O&M contract.*	Section F 1