Document of
The World Bank

Report No: ICR2173

IMPLEMENTATION COMPLETION AND RESULTS REPORT
(TF-91289)

ON A

GRANT

IN THE AMOUNT OF US$ 49.80 MILLION

TO THE

ARAB REPUBLIC OF EGYPT

FOR THE

KUREIMAT SOLAR THERMAL HYBRID PROJECT

April 30, 2012

Sustainable Development Department
Energy Unit
Middle East and North Africa

CURRENCY EQUIVALENTS

(Exchange Rate Effective April 26, 2012)

Currency Unit
LE – Egyptian Pounds 1.00 = US$ [0.165]
US$ 1.00 = LE – Egyptian Pounds [6.04]

FISCAL YEAR
July 1- June 30

ABBREVIATIONS AND ACRONYMS

BOO	Build Own Operate
BOOT	Build Own Operate and Transfer
BOT	Build Own Transfer
CAA	Competent Administrative Authority
CAO	Central Auditing Organization
CAS	Country Assistance Strategy
CC	Combined Cycle
CCGT	Combined Cycle Gas Turbine
COD	Commercial Operation Date
CSP	Concentrating Solar Power
CTF	Clean Technology Fund
DCS	Distributed Control System
DNI	Direct Normal Irradiation
DOH	Days on Hand
DSCR	Debt-Service Coverage Ratio
EEAA	Egyptian Environmental Affairs Agency
EEHC	Egyptian Electricity Holding Company
EETC	Egyptian Electricity Transmission Company
EHS	Environment, Health and Safety
EIB	European Investment Bank
EMP	Environmental Monitoring Plan
ENP	European Neighborhood Policy
EPC	Engineer, Procure and Construct
ESIA	Environment and Social Impact Assessment
ESMP	Environmental and Social Management Plan
FJP	Freedom Justice Party
FM	Financial Management
FMS	Financial Management System
FSC	Field Supervisory Control
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GoE	Government of Egypt
GWh	Gigawatt Hour
HRSG	Heat Recovery steam Generator
HTF	Heat Transfer Fluid
I&C	Instrumentation and Control
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
IPP	Independent Power Producer
IRR	Internal Rate of Return
ISA	International Standards on Auditing
ISCC	Integrated Solar Combined Cycle
ISDS	Integrated Safeguards Data Sheet
JBIC	Japan Bank for International Cooperation
kWh	Kilowatt hour
LEC	Levelized Electricity Costs
MEE	Ministry of Electricity and Energy
MJ/s	Mega joule Per Second
MOEE	Ministry of Energy & Electricity
MTU	Mobile Test Unit
NGO	Non-governmental Organizations
NPV	Net Present Value
NREA	New and Renewable Energy Agency
O&M	Operation and Maintenance
OCI	Orascom Constructions Industries
PDO	Project Development Objective
PIE	Project Implementation Entity
PMU	Project Management Unit
PPA	Power Purchase Agreement
PPF	Project Preparation Facility
PPP	Public Private Partnership
Pt	Piasters (LE 0.01)
SBD	Standard Bidding Documents
SFR	Self-Financing Ratio
STAP	Scientific and Technical Advisory Panel
Tcf	Trillion cubic feet
TOR	Terms of Reference
UAS	Unified Accounting System
WA	Withdrawal Application

Vice President:	Inger Anderson
Country Director:	A. David Craig
Sector Director:	Junaid Ahmad Kamal
Sector Manager:	Patricia Veevers-Carter
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ICR Team Leader:	Fowzia Hassan

Egypt, Arab Republic Of
KUREIMAT SOLAR THERMAL HYBRID PROJECT

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DATA SHEET

A. Basic Information

Country:	Egypt, Arab Republic of	Project Name:	KUREIMAT SOLAR THERMAL HYBRID PROJECT
Project ID:	P050567	L/C/TF Number(s):	TF-91289
ICR Date:	04/26/2012	ICR Type:	Core ICR
Lending Instrument:	SIL	Borrower:	GOVT. OF EGYPT
Original Total Commitment:	USD 49.80M	Disbursed Amount:	USD 49.80M
Revised Amount:	USD 49.80M		
Environmental Category: B		**Global Focal Area: C**	
Implementing Agencies: New and Renewable Energy Agency (NREA)			
Cofinanciers and Other External Partners:			

B. Key Dates

Process	Date	Process	Original Date	Revised / Actual Date(s)
Concept Review:	10/01/1997	Effectiveness:	12/16/2007	12/16/2007
Appraisal:	10/30/2006	Restructuring(s):		
Approval:	12/11/2007	Mid-term Review:		
		Closing:	10/31/2011	10/31/2011

C. Ratings Summary

C.1 Performance Rating by ICR

Outcomes:	Satisfactory
Risk to Global Environment Outcome	Moderate
Bank Performance:	Satisfactory
Borrower Performance:	Satisfactory

C.2 Detailed Ratings of Bank and Borrower Performance

Bank	Ratings	Borrower	Ratings
Quality at Entry:	Moderately Satisfactory	Government:	Satisfactory
Quality of Supervision:	Satisfactory	Implementing Agency/Agencies:	Moderately Satisfactory
Overall Bank Performance:	Satisfactory	**Overall Borrower Performance:**	Satisfactory

C.3 Quality at Entry and Implementation Performance Indicators			
Implementation Performance	**Indicators**	**QAG Assessments (if any)**	**Rating**
Potential Problem Project at any time (Yes/No):	No	Quality at Entry (QEA):	None
Problem Project at any time (Yes/No):	No	Quality of Supervision (QSA):	None
GEO rating before Closing/Inactive status	Satisfactory		

D. Sector and Theme Codes

	Original	Actual
Sector Code (as % of total Bank financing)		
Renewable energy	100	100
Theme Code (as % of total Bank financing)		
Climate change	100	100

E. Bank Staff

Positions	At ICR	At Approval
Vice President:	Inger Andersen	Daniela Gressani
Country Director:	A. David Craig	Emmanuel Mbi
Sector Manager:	Patricia Veevers-Carter	Jonathan D. Walters
Project Team Leader:	Chandrasekar Govindarajalu	Anna M. Bjerde
ICR Team Leader:	Fowzia Hassan	
ICR Primary Author:	Fowzia Hassan	

F. Results Framework Analysis

Global Environment Objectives (GEO) and Key Indicators(as approved)

The objective of the project is to contribute to an increase in the share of renewable energy in the Egyptian generation mix thereby contributing to the Governments aim of diversifying electric power production.

Revised Global Environment Objectives (as approved by original approving authority) and Key Indicators and reasons/justifications

(a) GEO Indicator(s)

Indicator	Baseline Value	Original Target Values (from approval documents)	Formally Revised Target Values	Actual Value Achieved at Completion or Target Years
Indicator 1 :	Increase the share of solar-based power in the Egyptian energy mix.			
Value (quantitative or Qualitative)	0	33.4 GWh		35.1 GWh (based on limited data)
Date achieved	12/11/2007	06/06/2011		10/31/2011
Comments (incl. % achievement)				
Indicator 2 :	Contribute to lower Co2 emissions in energy generation			
Value (quantitative or Qualitative)	0	20,000 tons of Co2/year		15,410-8710 tons of Co2/year
Date achieved	12/11/2007	06/06/2011		10/31/2011
Comments (incl. % achievement)				
Indicator 3 :	Support the development and demonstration of the operational viability of the ISCC configuration, and contribute to its replication			
Value (quantitative or Qualitative)	0	Monitored during construction and operation of the plant and will be reported on a quarterly basis. The dissemination to be determined based in lessons learned during implementation.		Monitored construction and operation of the plant, which was reported on a quarterly basis. The dissemination is still to be determined based on lessons learned during implementation via the ICR.
Date achieved	12/11/2007	05/18/2011		10/31/2011
Comments				

(incl. % achievement)				
Indicator 4 :	Solar output as percentage of total energy produced in the hybrid plant.			
Value (quantitative or Qualitative)	0	4%		4.1%
Date achieved	12/11/2007	05/18/2011		10/31/2011
Comments (incl. % achievement)				
Indicator 5 :	Total electricity generated from the ISCC plant (GWh/year)			
Value (quantitative or Qualitative)	0		852 GWh	860 GWh-842 GWh
Date achieved	12/11/2007		05/18/2011	10/31/2011
Comments (incl. % achievement)				

(b) Intermediate Outcome Indicator(s)

Indicator	Baseline Value	Original Target Values (from approval documents)	Formally Revised Target Values	Actual Value Achieved at Completion or Target Years
Indicator 1 :	Solar output completed and operational with a generation capacity of about 20MW.			
Value (quantitative or Qualitative)	0	Plant is operational		Plant has reached commercial operation.
Date achieved	12/11/2007	06/06/2011		10/31/2011
Comments (incl. % achievement)				

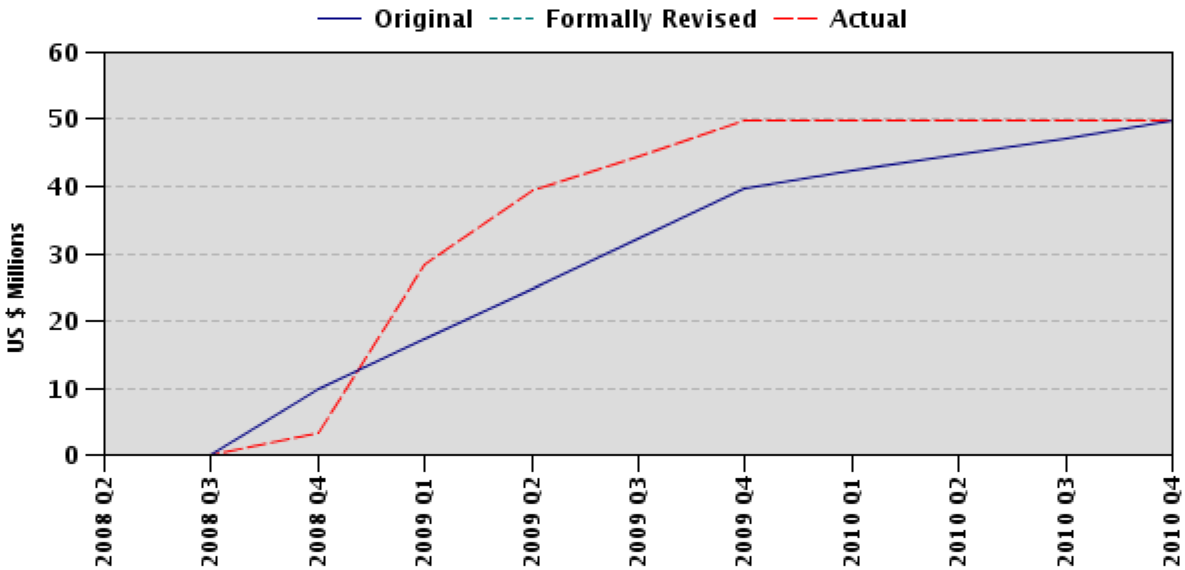
G. Ratings of Project Performance in ISRs

No.	Date ISR Archived	GEO	IP	Actual Disbursements (USD millions)
1	12/23/2007	Satisfactory	Satisfactory	0.00
2	06/13/2008	Satisfactory	Satisfactory	0.00
3	11/23/2008	Satisfactory	Satisfactory	35.52
4	06/02/2009	Satisfactory	Satisfactory	49.80
5	12/23/2009	Satisfactory	Satisfactory	49.80
6	06/30/2010	Satisfactory	Satisfactory	49.80
7	01/28/2011	Satisfactory	Satisfactory	49.80
8	06/25/2011	Satisfactory	Satisfactory	49.80

H. Restructuring (if any)

Not Applicable

I. Disbursement Profile



1. Project Context, Global Environment Objectives and Design

1.1 Context at Appraisal

Country Issues

1. Reliable electricity supply is critical for normal functioning of any modern economy. The power sector in Egypt plays a vital underpinning role in economic and social development, creating conditions for growth, job creation, and provision of social services. Egypt is a fully electrified country, as more than 99 percent of households are connected to the electricity grid. However, reliability of supply needs improvement and electricity infrastructure needs to be expanded as economic and population growth require continuing increase in electricity generation in particular, but also in the associated electricity transmission and distribution networks.

2. At the time of appraisal in 2006, Egypt was already well on its way to adopting a comprehensive economic reform program, a major objective for the new government that took office in 2004. An important driver for these economic reforms was the need to ensure adequate investments in infrastructure, while addressing rising fiscal deficits that rose from 3.9% in FY00 to 9.6% in FY05. The key measures included: (i) increasing retail utility prices, including increases in electricity and gas prices; (ii) reducing custom tariffs; (iii) reducing price controls and subsidies on basic products, including diesel-fuel; (iv) increasing interest in the potential for public-private partnerships (PPPs); and (v) strengthening and reorganizing the privatization program under the Ministry of Investment established in June 2004. GoE remained committed to providing public safety nets comprising of various subsidies, employment programs and cash transfers.

Sector Issues

3. As part of the GoE sector reforms, the electricity sector was unbundled in 2001 and was pursuing further reforms in market development, such as liberalization and greater regional integration. The Ministry of Electricity and Energy (MOEE) had ambitious plans to develop competition in the sector consistent with the implementation of further tariff increases and on-going improvement in the efficiency of the subsidiary companies. The aim was to gradually open the sector, starting with the generation segment. To facilitate this reform, a regulatory agency was established and an electricity law was under formulation. A higher energy council, called the supreme energy council, was established under the chairmanship of the Prime Minister and with members represented by the Ministers of electricity, petroleum, finance, planning and economic development. This council was to review energy alternatives, their economics as well as guide overall energy policy and planning.

4. The average increase in electricity demand in the country had been growing rapidly. Between 1997/98–2003/04 the increase averaged out to 7% and was expected to remain in the 6%–7% range over the next 10 years. Installed capacity of electric power was 20,452 MW in 2005/2006, of which 85% comprised thermal power (10% of which is

provided by the private sector through three Independent Power Producers, IPPs). The GoE's strategy was to continue to implement gas fired power plants, with a long-term view to increase the share of combined cycle gas turbine technology in the generation mix. In addition, the GoE was targeting meeting 3% of its electricity needs from renewable energy sources by 2010; and 20% by 2020.

5. At the time of appraisal, Egypt's natural gas played a key role in electricity production. Domestic gas consumption was dominated by the power sector at 65%, followed by the fertilizer industry, petrochemicals and other industrial sectors. The price of natural gas to industries as well as the power sector had been set at 21 Pt/m^3 (US$1/MMbtu), but an increase over a 3 year period was announced in May 2006 for the industrial sector which saw the gas price increase to US$2.65/MMbtu by the third year, the most current prices being US$3.0/MMbtu[1]. Proven reserves were estimated at 67.2 trillion cubic feet (Tcf), with an additional 120 Tcf identified as probable and possible reserves.[2] However, to meet projected domestic demand (industrial, commercial and residential) and export demand (via pipelines and liquefied natural gas terminals) over the next 20 years, it was estimated that about 15 Tcf would be required, which left Egypt with a proven Reserves/Production (R/P) ratio of over 80 years.

6. New & Renewable Energy Authority (NREA) was established in 1986 to act as the national focal point for expanding efforts to develop and introduce renewable energy technologies to Egypt on a commercial scale by implementing projects.

7. At the time of appraisal, NREA had installed 430 MW of wind-energy capacity and more than 1000 MW of projects were in the pipeline. The wind power plants were performing well with some of the highest capacity factors in the world in the range of over 40%. In February 2008, the Supreme Council of Energy of Egypt, headed by the Prime Minister, approved an ambitious plan targeting to have 20% of the total energy generation capacity from renewables by year 2020. At the time of this ICR, renewable energy accounts for about 13% of installed capacity in which wind accounts for less than 2% (522 MW) and the remaining is from large hydro projects. It is expected that total wind capacity will reach 7200 MW by 2020.

Figure .1: New & Renewable Energy Authority (NREA)

[1] Source: Personal communication Ministry of Petroleum, March 2012.

[2] Source: Ministry of Petroleum, July 2005.

8. In addition, the Kureimat Integrated Solar Combined Cycle plant (ISCC) with a capacity of a 140 MW (including 20 MW solar), recently reached commercial operation. The proposed Concentrated Solar Power (CSP) project with capacity of 100 MW in Kom Ombo city of Aswan Governorate, supported by the Clean Technology Fund (CTF) as part of the MENA regional CSP Investment Plan[3], is expected to become operational in 2015. NREA has significant experience in managing donor funded public projects. However, looking to the future of renewable energy development in Egypt, a dedicated project development company with a commercial orientation would be needed to be able to attract private investment and donor support. Morocco's experience in establishing the Moroccan Agency of Solar Energy (MASEN) is notable in this regard and offers a useful institutional model that could be considered in Egypt.

9. As an incentive for the development of renewable energy, the Government of Egypt (GoE) had established a financial mechanism called the Petroleum Fund, where producers of non-fossil fuel electricity receive 2 Pt/kWh (equivalent to 0.33 US cents/kWh). This mechanism accelerates development of renewable energy by sharing with developers the additional export revenues generated from fuel savings derived. Though the level of incentive under this fund is very small, this demonstrates GoE's positive intent in developing innovating financing mechanisms for supporting renewable energy development.

Rationale for Bank involvement

10. At the time this project was being prepared, the Bank had successfully re-engaged in a high-level partnership with the country's energy sector after a gap of some years. The project was also contributing to the goals, articulated in the CAS for Egypt, which included enhancing the provision of public goods through, inter alia, modernized infrastructure services to achieve higher growth. The GoE and the Bank were engaged in an intensive policy dialogue in this key sector, and a comprehensive program of financial and technical support had developed. Reliability and long-term involvement were the foundation of this relationship. In the new partnership and dialog, support for renewable energy was emerging as a key area for support by the Bank.

11. The project was designed to integrate conventional combined cycle gas turbines with solar thermal technology, with the strategic view of contributing towards introducing renewable energy in developing countries. As noted in the Bank's report to the Development Committee on the Clean Energy Investment Framework, incentives are needed to induce technological change suitable for a low carbon economy. The proposed project was to demonstrate how de-carbonizing of the power sector could be facilitated by the large-scale development of new energy production technologies.

[3] The MENA Regional CSP Investment plan targets about 1 GW of installed capacity in five participating countries – Morocco, Algeria, Tunisia, Egypt, and Jordan.

12. The Kureimat Solar Thermal Hybrid project was strategic for the achievement of the objectives of GEF's Operational Program 7 (OP7), which aimed to reduce, over the long-term, the costs of energy technologies with low greenhouse gas emissions, and which are currently not cost-competitive. The project was one of a series of similar projects supported by the GEF in Morocco as well as Mexico[4] which together contribute to the key higher level GEF objective of learning and dissemination of that learning. In this way, Egypt, GEF, and the Bank were jointly participating in what could be a very promising global experiment to encourage and accelerate global deployment of CSP through demonstration, learning and dissemination. Numerous papers and conceptual design studies supported this approach, and the sound operation of the parabolic trough Solar Electric Generation Systems(SEGS) plants in the Mojave Desert of California since the mid-1980's provided a firm foundation for this step (e.g., see Price, H., Lüpfert, E., Kearney, D., Zarza, E., Cohen, G., Gee, R., Mahoney, R., 2002. "*Advances in Parabolic Trough Solar Power Technology*" Journal of Solar Energy Engineering, Vol. 124, no. 2, pp. 109-125). The resulting fully dispatchable plants with GEF support were to be the first-of-a-kind demonstrating the ISCC design configuration.

1.2 Original Development Objectives (DO) and Global Environment Objectives (GEO) and Key Indicators

13. The objective of the project was to increase the share of solar-based electricity in the Egyptian energy generation mix thereby contributing to the Government's objective of diversifying electric power production.

14. The key performance indicators[5] for the development objectives of the project include:

a. Total electricity generated from solar sources (GWh/year).
b. Solar output as a percentage of total energy produced by the hybrid plant (%).
c. Total electricity generated from the ISCC power plant (GWh/year).

15. The global development objective of the project was to reduce greenhouse gas emissions from anthropogenic sources by increasing the market share of low greenhouse gas emitting technologies.

16. As indicated above, the key higher level objective of this project was to demonstrate the operational viability of hybrid solar thermal power generation technology and contribute to the replication of ISCC power generation technology in

[4] GEF Solar thermal portfolio initially comprised of projects in four countries, Egypt, Morocco, India and Mexico. The Morocco and Egypt projects have been commissioned while the India project was dropped subsequently and Mexico project is under implementation.

[5] At the time of project negotiation indicators were revised. Two financial indicators, Debt Service Coverage Ratio (DSCR) and Self Financing Ratio (SFR) were included and all five indicators are being monitored. See Annex 2.

Egypt and elsewhere through the learning effect provided by its construction and operation, and through economies of scale as use of the technology spreads. It was one of several similar projects in the world supported by GEF, and by other financing sources, as part of a global programmatic effort to accelerate cost reduction and commercial adoption of large-scale low greenhouse emitting generation technologies through demonstration, learning and dissemination. Secondarily, the project was to make a modest direct contribution to the reduction of greenhouse gas emissions.

17. To evaluate the performance of the project in achieving this global objective, the following indicators [6]were chosen:

- Indicator 1.Total electricity generated from solar sources (GWh/year).
  Target value: 33.4 GWh
- Indicator 2. Contribute to lower CO2 emissions in energy generation.
  Target value: 20,000 tons of CO2/year
- Indicator 3. Support the development and demonstration of the operational viability of the ISCC configuration and contribute to it replication.
  Target value: monitoring during construction and operations
- Indicator 4. Increase the share of solar-based power in the Egyptian energy mix.
  Target value: 4 %
- Indicator 5. Total electricity generated from the ISCC plant (GWh/year).
  Target value: 852 GWh

1.3 Revised GEO and Key Indicators, and reasons/justification

18. The development and global environment objectives as well and key performance indicators remained unchanged during project implementation.

1.4 Main Beneficiaries

19. The main beneficiaries of this project were the GoE and NREA, as well as the people of Egypt.

Job Creation

20. During construction most labor was hired locally and both the Combined Cycle Island as well as the Solar Island contributed to job creation. All road works and modifications of the main access roads, earth work of leveling the site to erect the steel structures, civil engineering, erection of the solar collectors and excavation works of the electrical building in the Solar Island, were all performed with local manpower. In operation, the plant employs 220 local people full time staff including highly skilled engineers as well as unskilled labor.

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[6] During project negotiations, the only additional indicator for measuring global objectives was emission reduction of CO2.

Social and Economic Inclusion

21. The plant generates enough electricity to serve about 500,000 households, which contributes to better living standards and economic growth.

22. The Project helped Egyptian companies move into the innovative CSP technology, as the lead contractor for the Solar Island was Orascom, an Egyptian company. Orascom was supported by German sub-contractor Flagsol. Under Orascom, a number of local firms provided materials and services for the construction of this plant, generating about 60% of the Solar Island's value. Most steel supply and erection of the steel structures that supported the parabolic trough were from national steel companies. It is estimated that for the Solar Island alone, approximately 3,200 tons of steel was supplied to the site. Mounting structures and tubes were fabricated by National Steel Fabrication Company (NSF), another Egyptian steel company. In addition, cables were supplied locally and local contractors took part in executing civil works. Solar collectors were assembled close to the project site by Orascom from pre-fabricated welded steel parts supplied by local companies (sub-suppliers). With this experience, Orascom and other Egyptian companies such as NSF have gained valuable experience in this new technology and are already participating in bids in other countries in the region.

23. In addition to the above, the environmental and social impact analyses and mitigation plans under the project also supported social and economic inclusion.

Accelerating Sustainable Growth

24. This solar thermal hybrid power plant operates as an integral part of the Egyptian power system contributing to electricity generation, a key input for sustainable economic growth. Dissemination of information on the learning from this demonstration project will contribute to future replication in other countries and also inform GEF's strategy for supporting advanced technologies. The approach adopted by the project is replicable within Egypt, regionally and globally.

Capacity Strengthening Framework

25. The project is particularly helpful in building institutional capacity in the area of CSP. As part of the Solar Island O&M contract, structured on the job training for NREA staff was included and is already underway in order to build experience and capacity at NREA.

1.5 Original Components (*as approved*)

26. The project was to finance the construction of an ISCC power plant, located at Kureimat, about 95 km south of Cairo, on the eastern side of the river Nile. This project, and other ISCC projects financed by GEF, were conceptualized in 1997 as Independent Power Producer (IPP) projects but were restructured as a public projects as there was limited private sector interest and GoE's policy change with respect to IPPs based on their experience. This policy change was the result of increased cost to the Government

from IPPs through the take or pay contracts mostly denominated in US$ in conjunction with the devaluation of the Egyptian pound. This caused a significant delay in moving from concept review to appraisal. Another cause of delay was the separation of bidding and construction of the Solar Island and the Combined Cycle Island portions at the strong preference of co-financier JBIC (now JICA). The Government, although recognizing the increased risks of this approach, decided to go in that direction eventually. In 2004, the Kureimat project received interest for co-financing from JBIC which eventually provided co-financing for the project.

27. The plant was to have a combined capacity of about 140 megawatt (MW) gross output, including 20 MW of solar capacity. Self consumption was expected to be 6.3 MW, leaving the net overall plant capacity of 133.7 MW. The total net energy produced by the plant was expected to be 852 GWh per year, which included the solar contribution of 29 GWh per year. This corresponded to a solar share of 4 % of the total annual energy produced by the plant operating at a full load.

28. The project was to be implemented through three components.

Component 1: The design, construction and initial operation of the proposed Integrated Solar Combined Cycle Plant include two sub-components:

(a) The solar portion of the power plant (US$111 million; *of which GEF financed US$49.8 million and NREA US$61.2 million*) included one contract for engineering, procurement, construction, testing, commissioning and two years operation and maintenance (O&M). The Solar Island was to consist of a parabolic trough solar field capable of generating 20 MW of solar heat at a temperature of 393°C, the related Solar Island Control System and the heat transfer fluid (HTF) system up to the HTF inlet and outlet flanges of the Solar Heat Exchanger(s).

(b) The capital cost of the combined cycle portion of the plant (US$201 million; *of which JICA*[7] *was to finance US$151.3 million and NREA US$49.7 million*) included the Engineer, Procure and Construct (EPC) contract for the Combined Cycle Island. The Combined Cycle Island was to consist of one gas turbine with ISO rating of about 74.4 MW, one heat recovery steam generator (HRSG), one steam turbine of about 76.5 MW (nominal), and solar heat exchanger(s) capable to absorb about 60 MW (thermal) solar heat plus all associated balance of plant equipment.

Component 2: **Capacity building to NREA through consulting services for construction management during the construction, testing and operation of the plant (US$6.36 million, including price contingency)**. The capacity building to focus on: (a) detailed engineering designs with special attention to the interface between the solar and CCGT parts; (b) supervising the construction and environmental aspects of the

[7] JBIC's ODA departments were merged with JICA in 2008.

power plant; (c) monitoring the commissioning and guarantee tests; (d) preparing the O&M contract for the CCGT part in terms satisfactory to the Bank. (e) providing assistance during the 2 year guarantee period as well as assisting NREA in monitoring and evaluation of the performance of the whole plant at least during the two years of the O&M period; and (f) providing training and transfer of know-how in ISCC plant operation, with particular emphasis to dispatching and integration into the power system so that NREA staff can successfully take over the power plant after the respective O&M contracts expire.

Component 3: **Environmental and Social Impact management component** financed by NREA (US$0.45 million, including price contingency). This component included the implementation of the Environmental Management Plan (EMP) which mitigated the potential environmental and social impacts associated with the construction and operation of the power plant.

Total project cost was estimated at US$327.57 million. The breakdown of the project components at appraisal is provided in table1.

Table 1: Project cost break down at appraisal

Items	**Equipment/ Work Cost**	**Others, Taxes & Contingencies**	**2-year O&M Costs**	**Total**
Component 1				
a) Solar Island	98.74	6.10	6.15	110.99
b) CC Island	184.69	16.28	8.80	209.77
Component 2				
Capacity Building	6.00	0.36	Not applicable	6.36
Component 3				
EMP	0.425	0.025	Not applicable	0.45
Total	**289.86**	**22.76**	**14.95**	**327.57**

Note: Amounts are expressed in US$ million

1.6 Revised Components

29. The above mentioned project components were not revised during implementation. However, the O&M for the Combined Cycle Island was not contracted out as originally planned. NREA was to seek the Bank's comments on the draft contract before requesting proposals. The RFP was submitted to the Bank and commented on, however during the course of bidding NREA indicated that the approach of hiring O&M consultants was being reconsidered due to high costs. Instead, an internal cadre drawn from experienced CCGT operators from Egyptian generation companies was created. The Bank emphasized the need to incorporate CSP operations expertise within the new approach.

1.7 Other significant changes

30. In the initial conceptual design, the Solar Island was projected to be the equivalent of 30MW capacity. However, after bidding (bidding was completed before Board approval) this was revised to a 20 MW at the request of the Government. Majority of financing for the Solar Island was provided by the Government as the GEF grant amount was not adequate. The capacity of the Combined Cycle Island, however, was not changed from its original projected size of about 140 MW gross.

31. During the course of implementation, both EPC contractors were delayed in meeting targets of commercial operation dates by almost one year (see Annex 5 for details). The main reason was the delay in disbursement of the second tranche of co-financing from the JICA[8], which led to suspension of the construction of the Combined Cycle Island for several months. As a consequence, this delay also impacted completion of work by the Solar Island EPC contractor due to the inability to carry out equipment acceptance tests without full function of the Combined Cycle Island. The political unrest leading to the revolution in Egypt in early 2011 also led to the contractors having to leave the country for several weeks, causing additional schedule delays. The cumulative effect of these delays led to completion and acceptance of the full ISCC plant about 9 months behind the original projected schedule (Original schedule was Oct 2010 and actual commercial operation was started in June 2011).

2. Key Factors Affecting Implementation and Outcomes

2.1 Project Preparation, Design and Quality at Entry

32. In the mid-1990's, the Global Environment Facility (GEF), through the World Bank, decided to allocate grants up to $50 million each to four so-called ISCC projects of this design in Egypt, Morocco, Mexico and India. In doing so, the GEF and World Bank saw an opportunity to encourage and accelerate global deployment of CSP. The proposed design of the plants was logically based on parabolic trough experience in California, combined cycle experience in Egypt and elsewhere, and careful evaluations and conceptual design studies on integration of the two technologies. Numerous papers and conceptual design studies supported this approach, and the excellent operation of the parabolic trough SEGS plants in the Mojave Desert of California since the mid-1980's provided a firm foundation for this step. The four plants were to be the first-of-a-kind demonstrating the ISCC design configuration and expected to contribute to global learning. This plan was thoroughly evaluated in an assessment[9] carried out by a team of

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[8] For the Combined Cycle Island contract, the first letter of credit was issued on 11 Dec. 2007 in the amount of JPY 9,885,000,000. The second and final letter of credit in the amount of JPY 7,545,000,000 on 26 May 2009 making total amount of JPY 17,430,000,000. (Contract price for foreign portion).

[9] "Assessment of the World Bank/GEF Strategy for the Market Development of Concentrating Solar Power" World Bank/GEF, 2006

independent CSP experts, and reviewed by a large experienced segment of the CSP community.

33. The first two countries to move projects forward for ISCC were Morocco and Egypt- the project in India was dropped and the Mexico project is under implementation. Based on the previous work in this area, the Egypt Kureimat project was planned to demonstrate the integration of a parabolic trough solar field with an otherwise conventional fossil-fired combined-cycle power plant, and support the objective to increase the share of solar-based electricity in the Egyptian energy generation mix, thereby contributing to the Government's objective of diversifying electric power production. Given the relatively modest solar contribution, however, the key higher level objective was learning through demonstration.

34. During the preparation of this project, the key technical challenge was rightly identified as the integration and performance of the Solar and Combined Cycle Islands. Further, in order to meet the requirements of the financing sources, the Government had to separate the procurement of the two portions, resulting into two contracts (one for Solar Island and one for the Combined Cycle Island). Accordingly, the integration and performance problems mainly due to these separate contractors was identified as a "high" risk and mitigation measures were incorporated as explained in para 35 and 36 below.

35. To mitigate construction risks the following was deemed necessary: (i) inclusion in the completed procurement process of data exchange between the two winning bidders; (ii) hiring of a construction management consulting firm for the supervision and integration of the Solar and Combined Cycle Islands; and (iii) hiring an experienced operator for O&M of the Combined Cycle Island with responsibility to coordinate operation with the O&M operator of the Solar Island.

36. To mitigate performance risks, incentive mechanisms were built in as below: (i) the heat production of the Solar Island was linked to the solar irradiation available and if not met, the Solar Island contractor would be penalized; (ii) The Combined Cycle Island was checked for electricity production as a function of solar heat supplied by the solar island.

37. The site was selected to comprise an uninhabited flat desert area, high intensity direct solar radiation which reaches 2400 kWh/m2/year, proximity to the extended unified power grid as well as natural gas pipelines, and proximity to water sources (primarily the Nile River). Four sites had been initially considered (Red Sea Coast, Sinai Peninsula, West Desert and Kureimat) and the Kureimat site was selected due to the minimal additional infrastructure required because of the proximity to the El Kuriemat Power Plant 750 MW Combined Cycle power plant. Although the impact of the emissions from proposed Kureimat ISCC plant on the air and water quality was studied adequately, the quality of the ambient air environment was deemed of appropriate quality for the operation of the plant itself. As per the ESIA "No industry, other than the existing power plant, is present near the site. Thus, the air in the background atmosphere is of appropriate quality".

2.2 Implementation

38. The implementation of the project by NREA was a logical choice given its institutional role in introducing and promoting renewable energy projects in Egypt. NREA received full support from the Ministry of Energy and Electricity during implementation of this project and also received support from the Egyptian Electricity Holding Company (EEHC) in building its capacity to develop and implement large projects.

39. NREA established a Project Implementation Entity (PIE) at the project site headed by a project manager, and staffed with specialists in technical, financial, procurement and environmental matters, some of whom were based at the NREA head quarters. The PIE was responsible for day to day management as well as compliance with the Environmental Management Plan (EMP). The PIE benefitted from the assistance of the construction management consultant, Fichtner, during implementation.

40. The organizational structure to implement the project is shown below. There were four contracts planned to undertake construction and supervision: (i) EPC contractor for the Solar Island (ORASCOM with Flagsol) with 2 year O&M; (ii) EPC contractor for the Power Combined Cycle Island (IBERDROLA); (iii) Construction and implementation supervision consultant (Fichtner) with a 2 year overlap during operations; and (iv) A 7 year O&M contract for the Combined Cycle Power Island, which eventually did not take place due to the high bids received.

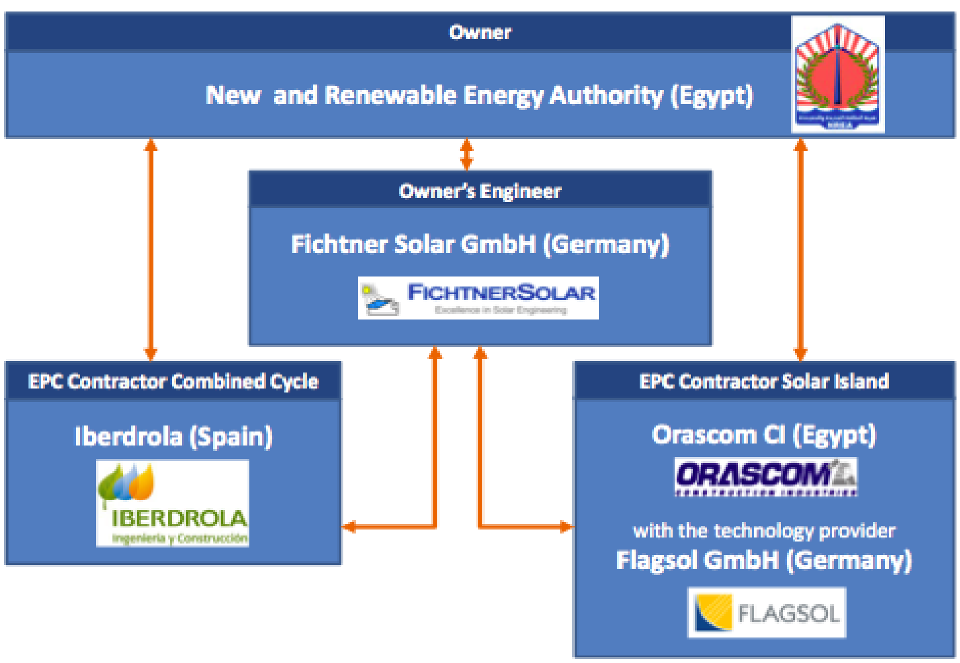

Figure 2: Organization of the Solar and Combined Cycle Islands

41. The split of EPC contractors for the Solar Island and Combined Cycle Island is illustrated in the figure 2 above. More detailed organizational structures were developed

for the construction and O&M phases. Imported components included mirrors, heat collector element (HCE), control system, heat transfer fluid (HTF), main/aux. pumps, heater, swivel joints, instrumentation, valves, commissioning equipment and quality control for collector assembly.

42. With hindsight, however, it is likely that the site selection missed an important factor – the corrosive nature of the ambient air environment at the Kureimat site. Given that there were no known cases of poor air quality impacting solar fields in the sizable capacity of projects under operation in the U.S since mid-eighties, this issue had no precedence among practitioners conducting feasibility studies or ESIAs. During construction, PIE identified problems together with the construction consultant and took corrective remedial action in association with the contractors. For example, it was found that that spring plate of the solar collectors were starting to corrode and upon examination, the quality of the material was found to be unsuitable. Consequently, the contractor replaced the spring plates. Similarly, analyses in 2009 revealed high concentrations of Sulfur in the environment that resulted in corrosion of chromatic bearings of torque tubes and Hydraulic pistons of the drive pylons. This issue was overcome by installing corrosion resistant pistons, use of special cleaners on the surface of the bearings followed by spraying a protective Zinc-Aluminum layer. Additionally, rubber bellows were mounted over the torque tube to protect the surface from severe environmental conditions. The contractor ORASCOM played a responsive and active role in resolving issues that arose during the construction (See Annex 5).

43. Quarterly progress reports were submitted regularly to the Bank by NREA. However, these reports focused mainly on construction progress but did not reflect the corrosion issue. Only the final completion report addressed this issue in detail.

44. The Combined Cycle Island O&M Contract was eventually dropped after bidding. According to NREA, this was due to high costs (at appraisal it was expected to be US$8.8 million and financed by NREA for a 7 year contract). Instead, an internal cadre of experienced CCGT operators was drawn from Egyptian generation companies and utilized, which was deemed acceptable by the Bank given the extensive operating experience for such plants in Egypt. According to NREA, the bid prices were three times more than expected at appraisal value and for this reason, NREA hired 45 qualified engineers from Egyptian generation companies to assist in plant operation and maintenance. While supportive of utilizing local skills to operate the plant, the Bank, however, emphasized the need to have CSP expertise on the Combined Cycle Island side as well.

45. As a result of the above change in contracting structure, NREA took on more risks than envisaged at the time of project design. In the initial design, the O&M contractor for the Combined Cycle Island was responsible for optimal utilization of the solar steam in the Combined Cycle Island as well as the O&M of the plant.

2.3 Monitoring and Evaluation (M&E) Design, Implementation and Utilization

46. *Commercial Operation*: As explained in section 1.7, the project was delayed by about 9 months from the projected commercial operation date (COD). The project duration was expected to cover an estimated three years of construction time and part of the two year O&M time with a view to capturing lessons learned in line with the project's development objectives and rationale for GEF support. However, given the construction delays and the ICR being written within a few months after start of commercial operations during which time maintenance issues were faced, it is able to capture only early O&M experience.

47. Following COD, the Solar Island shows excellent performance at or exceeding warranted output during the times when solar operation is possible. In this regard, the ability to fully operate the collectors and deliver warranted output appears to be high due to several reasons:

a) Overdesign of the heat recovery steam generator (HRSG) and solar heat exchangers (HEXs) for a total 150 MW capacity compared to the final implementation of 140 MW gross plant electricity capacity, which allows for high utilization of thermal output from the solar field. This is not a normal design feature, and apparently is the result of the split EPC contract and other factors such as reduction of Solar Island capacity from 30 MW to 20 MW. In discussions with the supplier, it proved to be cost-effective to retain the bottoming cycle equipment at the original capacities. The reduction of the solar capacity was necessary due to insufficient financing for the Solar Island at 30 MW.

b) Good design and construction practices of the Solar Island. Peak output at high solar conditions exceeds the nominal design capacity, and in monthly periods of continuous Solar Island operation the performance appears to exceed warranted levels by up to 5-10%. Since the Combined Cycle Island has been designed and constructed to utilize increased levels of Solar Island output, the plant output benefits by achieving a higher solar field capacity factor.

48. The full-power acceptance test of the Combined Cycle Island and the 30 day reliability test were completed during June 2011 and commercial operation started on June 28, 2011. Since that time, the Combined Cycle Island has been facing maintenance issues, causing significant periods in which the plant was either entirely off-line or in a gas turbine-only mode. However, the issues faced are largely attributable to limited experience in managing power plants and contractors at NREA as well as delayed response by the contractor and their vendors. The current combined cycle output appears, based on limited data, to be 5-10% under design capacity.

49. *Solar Field Integration*: The primary project goal of integrating a high temperature solar field with a conventional combined-cycle plant has been successfully achieved. However, maintenance issues related to operation of the Combined Cycle Island have limited normal operation of the complete system as designed.

50. Further, a current operating problem exists with feedwater entry into the heat transfer fluid (HTF) of the Solar Island, with leakage occurring at the tube sheets of the solar heat exchanger train, which is part of the Combined Cycle Island. Maintenance steps are being taken to correct this deficiency, specifically taking the leaking HEX train out of operation to examine the tube sheets and repair as necessary to stop leakage. Water in the HTF causes cavitation in the HTF pumps and, as the volume percentage of water increases above an acceptable limit, requires removal of the water for proper operation.

51. Technical Annex: More details on the design, construction and early O&M experience are provided in Annex 5.

2.4 Safeguard and Fiduciary Compliance

Environment Safeguards

52. The proposed project falls under the World Bank environmental category B classification due to the fact that the impacts are expected to be site-specific. The environmental impacts of this project during the construction and operation phases were properly identified in the environmental and social impact assessment (ESIA) report, and the mitigation measures and monitoring plan were detailed in the environmental management plan (EMP) contained therein. An environmental team member was assigned to the PIE to oversee safeguards implementation. All Bank supervision missions for this project after 2008 included an environmental team member to oversee safeguards implementation, and a specific section (and an annex) on safeguards was included in every mission Aide Memoire.

53. The evaluation and forecasting of the local environmental conditions was not adequately undertaken in the ESIA. As per the ESIA "No industry, other than the existing power plant, is present near the site. Thus, the air in the background atmosphere is of appropriate quality". With hindsight, however, it is clear that the site selection missed an important factor – the corrosive nature of the ambient air environment at the Kureimat site.

Progress during Project Implementation

54. During the early phases of implementation (2008), the environmental mitigation and monitoring measures were not adequately conducted nor thoroughly reported. For instance during the first missions, most of the staff on site were not aware of the existence of an EMP. As a result, a number of the environmental monitoring activities had not taken place as indicated in the EMP, such as noise and air quality monitoring; waste had not been properly managed; and no occupational, health, and safety plan had been prepared by the contractor. Had this performance continued, this would have constituted environmental, health and safety risks to workers, as well as reputational risk to the Bank.

55. After the Bank team raised this issue with the Chairman of NREA, the environmental performance was improved, and maintained a "Satisfactory" rating from

2009 all the way to project closure. During implementation the following steps were taken by NREA to comply to environmental safeguards:

- **Senior Management support for the implementation of the EMP.** The implementation of the safeguards considerably improved, once the Chairman of NREA, and Project PIE manager (who is also the vice chairman of NREA) became involved, and sent a strong message to the PIE to turn things around on environmental safeguards aspects.
- **Clarity of roles and responsibilities**. The PIE director has assigned the role of EMP implementation to a designated staff in the PIE. This ensured that proper accountability for the EMP implementation lies with a specific member of the PIE, and facilitated the communication on these issues with the PIE.
- **Training and capacity building**. The safeguards implementation improved once the PIE attention was drawn to the importance of ensuring that the EMP is properly disseminated to all relevant staff, including health and safety managers of the two main contractors on site, and to the site engineer. The training held by the Bank's safeguard team member in Cairo, which was attended by NREA and the PIE environmental staff, was very well received and set the stage for proper communication on safeguards issues.
- **Inclusion of EMP requirements in the construction contracts**. An important issue which should be ensured in future projects is to include the necessary mitigation measures and monitoring requirement, as stipulated in the EMP, in the construction contracts. This was not done in this project. Luckily, however, the two contractors on site were amenable to making the necessary modification to their operating procedures to ensure that the EMP requirements were met.
- **Proper reporting**. Quarterly reporting to the Bank on the EMP implementation has helped maintain a log on EMP implementation progress. Furthermore, bi-annual supervision missions on safeguards aspects helped in ensuring that any limitations in implementing the ESMP were corrected in a timely fashion.

Social Safeguards

56. The project was developed on a site already owned by NREA, close to the existing Kureimat gas-fired combined-cycle power plant owned and operated by EEHC. All construction-related activities were undertaken on this land and no land acquisition was needed. The proposed site had no existing residents or any economic activity. The site was several kilometers from the town of Kureimat, and a separate residential area was set aside for the employees of the existing power plant located about 2 kilometers from the project site. The residential complex developed for the project also included a kindergarten and a sports club. No labor camp was envisaged as the workers were recruited locally and commuted by bus on a daily basis. The project's only safeguard triggered was OP 4.01 (EA). Because of the rather remote location of the project, negative social development impacts were considered minimal. On the other hand the project has created considerable local employment, particularly during construction, approximately 2000 men/month. After construction the ISCC plant employs approximately 220 local personnel.

Procurement

57. Procurement for the proposed project was advanced during project preparation and had been carried out in accordance with the World Bank's "Guidelines: Procurement under IBRD Loans and IDA Credits" dated May 2004; and the provisions stipulated in the Legal Agreement. The Grant financed a single contract, for which the procurement process was completed in accordance to World Bank Procurement Guidelines. Procurement of non-bank financed contracts for other components of the power plant (the combined cycle component and consultant services) had been conducted using JICA's procurement procedures and Standard Bidding Documents (SBD), which were deemed satisfactory to the Bank.

58. The construction and operation of the ISCC power plant was to be implemented in four separate contracts: (a) the construction and 2 years O&M of the Solar Island (Main contractor is ORASCOM and the solar subcontractor is Flagsol (Germany); (b) the construction of the Combined Cycle Island (Main contractor is IBERDROLA); (c) the 7 years O&M of the Combined Cycle island portion (not contracted); and (d) a construction management consulting contract for the supervision and integration of the solar and Combined Cycle Islands (the firm is Fichtner (Germany).

Financial Management

59. The establishment and maintenance of the Financial Management (FM) arrangements were assigned to NREA's finance department which included sufficient FM staff. The recording and reporting of the project's transactions was done manually and on Excel sheets by NREA Foreign Exchange department. All of the IFRs were received on time, reviewed and found acceptable.

60. The project's FM arrangements were consistently found to be "Satisfactory" primarily due to the fact that NREA adopted the direct disbursement method throughout the entire life of the project. The audit reports were delivered on time, reviewed and found acceptable by the Bank. All of the audit reports were unqualified.

2.5 Post-completion Operation/Next Phase

[See Annex 5 for additional details]

61. *Learning and Knowledge Dissemination*: The project has already created greater awareness for CSP technology within Egypt as well as globally.

- The experience has been disseminated through (a) conferences and publications by NREA, its contractors as well as the World Bank and (b) Site visits of foreign delegations from a wide range of countries, donors, universities and other agencies. The Bank facilitated an Indian delegation visit to the plant in 2010 and a Chinese delegation has also expressed its interest to visit the plant in 2012.

- In view of the issues faced by the project and as this technology would be of major future interest, it is recommended that the performance of the plant is closely monitored utilizing same PDO indicators.

- It would be beneficial for the Bank to visit the project after another year of operations to best capture the lessons in O&M for future CSP development in Egypt and in the region.

- At the same time additional air quality assessment would need to be carried to understand the extent of the issues and sources of high sulfur content in the environment.

- The Bank will write a knowledge brief approximately one year after careful observation and disseminate the lessons learned to a much wider audience, including other stakeholder and academia in the region and globally.

62. *Operation and Maintenance*: Limited coordination and teamwork in the O&M operation is of concern. Operations would benefit from having set schedule for O&M meetings to discuss current problems and needs, such as the issue of water entry in the HTF oil. Further, proper O&M planning and implementation of the Solar Island would benefit from improved knowledge and forewarning of the operating condition of the Combined Cycle Island.

63. *Early signs of material* degradation in selected solar field components suggest that the considerable dust, morning dew, and air pollutants in the area together could contribute to the potential for long-term problems at the plant. The early need for replacement of solar field collector bearings and solar drive pistons due to abnormal surface corrosion after less than a year are examples of the air quality. Initial signs of small areas of abnormal corrosion on the protective mirror paint layers are also indicators of this concern that need to be examined further, and might lead to higher than anticipated mirror replacement rates. The quality of air was not adequately evaluated and forecasted within the site selection process. As per the ESIA "No industry, other than the existing power plant, is present near the site. Thus, the air in the background atmosphere is of appropriate quality". The project feasibility study, undertaken by experienced CSP consultants, also did not anticipate this issue of corrosive environment impacting the plant operations.

64. The Combined Cycle Island has been faced with maintenance issues since COD, causing significant periods in which the plant is either entirely off-line or in a gas turbine-only mode. The current understanding of the issues identifies the probable cause for under-capacity operation of the gas turbine during initial months as the plugged compressor inlet air filters, exacerbated by delayed shipment of replacements, leading to uneven flow and, non-uniform combustion of the inlet air. JICA, co-financier for the Combined Cycle Island is monitoring the issue and considers the O&M issues to be resolvable with help from other generating companies in Egypt. Although it is not envisaged in this project, JICA also provides post-completion support in its projects, in

case such a need arises. This is normally done through provision of JICA experts and engineers, residing in the host country/project site to resolve issues.

65. Water entry into the heat transfer fluid (HTF) of the Solar Island was identified in HEX No 2 and is currently being addressed, limiting the utilization of solar heat in the steam turbine even while the solar field remains fully operable (see also section 2. 3). However, given the oversized design of the HEX, HEX No. 1 alone is able to carry about 15 MW equivalent steam from the solar field.

66. The Government has taken the decision to transfer this asset to the Upper Egypt Generating Company as it is not in NREA's mandate to operate and maintain conventional power plants, such as CCGT, even if it is a hybrid with a renewable energy component. This is a welcome step given the extensive experience within the Upper Egypt generating company in operating combined cycle power plants. However, the process of asset transfer is likely to take several months.

Further implementation of CSP Technology:

67. Plans to implement the 100 MW Kom Ombo plant in Egypt, and considerable development activity in North Africa, e.g., Morocco, and South Africa will benefit from the experience at Kureimat. The capital cost of Kureimat was high at approximately about US$5000/kW, not including the Combined Cycle Island, making the technology five times more expensive than a CCGT plant and roughly three times more than the wind technology. However, little can be learned about economics of CSP from this experience given the small size of the solar field. But the ISCC plant brings useful lessons in the introduction of CSP technology through hybridization in developing countries by bringing overall costs in the range of 6-7 US cents/kWh by the virtue of a small solar complement and shared power block. While these facilities are expected to be stand-alone solar Rankine cycle plants, the contractual structure and solar field selection and O&M planning will benefit from the lessons learned in this facility.

3. Assessment of Outcomes

3.1 Relevance of Objectives, Design and Implementation

68. The project objectives and design are considered to be highly relevant to the current national priorities and the Bank assistance strategy.

Brief Technical Description-

69. The Integrated Solar Combined Cycle (ISCC) project consists of Combined Cycle Island (120 MW) and Solar Island (20 MW), the total gross power capacity of approximately 140 MW, as illustrated below.

70. The Solar Island consists of a parabolic trough solar field and the heat transfer fluid (HTF) system. The Contractor for the Solar Island (ORASCOM) guarantees the supply of solar heat to the solar heat exchangers as a function of solar conditions. The Combined Cycle Island consists of one gas turbine, one heat recovery steam generator (HRSG), one steam turbine, and solar heat exchangers plus all associated control and balance of plant equipment and installations. The generated electricity is output to the regional grid. The key technical data are given in the following table.

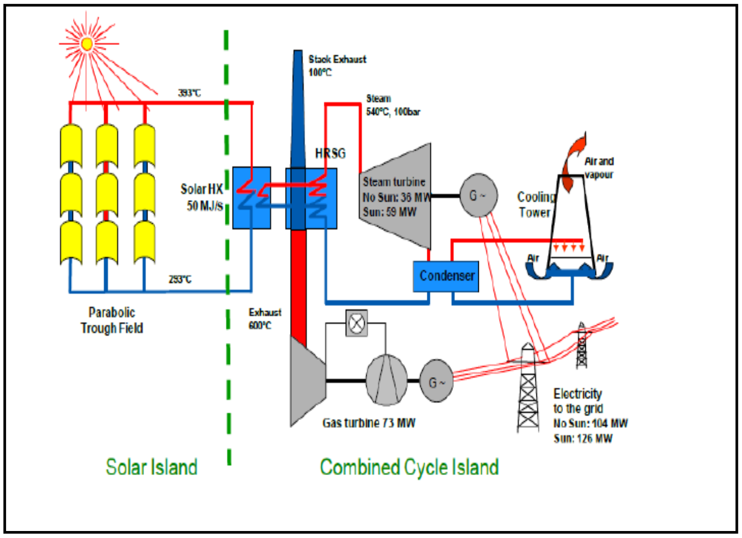

Figure 3: Technology Concept

Table 2: Key Technical Data

Key Technical Data	Unit	Value
Solar Field total Aperture Area	m²	130800
Number of Collectors	N°	160
Number of Collector Loops	N°	40
Design Irradiation	W/m²	700
Solar Field Design Thermal Power at Reference Conditions	MJ/s	50
Hot Leg HTF Temperature	°C	393
Cold Leg HTF Temperature	°C	293
Gas Turbine Generator Rated Power Output	MWe	74.4
Steam Turbine Generator Rated Power Output	MWe	59.5

Operation and Maintenance

71. The construction of the ISCC Kureimat power plant started in January 2008 and reached full commercial operation at the end of June 2011. Some delays during this period were experienced due to the revolution in Egypt and funding arrangements. Operation since that time has been below projected plant output for several reasons, largely connected with Combined Cycle Island issues. The basic concept of a solar field providing additional steam for the bottoming Steam Turbine cycle of a Combined Cycle plant (gas turbine cycle plus steam turbine cycle) via the HRSG has worked well. The solar field has also performed well, at or over design projections. The gas turbine and solar heat exchangers, however, have suffered continuing maintenance issues that are still requiring corrective action. The solar field equipment is showing corrosion of several key components due to an unexpected presence of Sulfuric acid particles in the local air environment.

72. The Kureimat ISCC plant's main contribution is to demonstrate a new technology with prospects for scale up through learning and dissemination (please see section 3.2 below). Furthermore, the ISCC plant is expected to contribute toward the ability of the Egypt's power system to support economic growth, entrepreneurship, job creation, and social development by providing reliable electricity supply. The program outlined in the Country Assistance Strategy (CAS) to support the government's reform agenda of "achieving growth with equity" is organized around three pillars: (i) facilitating private sector development; (ii) enhancing the provision of public services; and (iii) promoting equity. The project directly supports the pillar on enhancing the provision of public services, and contributes to the first pillar on private sector development by helping maintain reliable electricity supply to private sector activities. It also contributes to the third pillar, as Egypt is 99% electrified, and this project will contribute toward improving the reliability of the network. Thus, the project is fully consistent with the CAS

73. The project is also consistent with the priorities emerging as result of the political revolution, which require an enabling environment for economic growth, job creation, youth employment, transparency in governance, and public safety. The project supports these priorities by providing 220 jobs, mostly to young people and capacity building on the job for them. In addition, several local industries were involved in the construction of both plants, with 60% of the Solar Island's value being created locally. Reliable supply of electricity is a necessary condition for furthering these objectives.

74. The project objectives retain high overall relevance to the goals in Egypt to increase the solar share in electricity generation supplied to the national grid.

75. In addition the GoE is committed to sector reforms and is facilitating renewable energy development through specific policy interventions. The Supreme Energy Council in March 2010 announced key policy steps related to wind and CSP scale-up in the country, proposed under the new electricity law. These include:

- approval of the need to cover additional costs for renewable energy projects through tariffs,
- approval of zero customs duty on wind and CSP equipment,
- finalization of the land use policy for wind and CSP developers,
- acceptance of foreign currency denominated Power Purchase Agreements (PPA)s and confirmation of central bank guarantees for all Build Own Operate (BOO) projects,
- permitting support for developers with respect to environmental, social and defense permits.

3.2 Achievement of Development Objectives and Global Environmental Objectives

76. The key performance indicators[10] for the development objectives of the project included:

a. Total electricity generated from solar sources (GWh/year).
b. Solar output as a percentage of total energy produced by the hybrid plant (%).
c. Total electricity generated from the ISCC power plant (GWh/year).

77. The project achieved its development objective of increasing the share of solar based electricity generation (20MW) in Egypt and contributed to the Government's objective of diversifying electric power production. Although the contribution of this project to the total solar generation capacity in Egypt is small, it demonstrated a new technology with prospects for scale-up. Below are the details of PDO/GEOs achieved.

Table 3: PDO/GEO achieved

Project Outcome Indicators	Baseline	Target Values	Values Achieved
1. Total electricity generated from solar sources (GWh/year)	0	33.4 GWh	35.1 GWh (based on limited data)
2. Solar output as a percentage of total energy produced in the hybrid plant	0	4 %	4.1%
3. Total electricity generated from the ISCC plant (GWh/year)	0	852 GWh	860 GWh-842 GWh
4. Emissions reduced from use of solar fuel (tons of CO_2/year)	0	20,000 tons of CO_2/year	15,410-8,710 tons of CO_2/year
5. Debt service coverage ratio (DSCR).	0	1.1	0.5
6. Self finance ratio (SFR)	0	0.1	0.09

78. It is expected that the project will also meet its global development objective of reducing greenhouse gas emissions from anthropogenic sources by increasing the market share of low green house gas emitting technologies through dissemination of lessons learned from this project. The implementation of the Kureimat ISCC project has helped bring greater awareness of this technology in Egypt and the region. Beyond the region, there has also been keen global interest in this plant with south-south exchanges already taking place.

79. In part due to the experience gained in the implementation of this project, the Government is preparing its next CSP project at Kom Ombo, Upper Egypt at a scale of 100 MW. In particular, the localization prospects and the ability to develop a fully

[10] At the time of project negotiation, two financial indicators, Debt Service Coverage Ratio (DSCR) and Self Financing Ratio (SFR) were included. See Annex 3.

dispatachable renewable energy plant utilizing CSP technology is attractive to Egypt. This proposed project will also receive support under the MENA CSP Scale-up initiative.

80. The MENA CSP Scale-up Initiative is a $5.6 billion program (including $750 million of concessional funding from the Clean Technology Fund) led by the World Bank Group, working closely with the African Development Bank and other European, Arab, Islamic, and Japanese donors, to implement nine commercial-scale power plants (in Algeria, Egypt, Jordan, Morocco and Tunisia), and two EU-MENA interconnection projects. The NIF, KfW, the German Government, EIB, and AFD have been key partners in the development of the CSP Initiative. The overall objective is to help bring down the global costs of CSP technology, through economies of scale and learning effects from replication.

3.3 Efficiency

81. Based on the costs and benefits assumed in the Project Appraisal Document (PAD), the project was projected to generate a net present value of US$54 million and the EIRR of the project was 13%**.** The basis included a total installed cost of the plant of about $290 million based on bids awarded, wherein the cost of equipment excludes taxes and import duties (an estimated US$22.4 million). The present value of fuel, O&M costs and consumables amounted to $153 million over the 25-year lifetime. Also assumed were an economic cost of natural gas of US$2.52/MMbtu instead of the actual price charged to the power sector, and an average electricity tariff of US$0.07/kWh -- the price for electricity exports to Jordan.

82. As discussed in Annex 3, the cross-border electricity exchange price has changed significantly since the PAD was developed in 2007, now amounting to 11.18 US cents per kWh, or a 60% increase. Further, the EEHC now uses an economic cost of natural gas of US$4/MMbtu. Compared to the values, the actual generation for the first year of operation is 57% of that assumed in the PAD. Taking all these factors into account (electricity cost, natural gas cost; 1st year generation), the currently projected EIRR is 11.95% compared to the PAD value of 13.0%.

83. Financial Analysis: NREA has had a relatively intensive transition from being a research and development-focused entity to becoming a green electricity generating entity, given the realization of new projects and investments. Currently, the existing generation capacity is 522MW of wind and 140 MW of solar, with a pipe line of an additional 3190MWof future wind projects. A proposed CSP project with a capacity of 100 MW in Kom Ombo city as well as some Photovoltaic plants with total capacity of 20 MW are in the pipeline.

84. NREA's revenue from electricity sales has been increasing an average of 26% per year since 2004/2005 while OPEX/Revenues have decreased about 20% over the last three years. However, the entity has a loss-making profitability structure: the deficit in 2008/2009 was LE 118.8 million (USD22.0 million), which is funded by the government. According to preliminary information on financial status, the main reason for deficit is

intensive investment program and debt service. As of 2008/2009, the total long-term debt stock reached LE 5.02 billion (USD 913 million).

85. EEHC and NREA have been working to improve the financial structure of NREA, with the improvements positively affecting financial performance of the entity but far from ensuring self-cost coverage and profitability. In this regard, several options have been on the entity's agenda such as increasing current tariff of 13 Pt/kWh at the level EEHC sells power to end-users; increasing annual tariff escalation from 7.5% to 10%; and increasing the petroleum fund's income sharing rate of 0.02 Pt/kWh to higher levels or via another mechanism. From the performance monitoring point of view, two indicators have been agreed and targeted as proxies for financial soundness: Debt Service Coverage (a minimum of 1.1 required) and Self Finance (a minimum of 0.1 required). These ratios as of 2008/2009 period were: DSCR 0.5 (EBITDA [11] basis) and 1.2 (operating cash flow basis); and Self Finance Ratio 0.09 respectively[12].

86. ISCC System Efficiency: The operating efficiency of the ISCC system depends on the operation of the major components ¨the gas turbine cycle; steam turbine cycle; and solar field. There is limited full capacity operation and detailed data on the Combined Cycle Island systems to assess their performance, and it is highly recommended that these metrics be monitored for the next year. The initial operation of the Solar Island shows good performance, but this important subsystem should also be observed during the first year of normal operation.

3.4 Justification of Overall Outcome Rating

Rating: Satisfactory

87. The overarching objective of the World Bank/GEF grant to this project was to demonstrate the technical viability of an ISCC configuration in Egypt, and beyond. The cost and performance of the 20 MW-equivalent Solar Island are on target as proposed, and the early performance indications of the Solar Island are very strong. With appropriate O&M and proper operation of the Combined Cycle Island, the solar contribution will be an excellent demonstration of the concept. The design of the Combined Cycle Island is such that at design capacity operation, it is able to receive the full output of the Solar Island even at the highest solar conditions.

88. At this stage, the Kureimat Solar Island is functioning in an early operational stage. Since the Combined Cycle Island utilizes the steam generated by the solar field to increase its electrical output, design capacity operation of the Combined Cycle Island is imperative to take full advantage of the Solar Island. As of April 2012, the plant is in

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[11] Operating earnings before interest, taxes, depreciation and amortization expenses.

[12] The latest income statements and cash flow statements provided by NREA were for FY2008/2009.

integrated working condition, the Combined Cycle Island operation has been hindered by several significant O&M issues in the last several months (see Annex 5) that required immediate attention and resolution. With respect to the Solar Island, O&M requirements are expected to be greater than anticipated due to the corrosive nature of the local air environment, particularly related to sulfur content.

3.5 Overarching Themes, Other Outcomes and Impacts

(a) Poverty Impacts, Gender Aspects, and Social Development

See section 1.4

(b) Institutional Change/Strengthening

89. As noted earlier, the institutional development associated with this project was significant as it was the first CSP project in Egypt. The project design specifically includes formalized on-job training for staff during the contracted O&M period of two years for the Solar Island which will help build technical capacity in this area within the Government and support future CSP development in Egypt. Also, the project has led to strengthening of capacity in the Egyptian private sector and there are now companies and staff with skills in this area, not only in the design and implementation of CSP plants but also in local manufacturing of components.

(c) Other Unintended Outcomes and Impacts

90. At the time when this project was conceptualized and prepared, the Government and the Bank were not planning future CSP engagement and market momentum was slow globally. In fact, GEF through its support to the Kureimat project (as well as the other CSP Projects) helped keep global momentum in demonstrating CSP development at a time when there was slow down due to limited Government support in US and Europe. In wake of the revived global interest in CSP and availability of critical concessional support through the Clean Technology Fund (CTF) for CSP development in developing countries, the Bank is supporting a program on CSP scale-up in the region. Lessons from the Kureimat ISCC implementation experience informed the design of the MENA regional CSP Scale-up program.

91. Lessons related to the local manufacturing possibilities are particularly relevant for further CSP development in the region and have been captured in a regional study *"Middle East and North Africa (MENA) Region Assessment of Local Manufacturing Potential for Concentrated Solar Power (CSP) Projects"* World Bank, March 2011.

3.6 Summary of Findings of Beneficiary Survey and/or Stakeholder Workshops

This was a core ICR and no stakeholder workshops were carried out for this project.

4. Assessment of Risk to Development Outcome

Rating: Moderate

92. Normal full-capacity operation of the ISCC plant with a high availability factor will provide the basis for satisfaction of the GEO and key indicators of the project. The primary objective is to increase the share of solar-based electricity in the Egyptian grid through electricity generation by this hybrid solar-gas plant at projected levels at a reasonable cost.

93. The ISCC plant is still in the initial stages of commercial operation. Prolonged operation at full power has not yet been possible due to early maintenance issues, namely those associated with gas turbine air inlet filters and gas turbine combustor operation as well as solar heat exchanger tube sheet leakage. NREA has actively pursued solutions to these problems, while issues have been solved, the responsiveness of the contractors and their vendors has not been exemplary and the level of preventive as well as on-site maintenance could be improved.

94. The Solar Island is performing well. Integration of the Solar Island with the Combined Cycle Island appears to be functioning as designed, meeting the primary objective of the ISCC configuration. However, there might be longer-term problems linked to the potential of equipment degradation due to continuing corrosion issues associated with the sulfuric acid component in the local environment. True mitigation of this problem by NREA requires that steps be taken to improve the air quality in the region in conjunction with the provincial Government-but the evidence on air quality is not conclusive and needs to be studied further. More controlled, and more costly, mitigation steps will be to repair, refurbish or replace failures or severely degraded components of solar field components as necessary. Increased frequency of cleaning solar field mirror coating surfaces and components to strip away dirt and pollutants could also help mitigate the problem. Anti corrosion measure were proactively adopted by NREA with close cooperation of Solar Island contractors for components and are explained in greater detail in Annex 5.

95. Technically, the risk to achieving full power electricity generation and good performance in the short term is low to moderate. Mitigation of the current technology shortcomings can be corrected by equipment repair and maintenance.

96. The risk of not being able to maintain normal operation, once achieved, causes some concern. Mitigation requires improved O&M procedures in the short-term, and may be considerably more costly than projected in the medium to long-term due to the higher degradation of equipment caused by the corrosive air environment.

97. Steps must be taken to lower the O&M risk by appropriate training, addition of experienced O&M crews, and positive management steps to create a single comprehensive O&M organization for the plant.

98. The proposed transfer of the Kureimat plant to the Upper Egypt Generating Company is a positive step towards ensuring sustainable operation of the plant in the future. However, the transfer is expected to take several months and it would be important to ensure that adequate support is provided from Upper Egypt or other generating companies to support operation and maintenance of the plant.

5. Assessment of Bank and Borrower Performance

5.1 Bank

(a) Bank Performance in Ensuring Quality at Entry

Rating: Moderately Satisfactory

99. At the time when the project was prepared, adequate due diligence was undertaken by the Bank. The project was clearly defined and objectives precise and responsive to the request and needs of the country and consistent with the Bank's CAS and government priorities. The performance indicators were realistic and useful for assessing the progress towards achieving the project objectives. The support provided to the implementing agencies was adequate and issues addressed adequately. However, the possible impact of the evolving local environment on the project was not examined in depth in the ESIA as well as the feasibility study perhaps given the largely uninhabited area for the project and only a gas fired power in vicinity as the key source of pollution. There had also been no significant prior experience from operational CSP plants related to the corrosive impact of local environment on the operation of the solar field which would have called for an in-depth assessment of the local environment on the project. The bid documents also did not have any statement on air quality and left the corrosion issue open for bidders to consider. The poor air quality could have a significant impact on the performance of the plant in coming years. It is recommended that the Bank undertake a comprehensive assessment of air quality at the project site a year from now to identify the sources of pollution and understand whether the pollution impacts are regional or site specific in nature. Given the possible high impacts of the local air quality that could cause increased mirror replacements, the Bank performance at entry is rated moderately satisfactory.

(b) Quality of Supervision

Rating: Satisfactory

100. Bank supervision is rated as satisfactory. The Bank team visited the project approximately twice a year. The visits helped the team to address issues proactively and to support the achievements of project objectives. Although the Bank was not responsible for the Combined Cycle Island, it would have been perhaps prudent to also be involved in decisions related to the power plant being financed by JICA as the integration of the Solar Island and Combined Cycle Island is essential for the success of the plant. At the same time, the Bank team's supervision was thorough and proactive on issues on the Solar Island being financed by the Bank.

(c) Justification of Rating for Overall Bank Performance

Rating: Satisfactory

101. The overall performance rating of the Bank is satisfactory. This is based on the quality of preparation and supervision, as well as the experience and proactive approach of the Bank team. Procurement was completed by the time of Board approval and even with construction delays and impact of revolution during final stages of completion, the project was completed and legally closed on time. Bank reassured the clients that the funds were managed in a transparent and efficient manner and full disbursements of GEF funds took place well before closing. The technical and financial knowledge of the team was deemed useful for project implementation. The twice a year supervision missions by the Bank were adequate to stay abreast of implementation progress to guarantee an overall project supervision beyond desk reviews of progress reports and continuous interaction with the client. Bank support was considered beneficial for the capacity building and dissemination activities.

5.2 Borrower

(a) Government Performance

Rating: Satisfactory

102. The overall government performance is rated satisfactory. The project set a precedent in introducing CSP technology in developing countries through the ISCC configuration, including making a substantial financial contribution to this project. The significant contribution made by the Government demonstrates its ownership of this Project. This is particularly noteworthy as it was unanticipated (costs being much higher than expected and the GEF grant not being able to cover that increase). During that period, power equipment costs across all technologies were escalating rapidly and this effect was magnified in the thin CSP equipment market. The difference in the solar field EPC cost between the Kureimat project and the Ain Beni Mathar Project in Morocco was approximately US$ 24 million for the same size solar field. Together with the Ain-Beni Mathar plant in Morocco and Hassi R'mel plant in Algeria, Kureimat is one among three worldwide ISCC plants and the GoE commitment to this project is commendable.

(b) Implementing Agency or Agencies Performance

Rating: Moderately Satisfactory

103. As this was the first of its kind project, the Government and the implementing agency placed high emphasis on its smooth implementation. Qualified teams at NREA supervised the implementation, including a significant presence at the site on a full-time basis. Procurement was completed before Board approval satisfactorily and smoothly. The NREA team was largely responsive to Bank feedback, for example in tightening the

environmental safeguards compliance during implementation. As the implementing agency, NREA monitored the contractors closely and ensured that the project implementation was satisfactory (for example in addressing the corrosion issues) although having separate contractors for the Solar Island and Combined Cycle Island made issues more complicated. However, issues during implementation and early operations are also partly attributable to NREA's limited experience and institutional capacity in managing multiple large contractors. Also, it would have been prudent to highlight the corrosion issues during construction in the quarterly progress reports in detail which otherwise focused mainly on construction progress. The O&M issues also could have been mitigated to some extent had an O&M contractor for the Combined Cycle Island been appointed as planned. In the case of the companion GEF funded ISCC project, the project was managed by the National electric utility and appears to have been smoothly implemented. However, this would need to be confirmed as part of the ICR for that project. Within this context, the implementing agency's performance is rated as moderately satisfactory.

104. The agency has to be commended on being open to share experience with the global community through facilitation of a number of sites visits, including for World Bank senior management. Looking to the future course of CSP implementation in Egypt, there is a need for suitable institutional development to facilitate the implementation of private sector based solar projects in the future. In this context, it might be worthwhile to consider experience from Morocco where in order to scale-up CSP deployment through Public-Private Partnerships (PPP), a dedicated agency, MASEN, was established with primarily financial and Project management skills, not technical renewable energy skills.

(c) Justification of Rating for Overall Borrower Performance

Rating: Satisfactory

105. The Government demonstrated its strong commitment to this project by going ahead with the project even when the cost of the Solar Island proved to be much higher than originally envisaged. The GoE financed the Solar Island to the extent of about US$ 61 million and facilitated and provided smooth flow of counterpart funding during implementation. The project team at NREA was well staffed and actively worked with consultants and contractors to resolve issues during construction, sourcing sector expertise from other entities such as power generating companies. However, their lack of experience in the CSP technology as well as conventional power generation technology made the task challenging. The proactive measures being taken by NREA to transfer this asset to the Upper Egypt Generating Company, which owns and operates a fleet of combined cycle plants, is a positive step towards ensuring sustainable operation of this plant.

106. The Government continues to be committed to contribute to the development of this technology further through the preparation of the Kom Ombo Solar project. NREA is integrating lessons learned from the Kureimat project into the design of the upcoming Kom Ombo project.

6. Lessons Learned

- **The Kureimat ISCC project has the potential to demonstrate the value of a fully dispatchable hybrid CSP – Combined Cycle Power Plant.** Successful operation of this demonstration project will raise awareness of this technology and provide lessons for wider application, notably since it is one of the first ISCC projects deployed at a commercial scale in the world. A primary purpose of this CSP configuration is to implement the integration of a solar field with a combined cycle plant to produce additional turbine inlet steam, thus increasing electrical output with net positive effect on plant efficiency and the reduction of carbon emissions.

- **Demonstration projects can be highly effective as tools for "visual learning" with respect to new technologies such as CSP**. The Kureimat Project has made significant impact as one of the first CSP projects in the region and contributed to learning and greater awareness for CSP technology within Egypt, in the region and globally.

- **Implementation strategy should be aligned with institutional capacity. Early planning for the Egypt Kureimat ISCC project envisioned a single EPC contract for the solar and power plant implementation.** Funding considerations resulted in a change to a split EPC contract. Elements of the implementation of this project suggest that the split contract approach has hindered rather than helped the implementation process in both the construction and O&M phases. An approach involving a single EPC contractor with O&M responsibility would have been a better model in this context. Therefore, a key lesson emerging from this project is the importance of aligning procurement and implementation strategy with the capacity of the implementation agency.

- **Site selection for an ISCC project is of critical importance.** While most of the important site selection criteria were applied to the Kureimat site selection, it is apparent that air quality (and in particular its potential for accelerating equipment surface corrosion and mirror soiling) must be added to the high priority list for future projects.

- **The Kureimat project highlights the strong prospects for localization of the ISCC technology in Egypt**, with an active role being played by the Egyptian engineering firm ORASCOM and associated suppliers (See also *Middle East and North Africa (MENA) Region Assessment of the Local Manufacturing Potential for Concentrated Solar Power projects,* World Bank, March 2011). Up to 60% of the value of the solar field was generated locally.

- **The Solar Island at Kureimat is operating well and effectively in this early stage.** The performance levels are high and compare well with design projections. On hot summer days, the enhanced output of the solar field counteracts the typical diminished gas turbine performance due to high compressor inlet dry bulb air temperatures. The gas turbine power reduction is due to the reduced inlet air density under such conditions.

- **Few lessons can be learnt from the project about economics of CSP due to small size.** The Solar Island costs are pushed higher for the smaller solar fields typical of an ISCC project in comparison to a solar-only steam power plant project, due to fixed infrastructure costs in construction and O&M of the Solar Island. Larger solar configurations approaching practical limits set by performance and economics are encouraged in future projects. CSP market has evolved considerably since the time this project was bid with revival of interest in this technology in the U.S and Europe.

- **Sufficient data is not yet available to observe success of the total ISCC plant in operation.** The initial operation of the plant has been faced with Combined Cycle Island equipment problems, though early operation of the integrated system is functionally promising. It is clear that there is an economic benefit on the power block side from the reduced investment to achieve a modest capacity increase of the steam turbine cycle in an ISCC configuration. Lessons, particularly on plant operations and maintenance should be revisited in a year as adequate operational data is not available as yet.

- **The purpose and goals of the GEF grant to demonstrate solar integration also require appropriate design and operation of the Combined Cycle Island.** Without proper design, construction, operation and maintenance of the Combined Cycle Island, the value of the Solar Island is negatively affected. Should such projects be repeated in the future, the World Bank could take a greater role in the monitoring, review and approval of Combined Cycle Island design and O&M decisions.

7. Comments on Issues Raised by Borrower/Implementing Agencies/Partners
(a) Borrower/implementing agencies

107. NREA clarified the reason of reducing the solar field capacity from 30MW to 20MW and thereby reducing the capacity of the plant as a whole from 150MW to 140MW gross. According to NREA, the cost for a 30MW solar field was high and suitable additional funding could not be mobilized in time thus reducing the solar field to 20MW, which was deemed acceptable by the Bank.

(b) Cofinanciers

108. The Co financier originally was originally JBIC but its ODA departments were merged with JICA in 2008. Thus JICA took over the role of co financier. In addition to the Combined Cycle Island, JICA also financed the O&M consultant for the Solar Island as well as a spare parts contract for the Combined Cycle Island raising the overall financing for the project from JICA.

(c) Other partners and stakeholders

(e.g. NGOs/private sector/civil society)

109. The Bank has engaged a broad range of stakeholders including academia, NGOs and private sector during dissemination events that included sharing experience from the Kureimat project. There is also continued engagement with stakeholders to receive ongoing feedback on the future development of CSP in Egypt and in the region as part of the MENA CSP scale-up initiative.

Annex 1. Project Costs and Financing

Project Cost (in USD Million equivalent)

Components	Appraisal Estimate (USD millions)	Appraisal Estimates inc Contingencies (US millions)	Actual/Latest Estimate as April 2012						Percentage of Appraisal
			GEF	JICA			NREA	Total	
			USD	YEN (billion)	US equivalent (Xchange rate 2007)	US equivalent (Xchange rate 2012)	US equivalent	US equivalent	
					US1= YEN 118	USD1 = YEN 82.82			
a) Solar Island	111.31	117.80	49.80				60.00	109.80	
Solar Consultant	0.00	0.00		1.37	12.00	16.00	3.00	19.00	
Total Solar	**111.31**	**117.80**	**49.80**	**1.37**	**12.00**	**16.00**	**63.00**	**128.80**	**109%**
b) CC Island	193.49	209.77		17.40	148.00	210.00	60.00	270.00	
Spare Parts	0.00	0.00		9.80	8.00	12.00	12.00	24.00	
Total CC Island	**193.49**	**209.77**	**0.00**	27.20	156.00	**222.00**	**72.00**	**294.00**	**140%**
Total Baseline Cost	**304.80**	**327.57**	**49.80**	**28.57**	**168.00**	**238.00**	**135.00**	**422.80**	**129%**
Physical &Price Contingencies	22.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Interest, Commitment, Depreciation	0.00	0.00	0.00	4.30	4.00	5.00	0.00	5.00	
Total Project Costs	**327.57**	**327.57**	**49.80**	**32.87**	**172.00**	**243.00**	**135.00**	**427.80**	**131%**
Project Preparation Facility (PPF)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Front-end fee IBRD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total Financing Required	**327.57**	**327.57**	**49.80**	32.87	172.00	**243.00**	**135.00**	**427.80**	**131%**

Source of Funds	Type of Cofinancing	Appraisal Estimate (USD millions)	Actual/Latest Estimate (USD millions)	Percentage of Appraisal
Borrower		126.48	135.00	107%
Global Environment Facility (GEF)		49.8	49.8	100%
JAPAN: Japan Bank for International Cooperation (JBIC)		151.29	243	161%

Annex 2. Outputs by Component

As noted earlier, the project has been implemented through three contract components:

1. The design, construction and operation of the proposed Integrated Solar Combined Cycle Plant.
2. Capacity building within NREA through consulting services for construction management during the construction, testing and operation of the plant.
3. An Environmental and Social Impact management component to be financed by NREA.

Component 1: Implementation packages for the ISCC plant were eventually split into two contract lots:

(a) One contract lot for the Solar Island as an EPC contract for engineering, procurement, construction, commissioning and two (2) years operation and maintenance (i.e., EPC cum O&M). The prime contractor was ORASCOM Construction Industries (Egypt) with Flagsol (Germany) as a sub-contractor supplying the Solar Island.

(b) One contract lot for the Combined Cycle Island as contract for engineering, procurement, construction, commissioning and an extended two (2) year warranty period. The prime contractor was IBERDROLA Engineering and Construction (Spain) and MITSUI (Japan).

(c) A 7-yr O&M contract was planned for the Combined Cycle Island, but this plant was later changed to implementation by NREA as part to the capacity building in Component 2.

The Solar Island consists of a parabolic trough solar field, the heat transfer fluid (HTF) system up to the HTF inlet and outlet flanges of the Solar Heat Exchangers, associated control systems and control and service buildings. The Contractor for the Solar Island (ORASCOM) guarantees the supply of solar heat to the solar heat exchangers as a function of direct normal irradiation (DNI) and sun incident angle.

The Combined Cycle Island consists of one gas turbine, one heat recovery steam generator (HRSG), one steam turbine, solar heat exchangers plus all associated control and balance of plant equipment and installations. The Contractor for Combined Cycle Island (IBERDROLA) guarantees the generation of electricity and the heat rate as a function of ambient temperature and supply of solar heat from the Solar Island.

Both EPC contractors started in January 2008, with time to commercial operation scheduled for 30 months (ORASCOM) and for 33 months (IBERDROLA). Both EPC contractors were delayed in meeting the target commercial operation dates due to different reasons. The work on the Combined Cycle Island was delayed via a suspension by IBERDROLA due to missing letter of credit by NREA. This also resulted in a significant delay to the Solar Island work. For example, a lack of power supply to the Solar Island and availability of the solar heat exchanger impeded testing.

Component 2: Capacity building within NREA has proceeded as planned. NREA participated in the consulting services for construction management during the construction, testing and operation of the plant. NREA is responsible for overall operation and maintenance (O&M) coordination for the plant, and complete O&M services for the Combined Cycle Island.

The capacity building has included: (a) detailed engineering designs with special attention to the interface between the Solar and CCGT systems; (b) supervising the construction and environmental aspects of the power plant; (c) monitoring the commissioning and guarantee tests; (d) preparing the O&M contract for the CCGT part in terms satisfactory to the Bank; (e) providing assistance during the 2-year guarantee period as well as assisting NREA in monitoring and evaluation of the performance of the whole plant at least during the two years of the O&M period; and (f) providing training and transfer of know-how in ISCC plant operation, with particular emphasis to dispatching and integration into the power system so that NREA staff can successfully take over the power plant after the respective O&M contracts expire.

Initial indications, however, are that the O&M of the Kureimat plant has suffered from coordination of all parties, and from insufficient maintenance of key equipment.

Component 3: This comprises the Environmental and Social Impact management component to be financed by NREA. This component includes the implementation of the Environmental Management Plan (EMP) which mitigates the potential environmental and social impacts associated with the construction and operation of the power plant.

Annex 3. Economic and Financial Analysis

Economic Analysis

The total installed cost of the plant was about $290 million based on bids awarded. The cost of equipment excludes taxes and import duties (an estimated US$22.4 million). The present value of fuel, O&M costs and consumables amounts to $153 million over the 25-year lifetime. The economic analysis assumed an economic cost of natural gas of US$2.52/MMbtu instead of the actual price charged to the power sector. The cost of gas supply was based on an ESMAP study on the economic cost of natural gas in the domestic market. The economic benefits were derived from the economic value of electricity generated, where the average electricity tariff has been assumed to be US$0.07/kWh -- the price for electricity exports to Jordan. The GEF grant of $49.8 million has been included as an economic benefit as it reflects global willingness to pay for this project. Based on these costs and benefits, the project generates a net present value of US$54 million and the EIRR of the project was **13%.**

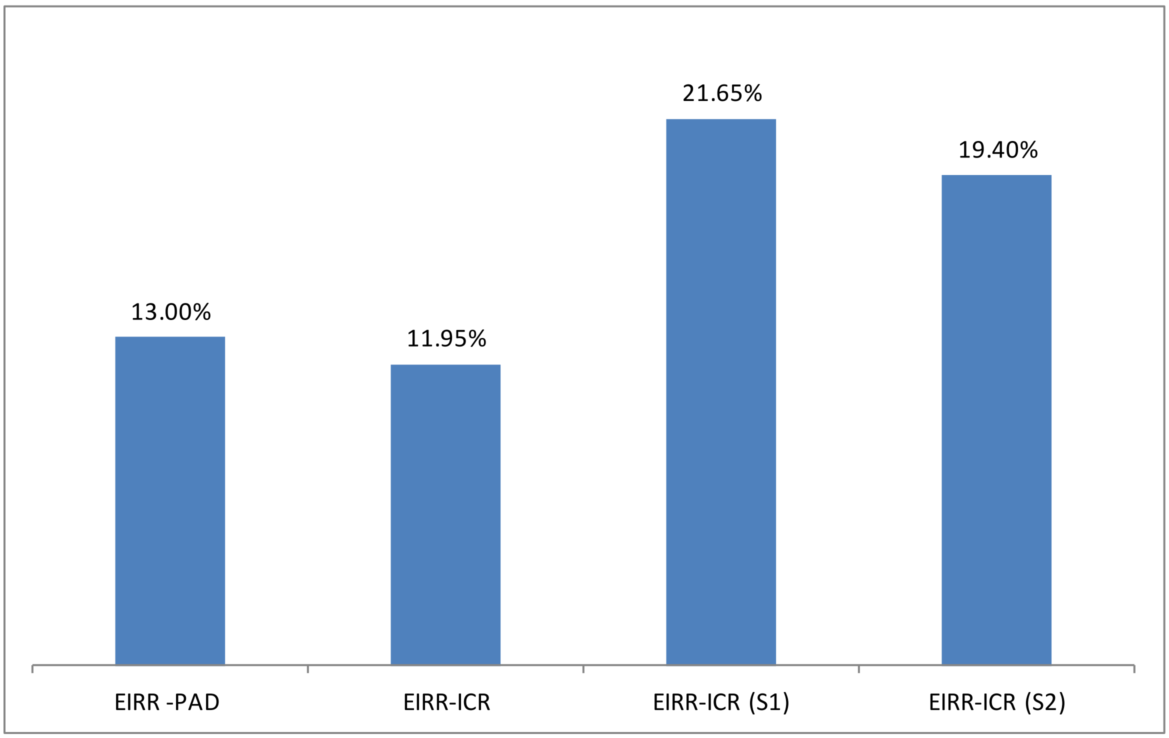
Economic Analysis based on PAD

Year	Economic Benefits				Economic Costs (Million US$)					Net Benefits Million US$
	GEF Grant	Electricity Sales			Capital Costs	Fuel Costs	O&M Costs	Consumables	Total	
		GWh	US$ (Million))	Total						
-3	9.96			9.96	58.0	0	0	0	58.0	-48.0
-2	29.88			29.88	173.9	0	0	0	173.9	-144.0
-1	9.96			9.96	58.0	0	0	0	58.0	-48.0
1		852	59.6	59.6		14.8	12.0	0.1	18.4	32.8
2		852	59.6	59.6		14.9	12.1	0.1	27.1	32.5
3		852	59.6	59.6		15.1	4.7	0.1	19.9	39.7
4		852	59.6	59.6		15.2	4.8	0.1	20.1	39.5
5		852	59.6	59.6		15.4	4.8	0.1	20.3	39.3
6		852	59.6	59.6		15.5	4.8	0.1	20.5	39.1
7		852	59.6	59.6		15.7	4.9	0.1	20.7	38.9
8		852	59.6	59.6		15.9	4.9	0.1	20.9	38.7
9		852	59.6	59.6		16.0	5.0	0.1	21.1	38.5
10		852	59.6	59.6		16.2	5.0	0.1	21.3	38.3
11		852	59.6	59.6		16.3	5.1	0.1	21.5	38.1
12		852	59.6	59.6		16.5	5.1	0.1	21.7	37.9
13		852	59.6	59.6		16.7	5.2	0.1	22.0	37.7
14		852	59.6	59.6		16.8	5.2	0.1	22.2	37.4
15		852	59.6	59.6		17.0	5.3	0.1	22.4	37.2
16		852	59.6	59.6		17.2	5.3	0.1	22.6	37.0
17		852	59.6	59.6		17.3	5.4	0.1	22.9	36.8
18		852	59.6	59.6		17.5	5.5	0.1	23.1	36.5
19		852	59.6	59.6		17.7	5.5	0.1	23.3	36.3
20		852	59.6	59.6		17.9	5.6	0.1	23.5	36.1
21		852	59.6	59.6		18.0	5.6	0.1	23.8	35.8
22		852	59.6	59.6		18.2	5.7	0.1	24.0	35.6
23		852	59.6	59.6		18.4	5.7	0.1	24.3	35.4
24		852	59.6	59.6		18.6	5.8	0.1	24.5	35.1
25		852	59.6	59.6		18.8	5.8	0.1	24.7	34.9
EIRR										**13%**

Sensitivity on Economic Analysis: ICR

The cross-border electricity exchange price has changed significantly since the PAD was developed in 2007. According to 2010 Annual Report of Jordan's National Electric Power Corporation (NEPCO), NEPCO purchased 445,783 MWh of electricity from Egyptian Electricity Transmission Company at the cost of 35.3 million Jordanian dollar, implying the average purchasing price of 11.18 US Cent per kWh using the fixed exchange rate of 0.708 JD per US$. This price is almost 60% higher than the 7 US Cent per kWh tariff assumed in the PAD. If this new price is used keeping everything else the same as in the above analysis, the EIRR exceeds 21.65%. The Egyptian Electricity Holding Company uses economic cost of natural gas as US$4/MMbtu. Although the World Bank could not verify this price, using this price, for the purpose of sensitivity analysis, instead of US$2.52/MMbtu assumed in the PAD, and new electricity price of 11.18 US Cents, the EIRR turns out to be 19.4%. Please see figure below.

Figure 4: Sensitivity on the Economic Analysis (EIRR under various Cases)



EIRR-PAD represents EIRR reported in the PAD. EIRR-ICR takes every assumption from PAD except the actual generation for the first year of the operation which is 57% smaller than that assumed in the PAD. EIRR-ICR (S1) takes all assumption from EIRR-ICR case but replaces old electricity price (7 US Cent per kWh) with the new one (11.18 US Cent per kWh). EIRR-ICR (S2) takes all assumption from EIRR-ICR (S1) case but replaces old fuel price (US$ 2.52/MMbtu) with the new one (US$ 4.0/MMbtu).

Financial Analysis

NREA has transitioned from a research and development-focused entity to green electricity and revenue generating entity, resulting in realization of new projects and investments. In 2010 the total installed capacity was 522 MW, with an additional 140MW that was completed in 2011. There are current projects under preparation with capacity of 1120 MW in Gulf of Zayt on Red Sea Coast. This trend emphasizes the importance of financial performance for the authority and targets on creating a commercially viable company in medium-long term.

NREA's revenue from electricity sales in 2008/2009 was LE 124.1 million (USD23.0 million), an average increase of 26% per year since 2004/2005 while OPEX was LE 28.8 (USD5.3 million), mainly salaries and wages with a working ratio (OPEX/Revenues) of 23% (29% in average over last three years). However, the entity has a loss-making profitability structure: the deficit in 2008/2009 was LE 118.8 million (USD22.0 million), which is funded by the government. According to preliminary information on financial status, main reason for deficit is intensive investment program and debt service.

As of 2008/2009, the total long-term debt stock was LE 5.02 billion (USD912.7 million) for the period 2008/2009 as a result of an average increase of 40% per year since 2004/2005.

The EEHC, purchasing electricity from NREA has recently increased the tariff from 12 Pt/kWh to 13 Pt/kWh with a 7.5% annual tariff escalation, which used to be 5%. The accounts receivable structure between NREA and EEHC is functioning better i.e.; LE 33.2 million and 287 days-on-hand in 2004/2005 to LE 18.5 and 54 DOH. These improvements have positively affected the financial performance of the entity, however, there is room for more development of the institution to ensure self-cost coverage and profitability. Thus, additional measurements are considered by the NREA in order to reduce government support on deficit and strengthen financial viability of the entity. In this term, several options have been in the entity's agenda such as increasing current tariff of 13 Pt/kWh at the level EEHC sells power to end-users; increasing annual tariff escalation from 7.5% to 10%; increasing petroleum fund's income sharing rate of 0.02 Pt/kWh to higher levels or establishing a mechanism in which total marginal income generated by exporting fuel saved in generation electricity from renewables is to be fully allocated to benefit of the NREA or future renewable energy investments.

From performance monitoring point of view two indicators, which have been agreed and targeted as proxies for financial soundness; Debt Service Coverage (a minimum of 1.1 required) and Self Finance (a minimum of 0.1 required) Ratios. These ratios as of 2008/2009 period were: DSCR 0.5 (EBITDA[13] basis) and 1.2 (operating cash flow basis); and Self Finance Ratio 0.09 respectively[14].

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[13] Operating earnings before interest, taxes, depreciation and amortization expenses.

[14] The latest income statements and cash flow statements provided by NREA was for FY2008/2009.

New and Renewable Energy Authority (NREA)

Summary Financial Statements – As of June 2009

-

Balance Sheet	2006/07 *Audited*	2007/08 *Audited*	2008/09 *Audited*
Assets			
Cash	11.7	21.2	52.0
Current assets, net	60.5	80.5	107.5
Fixed assets, net	2,648.1	3,964.7	5,857.1
Total assets	2,708.7	4,045.2	5,964.6
Liabilities & Equities			
Current liabilities, net	50.3	666.7	1,203.4
Long-term liabilities, net	2,402.7	3,468.7	4,900.5
Total liabilities	2,453.0	4,135.5	6,103.9
Retained earnings	-	(164.2)	(283.0)
Total Equity	255.7	(90.3)	(139.3)
Income Statement	2006/07	2007/08	2008/09
Revenue			
Electricity	68.5	96.7	124.1
Others	1.5	0.5	0.7
Expenses			
Operating expenses	20.2	33.3	28.8
Financing expenses	84.3	123.4	132.4
Depreciation	62.0	85.5	104.8
Net Income	**(0.0)**	**(164.2)**	**(118.9)**
Cash Flow *	2006/07	2007/08	2008/09
Net Changes in working capital	n/a	n/a	515.8
Operating cash flow, net	n/a	n/a	86.2
Investment cash flow, net	n/a	n/a	(415.2)
Financing cash flow. Net	n/a	n/a	359.7
Net change in cash for the year	(61.01)	9.51	30.71
Opening Cash Balance	72.7	11.7	21.2
Closing Cash Balance	11.7	21.2	52.0
Financial Ratios	2006/07	2007/08	2008/09
Gross operating margin	71.1%	65.7%	76.9%
Net operating margin	0.0%	-168.9%	-95.2%
DSCR**	n.a	n.a	0.53
Self Finance**	n.a	n.a	0.09
Current ratio	1.20	0.12	0.09
OPEX/Gross fixed assets	0.09%	0.11%	0.12%
Receivables day	215	184	126
Payables day	38	116	84
Debt to equity	9.6	(39.5)	(36.0)
RoE	0%	182%	85%

* Cash Flow statement is not audited. Values in the summary table are based on the World Bank financial projections document.

** The latest income statements and cash flow statements provided by NREA was for FY2008/2009. No cash flow statement data is available for 2006, 2007 and 2008

i.e. actual cash flow data is only available for 2009. Therefore, DSCR and self finance ratio are calculated for 2008/2009 only.

Annex 4. Bank Lending and Implementation Support/Supervision Processes

(a) Task Team members

Names	Title	Unit	Responsibility/ Specialty
Lending			
Rome Chavapricha	Sr. Infrastructure Specialist	MNSSD	Financial Specialist
Lizmara Kirchner	Water and Sanitation Specialist	LCSUW	Operations Analyst
Armando Ribeiro Araujo	Consultant (Procurement)	LCSTR	Procurement Specialist
Anna Bjerde	Task Team Leader	AFTSN	Team Leader
Mohamed Yahia Ahmed Said Abd El Karim	Financial Management Specialist	AFTFM	Financial Management
Mohab Awad Mokhtar Hallouda	Sr. Energy Specialist	MNSEG	Energy Specialist
Supervision/ICR			
Chandrasekar Govindarajalu	Sr. Energy Specialist	MNSEG	Energy Specialist
Fowzia Hassan	Energy Specialist	MNSEG	Energy Specialist
Akram Abd El-Aziz Hussein El-Shorbagi	Sr. Financial Management Specialist	MNAFM	Financial Management
Ferhat Esen	Energy Specialist	MNSEG	Financial Analysis
Mohab Awad Mokhtar Hallouda	Senior Energy Specialist	MNSEG	Energy Specialist
Maged Mahmoud Hamed	Senior Environmental Specialist	MNSEN	Environment
Sydnella E. Kpundeh	Program Assistant	MNSSD	Administration
Reinaldo Goncalves Mendonca	Consultant	AFTEG	Procurement
Govinda Timilsina	Sr. Economist	DEC	Economist
David Kearney	Consultant	SASDE	CSP Specialist
Laila Mohammad Kotb	Program Assistant	MNSSD	Administration

(b) Staff Time and Cost

Stage of Project Cycle	Staff Time and Cost (Bank Budget Only)	
	No. of staff weeks	USD Thousands (including travel and consultant costs)
Lending		
FY98	0.00	28,936.66
FY99*	0.00	21,079.00
FY00*	6.36	31,946.17
FY01	9.75	44,920.12
FY02	6.00	26,442.65
FY03	3.99	20,082.50
FY04	11.40	60,307.84
FY05	9.37	30,468.17
FY06	15.61	70,796.91
FY07*	22.74	117,109.30
FY08	8.98	19,307.17
Total:		471,396.49
Supervision/ICR		
FY07	0.00	248.03
FY08	3.37	20,741.64
FY09	9.27	48,352.08
FY10	9.44	56,219.32
FY11	8.03	34,368.05
FY12	10.35	61,309.80
Total:		221,238.90

Annex 5. Technical Annex

Introduction

The project is located in Kureimat, about 87 km South of Cairo (Al Qahirah) – Capital of Egypt. The site is located on the eastern side of the Nile river, at a northern latitude of 29° 16' and an eastern longitude of 31° 15'. The Integrated Solar Combined Cycle (ISCC) project consists of Combined Cycle Island (120 MW) and Solar Island (20 MW), the total gross power capacity of approximately 140 MW. The project associated with equipment and facilities including interfaces and connections to the Grid.

The construction of the ISCC Kureimat power plant started in January 2008 and reached commercial operation as a whole at the end of June 2011. The plant is owned by the New and Renewable Energy Authority (NREA) of the Ministry of Electricity and Energy of Egypt. The Global Environmental Facility (GEF), accessed through the World Bank, has contributed a grant of USD 49.8 Million towards the incremental cost of solar electricity generation.

The ISCC Project was implemented in two contract lots:

(1) One Contract Lot for Solar Island that comprised engineering, procurement, construction, commissioning and two (2) years operation and maintenance (EPC cum O&M). ORASCOM Construction Industries, (OCI) was the contractor and subcontracted FLAGSOL (a subsidiary of Solar Millennium AG) of Germany.

(2) One Contract Lot for Combined Cycle Island comprising engineering, procurement, construction, commissioning and extended two (2) year warranty period. The contractor was IBERDROLA Ingenieria y Construction, S.A.U. (Iberinco) of Spain.

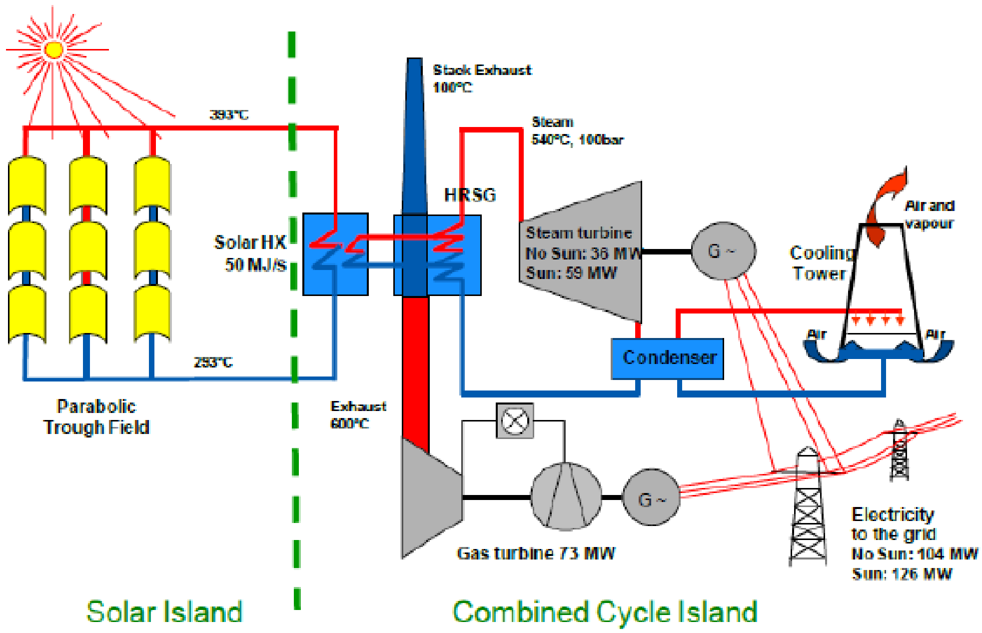
Technology Concept

The Solar Island consists of a parabolic trough solar field, the heat transfer fluid (HTF) system up to the HTF inlet and outlet flanges of the Solar Heat Exchangers, associated control systems and control and service buildings. The Contractor for the Solar Island (ORASCOM) guarantees the supply of solar heat to the solar heat exchangers as a function of direct normal irradiation (DNI) and incident angle of the sun.

The Combined Cycle Island consists of one gas turbine, one heat recovery steam generator (HRSG), one steam turbine, solar heat exchangers plus all associated control and balance of plant equipment and installations.

The Contractor for Combined Cycle Island (IBERDROLA) guarantees the generation of electricity and the heat rate as a function of ambient temperature and supply of solar heat from the Solar Island.

The scope split between the Solar Island and the Combined Cycle Island of the project is shown in the figure below. The thermodynamic interface between Solar Island and Combined Cycle Island is the HTF inlet and outlet flanges of the solar heat exchanger.



Technology Concept and scope of responsibility

Commissioning

Commissioning activities started on 29 March 2010. The activities initiated at that time were based on loop-by-loop testing with a temporary HTF test rig, rather than a full solar field test, which requires operation of the Combined Cycle Island. Loop-by-loop testing was authorized prior to the issuance of the Solar Island Completion Certificate by NREA. The basis for this decision was the contractual allowance in the EPC contract for the Solar Island to be commissioned loop-by-loop in case the Combined Cycle Island completion was delayed. When this decision was made it was clear that the Combined Cycle Island would not be able to achieve its original schedule. And it was expected that the Combined Cycle Island would not be available for the Solar Island Commissioning activities at the expected date of ORASCOM's Commissioning activities (after issuance of Solar Island Completion Certificate). Since the loop-by-loop Commissioning needed around 5-7months, assuming 1-2 loop tests per week, it was practical and expedient to commence loop-by-loop testing.

In addition, this decision was made under the condition that in case the Combined Cycle Island would be available for the integrated Commissioning activities before ORASCOM finished its loop-by-loop Commissioning activities, ORASCOM would switch to the integrated full Solar Island commissioning. However, since the loops are technically self-contained and no loop related work was outstanding, there was no reason to hinder the early start of the loop-by-loop Commissioning. Apart from that, the loop-by-loop Commissioning requires every loop to pass the performance test, whereas the performance test of the complete solar field would require the solar field to pass the test as a whole. With respect to the thermal performance, the complete solar field test is less challenging since lower performing loops are equalized by higher performing loops.

ISCC Plant Design

In reference day-mode (i.e., with solar operation) conditions (700 Watt/m²) direct normal irradiation at solar noon of 21 March and 20°C ambient temperature, the Solar Island will generate about 50 MJ/s of solar heat at a temperature of 393 °C; this enables the ISCC to generate 134.3 MW of net electric power output.

The table below shows the technical key data for the ISCC Kureimat according to the EPC Contract and the latest construction design. The design thermal power of the Solar Island will be reached for DNI values between 700 and 800 Watt/m² depending on incident angle and status of the solar field availability.

Table 4: Key Technical Data

Key Technical Data	Unit	Value
Solar Field total Aperture Area	m²	130800
Number of Collectors	N°	160
Number of Collector Loops	N°	40
Design Irradiation	W/m²	700
Solar Field Design Thermal Power at Reference Conditions	MJ/s	50
Hot Leg HTF Temperature	°C	393
Cold Leg HTF Temperature	°C	293
Gas Turbine Generator Rated Power Output	MWe	74.4
Steam Turbine Generator Rated Power Output	MWe	59.5

Solar Heat Exchanger

The Solar heat exchangers were in scope of the Combined Cycle Island Contractor. The solar heat exchanger equipment is designed to receive energy from the solar field by means of the HTF and to convert into high pressure/high temperature steam. The heat exchanger system comprises two trains - operating in parallel mode - each consisting of one economizer and one evaporator, both being a tube-and-shell design. The normal operating temperature of the HTF is 393 °C at the inlet of the evaporator and 293 °C at the outlet of the economizer. Both heat exchangers combined have a total capacity of 100 MW (Thermal). The solar heat exchanger unit generates saturated steam of approximately 90 bar (depending on load conditions), which is mixed with saturated steam from the high pressure steam drum. The solar heat exchanger system is equipped with all necessary piping, instrumentation, measuring and control devices in order to assure a safe and efficient operation of the recovered solar energy.

Equipment Capacities

The Kureimat project was originally envisioned to operate with a total 150 MW capacity, with approximately 74 MW generated by the gas turbine and 76 MW generated by the steam turbine. The steam turbine output was to be comprised of approximately 40 MW generated from gas turbine exhaust energy and 36 MW generated from the solar field contribution. During the evaluation of the initial bids, it was determined that the solar field capacity would need to be reduced to 20 MW to meet cost targets. This resulted in a reduced total capacity of 134 MW at rated, or nominal, conditions (see Table on previous page).

Because of this change, the steam turbine cycle and its ancillary equipment, notably the solar heat exchangers, could have been reduced in capacity to match the new solar field nominal output. However, in discussions with the supplier, it proved to be cost-effective to retain the bottoming cycle equipment at the original capacities. At certain times of the year (for example, a good summer day), the solar field output would be higher than the nominal 20 MW because of the better solar conditions, and consequently the solar field could, at those times, produce more steam than the nominal limit. Since the steam turbine cycle and solar heat exchangers are oversized, however, their capacity to accept a higher solar field steam flow exceeds the nominal limit. Without this condition, a portion of the solar field would need to be defocused at such times to reduce its output; with this condition, such defocusing will rarely be required and solar field contribution will exceed 20 MW.

The graphic below illustrates these relationships:

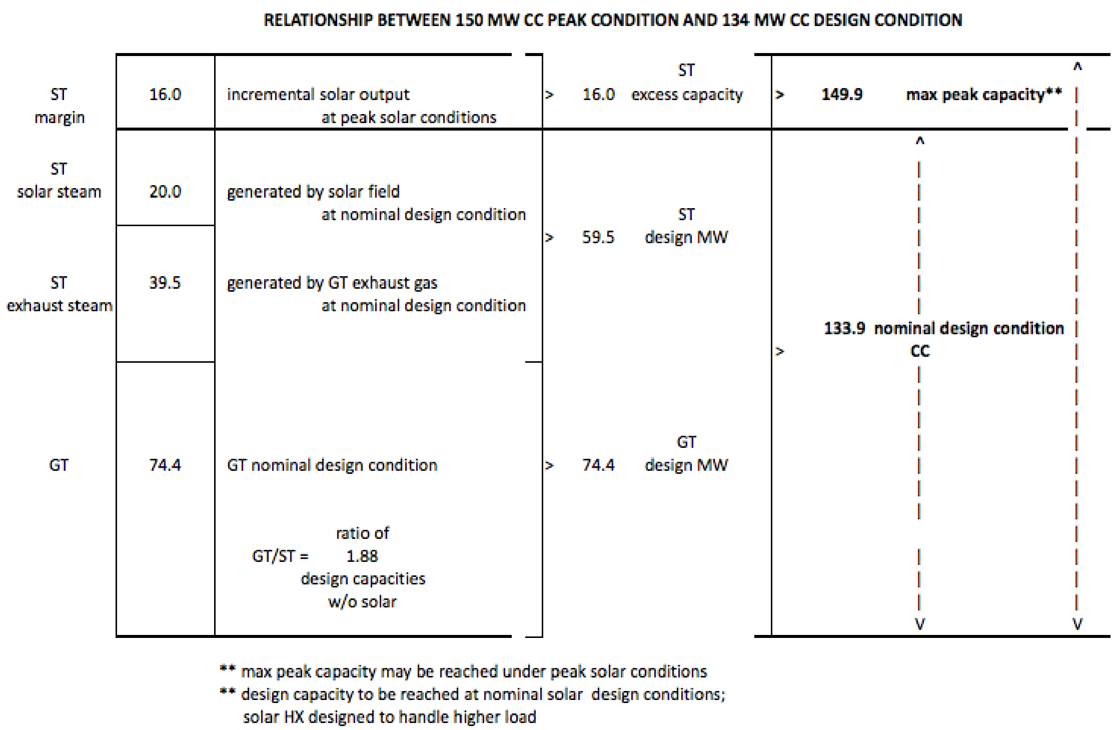


Figure 5: Variance of Peak and Design Conditions

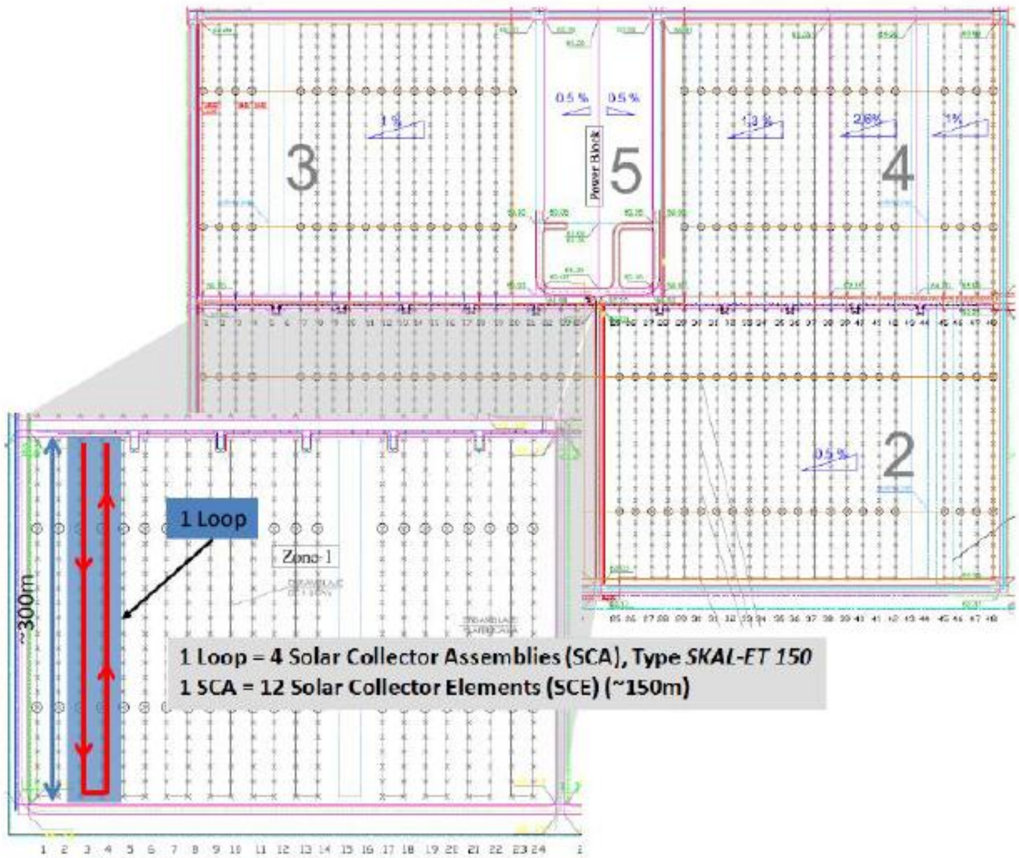


Figure 6: Solar Collector Field

Solar Field Layout

The solar field, see Figure 6, consists of 40 loops with each having 4 *SKAL-ET 150* parabolic trough collectors. The total aperture of one collector is 817.15 m² (total solar field aperture is 130,800 m²). The solar collector elements have been assembled in an assembly hall at the construction site. The design of the collectors varies depending on their position in the solar field (exposed to higher or lower loads) and consequently also the solar collector element foundation design varies. At its 100% operation point the solar field is able to deliver 61 MW(thermal) which is being transferred by the HTF system to the solar heat exchanger in the Combined Cycle Island.

The solar field is separated in an east and a west section each comprising of 20 loops, where at the northern sides of these sections consist of 9 and the southern sides of 11 loops. Additional space for a total four spare loops is available.

HTF System

The HTF system is designed for a HTF mass flow of 250 kg/s at 100% load. The HTF is *Therminol VP-1* from Solutia. Hot HTF returning from the solar field at 393 °C is pumped through the solar heat exchanger. The HTF leaves the solar heat exchanger at 293 °C and is pumped back into the solar field. The main HTF stream at 293 °C leaves the power block area at the southern end and is firstly split in the solar field by control valves into two streams: one stream flows into the east and the other one into the west section. These streams are feeding 20 solar collector loops each on the east and west side.

The HTF is pumped into the solar field by 3 x 50% HTF main pumps. HTF flow through the loops is controlled per individual adjusting valves. The HTF system of the ISCC Kureimat includes an expansion, an ullage and a reclamation system. For freeze protection reasons the HTF system is equipped with a natural gas fired freeze protection heater and freeze protection pumps.

Project Execution

ORASCOM started execution in January 2008 with the civil works for the main access road works according to the contract milestones. The priorities of the area works were staggered starting from area 3 to 1, 2 then 4. The reason was to prepare at least one area as soon as possible to start also with the erection of the solar collectors.

In July 2008 the assembly hall for the assembly of the solar collector elements was ready and in September 2008 ORASCOM had completed the pedestals for the solar collector pylons, which were essential to start with the erection of the solar collector elements. The excavation works of the electrical building in the solar field were completed in November 2008 and in April 2009 the concrete works of the electrical building were complete.

In January 2009 the solar collector element assembly and erection commenced, starting with the erection of the solar collector elements in area 3. This delay, due to late availability of assembly line components, was overcome by a high production rate for the solar collector elements by extending shifts. Photogrammetric quality control assured that the increased production rate did not cause any quality losses. In February 2009 all foundation works for the solar field components and the concrete works for the wind breaks (design height 6.5 m) had been completed.

Figure 7: Photogrammetry Station to Assure the Quality of the Assembly

However an unexpected problem was the corrosion in the spring plate of the collectors. It was noticed by FICHTNER SOLAR that after a certain time of the collectors exposed to the environment the spring plates started to corrode. ORASCOM carried out an analysis which indicated that the quality of the material did not meet the specifications. Consequently ORASCOM had to order new spring plates and change these on the erected collectors in the solar field.

The unexpected harsh environmental conditions due to the unforeseen high pollution (high concentration of Sulfides and Chlorine) caused also corrosion on the chromatic bearings and the hydraulic pistons of the solar collectors. ORASCOM expects that the corrosion effects will become limited when the solar field is in continuous operation, and the aggressive dust and dirt is stripped away from the surfaces through regular cleaning. This remains to be proven.

Nevertheless, after intensive discussions of several experts from NREA, FICHTNER SOLAR and ORASCOM, further appropriate countermeasures (spare parts, other materials and protective covers) were taken to deal with corrosion problem. In October 2009 all SCE's were erected in zone no. 2; in March 2010 the erection of the SCE's in all four zones was completed.

The erection works mainly ended in March/April 2010. However due to many pending minor mechanical and general Pre-commissioning works, the completion and the official release for the commissioning phase was still outstanding. In particular, this delay was caused by the unavailability of interfaces that were to be provided by the Combined Cycle Island EPC. Due to the unavailability of the Combined Cycle solar heat exchanger, the trial operation tests were performed isolated from the Combined Cycle.

As defined in the EPC Contract all functional tests, pre-commissioning tests and Trial Operation were carried out starting from about April 2010 and ending at the beginning of January 2011. Finally, at the beginning of January 2011 the Solar Island EPC finalized all pre-commissioning works and officially completed the construction phase.

In January 2010 the solar heat exchanger (scope of the Combined Cycle Island) was available for the electrical consumption test which also was witnessed and approved by NREA and FICHTNER SOLAR. Finally the reliability test was approved and the Operational Acceptance Certificate was issued with the validity date 01 June 2011. Unfortunately due to the unavailability of the solar heat exchanger due to a leakage, the Solar Island operation had to be interrupted regularly for boiling out (extraction of water from the HTF system). However, there was adequate time for operation of the Solar Island to detect further optimization potential and take measures for immediate implementation by ORASCOM.

Corrosion

As noted earlier, after a short period corrosion and pitting started on specific surfaces of the erected solar collector elements. This phenomenon was noticeable after two weeks of erection. Three different authorities made analysis of the environment and took samples of the corroded material at the site. These analyses were started in September 2009 and revealed that the environment contains high concentration of sulfur. In addition to the spring plates, the conclusion was that the sulfuric acid attacked the chromatic surface of torque tube and pistons of drive pylon and consequently the pitting started, as shown in Figure 8 and Figure 9.

Figure 8: Pitting Occurred in Torque Tubes of the Collector

Figure 9: Pitting Occurred on the Chromatic Surface of the Drive Pylon Piston

According to the approved procedure from ORASCOM, all the pistons of the drive pylons had to be replaced by pistons with a Powder Flame Spraying Layer (NiCrBSi- Material) according to EN 1274:2004 – 2.9 including Cu/Mo to provide the highest level of corrosion resistance against sulfuric acid. It is expected by the EPC contractor of the Solar Island that the new hydraulic cylinders will withstand this corrosion throughout the lifetime of the plant.

According to the approved procedure on-site, the chromatic surfaces of the torque tube, which is the part of SCE end plate, were cleaned by a special cleaner which removes the rust particles from the pitting, and sprayed with Zinc-Alu spray to protect the chromatic surface. Additionally, rubber bellows were mounted over the torque tube to protect the tube surface from the severe environmental conditions, as shown in Fig 10 below.

Fig 10: Mounting of rubber bellows over torque tubes

Time Schedule

Both EPC contractors started in January 2008, ORASCOM on the 3rd and IBERDROLA on the 16th. The ORASCOM time schedule projected 30 months until commercial operation, i.e. beginning of July 2010, and the IBERDROLA time schedule projected 33 months until commercial operation, i.e. middle of October 2010. Both EPC contractors fell short of these targets commercial operation dates due to different reasons. However, the decisive reasons where the suspension of work by the Combined Cycle Island IPC due to a missing letter of credit by NREA. As a consequence of this suspension, the required interfaces by IBERDROLA, such as power supply to the Solar Island and availability of the solar heat exchanger, were significantly delayed. Hence, ORASCOM was unable to carry out its work, causing a delay in completion of the Solar Island.

The revolution in Egypt which started in January 2011 also had a decisive schedule related negative impact on both EPC contractors. However it is noted that both EPC contractors resumed their construction works in an exemplary manner. In view of the above mentioned reasons, the Solar Island started commercial operation on June 28 2011 with a delay of about 9 months.

Pre-commissioning

The pre-commissioning of the Solar Island was comprised of functional tests of the particular components of all disciplines, plant protection related pre-commissioning tests, and trial operation of the complete ISCC plant. However, the Combined Cycle Island was not available as a whole for the combined trial operation as scheduled, delaying several of those steps.

The trial operation test of the Solar Island included the following contractual verifications and checks:

- Start-up tests
- Verification of start-up times and loading rates
- Operating stability when operated in the full range of load conditions with load variations
- Start-up tests of the Plant equipment, facilities and systems including checking of automatic change-over of standby facilities
- Verification of vibration and noise emission guarantees
- Environmental monitoring equipment, water quality monitoring equipment, functioning tests and verification of guarantees
- Verification of completeness of scope of supply.
- Following protocols have been used for the trial operation in their revision 02:
- Trial Operation - Operating Stability
- KU1_Pre-com Trial operation Verification of completeness of scope of supply
- Trial Operation - Start-tests, verification of start-up times and loading rates (including Mode 1 and 2)

Trial Operation - Test Mode 3 (Shutdown)

- Trial Operation - Test Mode 4 (Freeze protection mode without heating)
- Trial Operation - Test Mode 5 (Freeze protection mode with heating)
- Trial Operation - Test Mode 6 (Emergency flow)
- Emergency Power & UPS System
- Main Pumps
- Freeze Protection Pumps
- Start up Ullage system.

These protocols were adjusted to the circumstances that it was uncertain if the solar heat exchanger would be available for the tests and hence - where applicable - a case distinction was made for “with” or “without solar heat exchanger”. The trial operation was executed from the temporary control room in HTF building basement where Distributed Control System (DCS) and Field Supervisory Control (FSC) were temporarily located at that time. For all tests it was necessary to continuously adapt the protocols, since a number of DCS programming mistakes appeared, and consequently reprogramming was necessary. The functional description of the Solar Island also had to be revised several times. Finally however, all tests have been completed successfully by the middle of December 2010.

Views of a portion of the completed solar field, and a single loop

Figure 11: The Complete Loop with Insulation Works

Figure12: The Washing Truck and Washing Operation

Annex 6. Early Commercial Operation

ISCC

Since June 2011 operation had been below design capacity levels due to the O&M problems in the Combined Cycle Island. The following table summarizes the operating status from June through mid-December 2011.

Table 5: Operating Status

Kureimat Commercial Operation Pattern: June through December 2011

June	Days 1-30	Normal Operation during Reliability Test
July	Days 1-7	Normal Operation
	Days 8-31	Off-line
August	Days 1-13	Part Load Operation
	Days 14-31	Normal Operation < peak
September	Days 1-18	Normal Operation < peak 4 days part load
	Days 18-30	Off-line
October	Days 1-31	Off-line
November	Days 1-30	Part Load Operation 9 days off line
December	Days 1-16	Part load or off-line

Specific information on the causes for each off-line or part-load operational period are not known at this time (See Annex 9 for key issues faced). However, the information received to date points to problems with full-load operation of the combustion (gas) turbine and unscheduled downtime periods associated with water leakage into the HTF in the solar heat exchangers (which are part of the Combined Cycle Island equipment). As of April 2012, normal operation of the full plant has resumed.

The relative net power delivered each month by the Kureimat facility during this period is shown below. For calibration, the June value is 73.1 GWh; November is 37.5 GWh. At full load daily operation, without solar, the monthly output would be approximately 94 GWh. This data shows that the plant was typically operating in a part-load condition during the 2011 period after startup. The plant capacity factors calculated from a NREA output table are June-88%; July-21%; Aug-64%; Sep-45%; Oct-2%; Nov-45%. Parasitic power consumption averages about 6%. At present, there is insufficient data to quantify the solar contribution for each month. A better record of plant data will require careful examination of plant performance once a more stable operating mode is attained. Operation during 2011 and earlier is summarized in Table 6-2 (below) using data provided by NREA and Flagsol.

Operation and Maintenance status – early April 2012

ISCC Plant

The ISCC power plant was operating satisfactorily in early April 2012 having overcome problems in the combined cycle, primarily with the gas turbine but also with the solar heat exchangers. NREA stated that the main reasons for the unscheduled down period of the ISCC system are the diverter damper, hydraulic oil system, and the gas turbine (transition pieces). The gas turbine inlet air filters had also been a continuing challenge. It appears that most, but not all, of these problems have been solved.

<u>Solar Heat Exchangers</u>

The solar heat exchangers produce steam using the heat collected by the solar field. The units are shell-and-tube heat exchangers with water on one side and HTF on the other. The solar heat exchangers consist of two parallel sets, each carrying 50% of the peak load. Leakage of water into the oil has been a continuing problem, and usually occurs at the tube sheets. As of early April one set is out of service, limiting the steam turbine output to 50% of its potential level.

<u>Solar Field Thermal Performance Acceptance Tests</u>

1-Performance Test without Combined Cycle: Loop-by-Loop Performance Test with Mobile Test Unit (MTU)

<u>Results – Loop-by-Loop Performance Test</u>
• Amount of tested loops: 40
• Amount of approved loop tests: 40
• Duration of each loop test: 10 minutes
• Test period for 40 loops: 29th of March 2010 to 19th of November 2010
• Average loop efficiency: approx. 105 %

The loop-by-loop data is shown graphically in the following Figure:

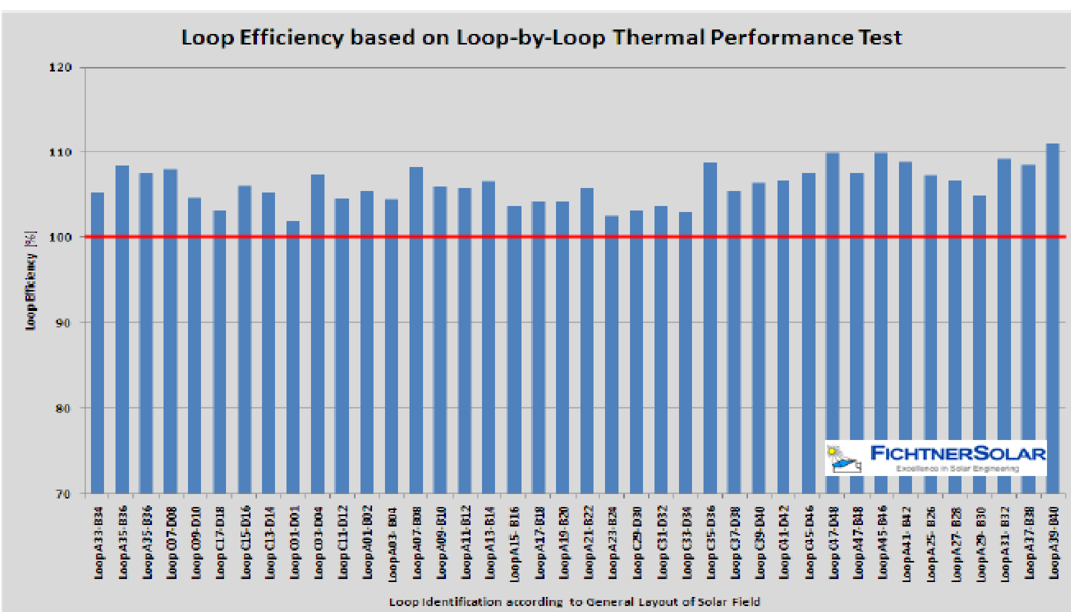


Figure 13: Loop-by-loop data

2-Performance Test with Combined Cycle: Entire Solar Field Performance Test

• Test Duration: 1 hour for each test mode (Day-Mode and Night-Mode)
• Condition for passing of thermal performance test:
Net Electrical Output (NEO) ≥ Guaranteed Net Electrical Output Corrected to Test Conditions (CGNEO) – Tolerance for Test Mode & Net Heat Rate (NHR) ≤ Guaranteed Net Heat Rate Corrected to Test Conditions (CGNHR) + Tolerance for Test Mode
• Performance test carried out according to code *ASME PTC 46:1996.*
This test was completed on 23rd of May 2011 for Day-Mode and on 24th of May 2011 for Night-Mode with duration of 1 hour for each test. The results are shown below.

	DAY-MODE	NIGHT-MODE	Result
$\frac{\text{NEO-CGNEO}}{\text{CGNEO}}$	≈ + 5%	≈ + 5.5%	ISCC Plant achieved more power output than guaranteed
$\frac{\text{NHR-CGNHR}}{\text{CGNHR}}$	≈ - 2.5%	≈ - 3%	Lower fuel consumption than guaranteed

Figure 14: Performance Test Results

ISCC Plant Status (early April 2012)

ISCC Plant

The solar field supplies thermal energy to the solar heat exchanger (HEX) train to produce steam, which supplements the turbine steam from the HRSG to increase the output of the steam turbine. The solar field tracks the sun on a single axis, absorbing direct normal radiation. Due to excellent performance of the solar field, 71% of the direct radiation incident on the aperture of the parabolic troughs is delivered to the HTF flowing through the solar field to generate steam in the solar heat exchanger.

ISCC Plant

The ISCC power plant was out-of-operation several times due to problems in the Combined Cycle Island, primarily with the gas turbine but also with the solar heat exchangers. In early April, NREA stated that the main reasons for the unscheduled down time of the ISCC system are the diverter damper, hydraulic oil system, and the gas turbine (transition pieces). It appears that most, but not all, of these problems have been solved at this juncture.

Solar Heat Exchangers

The solar heat exchangers produce steam using the heat collected by the solar field. The units are shell-and-tube heat exchangers with water on one side and HTF on the other. Leakage of water into the oil has been a continuing problem, and usually occurs at the tube sheets. The solar heat exchangers consist of two parallel trains, each carrying 50% of the peak load. As of early April one set is out of service, limiting the steam turbine output to 50% of its potential level.

ISCC Plant Output

Table 6 below shows partial ISCC performance from June 2011 through March 2012. In all months the solar field was available to operate at or near design capacity, but its operation was curtailed by the inability of the solar HEXs or the steam turbine cycle to accept design solar field steam output levels. This is by no means representative of a fully operational period. The reduced CO2 emissions due to the solar field performance are also presented in the table where the solar field thermal output is available.

Table 6: Plant Production Data July-Feb 2012

Kureimat ISCC Energy Production Data: July 2010 - February 2012							
Month	Gross ICSS Output	Net ICSS Output	Received from Grid	Net to Grid	Natural Gas Use	Solar Field Thermal Output	Reduced CO2/mo Emissions
	MWhe	MWhe	MWhe	MWhe	1000 m3	MWht	tonnes
Jul-10 to Dec-10	39,614	35,073	4,541	30,532	11,352	---	---
Jan-11 to Mar-11	53,668	48,965	5,956	43,009	14,037	---	---
Apr-11	24,410	23,564	674	22,890	5,189	---	---
May-11	25,648	25,081	1,197	23,884	4,988	---	---
Jun-11	76,029	73,112	10	73,102	14,802	6256	1162
Jul-11	18,810	18,088	402	17,686	3,228	3475	645
Aug-11	57,204	55,107	532	54,575	12,855	7295	1355
Sep-11	38,457	35,869	386	35,483	7,973	6370	1183
Oct-11	16,118	1,596	295	1,301	657	0	0
Nov-11	38,340	38,078	545	37,533	9,963	2756	512
Dec-11	16,423	15,647	339	15,307	---	1350	251
Jan-12	49,695	47,815	197	47,617	---	58	11
Feb-12	59,828	57,863	223	57,640	---	2605	484
Mar-12	23,035	23,035	207	22,828	---	---	---

As an example, the next plot illustrates the solar field data for November. In general the solar field has demonstrated performance over warranty levels. The red bars below show the actual performance; the blue bars show the warranty performance; the orange line shows the ratio of actual/warranty in % (see right axis for scale).

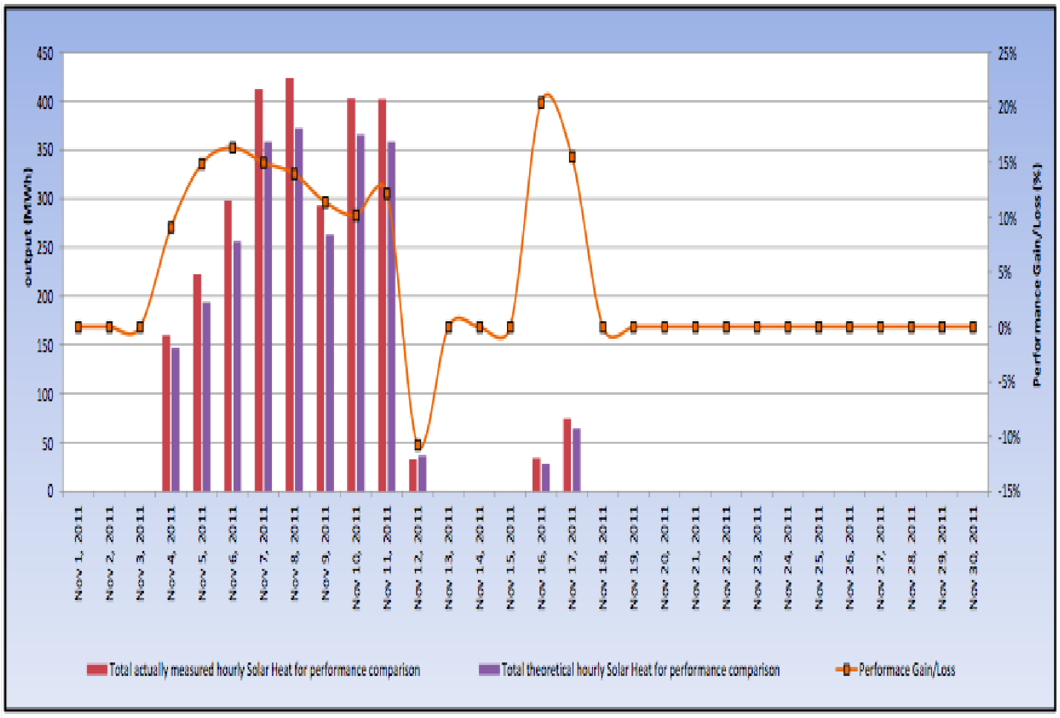


Figure 15: Solar Field Data for November 2011

Annex 7. Beneficiary Survey Results

N/A

Annex 8. Stakeholder Workshop Report and Results

N/A

Annex 9. Summary of Borrower's ICR and/or Comments on Draft ICR

From:	"NREA's Vice Chairman" <nre2.nrea@gmail.com>
To:	worldbank <mhamed1@worldbank.org>, fhassan2@worldbank.org, mhalloda@worldbank.org
Cc:	Chairman <nre@idsc.net.eg>, oaelgowainy@yahoo.com, Moustafa_nrea@yahoo.com, moyhn99 <moyhn99@gmail.com>
Date:	04/10/2012 10:02 AM
Subject:	Draft implementation completion report (ICR) For Kuraymat Project.

Dear Sir/Ms;

Reference is made to your e-mail dated March 11th, 2012 concerning the a/m subject and further to NREA's reply to the questions mentioned in the ICR.

Please be informed that NREA thanks you for the report and we confirm our acceptance for the basic information, key dates, ratings summary, sector and theme codes included in the data sheet.

Please find NREA comments and reply to the items raised in the meeting held today April, 4th, 2012 with World Bank representatives.

First: Regarding the extension for the EPC warranty period is as follows:

1. **For the solar field:**

According to EPC contract, the warranty period is two years started on June, 1^{st}, 2011 on the same day the operation and maintenance contract has been started. According to addendum No. 1 for the EPC contract between NREA & Orascom, the warranty period for:

a. HTF pumps extended for three years from the date of issuance the final acceptance certificate.
b. The collectors bearings and bellows extended for three years from the date of issuance the final acceptance certificate.
c. All hydraulic piston rods will be replaced by new ones.

2. **For the Combined Cycle Component:**

HTF evaporator #2 extended for one year further according to the execution agreement for issuing of operational acceptance certificate signed between NREA & Iberdrola on Dec., 14^{th}, 2011.

- **Default of operation heat exchangers:**

The unsuccessful operation of heat exchanger due to repairing because of water leakage to oil side, this effects the integration with the solar field. In this case the solar field will be out-of-service either completely or partially meanwhile, the combined cycle (GT - ST) is running and it was connected to grid to produce the base load.

Second: The main problems of combined cycle:

1. **Heat Exchanger No.2:** Leakage of tube and shell flanged happened many times. Heat Exchanger No.2 is still out-of-service therefore, the max. thermal generated power is limited.
2. **Gas turbine (Transition pieces):** GE replaced 5 transition pieces and Gas turbine is running probably.
3. **Diverter damper:** The vendor NEM adjusted the two hanges of the diverter damper and they were welded according the drawing of the manufacturer. The problem solved. This problem leads to stop the operation from March, 10th, 2012 to April, 4th, 2012.
4. **Dissolved Oxygen:** The Dissolved Oxygen reached to 30PPb at the dereator outlet. The vender stork check this reading by another device and he found that the actual reading 1ppb. The problem is the calibration of the measuring device.
5. **Some valves of HRSG have leakage inside their body:** The problem hasn't solved yet and this causes increasing the consumption of demineralized water.
6. **The hydraulic oil pump#2:** The coupling was broken and GE replaced it by new one and according to GE, the reason is due to the decreasing the pressure of hydraulic oil from 105bar to 95bar for pump#1 and to 91bar for pump#2.
7. **The circuit breaker SF6/66KV :** The problem is leakage of the gas SF6 and this problem was solved by NREA staff with assistance from Upper Egypt Electricity Production Company for testing filling through the QA and QC dept.
8. **The vacuum pump#2:** The shaft of the pump was broken and the steam turbine is running by the standby vacuum pump#1. The contractor didn't solve this problem till now.
9. **Intake filters of axial compressor of Gas turbine.**

   NREA replaced 50% of the filters by new ones and Gas turbine is running probably.

- **The ISCC power plant is out-of-operation due to problems in the combined cycle. The main reason for that is the defect of diverter damper, hydraulic oil system, gas turbine (transition pieces). Therefore, NREA will extend the warranty period for the combined cycle for 2.5 months, this period equal to the period which the facilities or such part affect the operation and production of the plant.**

Third: reference to you e-mail dated March, 29th, 2012 regarding your request for some additional financial data:

- W.B.: The cost of the combined cycle component of ISCC plant which is 17.43 billion of Japanese Yens meanwhile the value that was informed by JICA is 20.1 billion of Japanese Yens.
- NREA: The difference between the Combined Cycle Contract price and JICA's evaluation value results from the following additional amounts:
    - Consultant contract value.
    - Gas turbine spare parts and its accessories.
- And there are other additional costs equal to 185 Million L.E. as the following items:

- Customs fees 17572029.72 L.E.
- Taxes 71407449.9 L.E.
- Interests 95561125.4 L.E.

Fourth: Please find attached the generated power from ISCC plant during July, 2010 to March, 2012.

We hope these answers let you satisfied. If you have any further questionnaires, don't hesitate to contact us.

Best regards,

Vice Chairman
For Projects & Operation

Annex 10. Comments of Cofinanciers and Other Partners/Stakeholders

None Received.

Annex 11. List of Supporting Documents

1. Assessment of World Bank/GEF Strategy for Market Development of Concentrating Solar Thermal Power, World Bank, 2006
2. Mariyappan J and D. Anderson, "Thematic Review of GEF Financed Solar Thermal Projects" Monitoring and Evaluation Working Paper 7, Global Environmental Facility, 2001
3. Enermodal, 1999. Cost Reduction Study for Solar Thermal Power Plants, Kitchener, Ontario: Enermodal Engineering Limited
4. "Middle East and North Africa (MENA) Region Assessment of Local Manufacturing Potential for Concentrated Solar Power (CSP) Projects" World Bank, March 2011.

IBRD 39155

ARAB REPUBLIC OF EGYPT

KUREIMAT INTEGRATED SOLAR COMBINED CYCLE POWER PROJECT

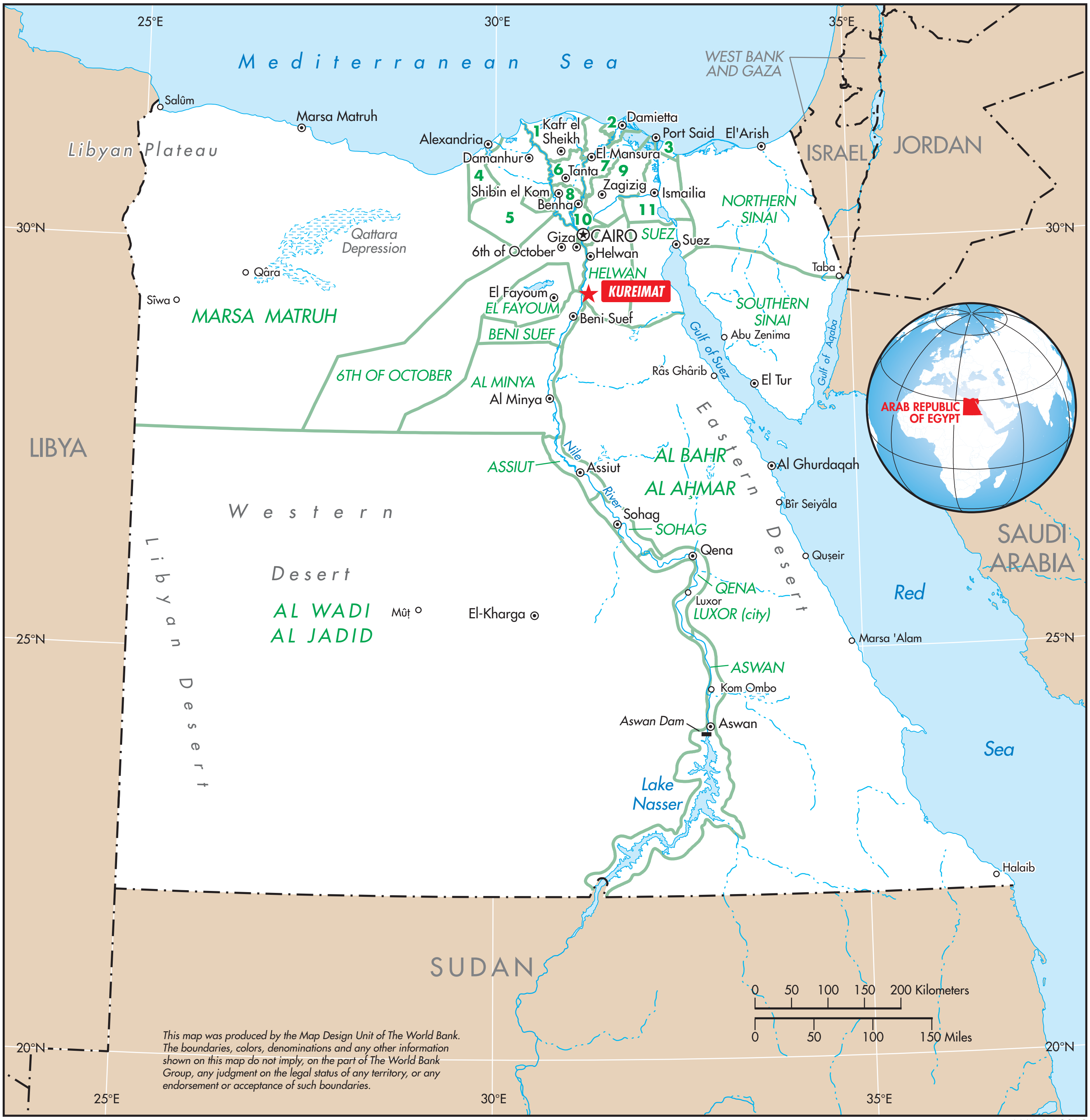
★ KUREIMAT INTEGRATED SOLAR COMBINED CYCLE POWER PROJECT SITE

SELECTED CITIES AND TOWNS
GOVERNORATE CAPITALS
NATIONAL CAPITAL
RIVERS

GOVERNORATE BOUNDARIES
INTERNATIONAL BOUNDARIES

GOVERNORATES IN NILE DELTA:

- 1 KAFR EL SHEIKH
- 2 DAMIETTA
- 3 PORT SAID
- 4 ALEXANDRIA
- 5 BEHEIRA
- 6 GHARBIYA
- 7 DAGAHLIYA
- 8 MENOUFIYA
- 9 SHARGIYAH
- 10 QALIUBIYA
- 11 ISMAILIA



MARCH 2012