



1. Project Data:		Date Posted : 06/27/2014	
Country:	Morocco		
Project ID:	P041396	Appraisal	Actual
Project Name:	Integrated Solar Combined Cycle Power Project	Project Costs (US\$M):	567.8
			543.6
L/C Number:		Loan/Credit (US\$M):	43.2
			43.2
Sector Board :	Energy and Mining	Cofinancing (US\$M):	0.0
			0.0
Cofinanciers :	African Development Bank; Spain's "Instituto de Crédito Oficial (ICO)	Board Approval Date :	04/19/2007
		Closing Date :	12/31/2012
			12/31/2012
Sector(s):	Renewable energy (100%)		
Theme(s):	Climate change (40% - P); Technology diffusion (40% - P); Infrastructure services for private sector development (20% - S)		
Prepared by :	Reviewed by :	ICR Review Coordinator :	Group:
Richard L. Berney	Fernando Manibog	Christopher David Nelson	IEGPS1

2. Project Objectives and Components:

a. Objectives:

According to the Global Environment Facility (GEF) Grant Agreement (page 8), the project objectives are: "to support the Recipient in increasing its power generation capacity, reducing greenhouse gas emissions and promoting renewable energy sources in the Kingdom of Morocco through the development of an integrated solar combined cycle power plant in Ain Beni Mathar."

The objectives in the Project Appraisal Document (PAD) are consistent with the Grant Agreement: "to increase the contribution of renewable energy sources in Morocco's energy mix and add capacity to the power grid to help cope with the sustained growth in electricity demand." The PAD further states that the project's global environmental objectives are "to reduce greenhouse gas emissions from anthropogenic sources by increasing the market share of low greenhouse gas emitting technologies."

This ICR Review is based on the objectives stated in the Grant Agreement .

b. Were the project objectives/key associated outcome targets revised during implementation?

No

c. Components:

The project components implemented by the national power company, Morocco National Electricity and Water Utility (ONEE), are the following:

(1) **Design, Construction and Operation of an Integrated Solar Combined Cycle Power Plant** and auxiliary facilities, including 225-kV and 60-kV power lines; a 225-kV substation; an access road; boreholes, a gas pipeline; land acquisition (203 hectares); and consulting services for management and supervision .
(Appraisal estimate US\$565.56 million including physical and price contingencies; Actual US\$ 543.51 million)

(2) **Environmental and Social Development, and Management** , including a comprehensive monitoring and evaluation program to disseminate the project's results and lessons; the implementation of the Environmental Management Plan (EMP); and the strengthening of ONEE's capacity to monitor EMP implementation .
(Appraisal estimate US\$2.24 million; Actual US\$0.09 million)

d. Comments on Project Cost, Financing, Borrower Contribution, and Dates:

Costs: The actual project cost was US\$543.6 million, which was 4.3% below the appraisal's total cost estimate (including physical and price contingencies) of US\$567.80 million.

Financing: The GEF financing was US\$43.2 million; there was no IBRD/IDA financing. The African Development Bank (AfDB) was the project's primary cofinancier, with one loan of Euro 136.45 million in 2005 and another of Euro 151.14 million in 2008. In 2009, ONEE obtained a loan of Euro 100 million from Spain's state financial agency to finance its contribution to the project. The GEF grant was intended to cover the incremental cost of the solar generation component. All co-financiers participated in the financing of one single contract for the design, construction, operation and maintenance of the entire plant .

Borrower Contribution: The Government's original project financing commitment of US\$ 136 million was covered by a loan of US\$129 million equivalent from the Instituto de Crédito Oficial (Spain).

Dates: The effectiveness deadline was extended from August 19, 2007 to March 31, 2008 to allow ONEE to complete the recruitment of the engineering consultant, which was one of the effectiveness conditions . The project became effective on December 31, 2007 and was closed on schedule on December 31, 2012.

3. Relevance of Objectives & Design:

a. Relevance of Objectives:

Substantial

The project is fully consistent with the third pillar of the Bank's FY2010-2013 Country Partner Strategy (page 37) for Morocco, that is, to support the Government's goal of enhancing energy security and to ensure availability of energy to all Moroccan households and businesses at competitive prices, while protecting the environment and mitigating climate change. To achieve these objectives, the strategy's key elements have been to: (i) diversify and optimize the energy mix around reliable and competitive energy technologies; and (ii) develop the national renewable energy potential.

b. Relevance of Design:

Substantial

The statement of the project objectives is clear, concise and monitorable . The intended outcomes are closely linked in a causal chain to the project's objectives, The project was designed to demonstrate the operational viability of hybrid solar thermal power generation technology and contribute to its replication in Morocco and throughout the world through the learning effect provided by its construction and operation . The capacity of the combined cycle was planned initially for 207 MW, and the solar plant was to be approximately 20% of this capacity (about 37 to 45 MW). When the original concept of a plant owned and operated by an independent power producer (IPP) failed to attract any bidders, ONEE took over the project. It subsequently decided to raise the capacity of the combined cycle island from 207 MW to 452 MW to meet Morocco's increasing electricity demand and the unexpected serious delays in another planned combined cycle plant . This change was fully consistent with the objective of increasing power generation capacity.

At the same time, the solar plant was reduced from 45 MW to 20 MW. The two design changes together reduced the solar operation from 20% to less than 5% of the power plant's total capacity, and also reduced its electricity production to only 1.2% of total plant output. While the revised design still provided an link in the causal chain of

demonstrating to technology for a hybrid solar and gas power plant , the demonstration effect was significantly less compelling than it had been in the project as originally designed .

4. Achievement of Objectives (Efficacy):

The three distinct parts of the GEF Grant Agreement's statement of objectives are assessed below :

Objective 1: To increase Morocco 's power generation capacity - Substantial

Output:

After a difficult start due to the unavailability of sufficient gas, the integrated power plant financed under the project is performing satisfactorily .

Outcome::

The new power plant has increased Morocco 's electricity generation by 3,703 GWh per year, which is above the appraisal target for the increasing generation by 3,538 GWh per year.

Objective 2: To promote reduce greenhouse gas emissions - Substantial

Output: The target value for yearly generation of solar electricity was 40 GWh, and the actual output in the first year of full production (2012) was 39 GWh. The target value for solar output as percentage of total electricity produced by power plant was 1.13%, and the actual value was 1.16%. The target value for the reduction in CO2 emissions was 24,300 tons/year, and the actual value in 2012 was 23,000 tons/year

Outcome:

The project promoted a way to reduce greenhouse gas emissions through the implementation of an integrated solar power generation plant.

Objective 3: To promote the use of renewable energy sources in the Kingdom of Morocco - Modest

Output:

As indicated above, two design changes resulted in the reduction of solar power generation to only 1.2% of total plant output. Otherwise, in terms of public information outreach, there were 440 visitors to the plant and experience of plant was presented at 91 workshops and conferences.

Outcome:

The reduction in the solar operation from 20% to less than 5% of the plant's total capacity diminished its demonstration effect. Nonetheless, while little can be learned about the economics of concentrated solar power (CSP) technology from the implementation of this relatively small solar island, useful lessons have been drawn in the areas of procurement, contractual structure, performance testing, and operations & maintenance for future solar projects.

5. Efficiency:

Substantial

Project implementation was delayed by 6 months due to *force majeure* events, including severe flooding of the project site, damage to collectors due to strong winds, total loss of one transformer and fire in one turbine filter . Nevertheless, the project was implemented on schedule and within budget .

An unanticipated shortage of gas for the combined-cycle plant hindered the maximization of solar-generated electricity for thirteen months . The plant had relied on gas transiting through the Maghreb-Europe pipeline from which Morocco had the right to consume around 7%. But total throughput declined with the reduction of gas demand in Europe. As a result, after commissioning, the plant could only operate intermittently to cover the evening peak electricity demand. The solar field was available, but steam was not produced due mainly to cost-efficiency reasons. This problem was solved in November 2011 when a dedicated gas supply pipeline from Algeria became available .

As a result of the shortage of gas supply from the October 2010 plant commissioning until November 2011, the performance of the solar field and its integration with the combined cycle island can only be evaluated on the basis of a single full-year of data (2012). The ICR calculates the a 16.6% financial rate of return of the project (FRR), using the actual values in 2012. This is significantly above the 11.4% estimate at Appraisal. The most significant factor in the increase in the FRR was the higher average electricity selling price, which increased from the appraisal value of US\$ 8¢/kWh to US\$ 9.15¢/kWh. Fuel costs are the other critical variable in this calculation . The ICR was unable to obtain the actual price of Algeria gas supplied to the project . It therefore took as a reference the price used in the PAD of US\$6/MMBtu. The project's FRR would fall below 10% if the price of natural gas exceeded \$7.7/MMBtu. The ICR points out correctly that since electricity prices are subsidized by the Government and are lower than the

consumer willingness to pay, then the economic rate of return (ERR) to the project as a whole would be higher than the FRR.

The FRR for the solar portion of the project could not be calculated . However the ICR shows that its costs were significantly greater than estimated at appraisal . Capital costs increased from the appraisal estimate of US\$ 62.5 million to US\$104 million, while the estimated the average cost of electricity from the solar system was estimated to be US\$38 per MWh, compared to the appraisal estimate of US\$ 21 per MWh.

a. If available, enter the Economic Rate of Return (ERR)/Financial Rate of Return (FRR) at appraisal and the re-estimated value at evaluation :

	Rate Available?	Point Value	Coverage/Scope*
Appraisal	Yes	100%	11.4%
ICR estimate	Yes	100%	16.6%

* Refers to percent of total project cost for which ERR/FRR was calculated.

6. Outcome:

The relevance of objectives is **high** because all of the project's objectives (to increase power generation capacity, to promote renewable energy sources, and to lower greenhouse gas emissions) are still relevant to Morocco . The relevance of design is **substantial** . It included the construction of a power plant in support of the objective of increasing power generation capacity, while incorporating solar technology to also lower the emission of greenhouse gases from what have would occurred if the entire output had been based in power generated solely from gas . The project's efficacy was **substantial** , by increasing Morocco's electricity generation by 3,703 GWh per year, above the target of 3,538 GWh per year, while promoting the use of solar energy, a renewable resource that also reduces greenhouse gas emissions The project's efficiency was **substantial** . Total capital cost were lower than the appraisal estimate, and the project's FRR is 16.6% (the ERR would certainly be greater than the FRR given the subsidized electricity prices and much higher consumer willingness to pay).

a. Outcome Rating : Satisfactory

7. Rationale for Risk to Development Outcome Rating:

The integrated plant completed a one year of operation (2012) with highly satisfactory performance values . The operation & maintenance (O&M) of the plant has been entrusted to a private company under a five -year contract. The contractor submits monthly reports to ONEE with details on the performance of the plant and a list of maintenance actions. The five-year O&M contract also includes performance tests at the end of this period, thereby guaranteeing good performance at least for the medium term . The technical risk is considered to be low to moderate .

When the O&M contract expires and ONEE will have to operate and maintain the plant with its own staff, the important issue is to ensure that the expertise acquired during the operation and maintenance of the pilot ISCC plant remains in Morocco. At present, 90% of the 60 staff employed by the private company in O&M are Moroccans, which already ensures achievement of this goal . This risk is considered to be low .

The initial acute problem related to gas supply shortages was resolved after ONEE signed a gas supply agreement with Algeria, thereby ensuring an adequate and continuous fuel supply to the plant . The risk of further supply problems is considered to be low to moderate .

The solar island is performing well. However, a mirror-soiling phenomenon, created by sand and dust wet with morning dew, has been noticed during the summer, which can reduce mirror reflectivity by 20% to 40% and hence decrease the solar island's performance in the long run . ONEE has recently started using manual mirror washing to complement the work of the contractors' mirror washing truck. The risk of lower performance of the solar island is moderate.

However, there are continued risks extreme from natural events, such as flooding and wind damage . Given the history of this problem during the project's construction phase, this risk is considered to be significant .

a. Risk to Development Outcome Rating : Moderate

8. Assessment of Bank Performance:

a. Quality at entry:

The project was approved by the Bank's Board in April 2007, after a preparation time of over eight years. The Bank was involved in the design of this project design since 1998. The original concept was for the project to be designed, built, financed, and operated by an Independent Power Producer (IPP). The Bank supported conceptual design as a "merchant plant", where electricity purchasers would be identified, and purchase contracts and prices negotiated only after the plant had been built. In 2002, the Government issued two calls for expressions of interest, which did not attract interest from the private sector. This scheme could have worked in a large and open market like the US, but without the security of a long-term power purchasing agreement, potential private investors considered it too risky for a project in Morocco, where there were very few potential buyers of bulk electricity. The project was subsequently redesigned so that it was owned by the public sector, based on a turnkey operation, a tripling of the size of the combined cycle plant (from 150 MW to 472 MW) and halving of the size of the solar plant (from 45 MW to 20 MW). Project implementation started in 2007.

A Bank's internal assessment on the project's quality at entry carried out in October 2007, stated that "delays appear to have been largely outside the control of the project team" and highlighted that the "GEF Council Approval was not obtained until October 2004, more than 6 years after the (August 1998) Concept Review". The Bank's assessment at that time rated the project "Satisfactory" overall. That assessment did not identify any other significant shortcoming, and highlighted the procurement arrangements among its strong aspects.

Quality-at-Entry Rating : Satisfactory

b. Quality of supervision:

The Bank carried out six supervision missions with teams composed of technical and safeguards policy experts. The Bank team monitored closely the compliance with the effectiveness conditions of the Grant Agreement. During construction of the plant, the Bank supervised adequately environmental and social issues. The Bank team contributed to the dissemination of lessons learned by, *inter alia*, presenting a paper about the project at the international Solar Paces Conference in 2011.

Quality of Supervision Rating : Satisfactory

Overall Bank Performance Rating : Satisfactory

9. Assessment of Borrower Performance:

a. Government Performance:

The Moroccan government was a major driving force behind the project, since it needed to reduce the risk of blackouts due to a fast-growing electricity demand in the country. The GEF grant provided the government with the opportunity to diversify its energy mix and to contribute to the demonstration and replication of the technology through learning effects. In 2006, the Moroccan government sent a letter to the Bank expressing its commitment to these objectives while reiterating the importance of the GEF contribution.

The government continues to be deeply committed to scale-up solar technology in Morocco to fulfill the target of 2,000 MW installed by 2020. Hence, its contributions will continue toward (i) the cost reduction of CSP technology through economies of scale and (ii) technology demonstration and lesson-learning.

The Government has also reinforced the legal and institutional framework for the large-scale development of solar energy by the adoption of a law on renewable energies. In 2010, the Government created a new specialized agency, Moroccan Agency for solar Energy (MASEN), to take over ONEE on the leadership role to implement

solar technology in the future .

Government Performance Rating

Satisfactory

b. Implementing Agency Performance:

ONEE deserves credit for having successfully implemented a unique project involving high uncertainties and risks. During construction, ONEE's project implementation unit was confronted by : (i) extreme weather events in 2008 and 2009 (wind and storms), which affected equipment in the solar field; (ii) incidents during construction, such as fire in the air filter of one gas turbine (May 2009); and (iii) lack of sufficient gas for testing . Despite these adversities, ONEE's project team reacted swiftly and construction was delayed by only 6 months. The establishment of a working environment based on trust and dialogue with its contractors was a significant part of the reason for the timely resolution of these problems .

After bid evaluation, ONEE knew that the GEF grant could not cover the total cost of the solar field . ONEE showed strong commitment to the project by covering the US\$ 23.8 million difference. On environmental protection issues, ONEE chose a cooling system that dramatically reduced the project 's water consumption, even though it had a higher price tag .

The implementation of the Environmental Management Plan for the ISCC plant was adequate, but the overall monitoring of environmental impacts could have been improved -including impact on groundwater and impacts related to transmission lines - with the appointment of an environmental manager with competences on all components of the project as suggested by the Bank .

Implementing Agency Performance Rating :

Satisfactory

Overall Borrower Performance Rating :

Satisfactory

10. M&E Design, Implementation, & Utilization:

a. M&E Design:

M&E design was adequate. It included all the critical project performance elements : the project's total annual electricity generation and annual generation from solar sources; and the solar thermal power plant generation costs . Other indicators, including solar output as a percentage of project output, which is a derivative figure, and share of project output in Morocco's total electrical energy output, which reflects energy investments in other parts of the economy, were less relevant.

b. M&E Implementation:

The contractors provided ONEE with the appropriate data . The ONEE staff that were being trained in various aspects of the integrated staff combined cycle technology were regularly monitored, to ensure smooth operations and maintenance once the contractors depart .

c. M&E Utilization:

ONEE provided data to evaluate project implementation after the Bank 's project closing date. The monitoring of performance indicators need to continue and be more systematic in the future . The availability of more operational data in the future could confirm that the satisfactory performance has been sustained . The government should monitor and report the results to the GEF . A systematic and comprehensive plan to compile lessons learned and disseminate knowledge resulting from the plant needs to be further pursued when more operational data becomes available.

Since only one year of operations was achieved (2012), and thus, given the limited information to guide operational decisions and establish long-term sustainability, M&E is rated modest.

M&E Quality Rating : Modest

11. Other Issues

a. Safeguards:

The project did not pose major environmental risks and was classified as Category B by the Bank . The operational policies OP4.01 on environmental assessment and OP 4.12 on involuntary resettlement were triggered . Appropriate safeguards documents were completed and disclosed, including (i) Environmental Impacts Assessment (EIA) for the Integrated Solar Combined Cycle plant, the gas spur and access road, and high voltage lines (three reports), (ii) Environmental Management Plan (EMP), (iii) Resettlement Policy Framework (RPF) and (iv) Resettlement Action Plan (RAP).

The main identified potential environmental impacts were those during construction and operation, i .e. site contamination by thermal fluid leakage, excessive water pumping and generation of large quantities of solid waste during construction. At the beginning of construction (2008), the environmental mitigation and monitoring measures were not adequately conducted nor thoroughly reported . ONEE staff on-site was not aware, for example, of the existence of an EMP. Hence, several measures required in the EMP such as noise and air quality monitoring, proper waste management, preparation of an occupational, health, and safety plan by the plant operator had not been done . ONEE rapidly remediated these issues when Bank supervision missions brought them to their attention . Based on the estimated consumption requirements of a wet-cooling system, the project had authorization to pump 3.1 million m³/year of water from the local aquifer . The choice of a dry-cooling system reduced dramatically the plant's impact on the aquifer. The water consumption in 2012 was only 334,112 m³. The project's overall environmental compliance was considered satisfactory, according to the ICR .

Measures implemented by ONEE for compliance with Bank's RAP policies, (e.g. compensation to landowners for loss of agricultural productivity), were considered satisfactory and no significant issues arose, according to the ICR .

b. Fiduciary Compliance:

The ICR contains no information on fiduciary performance .

c. Unintended Impacts (positive or negative):

The project provided invaluable experience during its different phases . The experience gained by ONEE's staff had a positive influence in the preparation of the Moroccan Solar Plan (2009) and the preparation of a 160 MW pure solar CSP project in Ouarzazate, which the Bank is supporting .

d. Other:

12. Ratings :	ICR	IEG Review	Reason for Disagreement /Comments
Outcome:	Satisfactory	Satisfactory	
Risk to Development Outcome:	Moderate	Moderate	
Bank Performance :	Satisfactory	Satisfactory	
Borrower Performance :	Satisfactory	Satisfactory	
Quality of ICR :		Satisfactory	

NOTES:

- When insufficient information is provided by the Bank for IEG to arrive at a clear rating, IEG will downgrade the relevant ratings as warranted beginning July 1, 2006.

- The "Reason for Disagreement/Comments" column could cross-reference other sections of the ICR Review, as appropriate.

13. Lessons:

The following useful lessons can be derived from the project's implementation experience (as adapted from the ICR):

The use of integrated solar combined cycle (ISCC) technology can be a stepping stone for scaling -up concentrated solar power (CSP). The integrated design allowed ONEE to take a measured risk and test the feasibility of introducing solar power in its generation system without hampering its objective of ensuring reliable electricity supply. The fossil fuel supply, however, needs to be guaranteed .

The choice of wet or dry cooling technology should to be fully evaluated . ONEE required bidders to submit separate proposals for both wet cooling technology and dry cooling, with associated required levels of water consumption. This approach allowed ONEE to take an informed decision, which yielded the best technical solution at a lower cost.

Bid the ISCC project with a single contract . Bidding the project with a turnkey contract for the construction, operation and maintenance of the plant enhances the prospects for achieving its smooth operation .

An operations and maintenance agreement for five years is preferable to the standard contract of two years . as the longer contract significantly reduces project risks . This procurement arrangement lowered ONEE 's operational risks by transferring these risks to the contractor and has assured the plant 's satisfactory performance to date .

The turnkey Engineering, Procurement and Construction (EPC) consortium should include the suppliers of the key ISCC plant components . This could reduce possible delays . At Ain Beni Mathar, the supplier of the steam turbine was not a member of the turnkey consortium contract for the design, construction, operation and maintenance of the plant. The inclusion of the steam turbine supplier in the consortium could probably have reduced unnecessary delays during construction because of the risk -sharing EPC arrangement.

Independent power producers (IPP) are unlikely to be interested in projects that lack a firm Power Purchase Agreements unless they have a fully operational, large scale market for electricity, with many independent producers and consumers. Initial IPP tenders in 2002 for this project failed primarily because it was considered too risky by potential bidders for a project in Morocco, where there were very few potential buyers of electricity .

14. Assessment Recommended? Yes No

15. Comments on Quality of ICR:

The quality of the evidence in the ICR is adequate to judge the project 's efficacy and efficiency. The quality of the analysis is keyed to the project 's outcome and impact. The ICR's internal reasoning demonstrates a good understanding of the causal chains that underlie the project 's results framework. The lessons are well articulated and are directly rooted in the ICR's evidence and analysis . It is generally well written. One important ICR shortcoming, however, is the absence of information on fiduciary compliance .

a. Quality of ICR Rating : Satisfactory