Financing for Renewable Energy in the Mediterranean Region Project

United Nations Environment Program
International Energy Agency

BASELINE SURVEY OF THE RENEWABLE ENERGY SECTOR

EGYPT

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List of Abbreviations

BOOT	Build-Own-Operate-Transfer
Danida	Danish International Development Assistance
EE	Energy Efficiency
EEA	Egyptian Electricity Authority
ESCO	Energy Services Company
GEF	Global Environment Facility
IPP	Independent Power Producer
KfW	Kreditanstalt Fur Wiederaufbau (German Development Bank)
LCC	Life Cycle Cost
LCOE	Levelized Cost of Energy
LRMC	Long Run Marginal Cost
MW	Megawatt
NGO	Non-government Organization
NREA	New and Renewable Energy Authority
PPA	Power Purchase Agreement
RE	Renewable Energy
R&D	Research and Development
RET	Renewable Energy Technologies
RESCO	Rural Energy Services Company
STWH	Solar Thermal Water Heating
TOE	Tons of Oil Equivalent
TWh	Terawatt hour
UNDP	United Nations Development Program
USAID	United States Agency for International Development

Introduction

UNEP has begun an effort, with the support of the Italian Ministry of Environment and Territory, to promote increased investment in the renewable energy sector in the southern Mediterranean. This finance facilitation program is one of three elements of a comprehensive WSSD Type II initiative Promotion of Renewable Energy Technologies in the Mediterranean Region coordinated with the International Energy Agency, the Observatoire Mediterranean de l'Energie (OME) and the Mediterranean Association of the National Agencies for Energy Conservation (MEDENER). The other two elements of the initiative focus on strengthening policy frameworks and building private sector project development capabilities.

The key objectives of the Financing for Renewable Energy in the Mediterranean Region Project are to investigate different options for increasing finance flows to renewable energy companies and projects in target countries, and to help structure various support mechanisms that help lenders and investors scale up financing to this clean energy sector. Tunisia, Morocco, and Egypt are the first three Mediterranean countries to be reviewed for the program. It is envisaged that in the future other southern Mediterranean countries will also be added.

The purpose of this document is to present an overview and analysis of the current status of the renewable energy (RE) sector in Egypt with focus on the economic, regulatory, and technical factors influencing the sector. It is planned that this report will be used by a finance consultancy team hired by UNEP to identify an array of financial support mechanisms that will contribute to the deployment of renewable energy technologies in Egypt, which should ultimately result in the creation of a renewable energy technologies market in the country.

1.1 Bibliographic Review

A list of bibliographic sources used in the preparation of this report is presented in Annex I. As part of the preparation for this report, the author conducted several meetings and interviews with various stakeholders in Egypt. A list of names and contact information of the persons interviewed is in Annex II.


0 50 100 150 200 km
Egypt - February 29, 2000 - MODIS/MODLAND/Descloitres

1.2 Technical-Economic Assessment of RE Potential in Egypt

1.2.1 Energy Needs Assessment

Since mid 1980s, Egypt's economy has been witnessing a steady but cautious transformation from a command and control economy to one in which market forces play an increasingly important role. Among the objectives of this transformation process is the liberalization of the economy in a way that would increase efficiency in all sectors and increase the role played by the private sector. By late 1990s, the economy grew at an unprecedented 6.5% as the effects of market liberalization started to emerge. The privatization program introduced by the government in mid 1990s has led to the sale of various state owned enterprises and contributed to alleviating the stress on national budget from having to sustain ailing public companies. In addition, a thriving tourism sector accompanied by increases in workers' remittances, Suez Canal revenues, and oil exports have all contributed to major improvement in hard currency inflow to the country and consequently to a growing economy. However, the amount of hard currency generated by these pivotal economic activities has plummeted during the past two to three years as regional political conflicts (i.e. the Israeli-Palestinian tensions and most recently the war to disarm Iraq) continued to affect the number of both tourists visiting the country and commercial vessels passing through Suez Canal. In 2002, the real growth in the country's Gross Domestic Product (GDP) was 1.6%, following a growth of 3.3% in 2001, and as high as 6.5% in 1999, as mentioned above. It is expected, however, that once the tensions in the region calm down, Egypt's macroeconomic indicators will improve, especially if tourism picks up to the high levels achieved in late 1990s.

Among the sectors in the economy that has demonstrated steady levels of expansion and growth was the energy sector. From 1980 to 1998, Egypt's energy consumption increased by 171%, from 0.7 quadrillion Btu to 1.9 quads (Ministry of Electricity Statistics 1997/1998). Although Egypt's energy sector is a relatively diversified one, oil and natural gas are the two dominant energy products with oil representing approximately 77% of total energy production but natural gas is rapidly emerging as a key energy product due to considerable new discoveries in the past few years. Table 1 presents Egypt's energy balance in 1999 based on IEA methodology.

Table 1: Egypt's Energy Balance

Million TOE	Coal	Crude Oil	Petroleum Products	Natural Gas	Hydro-power	Electricity	Total
Indigenous production	0.062	43.257	1.107	11.498	1.032		56.956
Imports	1.085		1.278				2.363
Exports	-0.311	-15.225	-5.422				-20.958
Intl. marine bunkers			-3.480				-3.480
Stock changes		0.209	0.112				0.321
Statistical differences		-0.109					-0.109
Total Primary Energy Supply	0.836	28.132	-6.405	11.498	1.032		35.093
Statistical differences			-0.230				-0.230
Electricity plants			-3.040	-7.314	-1.032	4.961	-6.425
Petroleum refineries		-28.132	27.949	-0.199			-0.382
Own use			-0.698	-0.500		-0.172	-1.370
Distribution losses				-0.028		-0.582	-0.610
Total Final Consumption	0.836		17.576	3.457		4.207	26.076
Industry	0.836		5.866	1.716		1.804	10.222
Transport			7.347				7.347
Agriculture			0.099			0.172	0.271
Commercial & service			0.275	0.191		0.760	1.226
Residential			2.744			1.471	4.215
Non-energy use			1.245	1.550			2.795

Source: Danida Mission in Cairo, 1999.

Oil Sector

In 2002, Egypt produced an average 631,616 barrels per day (bbl/d) of crude oil. This figure is lower than the average daily production in 2000, which was 748,000 bbl/day. The maturity of several oilfields along with a slow down in oil explorations has both contributed to this decline. However, it is expected that explorations in the coming few years will lead to discoveries of new oil fields that would compensate for the depleted ones. Offshore oil production is expected to be a major source for the new discoveries. In 2002, the proven oil reserves were 3.7 billion barrels and the average daily oil consumption was 538,000 bbl/d while net oil exports were 219,213 bbl/d. Approximately 40% of Egypt's hard currency inflows are generated by oil exports, while the remainder is generated by workers' remittances, tourism and Suez Canal toll fee.

At the same time, the demand for petroleum products has been slightly declining during the past few years due to partial removal of government subsidies on consumption of petroleum products, and a slow down in the economy in general. A third reason for the fall in consumption of petroleum products is the fact that abundant natural gas discoveries have been made in the past few years leading to fuel switching in several economic activities. Table 2 presents the change in consumption of petroleum products by sector.

Table 2: Oil Consumption in Egypt by sector ('000 metric tons)

	1996	1997	1998
Crude oil production	43,994	41,782	40,293
Imports (petroleum products)	629	1,218	1,840
Crude oil exports	16,220	15,332	11,819
Consumption by industry	5,908	5,841	6,216
Consumption by households and commercial	2,624	2,723	2,877
Consumption by transportation	6,660	6,876	7,484
Consumption by agriculture	95	91	86

Source: US Department of Energy, 1999.

The oil sector, along with the power generation and natural gas sectors play a key role in attracting Foreign Direct Investment (FDI) to the country. Among the key players in the domestic oil sector are Shell Oil, BP Amoco, Exxon Mobil, Marathon, Texaco, Total Fina Elf, ENI-Agip, Apache, Seagull, and Deminex.

Natural Gas

Egypt's natural gas sector has proven to have greater potential than oil in terms of known reserves. Natural gas production doubled in 1998 and 1999. In fact, in the 1985 Energy Balance, total indigenous natural gas production was 3.733 million TOE, and by 1999 were 11.498. By late 1999, production was at 2.3 billion cubic feet per day (Bcf/d) and is expected to reach 3.1 Bcf/d by the end of 2003. The present total proven gas reserves in Egypt are estimated at 31.5 trillion cubic feet. The government encourages FDI in the both upstream and downstream natural gas sectors, which explains the diversity and size of investments injected by foreign companies active in the sector. Shell, for example, is spending $1.6 billion in natural gas exploration and development in Egypt during 2000-2005, while BP-Amoco has invested $450 million by end of 2002. Domestically, as mentioned above, demand for gas is growing rapidly as thermal power plants are gradually switching from heavy oil fuel to natural gas. In addition, industries like fertilizer plants, foundries, bakeries are also switching to natural gas. Through a $70 million USAID project, public transportation vehicles in Cairo such as buses and taxis are switching to Compressed Natural Gas (CNG) to reduce air pollution in urban cities. The government has also contracted several private sector companies to connect households in urban and rural areas with natural gas. Finally, through a BOOT arrangement, a private sector company is currently building Egypt's first Liquefied Natural Gas (LNG) plant in order to export LNG to Europe.

Power Sector

A detailed sector description is presented later in the study.

1.2.2 Technical Potential for Commercial RE deployment in Egypt

Egypt has abundant solar energy resources and a wealth of wind resources in certain locations. In addition, large quantities of agricultural wastes are produced annually from various agricultural activities, which could potentially be utilized in biomass energy production. This section of the survey assesses the technical and commercial viability of various RE technologies based on literature review, analytical work by the author and discussions with various RE stakeholders in Egypt.

A. Photovoltaic Technologies

The following PV technologies are those that may have good economic viability in Egypt and some of which are already in the market.

A.1 PV Water Pumping

According to a report by the US Department of Trade, Egypt has one of the biggest water pump markets in the world. Diesel and electrical water pumps currently dominate this market, with the majority of pumps being diesel pumps. The use of PV water pumps in Egypt is primarily confined to R&D applications, but some remote off-grid desert farms have actually installed PV water pumps. However, there is no specific data on how many farms actually use PV pumping or the characteristics of these pumping systems (i.e. pumping head, irrigation technology, hours of daily pumping, crop type, etc.).

Agriculture in Egypt takes place in two types of land, Old Lands and New Lands. Old lands are situated in Nile Delta and Nile Valley, while new lands are any agricultural activities taking place outside of the Nile Valley and Delta. Old lands are characterized by being highly fertile due to Nile flooding before the construction of the Aswan High Dam. Old lands suffer from salinity problems due to over-watering as farmers in old lands typically use flood irrigation. Farmers in these lands are also known to apply much bigger quantities of fertilizers and pesticides per acre of land than their counterparts in new lands. On the other hand, new land farmers are typically more market oriented; adopt water-efficient irrigation techniques such as drip and sprinkler irrigation and on average use less pesticides and fertilizers. One final important contrast is the average size of land ownership. In old lands, farmers are either landless or own on average 1 to 3 feddans (1 feddan approximately equals 1 acre). Such small land ownership prevents them from benefiting from economies of scale. In new lands, farmers vary in land size from 2 feddans to several thousands of feddans (as in the case of large, export-oriented agribusinesses). Egypt has so far reclaimed about 3 million acres of desert land. Approximately half of this land is off-grid. The main source of water for irrigation for all farmers in Egypt is either Nile water or groundwater aquifers. The annual precipitation rates in Egypt are almost negligible and hence farmers rarely, if any, rely on rainwater for irrigation (95% of Egypt's fresh water resources originate from trans-boundary sources).

Although the Nile Delta is grid-connected, the majority of farmers in the Delta use diesel water pumps. A small minority use electrical pumps and usually own a backup diesel pump. The reason behind this is the fact that reliability of grid power is low as power supply in rural areas is plagued with frequent cuts. In addition, the rural electrification authority is not keen on extending a grid connection to each farmer's land given the low load demand in each farm (average power requirement needed per farmer is about 0.1 kW per feddan). Hence, farmers in old lands resort to diesel water pumps.

Another advantage diesel water pumps offer is that they are mobile which makes the farmer able to move it from one site to the other depending on irrigation needs in each section of the land. The fact that diesel fuel in Egypt enjoys around 65% subsidy from the government makes diesel pumps the technology of choice for small farmers (current diesel fuel price is LE 0.40 per liter or U$ 0.07/liter, where U$1 = LE 6.00 and the international diesel fuel price is around U$ 0.20 per liter.

Few years ago, the government launched an initiative in parts of the new and old lands aiming at reducing water consumption per farmer without directly imposing a water tariff on farmers. To reach this objective, the government reduced the water level in the irrigation canals from which farmers pump water, which has led to an increase in the water pumping head. As a result, the energy used per cubic meter of pumped water increased (typical range for water pumping head in old lands is 3 to 7 meters). Hence, it is now more attractive for some farmers to cut on pumping cost through using less diesel fuel or no fuel at all (i.e. PV pump). However, this will depend on whether the increase in pumping costs is high enough to economically justify the high initial capital cost of the PV pump. It should be mentioned that farmers buy their diesel fuel pumps from the market or through the agricultural cooperatives.

For farmers who use flood irrigation (e.g. rice farmers), the total daily pumping hours range from 10 to 16 hours per day. Such long pumping hours make it difficult to use PV water pumps without including a battery bank or a storage water tank. Either addition would most likely render the system expensive and uneconomic in comparison with the low-cost diesel pump. PV water pumping in Egypt would typically be suitable for farmers using drip or sprinkler irrigation and those who plant crops that could be irrigated during sunshine (to avoid energy storage). These farmers are available in some Delta land farms like in West Noubariah area north of Cairo and the new agricultural desert lands such as in Farafrah Oasis and East Owienat.

There is currently little published information on the economic viability of PV water pumping versus diesel water pumps in Egypt. NREA (New and Renewable Energy Authority), for example, stated that in their R&D work they usually do not look at the economic side of PV pumping as they only focus on the technical intricacies of the concept through the demonstration of PV pumping systems installed. A 2001 unpublished study by the Center for Energy and Environment at the Arab Academy for Science and Technology in Alexandria compared between PV water pumping with diesel pumps in a farm located in Toushka area in Upper Egypt. The pumping system provided water for a 110 acres desert farm irrigated from one borehole, which is average land size per borehole in Upper Egypt. The study derived both the price of cubic meter of pumped water and the price of electricity per kWh. It was assumed that the PV system was financed through a 5% interest rate loan to be paid off in 20 years and a project life of 25 years. However, the study incorporated the cost of carbon emissions and air pollution in the cost analysis which makes it difficult to use the results from this study given the debate surrounding the real cost of GHG emissions. Nevertheless, the study concluded that in the above conditions, and with 5% discount rate, the cost per cubic meter of pumped water using PV pump is less than that of diesel pump.

In 1999, the World Bank conducted a similar study comparing between the costs of PV water pumping versus diesel pumps. The results came opposite to that of the above, as it was concluded that the cost per cubic meter of pumped water using PV is higher than that from diesel pump. Table 3 presents results from the World Bank study.

Table 3 World Bank comparison of electricity cost between PV and diesel for water pumping at 0% discount

	PV	Diesel
Cost (¢/m^3)	2.79	1.34

Source: World Bank, 1999.

However, the World Bank study does not mention the water pumping head used in the calculation, the crop's daily water requirement, the hours of operation of the pump, and whether energy storage like batteries or water tank was included in the pumping system. Given the inconclusive results regarding whether PV water pumping is commercially-viable or not under the current diesel fuel subsidy, there is a need for a detailed study based on field testing looking at the economics of PV water pumping in various parts of Egypt (old versus new lands). The study should consider PV water pumping under different irrigation regimes, diesel fuel prices, water pumping heads, land size and crop type. Ultimately, least-cost water pumping technologies for each land category in Egypt would be identified. The study may also evaluate possible approaches for commercial deployment of PV water pumps (e.g. revolving fund to cover incremental cost of the expensive technology) among various consumer segments (large agribusiness vs. small farmers). Lessons should be learned from earlier successful government programs that have led to gradual deployment of mechanized water pumps and farm tractors, which later on became essential farm equipment for majority of farmers.

One possible project in this area is to establish a revolving fund through a village bank in one rural governorate where PV water pumping is the least-cost water pumping option. The fund would offer small soft loans to farmers wanting to switch from conventional diesel or electric pumps to PV pumps. The loans will cover the incremental cost of the expensive technology. For project sustainability to be achieved, the project should include awareness raising, capacity building, community participation and training on maintenance components. If successful, the project could be replicated in other governorates. It is also suggested that the proposed MEDREP financing support mechanism(s) takes into consideration feasibility studies submitted by local RE companies that may want to utilize financing from the fund for PV water pumping projects. If these studies are technically and economically sound, then it could be possible for the proposed MEDREP financing support mechanism(s) to support this technology.

A.2 PV for Telecommunication Posts

The main entities that use this technology in Egypt are oil and gas companies, advertising agencies, cellular phone companies, the railroad, the military, and the port authority. Three or four private sector companies exist in this market and compete over contracts from these entities. High system reliability is a key issue in this sector as none of these entities can afford to have a sudden system failure given the criticalness of the services they deliver. In addition, the isolated nature of the location where the load demand is plus the smallness of the load itself makes PV an ideal source of power for this sector. In fact, the importance of system reliability here overrides the general rule of least-cost power supply option.

A large share of PV systems installed in this sector is imported since locally manufactured components may be less reliable. PV companies operating in this sector operate on project tendering basis and their clients are typically well financed. There are no specific figures on the amount of installed capacity but this market is expected to continue growing as more sea ports are established and new mobile phone as well as oil and gas companies enter the market.

A.3 PV for Rural Electrification

As mentioned earlier, the majority of population in Egypt is connected to the grid (96%) while the remaining 4% of unconnected population relies mainly on mini-grids based on diesel generation stand-alone systems installed by the Rural Electrification Authority. However, NREA has installed several demonstration PV home systems in small off-grid communities in North and South Sinai using systems provided by private sector companies. Unfortunately, no least-cost analyses were done to compare the energy cost of these PV home systems with that of a diesel mini-grid.

The World Bank study (1999) referred to earlier did make a cost comparison between PV home systems and a diesel generation mini-grid for an imaginary village of 100 houses and a total population of 800 people. The study assumed 45 households with 200 W_p systems, 15 houses with 550 W_p systems and systems for the mosque, clinic, social center and a school. Other loads included 20 street lamps. Required installed capacity was calculated to be 42.85 kW_p at a total cost of $438,500. The cost analysis looked at an 18 kVA generator plus grid equipment for the households and centers and a diesel motor pump rated at 10 kW (mechanical). Diesel lifetimes were predicted as 7 years and PV at 20 years. The study assumed a zero % discount rate and considered several grid lengths. Following table presents the LCOE for the village electrification.

Table 3: PV vs. Diesel village electrification

	PV	***Central diesel with grid extension***				
		1.0 km	*1.5 km*	*2.0 km*	*2.5 km*	*3.0 km*
Cost of Energy (¢/kWh)	30.7	19.2	21.4	23.7	25.9	28.2

As shown, a diesel-based mini-grid for the electrification of the village is the least cost power supply system for this village, unless the diesel-based mini-grid line extends for a distance more than 3 kilometers then it could be possible that PV electrification is less costly. One aspect the World Bank study did not consider is the transportation cost for diesel fuel, which may alter the above results in favor of PV electrification. At the same time, the limited load demand size in many of the remote communities in Egypt may lead to infinite delays in delivering and installing diesel mini-grid systems which is a possible justification for deployment of PV systems in these communities.

Some private sector companies active in the PV home systems have identified some isolated communities in South Egypt and South Sinai where PV home systems are appropriate to use given the small size of the communities. These communities vary in size from ten to 50 households per cluster. However, financing of such projects was a hurdle these companies were facing. One approach these companies plan to adopt through the proposed MEDREP financing support mechanism(s) is to make special arrangement with the line-ministries responsible for the development of these off-grid communities (e.g. Ministry of Agriculture, local governorates, the Rural Electrification Authority, etc.) by which PV systems would be installed immediately while the government agency pays the company back the cost of the systems based on a relaxed payment schedule. For such scheme to materialize, PV companies need to obtain financing at relaxed terms (e.g. 18 months grace period, zero or subsidized interest rate and/or a grant component in the loan).

Another approach that may be considered is the establishment of a revolving fund as a means to assist potential users with electrification of their houses . The willingness of private sector companies to be involved in such an initiative would have to be initially secured before planning this program. The services of a local NGO could be hired to manage, disperse and monitor the revolving fund since commercial banks would most likely be unwilling to commit its administrative resources for the management of a micro-level scheme like this.

A.4 PV for Ice Making for Remote Fishing Villages

One specific area in Egypt where PV ice making is needed is Lake Nasser, upstream from the Aswan High Dam. NREA estimates that around 1000 households live on the shores of Lake Nasser where fishing from the lake is their key income generating activity. These communities are dispersed over the shores of the lake rather than being concentrated in one location. The daily need for ice stems from the fact that the fishermen find it impossible to transport the fish caught to nearby towns or urban clusters without storing it in ice. In addition, all the households are not connected to the grid and have no electricity.

One possible way to assist these fishing groups is through the establishment of a local revolving fund to enable them to procure PV ice making systems and PV home systems. The fund design should take into consideration the target group's willingness to pay. The author contacted Mr. Mohamed Abdel Latif at the Institute of Cultural Affairs (a Belgian NGO) in Aswan, who expressed interest in further discussions regarding the use of the proposed financing mechanism to provide PV ice making technologies for the above communities. The finance consultancy may also want to contact Mr. Mohamed Bayoumi at UNDP/GEF office in Cairo regarding UNDP's previous experience in dealing with remote communities. Local PV companies could be invited to submit offers for procurement and installation of these PV systems.

B. Solar Water Heating

Solar water heating is currently used in residential, commercial and tourist hotel buildings with varying degrees of success. Tourist resorts and hotels are considered to be the main customer in this market, especially those located in the Red Sea and Egypt's North Coast. NREA estimates that the current installed capacity is around 300 MW, while the potential capacity could easily exceed 1000 MW provided the appropriate set of policy instruments and the government offers incentives. In fact, solar water heating could potentially become a substantial market in Egypt for renewable energy technologies.

NREA's role is once again confined to testing, development and monitoring of solar water heaters and does not extend to the commercialization of the technology. Commercially, there are currently eight local companies active in this market with an annual total production capacity of 25,000 m^2 of solar collectors. In early 1980s, the government enacted a law requiring all residential buildings built in the new satellite cities and urban centers to have solar water heaters. However, the enforcement of this law was not diligently pursued by the local authorities in the new cities, which have led to gradual phasing out of the technology and a return to conventional electric water heaters. Added to this was the poor quality of solar water heating systems installed by many contractors who opted to comply with the law using cheap, low quality systems. The fact that there were no clear guidelines as to the minimum acceptable technical specifications for these systems has exacerbated the problem of malfunctioning systems. The result was unsatisfied system users, which gave solar water heaters poor reputation to what could have been a key energy saver in Egypt.

Solar water heating should be attractive to the utilities since water heating is usually a major contributor to peak load demand and the power grid in Egypt currently suffers from blackouts during peak hours in summer. A major policy and regulatory intervention is needed in this sector in order for this technology to be deployed at a national scale. Different types of barriers are presently facing this technology and which will be presented later in the section on barriers to RE technologies. Companies active in this sector expressed interest in the proposed MEDREP financing support mechanism(s) as it would make their technology even more competitive with ordinary electric heaters and hence contribute to faster deployment in the market.

C. Solar-Thermal Power

Considerable research work has been done by NREA on the technological viability of this technology in Egypt and the potential for its adoption as a contributor to the installed generation capacity added annually. NREA concluded in a 1995 study that Integrated Solar Combined Cycle System (ISCCS) is an appropriate technology where parabolic solar troughs are used in conventional fossil-fueled power plants. Ideal locations for this technology are areas with high solar radiation intensity, natural gas supply source, and proximity to the grid line.

The 1999 World Bank study has also looked at the comparative cost estimates of solar-thermal power in Egypt. Table 4 presents the results from the study conducted by the bank.

Table 4 Projected Costs of Integrated Solar Thermal and Gas Power Generation

Projection	***Discount rate***	
	8%	***15%***
2005		
Capacity (GW)	140	140
Production (TWh/yr)	325	325
Cost (¢/kWh)	4.0	6.5
2020		
Capacity (GW)	183	183
Production (TWh/yr)	639	639
Cost (¢/kWh)	3.5	4.5

Based on this study, the World Bank is currently funding the incremental cost of Egypt's first Integrated Solar Thermal Power Plant to be located in the North Coast. The Bank views the project as a means towards increasing the share of renewable energy in the power supply mix and to demonstrate the technology to local energy planners. Solar energy contribution in the 130 MW power plant is 35 MW. The plant will be implemented under an IPP arrangement and companies like Duke Solar and BP Solar are among the contenders. It is expected that the levelized cost of energy (LCOE) from this plant will be at levels competitive with conventional combined-cycle plants depending on the terms of the financing which were not readily available to the author.

D. Solar Industrial Processes Heat

The only study dealing with the economics of solar industrial processes heat was done by the World Bank in 1999. The study is brief and may not be accurately representative of economic viability of the technology in the different industrial sectors. It considered the existing market prices and did not attempt to run scenarios under different electricity subsidy levels. Results of the study came as follows:

Table 5 Cost Effectiveness of Solar Thermal Industrial Process Heat

Radiation level (kWh/m²/day)	Cost (¢/kWh) at given temperature		
	80°C	150°C	300°C
8% Discount			
5.5	0.69	1.26	4.24
6.0	0.63	1.15	3.85
6.6	0.58	1.05	3.53
15% Discount			
5.5	1.06	1.92	6.46
6.0	0.96	1.75	5.87
6.6	0.88	1.60	5.38

NREA has been active in testing several designs and technologies in this sector. Through assistance from USAID/Cairo, NREA is currently implementing two experimental solar industrial heat process projects in textile and food processing industries. Both projects are of low temperature (50 to 60 °C) with the objective of testing the technical viability of solar industrial heat and waste heat recovery systems in local industries. The projects involved the use of flat plate collectors with surface area of 356 m^2 producing 26 m^3/day of hot water with an estimated annual savings of 1,800 TOE for both projects combined. Energy audits and assessment of six other industrial sectors has been also completed to evaluate the technical viability of the technology. It is unclear, however, whether this assessment included an economic assessment of energy cost associated with the technology. There is a need for an updated and comprehensive economic assessment of the technology and its applications in various sectors in the economy while taking into consideration the effect of different electricity tariffs paid by various public and private industrial entities. Otherwise, it would be difficult to decide whether solar industrial processes heat is commercially viable in Egypt.

E. Grid-connected Wind

This sector is where Egypt's biggest potential is in terms of adoption of RE technologies. Good wind resources are available in various parts of the country, but the Gulf of Suez is confirmed to have the best wind resources with an estimated potential wind energy capacity of 30,000 MW, according to a study by the World Bank. Grid-connected wind in Gulf of Suez should be commercially viable with acceptable economic returns depending on the terms of financing and the power purchase price agreed upon between the government and the IPP. For example, the price the government is paying for 1 kWh from Zafaranna I Wind Farm, which is funded by Danida on grant basis, is LE 0.07/kWh. The project owner is NREA while the party purchasing the power is the Egyptian Electricity Authority. For Zafarana II, which is financed through Danida's mixed credit program, the government agreed to pay LE 0.09/kWh.

New wind farms in the Gulf of Suez could meet large share of the annual 1,000 MW additional generation capacity Egypt needs. Danida mission in Cairo is the one donor with the biggest support to this sector as it has funded the implementation of a 30 MW wind farm in Zafarana, Red Sea, and is partially funding a second 30 MW wind farm in the same location. One barrier in this sector is the lack of local wind energy consultancy companies and manufacturing companies. So far, the biggest share of work in the implementation of the wind farms in Gulf of Suez involved heavy reliance on foreign experts and equipment. It is expected that as more wind farms are established, the consultancy, and to an extent, the manufacturing sides of the sector would develop and prosper.

F. Hybrid Power Systems (HPS)

F.1 HPS (wind-diesel) for Desert Agriculture

Desert agriculture in new lands is gaining more importance as urban encroachment of premium agriculture old land in the Nile Delta and Nile Valley is worsening. In fact, both the public and private sectors have so far reclaimed about 3 million acres of desert land. Approximately half of the this land is located off-grid. At the time being, diesel-generation is the default stand-alone power supply system for these off-grid farms. Three main reasons could be identified as the explanation for the heavy reliance on diesel generation in desert agriculture in Egypt:

1. The need to minimize the initial capital cost of the total investment in the farm.
2. A 65% diesel fuel subsidy.
3. Lack of awareness and information on the economic and technical characteristics of clean energy technology applications in agriculture.

A 2002 study by the author of this report has found that wind-diesel hybrid power systems are commercially viable for certain off-grid desert agriculture projects in Egypt. The study looked at a 100 acres desert farm in East Owienat in southwestern desert of Egypt under the following assumptions:

- Two crops are cultivated in the 100 acres, potatoes and corn, in order to benefit from differences in growth cycles that level the daily water requirements per acre and hence level the load demand profile.
- The daily consumptive water requirement per acre of potatoes or corn is 30 cubic meters using sprinkler irrigation with 80 % efficiency and an evapotranspiration level for potatoes of 9 millimeter/day.
- Average wind speed of 5.5 m/sec.
- Subsidized diesel fuel price of U$ 0.09 per liter.
- The groundwater depth (static head) in the area is around 100 meters.
- One borehole serves 100 acres.

The study compared between the economics of using a diesel-only system versus the use of a wind/diesel hybrid power system with a water storage tank. Both systems were designed to address 100% of the load demand given the precariousness of desert agriculture to water shortages, full-time system availability is crucial. In the hybrid system, the dispatch strategy was set that renewable energy is always used when available and any extra renewable power is used to charge the batteries and/or fill up the water storage tank, depending on the level of water in the tank. Table 6 presents the result of the analysis, which also looked at the carbon emissions from both systems.

Table 6 Results for comparison between a diesel-wind vs. diesel-only stand-alone systems

System Architecture	Initial Capital Cost ($)	NPC ($)	LCOE ($/kWh)	Renewable Fraction (%)	Diesel Fuel (liters/yr.)	Carbon Emissions (ton/yr.)
Hybrid System: Three 50kW wind+100kW genset+50kWh battery+5kW inverter	516,146	820,668	0.124	62	80,473	57.9
Diesel-only: 100kW Genset	287,500	1,214,483	0.183	0.00	225,258	162.2

Source: Kamel, 2003

On LCOE basis, the wind-diesel system was the least-cost power system for this location. However, the feasibility of HPS in desert agriculture is location-sensitive as it will depend, among other things, on the wind speed in each location, which will vary widely. Generally, the wind energy penetration level should be high enough so that the increase in initial capital cost due to adoption of costly wind turbines should be offset by the savings achieved in diesel fuel and reductions in recurring O&M costs.

There are currently no private sector companies in Egypt that design or install HPS. Yet, the available technical capability in power systems design existing in the private sector is probably adequate to enable existing RE companies to add hybrid power systems to their portfolio of RE technologies, provided there is demand for the technology. Creating a market for hybrid power systems in Egypt will require building up good reputation for the technology among potential users (i.e. agribusiness firms with large desert farms). These firms are cost minimizers and are willing to adopt new technologies that will increase their global competitiveness. Marketing the technology as cost-minimizing option and accompanied by soft-term financing from the planned fund is one possible way to create demand for the technology in Egypt. It may also be possible that through the proposed MEDREP financing support mechanism(s), private sector companies could make few commercially-based demonstration projects. On the supply side, a commercial vehicle would have to be identified to promote this technology. Besides existing RE companies, diesel generator dealers could also be a good candidate since they have experience in the off-grid market and its needs and have an already existing clientele base that could be the initial marketing target group.

F.2 HPS (wind-diesel) for desalination

The past few years have witnessed a spur of growth in tourist resorts built on the Red Sea Coast in off-grid locations. Diesel generation based mini-grids have been the key source of power for these hotels. Desalination using diesel generators is used in these hotels at high cost per cubic meter of drinking water. Given the fact that the Red Sea coastal area enjoys good wind speed all year round, the use of wind-diesel hybrid power systems for desalination is worth investigating since there are no studies done on the economic viability of this technology versus the current diesel powered one. The technology uses reverse osmosis for water desalination and uses power generated from the attached wind turbine and diesel generator.

If hybrids prove to be more cost effective, there would be a good market potential for this technology in Egypt. The technology could be deployed early during the construction of the resort to provide hotel construction workers with drinking water and later after the completion of the hotel water for hotel guests. Soft financing through the proposed MEDREP financing support mechanism(s) would make the technology more attractive to potential users. However, given the novelty of the technology, the success of the deployment will depend to an extent on the effectiveness of the marketing of the new technology. One company that produces this technology is Danvest (www.danvest.dk). Among the expected barriers facing this technology is lack of information about this technology among potential customers and the need to import the whole technology from abroad while there is now severe shortage of foreign currency in the financial market in Egypt.

G. Biomass

Several R&D projects were made by NREA to test various biomass technologies, but there have been no attempts so far to commercialize the technology. Around 500 biogas digestors were installed for demonstration purposes. In Gabal El Asfar area in Cairo, the sewage treatment authority has established a biogas plant with 22,000 m^3 digestors and has been in operation since 1999. Danida mission in Cairo evaluated the sector in Egypt and recommended the rehabilitation of the above plant, and that plant management needs both financial and technical support to efficiently manage the plant.

The UNDP/GEF in Cairo will soon commence the activities of a Biomass project in two rural governorates that aims at exploring several biomass technologies and devise some financial and marketing mechanism for its deployment. One possible constraint biomass energy could face in Egypt is the fact that the areas where there are abundant agricultural wastes are covered by the grid, which from a least-cost perspective puts biomass in an uncompetitive position. However, if biomass will be viewed as means of air pollution reduction then it may be justified. It should be mentioned that the

Biomass energy is used widely in rural areas for cooking through direct combustion in open-fire stoves inside rural houses. The technology has limited potential as a source of electricity due to the fact that all the areas with large quantities of agricultural wastes are mainly in the old Delta lands, which are already covered with grid power.

The results of the UNDP/GEF project should be assessed before devising strategies for the commercial support of the technology. Yet, there might exist private sector companies with commercial interest in the technology and which could be supported depending on the feasibility studies submitted by these companies.

H. Small and Medium hydropower

The terrain and topography in Egypt allows for limited opportunities for small and medium hydropower projects. At the same time, average annual precipitation levels in Egypt are extremely low (reaches zero in many year), which makes it difficult to use utilize micro dams. The following table presents the few potential sites where small and medium dams could be built along with the estimated capacity. As shown, the total capacity for all possible small & medium dams does not exceed 100 MW. No studies where done to assess the cost-effectiveness of these potential dams.

Table 7 Potential sites suitable for small and medium hydropower generation

Site Location	Head (meters)	Discharge (m^3/seconds)	Estimated Capacity to be Installed	Number of Units	Type of Units
Nag-Hammadi	4.5	1,500	56.5	5	Bulb Turbines
Assuit	4	1,200	40	4	Bulb Turbines
Dameitta Branch	4.4	280	12	2	Semi Kaplan Gear Siphon
Rosetta Branch	5.3	60	3.1	1	Kaplan w. Gear
Zefta	3.5	90	3.1	1	Semi Kaplan Gear Siphon
Dairout	5.1	60	3	1	Kaplan w. Gear
El Azab	5.6	15	0.71	2	Francis Pit Turbine
Tamiya	6	9	0.475	1	Kaplan Tube Turbine

Source: Danida Cairo Mission, 1999.

The use of water wheels for small-scale power generation is also limited by the flatness of the terrain in the areas where water canals are. The following table presents the results of a survey conducted by a Danida funded mission in 1999. As shown, the total potential output capacity at the national level from these wheels if installed would be around 9.8 MW. A fact that should be considered here is that all the areas identified in both tables for small and medium hydropower projects are already covered by the grid.

Table 8 Potential sites for water wheel installation

Site Location	Head (Meters)	Discharge (m^3/seconds)	Number of Wheels	Capacity to be installed (KW)	Energy Production (GWh/year)
Mansouria Canal	1.37	73	3	500	2.5
Abassy Canal	1.53	150	6	1,000	5
Menoufia	1.3	201	6	1,000	4.5
Nassery	1.77	31	2	360	2
Bagouria	1.84	42	2	400	2
Karenein	1.31	92	4	750	3.8
Tewfiki	2.25	155	6	1,200	7
Gamgara	2.06	61	4	750	3.8
Yousef Canal	1.67	138	6	1,200	6
Ibrahimia	1.67	133	6	1,200	6
Lahoun Barrage	1.85	49	3	600	3
Hebab Weir	2.55	13	1	180	0.9
Sikka Elhaddeed	1.86	12	1	150	0.8
Asfoun Canal	2.00	16	1	150	0.8
Kellabia Canal	2.06	39	2	380	1.5

Source: Danida Cairo Mission, 1999.

Conclusion

In the immediate to the short term, the following technologies are commercially or near-commercially viable and could be supported through proposed MEDREP financing support mechanism(s):

1. Grid-connected large scale wind.
2. Small & Medium wind for off-grid water pumping.
3. Wind-diesel hybrids for off-grid pumping and electrification.
4. Solar water heating.
5. PV for telecommunications.
6. Solar-thermal power.
7. PV for off-grid ice making.
8. PV for home systems.

Tailor-made finance support mechanisms would contribute to a faster deployment of the above technologies and in some cases will create new markets for the technologies with no existing market.

Ideally, the finance mechanism should be accompanied by both regulatory reform at the national level and the introduction of an array of financial and non-financial incentives by the government with the objective of increasing the attractiveness of investing in these technologies. Experience from developed and developing countries show that the commercial viability of a renewable energy technology is usually inadequate as a prerequisite for that technology to be picked up by the market and that government/donor support is usually needed before the market is mature.

In the short to the long-term, hybrids for water desalination, PV for water pumping, biomass energy and solar industrial processes heat may require further studies and planning before deciding how it could be commercially deployed. However, if private sector RE companies are able to conduct their own technical and economic analysis that proves that these technologies are commercially viable, then it could be possible for the proposed MEDREP financing support mechanism(s) to look into these technologies.

1.2.3 Availability of RE Resource Assessment Data

Solar Resource Data

Accurate and detailed solar insolation data is available at NREA. A Solar Atlas was issued by NREA in 1991, which covers all of Egypt's climatic zones. Solar resources in Egypt are excellent with "average global radiation between 1,900 and 2,600 kWh/m^2/year from northern to southern parts of the country, while the direct normal solar radiation reaches 1,970 to 2,600 kWh/m^2/year with low levels of cloudiness."

Wind Resource Data

Wind Atlas for the Gulf of Suez was completed by Risoe National Laboratory in 1996. In February 2003, an updated and more detailed version of the same atlas was completed by Risoe as well. The level of details in the updated version is adequate for wind farm project design and development including detailed feasibility studies. At the time being, Risoe is making a Wind Atlas for the whole of Egypt, which is expected to be completed by summer 2004. As part of the work for this national atlas, Risoe has installed wind-measuring instruments in sites in North Coast, East Owienat, around Cairo, Red Sea coast, and some of the western desert Oasis. However, when designing wind/diesel hybrid power systems for off-grid desert agriculture, wind speed may have to be measured in the specific project locations.

Biomass

A UNDP project document estimates that the agricultural sector in Egypt produces "16 million tones per year of agricultural residue plus enough dung to provide several million households with biogas. In addition, roughly 50% of agricultural residues are burned on the field" which creates air pollution problems in both rural and urban areas during certain months of the year. There is lack of statistics as to the breakdown of the amount of agriculture wastes produced in Egypt, although it is expected that agricultural wastes from rice and sugar cane cultivation have the biggest share of the 16 million tones.

1.2.4 Potential for Energy Efficiency (EE) deployment in Egypt

Through support from USAID and UNDP in Cairo, at least thirteen Egyptian ESCOs have been established in Egypt with the objective of investing in EE technologies. A national association for ESCOs has also been established. Many investors view investment in the EE sector as a potentially rewarding business area, primarily due to three reasons. First, energy intensity figures in many local industries are high which implies there is a good chance for improving energy utilization. Second, old manufacturing technologies and processes in industries like oil refineries, textile, iron and steel, aluminum, fertilizers, and food processing all create good opportunities for investing in EE. Third, cogeneration in large service-based buildings like hospitals and hotels offers an equally attractive opportunity for improving energy utilization. A USAID study (by the Energy Efficiency Policy Program) estimates that the "net present-value energy-savings figure is about LE 12 billion," where the potential for energy savings is roughly equivalent to 50% of current energy consumption. Many ESCOs are hoping that the government continues its gradual removal of electricity subsidies, which would increase the attractiveness of investing in EE technologies in the long run. The current USAID program supporting ESCOs is helping several potential EE projects in securing financing from commercial banks in order to set precedence and eventually create a market for EE investment. The speeding up of the privatization program by the government may lead to bigger interest in EE from newly privatized industrial entities in which the new management would like to improve the efficiency of the production process and minimize cost of production which were typically compromised under state or public ownership. There is currently an immediate need for a source of funding that is willing to finance several startup EE projects in the Egypt in various industries with soft lending terms. Yet, the need for financing does not seem to be the only barrier facing this sector and other barriers to EE investment will be presented later in the study.

1.3 Policy Framework Review for RE in Egypt

1.3.1 Status of the Electricity Sector

Electricity was first introduced in Egypt in 1893. The sector was controlled and operated by different government agencies until 1964 when the government established the Ministry of Electricity and Energy. For many years, the Egyptian Electricity Authority, which functions as part of the Ministry of Electricity, controlled the whole power sector - generation, transmission, distribution, meter installation, and operation and maintenance of power generation facilities. However, structural reforms to the power generation sector were implemented in year 2000 which led to the creation of Egyptian Electricity Holding Company (EEHC), the primary player today in Egypt's power sector. EEHC owns seven holding companies each of which has power stations and distribution lines and is wholly owned by its employees. Yet, the overall supervision of the power sector continues to be done by the Egyptian Electricity Authority (EEA).

At present, the total annual amount of electricity generated in Egypt is about 68,031.3 million kilowatt/hours (kWh) produced by a total installed generating capacity of 15,223 MW, excluding the 63 MW installed capacity of wind farms in Zafarana. This output is generated from 102 state-owned power plants. Given the current annual increase in demand for power, Egypt needs 1000 MW of additional generation capacity every year. In 1996, the government decided that only the private sector would develop new power generation plants. This would be coherent with the national privatization scheme adopted by the government and triggered by the World Bank. There is now 2000 MW of privately owned power generation entities, which roughly represents 10-15% installed capacity. At the time being, two foreign Independent Power Producers (IPPs) have developed two separate power plants under a Build-Own-Operate-Transfer (BOOT) system. Through this program, the private investors build, own and operate power generation plants for a specified period, during which they can regain invested capital plus a decent return, and then transfer the plant's ownership to the government at the end of the contract period. The first plant is the Sidi Kirir 685 MW combined-cycle power plant in Alexandria owned and operated by Intergen (a US based joint venture owned by Shell and Bechtel). The second is a 680 MW power plant owned and operated by Electrecite' de'France (EdF). The government normally views the BOOT arrangement as an opportunity to fulfill infrastructure development plans without putting a burden on the national budget or increasing the country's foreign debt. However, this may change as there are now voices within the Ministry of Electricity calling for the halting of the use of the BOOT approach on the grounds that IPPs charge the government high prices for the produced power given their high cost of capital, while power projects built by the government receives some preferential treatment from public sector banks leading to lower cost of capital and lower price of electricity! At the same time, a new BOOT law issued early 2003, estates that BOOT foreign contractors will be paid by local currency and not by US Dollars. Such amendment to the law may reduce the attractiveness of the power generation sector in the eyes of Independent Power Producers (IPP) and Foreign Direct Investors given the fact that their project financing is typically done through loans from foreign banks abroad hence their loan repayment would have to be done in foreign currency as well. One exception this law makes is BOOT projects that generate foreign currency through exporting the good produced, such as Liquefied Natural Gas (LNG) projects, which are allowed to be paid back in foreign currency. The exact impact of the new amendment to the BOOT law will remain to be monitored especially that the government may rescind its decision later.

Egypt's power grid is currently connected to grids of neighboring countries where Jordan and Libya both import part of their electricity from Egypt. A new power grid connection to Tunisia is currently being finalized which would ultimately enable Egypt to export power to anywhere in Europe. However, Egypt's energy planners are debating the cost effectiveness of exporting natural gas in the form of LNG versus grid power.

Since 1980, electricity demand has been growing by around 6% annually. Given this level of increase, Egypt requires approx. 1000 MW of additional generation capacity every year.

Table 9 shows consumption of electricity in Egypt by sector. The industrial and residential sectors are the biggest consumers.

Table 9. Electricity Consumption in Egypt by Sector

Sector	Percentage of total electricity consumption
Agriculture	4.1%
Industrial	41%
Transportation	0.3%
Residential and Commercial	37.9%
Government and Public Sector	4.6%
Other	12.1%

Source: Egyptian Electricity Authority, 1998/99.

Almost all of the new added generation capacity will come from the construction of new power plants. The government plans to achieve 3% RE share in the power supply mix by 2010 (excluding hydropower from Aswan High Dam which currently contributes about 20% of annual total power generation). The government realizes that at least four direct benefits can be immediately realized from the use of renewable energy. The first is a reduction in the emission of greenhouse gases produced from conventional power generation. The second is revenues generated from being able to export saved power to neighboring countries. The third is that saved natural gas used as fuel for power plants would be exported for much-needed hard currency, and finally savings in the budget allocated for energy subsidies paid by the government. However, this 3% target seems to be more of an official statement than an actual commitment as there are currently no specific policy instruments or incentives adopted to facilitate the achievement of this objective.

As mentioned earlier, Egypt's geographic distribution of population has resulted in having 95% of Egypt's population to be connected to the national power grid, which is mainly extended from Aswan in the south to Nile Delta in the north. The rest of the population is scattered in several western desert Oasis, north Sinai's fishing villages and south Sinai. The primary source of power for these off-grid communities is stand-alone diesel power systems. A 60% diesel fuel subsidy makes diesel generation an attractive power supply solution to local energy planners.

Electricity tariff structure in Egypt is characterized by having large private sector consumers paying a price that is close, if not equal, to the Long-Run Marginal Cost (LRMC) of electricity, while smaller consumers enjoy various levels of subsidy. It is estimated that the LRMC of the electricity from the grid is LE 0.24 per kWh or 4 US cents (based on an exchange rate of 6 Egyptian Pounds = 1 US dollar). Also, there is a differentiation in electricity tariffs among public versus private industrial and other commercial consumers. In addition, cross-subsidization is used by the government as means for assisting poor consumers in rural areas and for financing of rural electrification. The energy sector in Egypt, in general, remains to be one of the biggest recipients of government subsidies. In 2001/2002, the government spent at least U$ 2.2 billion on energy subsidies. As part of the structural adjustment program, energy subsidies continue to be gradually decreased since late

1980s. Yet, small household consumers and public sector industries remain to receive large shares of that energy subsidy. Table 10 presents examples of the current electricity tariff structure.

Table 10 Examples of the various electricity tariffs charged by the electricity utilities in Egypt

Consumer Type	Tariff Paid by Consumer (Egyptian Pounds Per kWh)
Very High Voltage consumers (e.g. Kima Aluminum Factory)	0.05
High Voltage consumers	0.12
Agricultural consumers (e.g. electric water pumps for irrigation)	0.10
Residential consumers:	
First 50 kWh/Month	0.05
51-200 kWh/Month	0.08
201-350 kWh/Month	0.11
351-650 kWh/Month	0.15
651-1000 kWh/Month	0.21
More than 1000 kWh/Month	0.25
Commercial Consumers:	
First 100 kWh/Month	0.18
101-250 kWh/Month	0.26
251-600 kWh/Month	0.33
601-1000 kWh/Month	0.41
More than 1000 kWh/Month	0.43
Public Lighting	0.30

Source: Danida Mission in Cairo, 1999.

1.3.2 Policies, Barriers & Regulatory Framework for RE

Various barriers exist which hinder the spread of RE technologies and the creation of a market for clean energy technologies. These barriers may be categorized and described as follows:

Awareness and information. Lack of awareness and information about RE technologies among policy makers, energy planners, and potential users of the technology. In addition, certain RE technologies (i.e. solar water heating) have poor reputation among residential consumers. Poor maintenance of installed solar water heating systems and substandard equipment led to malfunctioning systems which contributed to deteriorating reputation of the technology itself.

Financial. First, lack of financing, especially soft-terms financing. This is partially attributed to the fact that there is a considerable lack of knowledge and awareness among finance institutions towards clean energy technologies and how to evaluate investments in that sector. Therefore, awareness raising and capacity building for the finance sector would have to be incorporated in any finance facilitation schemes. A program that strictly deals with finance facilitation may not be holistic enough to tackle the inherent problems in the RE sector in Egypt. Second, the economics of some renewable energy technologies (e.g. PV water pumping and PV home systems) are in an unfavorable competitive position due to large energy subsides in the market, specifically diesel fuel subsidy (approximately 65%) and electricity subsidies. In addition, high import tariffs on some components of RE technologies (e.g. 50% import tariff on batteries for PV systems, and 30% on integrated PV systems, and 10% import tariff on PV cells). Third, minimization of initial capital cost is the primary decision criteria used by local energy planners when designing off-grid power generation systems. Levelized Cost of Energy (LCOE), carbon emissions, diesel fuel consumption, and life cycle cost are seldom, if at all, included in calculations made while designing off-grid power supply solutions.

Institutional. First, the national economic development plan does not incorporate renewable energy as a target sector that should be given priority as a means for achieving savings in the national budget and improved environmental conditions. This is partially attributed to large discoveries of natural gas which has shifted the attention from RE as a possible contributor to energy supplies in the country. Second, NREA does not seem to be directly involved with local energy planners in the evaluation of technology options for off-grid power supply systems as its role seems to be confined to R&D work rather than technology deployment. Third, there are no financial/non-financial incentives or command & control regulations that would increase the adoption of RE technologies (Annex 4 lists examples of policy instruments used by other countries to promote use of clean energy technologies).

Regulatory. For grid-connected wind, and as mentioned earlier, one barrier is a modification recently made to the BOOT laws in Egypt. The amendment stipulates that in the Power Purchase Agreement (PPA), the government will buy the power from the IPP in local currency and not in foreign currency as was done before. The implications are that foreign investors interested in becoming an IPP in a grid-connected wind project will not be interested in such offer given the fact that all project financing will be done in foreign currency and probably from a foreign bank. However, this amendment is quite recent and the situation should be monitored as to the impact of this regulatory change on potential IPPs in the wind energy sector.

Business size. RE companies in Egypt are relatively small which makes them unable to influence policies or regulations set by the government. In addition, there is no strong or active specialized trade association that could convey or voice their demands or concerns.

Reputation. Several businessmen the author talked to knew very little about RE technologies but thought that the reason why they don't adopt it is its' high initial capital cost. Among local policy makers, the same reputation for RE technologies prevails. Add to this is that among the residential buildings community, there is a belief that solar water heating is a technology that does not function well and is unreliable. As mentioned earlier, the government's attempts to introduce the technology in new urban settlements was not accurately done as it did not outline or adhere to clear and strict quality standards for the systems to be installed. Many of systems installed stopped functioning later on due to poor quality and substandard equipment. However, among owners of Red Sea tourist resorts, there is a good appreciation of the technology hence the wide spread adoption of it in Red Sea hotels and resorts.

Human resources. There are no specialized consultancy firms that provide consultancy services in the area of RE. Companies active in the RE sector are basically capable of installing technologies and conducting needs assessment but little economic evaluation of least-cost options is conducted. In addition, curriculum in local engineering universities pays limited attention to renewable energy technologies. Also, majority of managers in the RE company themselves lack appropriate business development training and are strictly engineers.

Competing resources. Large discoveries of natural gas in recent years continue to strategically shift the government's attention away from developing the renewable energy sector and markets.

1.3.3 Policy Framework for EE Investments

The one policy framework that could be considered as a factor favoring EE investments is the government stated interest in seeing EE investments taking place in order to reduce the load demand on the national power grid and maybe slow down the level of annual increase in energy consumption. Nevertheless, there are currently no special incentives (financial or non-financial) offered by the government to ESCOs wanting to invest in EE projects. On the other hand, the policy framework factors hindering EE could be described as follows:

Electricity tariff. Biggest electricity consumers (commercial and industrial) entities that also suffer from high levels of energy intensity happen to be public sector entities that receive large electricity subsidies. For example, KIMA fertilizer plant is charged only LE 0.03 per kWh while a similar private sector facility is typically charged LE 0.22 per kWh. With electricity prices as low as these, there is no real incentive to invest in an energy saving technology.

Finance. Banks are reluctant to lend EE projects. Several project proposals were submitted by the local ESCOs to banks and were rejected. Banks state two main reasons for their rejection. First, they are unfamiliar with this kind of technology and have not seen any success stories within the Egyptian context that would make them want to replicate this type of investment. Second, the amount of loan applied for it too small to justify the bank's administrative costs involved in the management and monitoring of a loan. To the banks, a U$ 100,000 loan requires the same level of effort and paper work that a U$ 10 million loan needs. All EE investment proposals involved what banks consider small amount of money (e.g. U$ 100,000 to U$ 500,000 per project). Finance consultancy could look into the role of investment guarantees mechanisms and how it can be employed here to facilitate EE investments.

1.4 RE Sector Overview

1.4.1 Status of RE sector in Egypt

The government has set a target of increasing the share of renewable energy in the power supply mix to reach 3% by year 2010. The biggest share of this increase is expected to be in the form of additional wind energy production capacity in Gulf of Suez where the wind resources are quite promising. In general, the government expresses strong support of RE technologies but this support is not accompanied by policy instruments that would lead to the creation of RE markets or the achievement of the set target of 3%.

The government normally encourages local and international private sector investors to developing grid-connected wind farms in Gulf of Suez area through the Build-Own-Operate-Transfer (BOOT) arrangement. Until recently, grid-connected farms were a fairly new concept but with the completion of Danida's 30 MW wind farm in Zafarana in Gulf of Suez, the concept become much familiar to local energy planners. Zafarana II and III each with generation capacity of 30 MW are currently in the pipeline through assistance from Danida and KfW.

At the R&D level, and through the work of NREA, the government is supporting several experimental RE technologies. The following are some examples of NREA-sponsored RE demonstration projects:

- NREA installed a 14 kW PV water pumping system in Wadi El Natroun (an off-grid area 100 km north of Cairo). The system produces between 70 to 100 m^3 per day of irrigation water.
- A portable 2.2 kW PV water pump installed in West Al Noubaria in order to supply a drip irrigation system with groundwater.
- A PV/Diesel hybrid Ice Making system is installed on Wadi El Rayan Lake, an off-grid area 100 km South-West of Cairo near Fayoum City. The system provides ice flakes used for fish storage during the fishing season in the lake. A 38 kW PV array operates during daytime, while a 50 kW diesel genset operates during night.
- An 18 kW PV reverse osmosis desalination system has been installed on the Red Sea coast south of Hurghada. The system produces 60 m^3 per day of drinking water.

Another RE technology the government supports is solar water heating. The purpose of the 1986 law enacted was to impose on all new apartment buildings built in the new urban cities outside of main citifies to use solar water heating systems. Urban developers and contractors complied with the new law for some years but gradually stopped abiding by this law due to two main reasons. First, adequate enforcement of the law by the government was not sustained, and second, tens of solar water heating systems of poor quality were procured and installed. These bad systems stopped functioning soon after installation, which created bad reputation for solar water heaters among potential customers. A fall in the demand for solar water heaters accompanied by lack of enforcement of the law eventually led to a sharp and long recession in the solar water heaters market in Egypt. However, the construction of tens of off-grid tourist resorts on the North Coast and the Red Sea coast has some how resulted in the partial revival of the solar water heaters market in Egypt. Several hotels have already installed solar water heater systems but ample opportunities remain to be explored as more and more tourist resorts are being built every year. A potential threat to this market is the lack of technical standards set by a government body that would secure the quality of the systems installed. Malfunctioning solar water systems in the tourist resorts sector would lead to yet another blow to the reputation of the technology itself. Unfortunately, poor maintenance of the installed systems is currently making some hotels switch to electric water heaters operated by power supplied from diesel generators in the hotel premises. As mentioned earlier, solar water heating has good commercial viability but requires regulatory support from the government that would protect the reputation of the technology among potential users.

Another way the government supports the renewable energy sector is through funding R&D work in the area of renewable energy technologies through provision of financial support to the New and Renewable Energy Authority (NREA). This government body is part of the Ministry of Electricity and is charged primarily with conducting R&D work in the area of RE technologies. In addition, the authority works closely with foreign donor agencies injecting funds in this sector through joint implementation of various demonstration projects. The Zafarana wind farm is a good example of collaboration between NREA and Danida in Egypt, where NREA is responsible for the operation and maintenance of the wind farm while Danida funded the project implementation and the purchase of project capital equipment.

One challenge NREA faces is to transform its orientation from being an R&D institution into a commercially oriented body focused on the commercialization of the RE sector in the country. A second challenge is to raise the awareness of local energy planners towards the possibilities of using RE technologies in some remote locations instead of choosing, by default, diesel-only stand-alone power supply systems.

1.4.2 Profile of Sample RE Companies

Companies working in the RE sector in Egypt are limited in number and could be considered medium to small enterprises with workforce that ranges from 10 to 50 technicians and engineers. Given the limited RE market in Egypt, some of these companies are struggling to exist.

The main method these companies operate is through bidding for tenders issued by various companies and government entities. In the PV sector for example, the lucrative bids are typically issued for PV for telecommunication posts mainly by mobile phone, oil and gas, railroad , telecommunications, and advertising companies. When a company wins a bid it applies for a bank loan through presenting a letter of guarantee that shows the credit worthiness of this company as assessed by its own bank. The company is typically paid its fees from the clients in installments depending on the terms of contract. There are some cases where local private investors participated in funding some of these companies but no specific data on the size and conditions of this type of equity financing is available.

Key source of funding for these companies is bank loans. RE companies stated that some banks are concerned about the RE sector in general as the banks could not identify a RE investment success story in the market that they would want to replicate. However, several companies interviewed stated that securing bank loans is an issue of collateral as well. If a company has a good RE track record and a good business proposal but could not submit adequate collateral, its loan application would be rejected. One common element in the companies interviewed was that none of its managers had received business development training before as they were all engineers with hands on market experience but no professional or academic business training.

None of the RE companies in Egypt are publicly traded, and debt financing is typically the main source of financing for these companies. Some of the companies have managed to reach agreement with international RE companies to become their representative in Egypt. For example, Shell Solar is represented by a company called MEET (see table below). One way these companies plan to utilize the proposed MEDREP financing support mechanism(s) is through implementing RE projects for government agencies based on relaxed payment schemes from the government authorities to the companies. The RE companies would then repay the loan to the bank based on terms and conditions stipulated by the proposed MEDREP financing support mechanism(s). The finance consultancy should assess this approach and advise whether such an approach would facilitate RE market creation.

Two of the active companies mentioned they are interested in applying for loans from the proposed MEDREP financing support mechanism(s) to expand and/or update their manufacturing and assembly facilities to enable them to enter the export market to several African countries. However, these companies expressed need to apply for international certifications in order to have their products certified and accepted by international donor agencies interested in deploying RE technologies in African countries. Among the financing terms and conditions the companies expressed need for were extended grace periods for the loans (12 to 18 moths), zero interest rate loans and portion of the loans would be in the form of a grant.

One of the local PV companies made serious attempts to penetrate the off-grid rural electrification market in other African countries and achieved good results but could not continue the effort due to high travel costs associated with identification of new business opportunities in African countries. However, the company owner believes that Egypt is well positioned to be a key regional manufacturing and assembly hub for PV systems to be exported to African countries. He stressed that his company needs to obtain international certifications in order to bid for RE projects in Africa.

Another medium-size local PV that specializes in assembly of PV systems, imported the components for its systems from a North American company and assembled the systems in its facilities based on the client's needs. The assembly facility has approx. 20 technicians and engineers with a maximum output capacity of 1 MW per year, but the biggest production they ever did was 300kW. The company implemented PV home systems for remote villages under funding from the government. However, the focus of their work is on PV systems for telecommunication posts and for advertising boards, but since the recession in the economy, advertising budget is going down and market for PV in this sector is slowing down. The company presented various project proposals that it would like to implement through assistance from the proposed MEDREP financing support mechanism(s).

Table 11 List of RE companies active in the market

Entity Name	RE Sector	Activity	Contact Information
IGSR Solar Cells Laboratory, Alexandria University	PV	Fabrication and assembling of photovoltaic cells and modules; photovoltaic energy systems.	163 Horrya Avenue, P.O.Box 832, Alexandria, Egypt Tel. + 20 3-5565272 Fax. + 20 3-429624
Arabian Solar Energy and Technology Co - ASET	PV	Photovoltaic systems integrator, nickel cadmium batteries, telecommunication batteries	11 Sherif Street, Cairo, Egypt Tel. 20 2 393 6463 Fax 20 2 392 9744 Mr. Mustafa Ebeed
BIC for Electronics Environment and Energy Photovoltaic Division	PV	Manufacturer of PV modules: Design, installation and maintenance of PV systems	9 Marouf Street, Cairo 11522 Egypt Tel. 20 2 5798334 Fax 20 2 5795744
Electronics Research Institute Photovoltaic Cells Dept	PV	Consultancy and research on PV systems	National Research Center Building, El Tahrir
United Company for Light Industries - PILCO	solar thermal applications	Supplies solar systems	Eng. Galal Maamoun, 2 Suliman Abaza, Mohandeseen, Giza. Tel. 20-2-3617060 Email: fimco@link.com.eg

I.M.F	PV and Wind	Whole supplies, installation and maintenance of PV modules, and large-scale wind energy systems.	17 A Yehia Ibrahim St. Zamalek, Cairo. Tel. + 20 –2-7369239 Fax: 20-2-7354346 www.imfgroupegypt.com
Middle East Engineering and Telecommunications (MEET)	PV	Supplier of PV systems for telecom. and home systems (Agent of Shell Solar).	Mr. Wael Nashar 16 Anwar El Mofty Street, Nasr City, Cairo Tel. + 20-2-2638123 Mobile: +20-10-1043043
Minar Engineering Co.	PV and Wind	Supplies and installs solar electric power systems, photovoltaic systems, photovoltaic modules, wind energy systems (small), wind turbines (small), renewable energy system batteries.	5 Ahmed Abdel Ghafaar St., Heliopolis West, Cairo. Tel. & Fax + 20-2-2467261
Solenco	PV	Supplies and installs PV modules	17 Kasr El Nil St., Cairo. Tel. + 20 – 2 393-7678
TUV Hessen Egypt	Technical Inspection and Certification of PV systems	Inspects and certifies PV pumps, generators, PV modules, and hybrid power systems.	20 El Montazah Street, El Zamalek, Cairo. Tel. + 20-2-7364979 Fax + 20-2-7351031
Exact Company	Battery production	Produces sealed lead-acid storage batteries as well as lead-calcium batteries.	35 El Gazaeer St., New Maadi, Cairo. Tel. + 20-2-7030611 Fax + 20-2-7036549 Email: expo@infinity.com.eg
Egyptian Solar Energy Systems Company	Solar water heating	Manufacturers and installs solar water heating components and systems.	11 El Gamaa St., Giza. Tel. & fax + 20-2-5737813

1.5 Overview of past and current commercially oriented RE programs

The government supports the deployment of renewable energy technologies in general, yet, as mentioned previously, there are no specific commercial programs that the government is currently implementing and which aim at facilitating commercial deployment of renewable energy technologies. Also, no policy instruments or regulations currently set to promote the adoption of clean energy technologies. However, the government has been committed over the years to allocate a budget for NREA and its R&D work in the various RE technologies, specifically wind, PV, biomass, and solar thermal technologies. The majority of existing RE programs with commercial orientation is donor-related. Below is an overview of these programs.

As mentioned earlier, the UNDP/GEF office in Cairo is currently planning a U$410,000 biomass project that aims at establishing a commercial biomass sector in two rural governorates as a pilot project. The project is expected to commence activities by late 2003.

The United States Agency for International Development (USAID) has been implementing a program called the Commodity Import Program (CIP) with an annual budget of $200 million. The program offers soft financing for Egyptian businesses importing US manufactured products. The program supports the importation of tens of products including clean energy technologies including wind turbines, PV systems, and biomass energy technologies. Such program could be utilized by the proposed MEDREP financing support mechanism(s) target group in the procurement of necessary RE technologies. The terms and conditions of the program are that an Egyptian investor interested in importing specific product from the US, say a 50kW Atlantic Orient Corp. (AOC) wind turbine, should first get a price quote, and finalize the Letter of Credit arrangement with an Egyptian bank. The applicant takes a loan from the USAID under this program and which he uses to import the good. The advantage the program offers here is that the interest rate on the loan is zero during the first six months of the loan period, and then the loan repayment is spread over a period between 12 to 36 months pending on the technology type and whether the importer is the final user of the good or he will sell it to a third party. Clean energy technologies are among those given a six months grace period, and a three years loan repayment period. In addition, the USAID in Washington, D.C., is currently planning to establish a clean energy technologies fund that will operate in all USAID countries including Egypt. The technologies the fund will support or the terms and conditions of the lending process are not yet decided.

Danida's Private Sector Support program is Danida funded program that aims at promoting Danish-Egyptian joint ventures in any sector or industry, including renewable energy technologies. The program covers costs pertaining to the establishment of the joint venture. For example, the cost of the feasibility study for the investment to be made by the joint venture is typically covered by the program. The key condition is that the Danish partner should be an equity partner rather than just a franchiser or a technology provider. Although the program does not give special preference to RE joint ventures, it welcomes business cooperation in the sector. So far, there has been no RE joint ventures formed under this program.

Danida is currently producing Egypt's Wind Atlas and has already funded the implementation of a 30 MW wind farm in Zafarana, Gulf of Suez and is currently partially funding another 30 MW wind farm in the same location. This second wind farm is being implemented under a Danida global program called Mixed Credit Program, which entails that Danida covers all the interest on a loan made by a developing country to implement a project using at least 50% Danish-manufactured technologies. For Zafarana II, the wind turbines are imported by NREA for this second wind project and Danida will pay the interest on the loan made by Egyptian Government while the principle loan amount will be repaid by Egypt. Danida mission in Cairo stated that the government welcomes this mixed credit arrangement as it has encouraged them to request the construction of the second wind farm through the mixed credit program. Another Danida program is to offer technical Assistance in the RE sector to NREA. This is done through placing for five years a Danida RE advisor at NREA. He advised NREA on technical and policy issues pertaining to RE deployment in Egypt. Danida is also funding a study by a Danish consultancy firm that will produce four possible detailed scenarios for Egypt to adopt in the development of the Gulf of Suez as a major wind energy center for Egypt. The study should be completed by early summer 2003.

The World Bank is currently implementing in Egypt a program called the Private Sector Wind Power Development Project. The project concept is based on the development of private sector wind farms in the Suez Gulf area. The project will form part of the World Bank/GEF Strategic Partnership for Renewables. The role of the GEF is "to assist in developing a national policy framework for renewables in Egypt through the introduction of a mandated market share (MMS) - a means by which utilities have legal obligation to meet some of their supply from renewable sources and have a legal right to recover the incremental financial costs from consumers. GEF will finance studies, technical assistance and cost-shared activities, which will develop the 'market infrastructure' for wind energy development. Investment, ownership and operation of wind farms will be by the private sector."

Another on-going World Bank program is the Integrated Solar Thermal Power Project. The objectives of the project are to "increase the use of renewable energy sources in Egypt and, to enhance the level of commercialization and financial performance in the Egyptian power sector using private sector participation. The global environment objective of the project is to increase the economic attractiveness of solar thermal power generation worldwide by creating learning effects that will lead to a reduction in costs in the long-term." Through the project, the World Bank will cover an incremental cost of approximately $40 million as a GEF grant. The solar energy share in the total plant installed capacity is 30MW. Project contractors have been selected but work has not initiated yet.

UNDP/GEF office in Cairo will later this year start implementation of a biomass project in two rural governorates (Assuit and Fayoum Governorates). The project will design and adopt anaerobic biomass digestors for dung, briquetting, and leafy feedstocks including agricultural wastes. UNDP/GEF are also funding a fuel cell pilot program for public transportation vehicles.

The Dutch Development Cooperation is implementing a project with NREA with the objective of installing five diesel-wind hybrid stand-alone power systems to communities in the western desert south of Marsa Matrouh. The project is facing delays due to the Dutch contractor's inability to deliver the agreed upon systems on time. The Dutch Development Cooperation is coordinating the project with NREA, which is helping with the selection of specific locations for the hybrid power systems.

One program that could compliment the proposed MEDREP financing support mechanism(s) is the European Commission's (EC) Modernization of Industries program. This on-going project offers technical assistance to Egyptian small and medium industries interested in modernizing themselves in order to become more competitive in the global markets. The project manger expressed willingness to assist small and medium RE companies interested in expanding or modernizing their assembly or manufacturing facilities by making technical assessment of how this could be best done. Based on this assessment, these companies could possibly approach the planned fund for a soft loan to implement the advised up-grades.

KfW currently has a Euro 30 million program in Egypt that offers soft loans for companies interested in installing environmental technologies for their manufacturing facilities in order to comply with Egypt's pollution prevention regulations. Annex 4 provides detailed description of the fund. Although the fund does not target RE technologies, the author has included it in this section, as it may be useful for the finance consultancy to consider the finance mechanism adopted by KfW and which is acceptable to local banks. The finance consultancy is advised to consider the lending mechanism devised for this program given the fact that it has been approved by three commercial banks participating in the fund management. Details on this lending mechanism are available at request from the author.

In conclusion, there are no specific RE support programs sponsored by the government. Yet, there are several donor funded private sector programs that deals directly or indirectly with the adoption and commercialization of clean energy technologies.

1.5.1 Listing of relevant RE programs (sorted by technology)

Biomass:
- A pilot project funded by UNDP/GEF Cairo.

Wind Energy:
- Private Sector Wind Power Development Project, the World Bank.
- Funding and implementation of a 30 MW Wind Farm in Gulf of Suez, Germany's KfW.
- Funding and implementation of 30 MW Wind Farm in Gulf of Suez, Danida.
- Joint-funding of a 30 MW Wind Farm in Gulf of Suez, Danida and Government of Egypt.
- Technical Assistance for RE sector to NREA, Danida.
- Production of Egypt's Wind Atlas, Danida.

Solar-Thermal Power Plants:
- Integrated Solar Thermal Power Project, The World Bank.

The author has identified four banks with experience or interest in managing environment or energy-related funds. Some of the banks were briefed about the proposed MEDREP financing support mechanism(s) and expressed interest in further discussions. Annex 4 lists the banks and contacts at each bank.

1.5.2 Summary of RE Programs

Program title: Biomass Resources and Biomass Energy Technologies for Rural Development.

Program Objectives: Utilization of agricultural wastes through and the commercialization of biomass technologies in rural markets.

Stakeholders: UNDP, villagers in two governorates, NREA, local governorates, technology providers.
Finance Sector Involvement: None. A multilateral donor funds project.
Role of Private Sector: Procurement of technology, training target group on maintenance, provision of spare parts.

Program title: Private Sector Wind Power Development Project.
Program Objectives: Create and increase role of private sector in wind project development.
Stakeholders: NREA, World Bank.
Finance Sector Involvement:
Role of Private Sector:

Program title: Mixed Credit program.
Program Objectives: Promotion of clean energy and other technologies in program countries.
Stakeholders: Danida, NREA, Vestas.
Finance Sector Involvement: Commercial bank.
Role of Private Sector: Installation of wind energy.

Program title: Technical Assistance for RE.
Program Objectives: Improve NREA's ability to plan and design RE policies and projects.
Stakeholders: Danida and NREA.
Finance Sector Involvement: None.
Role of Private Sector: Provision of intermittent consultancies.

Program title: Integrated Solar-Thermal Power project.
Program Objectives: Introduce solar-thermal to local energy planners and demonstrate viability.
Stakeholders: NREA, World Bank, Duke Solar and other US companies.
Finance Sector Involvement: GEF grant.
Role of Private Sector: Construction, operation and management of the plant all to be done by a private sector contractor.

Program title: Fuel Switching, USAID – not a RE program but worth mentioning.
Program Objectives: Reduce air pollution in urban centers through switching public transportation to run on compressed natural gas (CNG). Fifty public busses and 26,000 vehicles in Cairo have already switched fuel.
Stakeholders: Cairo Air Project.
Finance Sector Involvement: Private companies are assisting with engine alteration.
Role of Private Sector: Some private companies have been bidding on small parts of the project.

1.5.3 Major EE Programs

Program title: Energy Efficiency Policy Program II, USAID.
Program Objectives: Support establishment of ESCOs and private sector investments in EE and advise the government on EE policy and regulatory issues.
Stakeholders: Ministry of Electricity, USAID, Nexant/Bechtel, EEAA, Egyptian industries.
Finance Sector Involvement: Limited but expected to be increased soon.
Role of Private Sector: Thirteen Egyptian ESCOs participate in project activities.

Program title: Energy Efficiency Improvement and GHG Reduction program, UNDP/GEF.
Program Objectives: Improve EE in various Egyptian industries through creating suitable EE investment environment for local ESCOs.
Stakeholders: UNDP/GEF, EEAA, Organization for Energy Planning (OEP), Egyptian industries.
Finance Sector Involvement: On going negotiations to get them involved.
Role of Private Sector: Thirteen ESCOs established through assistance from UNDP and USAID.

Annex I

Bibliography

Aboul Foutouh, Fuad. Prospects for PV Water Pumping in Toushka Project. Submitted to Ministry of Irrigation and Water Works, 2001, Egypt.

Aboul Nasr, Sherif. Renewable Energy in Egypt: Strategy, Achievements, and Plans. October 2002.

Power generation in Egypt. Article in Al Ahram Newspaper [in Arabic], Cairo, Egypt, December 5, 2001.

New developments in the Electricity Sector. Article in Al Ahram newspaper, [in Arabic], Cairo, Egypt, April 22nd, 2002.

Baseline Survey of the Energy Sector: Egypt. Danida report. August 1999.

Biomass Resources and Biomass Energy Technologies for Rural Development in Egypt. UNDP Project Document. June, 2002.

Desert Agricultural Investment Indicators: Chapter Five: Renewable Energy Applications [in Arabic], Report by Ministry of Agriculture, Cairo, Egypt, 2000.

Egypt Country Report, Energy Information Administration, US Department of Energy. 2003.

Electricity Annual Statistics Report. Ministry of Electricity [in Arabic], Cairo, Egypt, 1997/1998.

Environmental Management Guidelines for Coastal Hotels and Resorts: Environmental Management Assessment. USAID-Cairo Study. November 2000.

Guy, Brown. Power the People. A Report on Egypt's Power Generation Sector. Business Today Magazine. Cairo, Egypt. August 2002.

Implementation of Renewable Energy Project in Egypt. A study by UCCEE. September 2000.

Kamel, Sami. An Optimization Approach to Hybrid Power Systems for Remote Area Applications in Egypt. PhD Thesis, Colorado School of Mines, Colorado, USA. January 2003.

Kamel, Sami. Forecasting Electricity Consumption in Egypt. Proceedings of the 21st Annual Conference of the United States Association for Energy Economics, Sept. 24 – 27, 2000, Philadelphia, Pennsylvania, USA.

Kamel, Sami. Carol Dahl. *The Economics of Hybrid Power Systems for Sustainable Desert Agriculture in Egypt*. Proceedings of the Sustainable Energy and Development Conference, June 2-7, 2002, Dubrovnik, Croatia.

Ministry of Agriculture, Cairo. Report on Desert Reclamation Five Years Plan. [in Arabic]. Cairo, Egypt. 2001.

Moussa, Ashour. Wind Energy in Egypt. DEWI Journal, 17 August 2000.
Renewable Energy In Egypt, Report by the New and Renewable Energy Authority, Cairo, Egypt, 2000.

Renewable Energy Strategy and Institutional Strengthening Study: Egypt. Activity Completion Report. An ESMAP report (unpublished), World Bank Study, April, 1999.

Ringuis, Lasse. Wind Power Projects in the CDM: Methodologies and Tools for Baselines, Carbon Financing, and Sustainability Analysis (A case Study from Zafarana Wind Farm in Egypt). Risoe National Laboratory, December, 2002.

Solar Thermal Power: The seamless solar link to the conventional power world. Renewable Energy World, July-Aug. 2000.

The Photovoltaic Market in Egypt. A report by the National Renewable Energy Laboratory, 1996, Golden, Colorado.

US Department of Trade. Environmental Technologies Market Overview – Egypt. 1997.

Zannoun, Sami. Egypt's Renewable Energy Strategy, Achievements, and Programs. Paper presented at 18th Congress, World Energy Council, October 2001. Argentine.

Annex 2

List of People Interviewed

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Annex 3

List of Egyptian Banks with possible interest in managing the proposed MEDREP Financing Support Mechanism(s)

1. United Bank of Egypt: Established a SME unit with focus on environmental projects and EE projects. The author briefed the Bank's Credit Risk Manager on the planned MEDREP fund and the bank is interested in meeting the finance consultancy.
   Contact: Mr. Atef Al-Deeb, Deputy General Manager, United Bank of Egypt
   Tel. + 20-2-792 0146, Email: ael-deeb@ube.net , or Mr. Sief Kotry, General Manager.

2. **Societe' General National Bank:** The bank manages an environmental technologies fund for the World Bank, a fund for Germany's KfW, and a fund for USAID. All three funds focus on environmental technologies. Bank expressed interest in further discussions regarding MEDREP fund.
   Contact: Mr. Mohamed Antably, Cell phone: + 20-12-390-8714, Email: mohamed.antably@socgen.com.

3. Commercial International Bank: Bank manages a Euro 30 million environmental fund for KfW. The fund targets manufacturing industries wanting to install pollution prevention technologies.
   Contact: Mr. Mounir Yassin, Manager Correspondent Banking Dept., or Mr. Tamer El Zant, phone: + 20-2-5714705, fax: +20-2-573 1541

4. Misr International Bank: Manages part of the KfW environmental technologies fund. Contact: Mr. Mohsen Rashad, Manager Correspondent Banking, tel.: +20-2-7498061, or Mr. Amr Mostafa, tel. +20-2-7496397

5. Egyptian American Bank: Manages part of the KfW environmental technologies fund. Contact: Mr. Emad Helmy, Manager Trade Finance Dept., tel. + 20-2- 739 1595.

Annex 4

Examples of Policy Instruments and Incentive Schemes for Promotion of RE

Financial Incentives

Corporate Tax Incentives

Corporate tax incentives allow corporations to receive credits or deductions ranging from 10% to 35% against the cost of equipment or installation to promote renewable energy equipment. In some cases, the incentive decreases over time. Some countries allow the tax credit only if a corporation has invested a certain dollar amount into a given renewable energy project. In most cases, there is no maximum limit imposed on the amount of the deductible or credit.

Direct Equipment Sales

A few utilities sell renewable energy equipment to their customers as part of a buy-down, low-income assistance, lease, or remote power program.

Grant Programs

Governments offer a variety of grant programs to encourage the use and development of renewable energy technologies. Most programs offer support for a broad range of renewable energy technologies, while some countries focus on promoting one particular type of renewable energy such as wind technology or alternative fuels.

Grants are available primarily to the commercial, industrial, utility, education, and government sectors. Some grant programs focus on research and development, while others are designed to help a project achieve commercialisation. Programs vary in the amount offered.

Industrial Recruitment Incentives

This category focuses on special efforts and programs designed to attract renewable energy equipment manufacturers to locate within a city or province. Renewable energy industrial recruitment usually consists of financial incentives like tax credits, grants, or a commitment to purchase a specific amount of the product for use by a government agency.

The recruitment incentives are designed to attract industries that will benefit the environment and create jobs. In most cases, the financial incentives are temporary measures that will help support the industries in their early years but include a sunset provision to encourage the industries to become self-sufficient within a number of years.

Leasing / Lease Purchase Programs

Utility leasing programs target remote power customers for which line extension would be very costly. The customers can lease the technology, e.g., photovoltaic, from the utility, and in some cases, the customer can opt to purchase the system after a specified number of years.

Loan Programs

Loan programs offer financing for the purchase of renewable energy equipment. Low-interest or no-interest loans for energy efficiency are a very common strategy for demand-side management by utilities. Some governments also offer loans to assist in the purchase of renewable energy equipment. A broad range of renewable energy technologies is eligible. In many countries, loans are available to residential, commercial, industrial, transportation, public, and non-profit sectors. Repayment schedules vary; while most are determined on an individual project basis, some offer a 7-10 year loan term.

Personal Income Tax Incentives

Many states offer personal income tax credits or deductions to cover the expense of purchasing and installing renewable energy equipment. Some countries offer personal income tax credits up to a certain percentage or predetermined dollar amount for the cost or installation or renewable energy equipment. Allowable credit may be limited to a certain number of years following the purchase or installation or renewable energy equipment. Eligible technologies may include solar and photovoltaic energy systems, geothermal energy, wind energy, biomass, hydroelectric, and alternative fuel technologies.

Production Incentives

Production incentives provide project owners with cash payments based on electricity production on a $/kWh basis, as is the case with the Federal Renewable Energy Production Incentive in the US, or based on the volume of renewable fuels produced on a $/gallon basis, as is the case with a number of state ethanol production incentives. Payments based on performance rather than capital investments can often be a more effective mechanism for ensuring quality projects.

Property Tax Incentives

Property tax incentives typically follow one of three basic structures: exemptions, exclusions, and credits. The majority of the property tax provisions for renewable energy follow a simple model that provides the added value of the renewable device is not included in the valuation of the property for taxation purposes. That is, if a renewable energy heating system costs $1,500 to install versus $1000 for a conventional heating system, then the renewable energy system is assessed at $1000.

In the US, property taxes are collected locally, so some states allow the local authorities the option of providing a property tax incentive for renewable energy devices. Six states have such provisions: Connecticut, Iowa, Maryland, New Hampshire, Vermont, and Virginia.

Rebate Programs

In the US, rebate programs are offered at the state, local, and utility levels to promote the installation of renewable energy equipment. The majority of the programs are available from local agencies and municipally owned utilities and support solar water heating and/or photovoltaic systems. Eligible sectors usually include residents and businesses, although some programs are available to industry, institutions, and government agencies as well. Rebates typically range from $150 to $4000. In some cases, rebate programs are combined with low or no-interest loans.

Sales Tax Incentives

Sales tax incentives typically provide an exemption from the state sales tax for the cost of renewable energy equipment.

Outreach & Voluntary Programs

Outreach Programs

Increasing awareness and understanding of renewable energy technologies and providing technical assistance and training for their deployment are critical to building a strong market for renewables. Programs in this category include those that provide ongoing renewable energy awareness campaigns, public exhibitions and events, school curricula, workshops, technical training for professionals, consumer seminars, or demonstration projects with an accompanying educational component. Programs in this category include state and local Million Solar Roofs Partnerships and other government-sponsored renewable energy outreach programs and activities. DSIRE does not include information on the many non-profit organizations that promote renewable energy technologies as part of their mission.

Utility Green Pricing Programs

Green pricing is an optional utility program that allows customers to support a greater level of utility company investment in renewable energy technologies. Participating customers pay a premium on their electric bill to cover the incremental cost of the additional renewable energy. Nearly all programs are structured such that customers choose a discrete amount of electricity to be supplied by renewable resources -- $3 for a 100-kWh block of electricity, for example. The median premium is around 2.5 cents per kWh. In a handful of states, utilities are required to offer a green power option.

Voluntary Installer Certification Programs

Certification provides a means by which to judge the skills and qualifications of solar practitioners, giving consumers increased confidence in the solar industry and rewarding practitioners for meeting high standards of training and practice. An increasing number of renewable energy associations, state energy offices, technical colleges, and other organizations are working together to develop voluntary training programs for those who install solar energy equipment. As these programs are developed, DSIRE will include information on the standards used for certification, training and testing requirements, and accredited training facilities.

Rules, Regulations & Policies

Construction and Design Policies

Construction and design policies include state construction policies, green building programs, and energy codes. State construction policies are typically legislative mandates requiring an evaluation of the cost and performance benefits of incorporating renewable energy technologies into state construction projects such as schools and office buildings. Many cities are developing "Green Building" guidelines that require or encourage consideration of renewable energy technologies.

Some guidelines are voluntary measures for all building types, while others are requirements for municipal building projects or residential construction. Local energy codes are used to achieve energy efficiency in new construction and renovations by requiring that certain building projects surpass state requirements for resource conservation. Incorporating renewables is one way to meet code requirements.

Contractor Licensing

Many governments have rules regarding the licensing of renewable energy contractors. Contractor licensing requirements can be enacted for solar water heat, active and passive solar space heat, solar industrial process heat, solar thermal electricity, and photovoltaics. These requirements--where they do exist--are designed to ensure that contractors have the necessary experience and knowledge to properly install systems.

Equipment Certifications

Statutes requiring renewable energy equipment to meet certain standards are generally seen as a tool for reducing the chance that consumers will be sold inferior equipment. Beyond being a consumer protecting measure, equipment certification benefits renewables by reducing the number of problem systems and the resulting bad publicity.

Generation Disclosure Rules

In the US, "Disclosure" typically refers to the requirement that utilities provide their customers with additional information about the energy they are supplying. This information often includes fuel mix percentages and emissions statistics. Fuel mix information, for example, can be presented as a pie chart on customers' monthly bills. "Certification" is a related issue, which refers to the assessment of green power offerings to assure that they are indeed utilizing the type and amount of renewable energy as advertised. One example of green power certification is the Green-e stamp.

Both disclosure and certification are designed to help consumers make informed decisions about the energy and supplier they choose. It is worth noting, though, that two states that have not moved ahead with restructure--Florida and Colorado--have enacted disclosure provisions. Indeed, disclosure is often thought of as a good policy to help educate customers about electricity and thereby to prepare markets in advance of retail competition.

Green Power Purchasing / Aggregation Policies

Municipalities, state governments, businesses, and other non-residential customers can play a critical role in supporting renewable energy technologies by buying electricity from renewable resources. At the local level, green power purchasing can mane buying green power for municipal facilities, streetlights, water pumping stations and the like. Several states require that a certain percentage of electricity purchased for government buildings come from renewable resources. A few states allow local governments to aggregate the electricity loads of the entire community to purchase green power and even to join with other communities to form an even larger green power purchasing block. This is often referred to as "Community Choice". Green power purchasing can be achieved via utility green pricing programs, green power marketers (in states with retail competition), special contracts, or community aggregation.

DSIRE provides information only on the policies of government agencies and the efforts of community aggregators to purchase green power; it does not track purchases by individual businesses and institutions such as universities.

Line Extension Analysis

When an electric customer requests service for a location not currently serviced by the electric grid, they are charged a distance-based fee for the cost of extending power lines to their load. In many cases it is cheaper to have an on-site renewable energy system to meet their electricity needs. Certain states require utilities to provide their customers with information on renewable energy options when a line extension is requested.

Net Metering Rules

For those consumers who have their own electricity generating units, net metering allows for the flow of electricity both to and from the customer through a single, bi-directional meter. With net metering, during times when the customer's generation exceeds his or her use, electricity from the customer to the utility offsets electricity consumed at another time. In effect, the customer is using the excess generation to offset electricity that would have been purchased at the retail rate. Under most state rules, residential, commercial, and industrial customers are eligible for net metering, but some states restrict eligibility to particular customer classes.

Public Benefit Funds

Public Benefit Funds (PBF) are typically local-government programs developed through the electric utility restructuring process as a measure to assure continued support for renewable energy resources, energy efficiency initiatives, and low-income support programs. (These funds are also frequently referred to as a system benefits charge, or SBC). Such a fund is most commonly supported through a charge to all customers on electricity consumption, e.g., 0.2 cents/kWh. Examples of how the funds are used include: rebates on renewable energy systems; funding for renewable energy R&D; and development of renewable energy education programs.

Renewables Portfolio Standards/Set Asides

Renewables Portfolio Standards (RPS) require that a certain percentage of a utility's overall or new generating capacity or energy sales must be derived from renewable resources, i.e., 1% of electric sales must be from renewable energy in the year 200x. Portfolio Standards most commonly refer to electric sales measured in megawatt-hours (MWh), as opposed to electric capacity measured in megawatts(MW). The term "set asides" is frequently used to refer to programs where a utility is required to include a certain amount of renewables capacity in new installations.

Required Utility Green Power Option

In the US, a handful of states require certain classes of utilities to offer customers the option to purchase power generated from renewable sources. Typically, utilities may provide green power using renewable resources they own or for which they contract; or they may purchase credits from a renewable energy provider certified by the state's Public Utilities Commission.

Solar and Wind Access Laws

These statutes provide for solar or wind easements or access rights. Easements allow for the rights to existing access to a renewable resource on the part of one property owner to be secured from an owner whose property could be developed in such a way as to restrict that resource. This easement is transferred with the property title. Access rights, conversely, automatically provide for the right to continued access to a renewable resource. Solar easements are the most common type of state solar access rule. Furthermore, some states prohibit neighborhood covenants that preclude the use of renewables.

At the local level, communities use many different mechanisms to protect solar access, including solar access ordinances, development guidelines requiring proper street orientation, zoning ordinances that contain building height restrictions, and solar permits.