Clean Energy Development in Egypt

2012

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List of Abbreviations

AFD	French Development Agency
AfDB	African Development Bank
bbl/d	Barrels per Day
bcm	Billion Cubic Meters
BOO	Build-Own-Operate
BP	British Petroleum
CBE	Central Bank of Egypt
CDM	Clean Development Mechanism
CIF	Climate Investment Fund
CNG	Compressed Natural Gas
CSP	Concentrated Solar Power
CTF	Clean Technology Fund
DNI	Direct Normal Insolation
DSM	Demand Side Management
EC	European Commission
EE	Energy Efficiency
EEA	Egyptian Electricity Authority
EEHC	Egyptian Electricity Holding Company
EETC	Egyptian Electricity Transmission Company
EEUCPRA	Egyptian Electric Utility and Consumer Protection Regulatory Agency
EGAS	Egyptian Natural Gas Holding Company
EGEF	European Greek Energy Fund
EIA	Energy Information Administration
EIB	European Investment Bank
EPC	Energy Performance Contract
ESCO	Energy Service Company
ESMAP	Energy Sector Management Assistance Program
ESTELA	European Solar Thermal Electricity Association
EU	European Union
FEMIP	Facility for Euro-Mediterranean Investment and Partnership
FIT	Feed-In Tariffs

GEF	Global Environmental Facility
GHG	Greenhouse Gas
IEA	International Energy Agency
IEA	International Energy Association
IPP	Independent Power Producer
KEMCO	Korea Energy Management Corporation
KfW	Kreditanstalt für Wiederaufbau
kWh	Kilo Watt Hour
LNG	Liquefied Natural Gas
mmbtu	Million Metric British Thermal Unit
MOEE	Ministry of Electricity and Energy
MSP	Mediterranean Solar Plan
mtoe	Million Tons of Oil Equivalent
MW	Mega Watt
NIF	Neighborhood Investment Facility
NREA	New & Renewable Energy Authority
OECD	Organisation for Economic Co-operation and Development
OEP	Organization of Energy Planning
PPA	Power Purchase Agreement
PPP	Public – Private Partnership
PV	Photovoltaic
R&D	Research & Development
RE	Renewable Energy
REA	Rural Electrification Authority
RPO	Renewable Purchase Obligation
RPS	Renewable Portfolio Standard
SCF	Strategic Climate Fund
SEC	Supreme Energy Council
STDF	Science & Technology Development Fund
Sumed	Suez Mediterranean
SWEG	Sewedy for Wind Energy Generation
TA	Technical Assistance
toe	Tons of Oil Equivalent
TSO	Transmission System Operator
VA	Voluntary Agreement

Executive Summary

Once an exporter of oil and gas, Egypt is now struggling to meet its own energy needs. The growth in energy consumption is a response to the country's economic expansion, industrialization, and change in people's life style. Although all energy forms have been subject to high growth, electricity consumption has increased substantially causing serious concerns over the power sector's fuel mix, heavier reliance on fuel oil, and an unaffordable burden on the government budget. As a result the government is determined to diversify the energy mix and to improve the efficiency of electricity consumption. It has also recognized that energy diversification and efficiency can impart other benefits such as cleaner environment, transfer of advanced technologies, and possible new areas of manufacturing and services.

This report reviews the opportunities and challenges involved in improving energy efficiency, developing renewable energy resources and promoting the local manufacturing of the corresponding equipment in Egypt. The international experience indicates that the three subjects are intertwined and that there are four pre-requisites for their success: (i) a clear strategy; (ii) a proper institutional framework; (iii) a well designed incentive system; and (iv) a suitable set of financing instruments. Egypt, however, has shortcomings these four areas.

Energy Efficiency

Although energy efficiency had not taken a prominent role in Egypt's past energy strategy, it has now become a high priority. Due to inadequate supply of domestic oil and gas and a tight public budget, the government has now arrived at the conclusion that energy efficiency should be pursued aggressively. At the same time, the country is facing significant constraints that need to be addressed in order to move forward the energy efficiency agenda. The most mportant constraints include:

- Institutional and legal constraints: There is no law, regulation or effective policy to promote energy efficiency. There is no clear and comprehensive strategy and/or program for improving energy efficiency. Notwithstanding the creation of the new Energy Efficiency Unit, still there is no dedicated institution that have clear implementation and executive authority for pursuing energy efficiency objectives.

- Data and Information Availability: There is little reliable data and information on energy use by subsectors, key industries, equipment and appliances. There are no mandatory fuel efficiency standards in transport, no mandatory energy efficiency building codes, no benchmarking for industries, and only few energy efficiency standards for appliances.

- Capacity Constraints: There is an insufficient capacity to develop and undertake energy efficiency programs and projects.

- Financial constraints: There are no dedicated funds or other financial mechanisms and incentives to support energy efficiency activities. Energy prices are well below costs and do not encourage energy savings.

It is therefore fair to state that energy efficiency improvement in Egypt is at an early stage despite the fact that there have been various studies and technical assistance activities over the course of the last two decades. There is, at the same time, vast international experience that Egypt can draw upon while designing its energy efficiency agenda. The review of best practices indicates that energy efficiency programs would require:

- Long-term political commitment at a high government level;

- Creation of proper (and specialized) institutional set up;
- Creation of incentives including appropriate energy pricing schemes;
- Mobilization of sustained financial resources;
- Monitoring and measurement of the results; and
- Effective communication with the public.

Within the above framework we recommend the following actions:

1. Strengthen the Present Institutional Arrangements: The institutional set up should enable all stakeholders to work together to provide and implement the specific plan of energy efficiency improvement. A high-level decision making body is needed to bring all parties together and provide strategic directions to the energy efficiency agenda. Though the eventual decision maker regarding all aspects of the energy sector is the Supreme Energy Council, there is a need for a specialized committee to direct the energy efficiency program. The recently established Energy Efficiency Unit at the Cabinet of Ministers may be able to serve this function. An alternative would be to establish a Clean Energy Committee that would provide strategic directions to the energy efficiency and renewable energy programs. In addition there is a need for a specialized entity that would function as the country's hub for promoting energy efficiency. It should have the capability to compile energy information, pursue the requirements of the law and regulations, and to monitor and evaluate the results. It should have the overall strategic responsibility for implementation of energy audits and surveys; enforcing energy efficiency standards and labeling programs; promoting R&D and dissemination of advanced energy technologies; facilitating market penetration and commercialization of high-efficiency equipment; and mobilizing financial support for energy efficiency projects. The recently established Energy Efficiency Unit is mandated with some of these responsibilities but is not an executive body. It is possible to expand the mandate of the Energy Efficiency Unit to that of a specialized entity with implementation capacity. Alternatively Egypt should consider creating an energy efficiency entity.

2. Establish an Energy Efficiency Fund: To attract public and private capital to the energy efficiency market, specific financing strategies and mechanisms are needed for the various sectors and stages of energy efficiency development. The financing instruments should fit the requirements of: (i) project preparation consisting of audits, surveys and technical assistance in project formulation; (ii) energy efficiency projects; (iii) energy efficiency ventures; and (iv) R&D and promotion of new technologies. Although the specialized agency should have the capacity and the obligation to consider an entire host of financial instruments, it would need a specific fund to use and allocate to various energy efficiency activities. Considering Egypt's potential energy efficiency program, we recommend establishment of an Energy Efficiency Fund. Creation of this specialized fund will provide the loudest political signal and the most important facility for the formulation and implementation of the energy efficiency program in Egypt. Creation of the Fund will also enable Egypt to mobilize the rather abundant international (financial and technical) resources currently available for improving energy efficiency in Egypt.[1]

3. Jump Start the High Priority Programs: The supply-side (generation, transmission and distribution) energy efficiency improvements can yield immediate benefit. A study supported by AfDB's Middle Income Country Trust

[1] In proposing the above suggestion we have also considered the option of including the Energy Efficiency Fund in the Renewable Energy Fund that is currently proposed in the draft Electricity Law. The experience in other countries indicates that combining the energy efficiency and renewable energy funds, as well as combining the specialized agencies, is suitable to countries where renewable energy development is of rather modest magnitude. On the other hand, in countries where renewable energy is of large scale it should have a separate agency and a separate fund from those of the energy efficiency. Egypt falls in the latter category.

Fund is underway to review the efficiency of power plant operations and maintenance. EEHC would need further support to apply the results of this review to all plants in operation. On the demand-side there are at least four activities that could be considered as low-hanging fruits and need immediate attention: (i) building codes; (ii) appliance standards; (iii) energy audits and housekeeping measures that would ensure usefulness and implementation of the recommendations of these audits; and (iv) a program of demand-side management (DSM) for public buildings. Building codes and appliance standards have already been prepared. These codes and standards should be reviewed to ensure that they are up-to-date. Compliance with these codes and standards should be made mandatory. A decision should be made to appoint and equip a responsible entity. Energy audits for industrial and commercial firms should be launched as quickly as possible. The responsibility should be assigned to the specialized agency that would in turn decide possible outsourcing to private service firms. Finally, energy efficiency improvement in public buildings provides an important opportunity that should be tapped quickly to demonstrate government's will to implement an energy efficiency agenda.

4. Develop Technical and Implementation Capacity: Capacity building covers a wide range of skills and capabilities needed by the government agencies, equipment suppliers, financial intermediaries, energy consumers and energy efficiency service providers. In each of these areas capacity building should draw upon the international experience, resources and funding in a practical manner. Capacity building should be pursued as a component of all the above items. In addition there should be an explicit support for programs identification, development and implementation and assistance to put in place all proposed actions.

Renewable Energy Development

Egypt's present energy strategy (the resolution adopted by Supreme Council of Energy in February 2008) aims at increasing the share of renewable energy to 20 percent of the energy mix by 2020. This target is expected to be met largely by scaling-up of wind power as solar is still very costly and the hydro potential is largely utilized. The share of wind power in total electricity generation is expected to reach 12 percent, while the remaining 8 percent would come from hydro and solar. This translates into a wind power capacity of about 7200 MW by 2020. The solar component is limited to 100 MW of CSP and 1 MW of PV power.

The development of renewable energy resources in Egypt is on the right track but would need substantial strengthening in several areas. The wind development program has the right ingredients including a targeted vision, a specialized agency with some accumulated skills, and a reasonable incentive system. The solar development program lacks most of these ingredients. Also, both wind and solar development suffer from the lack of a high level decision making body and a clear financing mechanism.

To address the present shortcomings of the renewable energy development program we recommend the following government actions:

1. Strengthen the Present Institutional Arrangement: The presence of a specialized energy agency – NREA – has provided an important vehicle for research and development, technical capacity building, and preparation and implementation of renewable energy projects. However, there is a need for a strategic body with higher political clout and wider reach among the stakeholders. It is recommended that the government should form a high level committee for this purpose. Since the same body is missing in the case of energy efficiency we recommend that a Clean Energy Committee be formed to provide strategic directions to the energy efficiency and renewable energy programs. As mentioned earlier the government may revisit the duties of the Energy Efficiency Unit to expand it into this Committee.

2. Formulate a Strategy for Solar Power Development: Egypt's current plans for solar energy are rather unclear and of modest size. The un-ambitious approach is understandable while solar energy is expected to cost substantially more than the available alternatives. However, there are two advantages that Egypt needs to incorporate into its deliberation of a solar energy strategy. First, most other developing countries which

are pushing in this direction are focusing on the acquisition of a market niche and technology. Second, there is substantial financial support that Egypt could tap into through a calculated and innovative approach for financing solar projects. The decision to be aggressive or passive in the development of solar energy should emerge from a well designed strategy rather than by default. There is a study being supported by KfW to develop a Combined Renewable Energy Master Plan. It is recommended that the solar strategy be declared by the Government drawing upon the results of this study and further specific analysis.

3. Develop a Coherent Financing Mechanism: The draft Electricity Law introduces the idea of establishing a "Fund for Development of Power Generation from Renewable Energies (RE Fund)". Although the Law has not yet been approved the Supreme Energy Council endorsed in May 2011 the establishment of the RE Fund. This is clearly a helpful first step but there is still a lot of uncertainty about the sources of finance and the process of disbursement. It is recommended that the proposed Clean Energy Committee take charge of designing a coherent financing scheme which would (i) clarify the parameters of the RE Fund; and (ii) lead the communication with the international financiers with the objective of making the RE Fund an umbrella instrument for channeling resources from various donors to the high priority renewable energy projects.

4. Reduce the Technical Risks: The government and particularly NREA have made significant effort and progress in reducing the technical risks of wind power development. The impact of wind power on system stability, which has not been an issue thus far due to the small wind capacity compared with the country's total electricity generation capacity, is now becoming a serious concern as the share of wind power increases. A study supported by AfDB's Middle Income Country Trust Fund is underway to review the impact of integrating up to 7,200 MW of wind power into the power grid. The study will examine the impact of wind farm characteristics on the potential static and dynamic stability issues, and will investigate how EEHC can require certain technical specifications from the manufacturers and developers to minimize the impact on the grid stability. A second major technical issue relates to the intensity of solar energy. There is a need for implementing a broad-based measurement of Direct Normal Insolation (DNI) data which constitutes a critical data input into the design of solar power plants. Egypt has DNI data modeled from sunshine hours routinely collected by meteorological stations but this is not considered accurate. It is recommended that a program be designed to install the DNI measurement/monitoring equipment in a number of pre-identified locations in order to arrive at a broad measurement and reliable accumulated DNI data.

Local Manufacturing and Services

The private sector in Egypt has shown a lot of interest in energy related manufacturing and services. The wind industry has had a good start but solar manufacturing has not developed. The government has been supportive of the development of local manufacturing capacity in the renewable energy industry. However, the support has been of an ad hoc nature. Going forward, the local industry would need a clearly announced support mechanism from the government. The mechanism should enable local manufacturers to assess the size of the market and to understand the decision making process and the available incentives.

Egypt is well positioned to embark on developing local manufacturing of wind and solar equipment and services. It has a good basis for acquiring the required technical and managerial skills. It has the support of the international community and it can count on export potentials to other countries in Africa and the Middle East. However, it needs to develop a vision as well as a clear design for the institutional arrangements, the centive systems, the R&D facility, human resource development, and international cooperation. Within this framework we recommend the following actions:

1. Set up a Clear Institutional Arrangement: The Ministry of Electricity and Energy as well as NREA have often stated their support for increasing the local contents of renewable energy facilities. However, there is no specialized decision making body that could develop a comprehensive view of the challenges and solutions to encourage new manufacturing and service ventures.

It is recommended that the proposed Clean Energy Committee takes a leadership role to work with the private sector as well as other stakeholders to develop a vision and strategy for the expansion of local manufacturing and services. The Committee may form various working groups to investigate each specialized outstanding issue.

2. Establish a Well Designed Incentive System: The government has exempted all renewable energy equipment, spare parts and materials from all custom duties. The incentive system should be further strengthened by: (i) local demand creation that is normally declared through setting a target for the renewable energy industry; (ii) financing through low interest rate loans, and priority sector lending; (iii) ease of doing business often in the form of creating a single window clearance mechanism for all related permissions; and (iv) infrastructure enablers such as promoting technology parks consisting of manufacturing units (across the value chain), housing, offices, and research institutes. The financial support aspect would require its own mechanism and instruments. These issues are intertwined with those discussed in conjunction with the establishment of the RE Fund. However, an additional consideration is the manner in which the government may support the start-up companies. It is recommended that the RE Fund is provided with a window to give (equity/debt) support to start-ups, entrepreneurs and innovators for R&D and pilot projects.

3. Launch an R&D Program: R&D in Egypt should follow a clear strategy to combine technology transfer with local adaptation in order to provide advice to local manufacturers on: (i) innovative and new materials, processes and applications, (ii) new and potential improvement to the existing processes, materials and the technology for enhanced performance, durability and cost competitiveness of the systems/devices, (iii) technology validation and demonstration projects aimed at field evaluation of different configurations in order to obtain feedback on the performance, operability and costs, and (iv) support for incubation and start ups. The Supreme Council for Research Centers[2] and the Clean Energy Committee should develop and declare a clear strategy for R&D in the area of renewable energy.

4. Support Human Resource Development. The key to development of wind and solar manufacturing industries is the ability to acquire technically qualified manpower of international standard. Some capacity already exists in Egypt in wind manufacturing. However, there is substantial further skill requirement in both wind and solar manufacturing and services. A coherent strategy is needed to develop human resources while drawing upon the country's educational and vocational facilities, as well as utilizing the abundant international assistance. The strategy should consider: (i) designing and offering by engineering colleges courses in solar and wind technologies with financial assistance from the government; (ii) technical training courses for technicians aimed at providing skilled manpower for field installations and after sales service network; and (iii) introducing a government fellowship program to train selected engineers and scientists in wind and solar energy in world class institutions abroad; this could be supported under programs of bilateral cooperation, or institution to institution arrangements. The vision announced by the Ministries of Higher Education, and Science and Technology providea framework within which one should develop a comprehensive program for human resource development in renewable energy.

5. Take a Strategic Approach to International Collaboration: Egypt has a good track record in international cooperation in the energy sector in general and in the wind energy development in particular. However, international cooperation in local manufacturing has been limited to the efforts of the El Sewedy for Wind Energy Generation (a private company that is focused on wind energy equipment and facilities). There is a lot that the government can do to help in strategizing and

[2] An organization co-chaired by the Minister of Higher Education and Scientific Research and the Secretary of State for Scientific Research.

optimizing cooperation with the international community particularly in regard to technology development. A well coordinated public-private partnership on the Egyptian side would enable the country to take advantage of both private and government facilities in other countries particularly Europe. Cooperation should be implemented at the level of research organizations as well as industry partners.

Potential Areas of Technical Assistance

Egypt would need substantial technical assistance (TA) in order to establish a clean energy industry. The TA requirements are quite extensive but focusing on the short to medium term requires a set of TA activities are proposed that are listed below according to the order of priority:

- Operationalizing the Renewable Energy Fund (RE Fund). This TA is immediately necessary to move forward the activation of the recently established RE Fund;
- Supporting the Institutional Arrangements for Clean Energy Development. This TA is immediately necessary to review the present institutions and provide support in designing and setting up a high level and specialized decision making body that would give strategic directions to all the major players in energy efficiency, renewable energy development and local manufacturing and services;
- Designing and Establishing the Energy Efficiency Fund;
- Capacity Development for Enforcing Building Codes and Appliance Standards;
- Efficiency Improvement of Public Buildings;
- Formulating the Solar Energy Development Strategy;
- Installation of Direct Normal Insolation (DNI) measurement equipment;
- Designing the Incentive System for Local Manufacturers;
- Developing a plan for R&D and Human Development.

The above TA activities are all considered essential in the short to medium terms. However, the most urgent activities include: (i) TA for operationalizing the RE Fund; and (ii) the TA for supporting Institutional Arrangements for Clean Energy Development. Other TA activities are also listed in the above table according to the order of priority.

More generally, a reasonable time-frame for implementing the action plan and the TA activities would aim at:

(a) Addressing the institutional and financing arrangements immediately. The institutional arrangement can and should be deliberated for all three aspects (energy efficiency, renewable energy and local manufacturing). Also of immediate attention is jump starting the energy efficiency program with the items considered "low hanging fruits." The time-table for these activities should not exceed two years. The associated TAs should be launched to support these activities.

(b) Pursuing other items within the next five years. This includes (i) formulating a strategy for solar power development; (ii) reducing technical risks associated with renewable energy; (iii) establishing a well designed incentive system for local manufacturing and services; and (iv) taking a strategic approach to international collaboration.

1. Context and Objective of the Study

Egypt experienced a rapid economic growth in the last decade. The average annual growth rate was above 5 percent between 2000 to 2010. The recent political events have slowed down economic growth substantially. GDP growth contracted by about 3% in the first six months of 2011 reducing growth for the entire fiscal year 2010/11 to only about 1.4%.

The government of Egypt has recognized that the availability of sustainable power supply is essential for economic and social prosperity and human development as well as for attracting private sector investments in the country. The government has therefore a clear policy of securing a reliable supply of power to all sectors of the economy. However, the power sector is facing a number of outstanding issues that hamper efficient development and operation of the sector.

Rapid Increase in Electricity Demand: The high economic growth rates of the last decade triggered a rapid increase in electricity demand. Peak load growth rate averaged 7.5% p.a. in 2005-2010 reaching 22,500 MW. In response to the rapid growth in demand, the supply capacity has been expanded through an ambitious power sector investment program that has resulted in an installed capacity of about 25000 MW at the end 2010. This installed capacity is viewed as rather insufficient to meet the prevailing peak demand because the reserve margin has declined to unacceptably low levels since 2009, and wide-spread electricity shortages were experienced, particularly in the summer of 2010. The complexity of the electricity and gas supply situation became publicly evident in August 2010 when the government had to review at the highest level the prevailing power shortages. The review brought out the fact that the availability of natural gas for power generation has turned into a real constraint and that the power sector is forced to using increasing amounts of oil for power generation. The issue is exasperated by the projection that there is a need to expand the power supply capacity by a rather large magnitude in the next 10 years. Such an expansion raises certain concerns about: (a) the volume and the cost of natural gas that would be available to the power sector; (b) the realistic potentials, costs, and time-line of other (hydro, solar, wind, nuclear) energy options; and (c) the manner in which the corresponding huge investments would be financed.

Investment and Finance: The concern about financing the large power sector investments has been deliberated at various levels of the government which have all agreed that there is a need for the reform of the electricity sector in order to attract private sector investment in power generation and distribution. The power sector reform began in the mid 1990s but has been accelerated in recent years with the objective of establishing a fully competitive electricity market where electricity generation, transmission and distribution are fully unbundled. This vision is reflected in the new electricity law which was endorsed by the Cabinet in 2008 and also in the new Public-Private Partnership (PPP) Law that was approved by the Parliament in 2010. The new electricity law, which is not yet approved by the Parliament, would enable competition by recognizing the right of eligible consumers to conclude direct (bilateral) contracts with present/future generation companies, providing third-party access to the transmission/distribution networks, and establishing a Transmission System Operator (TSO) which is independent from other sector entities and takes responsibility for fulfilling bilateral contracts. The new law also stipulates for the development of renewable energy through establishment of feed-in tariffs, and a "Fund for Development of Power Generation from Renewable Energy", which will be affiliated with the Cabinet. The PPP Law provides a rather clear framework for private sector investment in the electricity sector and in particular in wind power generation.

Sector Inefficiencies: Financing the power sector investments by public or private sector is constrained by prevailing energy subsidies. The low electricity tariffs are also blamed for the inefficient use of electricity. However, improving energy efficiency goes beyond tariff adjustment and would require a well designed strategy and institutional framework. Energy efficiency improvement had not taken a prominent role in Egypt's past energy strategy, but is now taking a high profile in response to the inadequate supply of domestic oil and gas and a rather tight government budget. As a result, Egypt is now trying to address energy efficiency from-both the demand and the supply sides. At the same time, the country faces significant constraints that need to be addressed in order to move forward the energy efficiency agenda.

Heavy Reliance on Fossil Fuels: Electricity supply in Egypt is generated mainly from thermal and hydropower stations. However, the percentage of hydro power energy generated (12 % in 2010) is gradually reducing due to the fact that all major hydropower sites have already been developed and new generation plants being built are mainly based on fossil fuels. Natural Gas covered 98 % of thermal generation in 2000 but this share has declined to around 78 % in 2010 because of the insufficient supply of gas to the power sector. Heavy fuel oil has been used to compensate for the declining share of gas. The increasing use of fossil fuels in the power sector has created concerns about fuel availability, the cost of electricity supply and the environmental impacts of power generation. These concerns have triggered a strong interest in the diversification of energy mix particularly the development of renewable energy resources.

Power sector issues are likely to become even more pressing in an environment of tight public budget and risky business environment. These circumstances strengthen the incentives for addressing efficiency and diversification of energy supply and consumption in the country.

The objective of this study: The aim of this study is to review the outstanding issues in the development of clean energy in Egypt. Its specific intention is to arrive at recommendations regarding: (a) improving energy efficiency; (b) promoting the development of renewable energy resources; and (c) facilitating the development of local manufacturing of solar and wind power equipment.

2. Overview of the Energy Sector

2.1 Structure of the Power Sector

Egypt's energy sector falls under the responsibilities of two ministries – the Ministry of Petroleum which oversees upstream and downstream oil and gas activities, and the Ministry of Electricity and Energy which is responsible for electricity generation, transmission and distribution. The Council of Ministers is the main forum for coordination in the sector, operating through specific Ministerial Committees. It is also responsible for the pricing of petroleum products and electricity. In 2006, the Prime Minister issued a decree to form the Supreme Council for Energy. The Council is headed by the Prime Minister and comprises all the concerned ministers. The Council oversees the various policies and strategies of the energy sector including their supportive legislative and institutional frameworks, policy initiatives, investment programs, and energy pricing.

The Ministry of Electricity and Energy (MOEE) acts as the owner of the state entities in the power sector. The electricity industry, which was vertically integrated under Egyptian Electricity Authority (EEA) until 2000, has been structurally unbundled, both "vertically" (along the functional lines of generation, transmission, and distribution/supply) and "horizontally" in the generation and distribution/supply segments, with a number of companies operating in each segment. This unbundled structure is linked together under the umbrella of Egyptian Electricity Holding Company (EEHC), which has 16 subsidiaries including: one hydropower and five thermal electricity generation companies; nine electricity distribution companies; and a transmission-and-dispatch company: Egyptian Electricity Transmission Company – (EETC).

All EEHC affiliates remain fully owned by the state. EEHC plays a strong role in coordinating the plans and investments in the power sector, and also manages the sector's overall finances. In addition to the EEHC affiliates, there are six authorities operating in the electricity sub-sector which report directly to MOEE. These are: (i) Rural Electrification Authority (REA), (ii) Hydropower Projects Executive Authority, (iii) New and Renewable energy Authority (NREA), (iv) Atomic Energy Authority, (v) Nuclear Power Plants Authority, and (vi) Nuclear Material Authority. These authorities are concerned with research activities and execution of projects in their domain. Once the projects are completed they are transferred to EEHC, which has all operational responsibilities. However, NREA is playing a more structural role with its recent activities. It has currently about 500 MW wind power plants in operation or under construction, and is expected to contribute substantially to the rapid expansion of wind power capacity. There are also three privately owned independent power producers (IPPs) with total generation capacity of about 2,049 MW, which started operations in 2002-2003 under 20-year long power purchase agreements with EEHC.[3]

Finally, the Egyptian Electric Utility and Consumer Protection Agency (EEUCPRA) has been operational

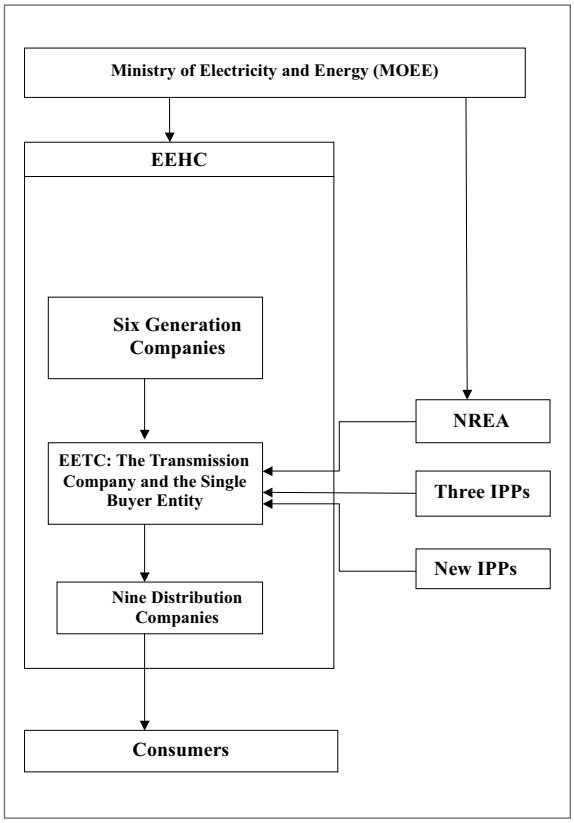
[3] The first build, own, operate, transfer (BOOT) project was a US$450mn gas-fired plant with two 325MW generating units located at Sidi Kerir. It began commercial operation in 2001.The second BOOT award went to Electricité de France (EdF), for two gas-fired plants located near the cities of Suez and Port Said. The two plants, which came online in 2003, have a combined capacity of 1.4GW. These units now belong to Tanjong's Powertek, which formally took them over from EdF in 2006. In February 2010 EEHC and MOEE launched the international tender for the Beheira power plant. EEDC will sign a 20 year power purchase agreement with the new owner of the power plant. Capacity is designed to be 1.5GW, with the possibility to expand it by a further 750MW.

since 2002 and functions as the sub-sector regulator. The Agency licenses companies that operate in the sector and establishes performance benchmarks. The Agency's mandate also includes creating conditions for competitive trading arrangements, but it has no tariff-setting powers, which, as mentioned earlier, is the prerogative of the Cabinet of Ministers. The power market is presently organized to function with a single-buyer. All generation companies sell to the transmission company. The transmission company in turn sells the electricity to large customers and eight distribution companies. This single-buyer market does not allow for direct transactions between the generators and major consumers. However, this is considered an intermediate step towards the establishment of aliberalized electricity market envisioned in the new electricity law. The law would introduce some fundamental changes to the structure and behavior of the electricity market while authorizing EEUCPRA to set electricity tariffs.

2.2 Energy Resources

Egypt's total primary energy demand has grown at an average annual rate of 4.5% during the last two decades. This rather high growth is linked to strong economic growth and is particularly reflected in the rapid increase in demand for electricity and transport services. The increase in energy demand has been met primarily by increased use of fossil fuels, leading to the high energy and carbon intensity of the economy. The total primary energy supply from fossil fuels in 2010 was about 63 million tons of oil equivalent (mtoe) composed of 52 percent oil, 46 percent gas, and 2 percent coal. For the past several years, the supply of oil has not been sufficient to meet the domestic demand. A demand-supply gap is also emerging in the gas sector.

Figure 2.1: Structure of the Power Sector

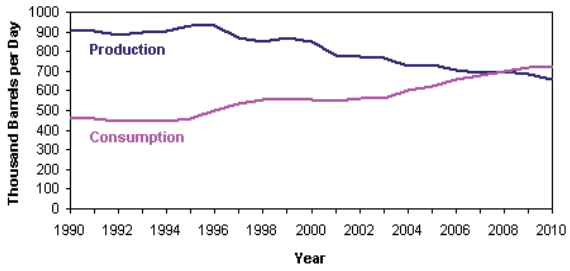


Oil: Egypt had a rather significant level of oil export through the 1980s and 1990s. Total oil production, however, has declined since the country's 1996 peak of close to 935,000 barrels per day (bbl/d) to current levels of about 660,000 bbl/d in 2010. On the other hand, oil consumption has increased steadily to reach 710,000 bbl/d in 2010 and surpassing domestic production since 2006.[4] Although not an important oil exporter, Egypt has still a strategic importance in

[4] The decline in crude oil production was even faster than the above numbers indicate. Part of this decline has been compensated by an increase in natural gas liquids. According to the Oil and Gas Journal's estimate, Egypt's total oil production averaged 660,000 barrels per day (bbl/d) in 2010, of which approximately 540,000 bbl/d was crude oil. This indicates that despite the use of enhanced oil recovery techniques at mature fields, crude oil production is still declining rather rapidly. At the same time, new natural gas field production has led to increases in the production of natural gas liquids and lease condensates which have offset some of the declines in total oil liquids production.

international oil trade because of its operation of the Suez Canal[5], Sumed (Suez-Mediterranean) oil pipeline[6] and its significant oil refining capacity (comprising ten refineries with a combined capacity of more than 900 thousand barrels per day)[7].

Figure 2.2: Egypt's Oil Production and Consumption



Source: EIA

Natural Gas[8]: Natural gas has substituted for oil both in domestic use and in export of energy. Production of gas has nearly tripled between 1998 and 2010. In 2010, Egypt produced roughly 63 billion cubic meters (bcm), exported 18 bcm and consumed 45 bcm. The electricity sector is the dominant gas consumer, accounting for 57 percent of the total gas demand. The government has aggressively pursued the use of gas since the early 1990s, not only in power stations but also in industry. The industrial sector consumes about 11 percent of total gas consumption while fertilizer and cement industries are also large consumers, accounting for 10 percent and 8 percent respectively. The petroleum sector uses a substantial amount of gas for its own use and re-injection, accounting for 5 percent of total gas consumption. Gas is delivered to the residential sector through low-pressure pipeline distribution systems and in LPG cylinders supplied by retailers. Combined, they account for 2 percent of the total gas demand but expected to grow at a fast pace (about 15 percent p.a.). Finally, the use of compressed natural gas (CNG) in vehicles accounts for about 2 percent of total gas consumption; all taxis in the Cairo area must now run on CNG. Currently there are about 60,000 vehicles converted to run on CNG, and Egypt now has the eighth largest CNG fleet in the World.

Since the early 1990s, gas reserves have been quadrupled. According to the Oil and Gas Journal, Egypt's estimated proven gas reserves stood at 77.1 Tcf in 2010, making the country the third highest in Africa after Nigeria (185 Tcf) and Algeria (159 Tcf). The rise in gas reserves led Egypt to seek export options in the form of liquefied natural gas (LNG) and piped gas. There are three LNG trains in operation though there is room to increase their throughput. Also Egypt now exports natural gas to Jordan, Syria, and Lebanon through the Arab Gas Pipeline, with further planned connections to Turkey and Europe, and to Israel through the Arish-Ashkelon gas pipeline (completed in 2008). Egypt exported 18.1 bcm of natural gas in 2010, around

[5] In 2009 total crude oil volumes transiting through the Suez were about 29.2 million metric tons (mmt), or approximately 585,000 bbl/d, the majority originating in the Persian Gulf. This indicates a significant (about 44 percent) drop from the 2008 level. The drop was due to the collapse of oil prices, OPEC production cuts, and also some of the changing dynamics of crude oil markets where Asian demand is increasing at a higher rate than European and American markets while West African crude production is meeting a larger share of the latter's demand.

[6] The Sumed pipeline runs 200-miles from Ain Sukhna on the Gulf of Suez to Sidi Kerir on the Mediterranean. The Sumed's original capacity was 1.6 million bbl/d, but with the completion of additional pumping stations, capacity has increased to 2.34 million bbl/d. The pipeline is owned by the Arab Petroleum Pipeline Company (APP), a joint venture between Egypt, Saudi Aramco, a consortium of Kuwaiti companies, the International Petroleum Investment Co of Abu Dhabi, and Qatar Petroleum Corp.

[7] Egypt has the largest refining sector on the African continent with ten refineries. The largest refinery is the 146,300-bbl/d El-Nasr refinery at Suez. The government has plans to increase production of lighter products, petrochemicals, and higher octane gasoline by expanding and upgrading existing facilities and promoting new projects including a recently announced 600,000 bbl/d refinery in partnership with two Chinese companies to be built in two phases and a planned 130,000 bbl/d refinery to be built at Ain Sukhna, on the Red Sea coast.

[8] The gas sector is dominated by the Egyptian Natural Gas Holding Company (EGAS) which participates in upstream joint ventures and export schemes, and serves as the single buyer and seller of all gas in the domestic market. The upstream sector is open to participation by the private sector through conventional Production Sharing Contract (PSC) arrangements. A fully owned subsidiary of EGAS, called GASCO is responsible for planning and operation of the transportation system. There are also seven privately-owned and two publicly-owned local distribution companies responsible for gas distribution services.

70 percent of which was exported in the form of LNG and the remaining 30 percent via pipelines.

The rapid growth in internal and external demand for Egyptian gas has triggered some political sensitivity to further exports and a technical need to revisit the gas allocation policy. In particular, there is a concern about long-term availability of gas for Egypt's own future use. Export plans are supposed to be reevaluated soon.

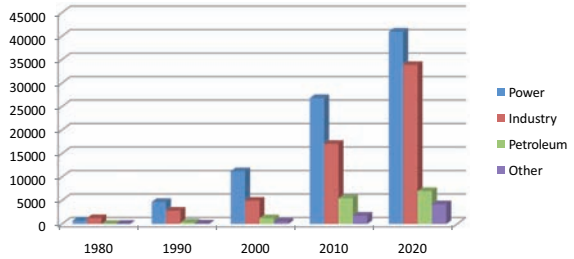
A number of policy decisions have led to the prominent rise in domestic gas consumption in Egypt. Although domestic gas prices were low, the government offered the upstream producers substantially higher prices in order to create the incentives necessary for upstream producers to develop existing reserves and explore for new gas reserves. It is important to note that the government intends to phase out subsidies over time, and has aggressively raised the price of gas to certain customer groups. The present price is $1.00 to $1.25/mmbtu for the power sector, $3/mmbtu for energy intensive industries and $1.7/mmbtu for otherindustries. In the residential sector the price remains between $0.5/mmbtu and $1.5/mmbtu.

2.3 Electricity Demand and Supply

Egypt is well electrified, with 99 percent of households connected to the electricity system. Electricity demand has grown significantly in recent years due to the country's socio-economic development. Peak electricity demand increased by more than 200 percent, from 6,902 MW in 1990 to 22,500 MW in 2010. The residential sector accounts for 47 percent of the total electricity consumption. The industrial sector accounts for 20 percent, while Government, public lighting, agriculture and commercial account for 12 percent, 9 percent, 4 percent and 3 percent, respectively. There are potentials and plans to improve energy efficiency and to moderate the growth of electricity consumption. Also the demand growth softened somewhat due to the 2008-2009 global economic downturn. Nevertheless, electricity demand is forecastzd to continue growing at a rather high annual rate of 6.5 percent over the 2010-2020 period.

Electricity generating capacity has grown steadily to keep up with the peak demand, almost doubling between 1990 and 2010 from 12,230 MW to 25,000 MW. The installed capacity comprised 22,410 MW of EEHC owned power plants (2,800 MW hydropower and 19,610 MW thermal); 2,048 MW in three private power plants; and 550 MW in wind power. Although the nominal installed generation capacity exceeded the peak demand by about 10 percent, the available capacity was less than the summer peak demand. As a result the dispatchers had to resort to load shedding in the summers of 2008, 2009, and 2010.

Figure 2.3: Gas Consumption by Major Users (in million cubic meters)



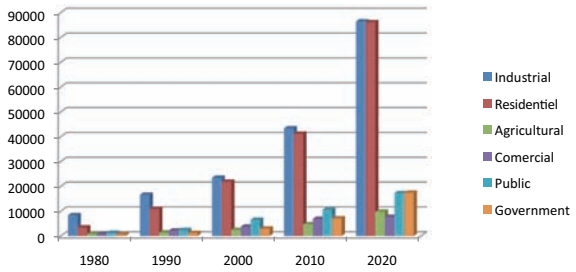
Source: Nexant (2009)

Electricity in Egypt is generated mainly from thermal and hydropower stations. However, the percentage of hydro power energy generated is gradually declining due to the fact that all major hydropower sites have already been developed and there is no significant addition to hydro capacity. Thermal power capacity is expanding rather quickly with the assumption that the new generation plants will be using natural gas. However, the amount of natural gas that will be available to the power sector has been subject to some uncertainty. EEHC is therefore building some of the thermal plants with dual (oil and gas) firing capability to deal with any uncertainty in the availability of natural gas.

The electricity transmission and distribution network has developed into a complex interconnected system commonly referred as the UPS, serving all major load centers countrywide. In 2009, the transmission system had a network of 41,334 km of overhead lines and 79,000 MVA of transformer capacities. The distribution

system consisted of 143,600 km of medium voltage lines, 225,315 km of low voltage lines and 136,322 transformers with aggregate capacity of 48,324 MVA supporting almost 22 million consumers. Transmission and distribution losses were about 14.7 percent including 3.7 percent for the transmission and 11 percent for the distribution network respectively. There is room to reduce the transmission/distribution losses though the present level is not very high. The transmission system includes interconnection with other countries in the region. The Five-Country interconnection of Egypt's system with those of Jordan, Syria, and Turkey was completed by 2002. Egypt also activated a link to Libya's electric grid in December 1999.

Figure 2.4: Electricity Consumption by Major Sectors (in MWh)



Source: Nexant (2009)

2.4 Legal and Regulatory Framework

Egypt has put in place a number of measures to reform the power sector from a vertically integrated state-owned monopoly into a commercially oriented flexible structure, although the transition has been gradual. A regulatory agency (the Egyptian Electric Utility and Consumer Protection Regulatory Authority - EEUCPRA) has been established to promote investments in the electricity sector by ensuring competition while at the same time taking care of the consumer's interest. EEHC has been unbundled, but operates as a tightly controlled holding company with strong links to the government, through subsidies, facilitation of investment financing, fuel prices, and electricity tariff regulation. EETC functions as the wholesale single-buyer/single-seller of electricity, procuring electricity from generation companies and selling it to distribution companies and transmission network customers. All generation companies, including three BOOT projects, wind power plants, and four industrial plants sell their electricity to EETC.

The government is preparing the ground for advancing the sector reform further. The new Electricity Law (which is not yet approved by the Parliament) introduces a number of changes toward strengthening sector's commercial orientation and its opening to private investment and competition. It also addresses the promotion of renewable energy and energy efficiency. The law, inter alia, gives the authority for tariff regulation to the electricity regulatory agency; grants more independence to EETC, converting it to an independent system operator with open access for bilateral trading between generation and consumers; and promotes introduction of a competitive end-user market. The draft law is designed to gradually reduce the investment burden on the state by building up a competitive market and encouraging private investment. It provides for a gradual elimination of the single buyer market by allowing third-party access to the infrastructure owned by the Ministry of Electricity and unbundling ownership of the distribution system. While the electricity transmission company will continue to be state-owned, the law provides a legal framework conducive to private sector investment in generation and distribution. Competition is encouraged in the beginning, by allowing a limited number of large consumers to contract directly with generators.

In practice the government has already taken a step in allowing bilateral contracting by announcing that the new energy-intensive companies will not receive electricity supply from the national grid, which implies that these companies should either build their own power plants or buy from private power producers. However, direct contracting between private power producers and new industrial consumers has not progressed due to the presence of a number of risk factors. The risks which hamper the developers' ability to secure finance include uncertainty in both demand and supply of power. The demand uncertainty relates to the fact that the consumer is a future industrial plant with no track record. Similarly, the supply uncertainty stems from the newness of the

power producing company. In order to mitigate the above risks, it has been suggested that EETC should commit to off-take part of the output. The challenge of combining the off-takes of EETC with those of some future industrial plants may prove too complex, and the arrangement may default back to EETC acting as a single-buyer.

The new law is expected to facilitate private sector investments. The government has recognized the limitations of public sector's ability to finance power investments. Accordingly it is seeking private sector's participation in power generation and distribution. Private sector participation in the power sector was initiated in mid 1990s and resulted in commissioning of three independent power producers (IPPs) plants in 2002 – 2003. The underlying power purchase agreements of these IPPs stipulated an off-take price denominated in US cents per kWh. As a result the currency devaluation of 2003 caused a sharp increase in the purchase price of electricity from these IPPs effectively turning them into loss-making ventures for the government and the power sector entities. Subsequently a view emerged that private power was substantially more expensive than public supply of electricity. The government is now encouraging the re-entry of the private sector with the provision that the government is not asked to take market risks.

In retro respect, the three IPPs have been successful in that they attracted foreign investment, brought in quality operators and resulted in competitive tariffs. Although their selling price had increased in local currency terms following a devaluation of the Egyptian pound in 2003, the average cost of purchased electricity from the IPPs was around 15 piasters per kWh (2.7 US cents) in FY 2007/08. For the above three IPPs, the EEHC's payment obligations were guaranteed by the Central Bank of Egypt ("CBE") – effectively a sovereign guarantee. The prevailing view at the time was that that the CBE guarantee was essential for the project sponsors (InterGen and EdF) to participate. There is a debate now whether such a guarantee should be provided to the future IPPs. There are a variety of alternative options as practiced in different parts of the world. However, the main pre-requisite for structuring IPPs without sovereign guarantee is a creditworthy off-taker. Therefore, any steps the EEHC can take toward establishing its own credit would help a long-term move towards securing flexible IPP arrangements.

Egypt is currently soliciting the 250 MW wind IPP based on a similar risk allocation framework as those of the three IPPs. However, a private sector engagement framework for future private thermal power projects is not yet in place.

Finally it is noted that the Supreme Energy Council approved in February 2010 an Energy Strategy (based on a study done by Nexant (2009) which, among other measures, recommended preparation of the Egyptian Combined Renewable Energy Master Plan. This study is expected to provide a long-term strategy for the development of wind and solar energy[9].

[9] Combined Renewable Energy Master Plan (CREMP), was launched in July 2011 and expected to be finalized by end of 2012 and adopted by SEC in 2013. The study will cover the major renewable energy technologies (wind, solar, hydro, waste), address the institutional framework required for the promotion in scale of RE investments and define investment plans up to 2035 for each of these technologies.

3. Energy Efficiency and Conservation

3.1 Egypt's Current Program and Accomplishments

As discussed in the previous section, Egypt's final energy consumption expanded by more than 70 % in the last decade. Egypt's energy consumption per capita still remains very low at 0.89 tons of oil equivalent (toe), compared with the world average of 1.82 toe and the OECD average of 5.1 toe (IEA). However, Egypt's energy consumption per capita will increase rapidly as the overall energy demand is expected to double in the next 10 years. Aside from the increasing per capita consumption, Egypt's energy intensity (7000 BTU/ dollar of GDP) is also on the high side compared with some other countries such as Morocco and Tunisia that have been more conscientious about energy efficiency (ESMAP 2009).

For the last 20 years the government of Egypt has been preoccupied by the objective of ensuring adequate supply of energy. Improving energy efficiency did not take a high priority in the government's agenda until recently. Nevertheless, a number of initiatives have been taken in the last 10 years to study or to implement energy efficiency plans. Most of these initiatives were funded by various donors (USAID, UNDP and GEF) and aimed at improving the technical and/or the institutional parameters.

On the technical side, there were several efforts with limited success. A number of energy audits were carried out but only a few projects were implemented afterwards. Some demonstration projects were identified and implemented but there has not been a large-scale replication of these projects. Most of these projects were entirely financed by grants under donor programs and failed to stimulate investment activities by the business and industries. A rather important task, the UNDP funded the preparation of energy efficiency standards for four domestic appliances and also for the efficiency codes of new buildings. These standards and codes could result in substantial energy efficiency improvements but compliance is considered voluntary with no implementation capacity or procedure to make them mandatory. A more successful case on the project side is a program to promote the use of CFLs to replace incandescent lamps. This program was launched by EEHC in 2005 and is known to have achieved some success but the effectiveness and sustainability of the program has not yet been assessed.

On the institutional side, the Organization of Energy Planning (OEP) had the mission to promote energy efficiency through data collection and analysis, energy auditing, awareness programs and demonstration projects. But OEP was abolished in 2005. Aside from the lack of the organizational structure, most institutional support activities focused on creating market-based programs to promote energy efficiency investments while the prevailing low energy prices did not incentivize such investments. As a major effort in this regard, the USAID and GEF supported the development of Energy Service Companies (ESCOs). This resulted in the creation of a few ESCOs which have not been able to do much business because of difficulties in accessing financial resources. In summary, there is not yet a clear organizational, institutional, and regulatory framework to support energy efficiency activities and programs in Egypt.

In an attempt to coordinate various aspects of energy efficiency the Supreme Energy Council established through a decree in June 2009 an Energy Efficiency Unit at the Cabinet of Ministers to coordinate, guide, support and monitor all energy efficiency activities in the country. The unit includes members of eight ministries representing the end user sectors such as Transport, Housing, Tourism and Trade & Industry, and the supply sectors

such as Electricity and Petroleum. The Ministries of Environment and Finance are also represented on the Energy Efficiency Unit. The Unit is headed by the Secretary General of the Cabinet and is intended to be the coordinating arm for the Cabinet and its Supreme Energy Council but has no executive or implementation authority. The Energy Efficiency Unit has not yet become a leading body in developing strategy or monitoring implementation. There is a need to review the current status of the Unit in light of the institutional requirements of the clean energy development.

3.2 Lessons from International Experience

There is by now a very extensive international experience in improving energy efficiency. Some countries like Japan and Korea, that faced a lack of domestic energy resources, were the early pioneers in applying energy efficiency standards, technologies and incentive systems. The second group includes some European countries that have been pushing hard to rationalize energy consumption in response to the issues of energy security and climate change. More recently a large number of developing countries have launched energy efficiency programs. Among this latter group Brazil and China have attracted more attention due to the size of their programs as well as the aggressive and rather clear strategies that they have pursued to ensure quick success. Japan was able to achieve a 40% reduction in energy intensity in the last 30 years and aims at reducing the energy intensity by another 30% by 2030. In Brazil, a quick demand management campaign reduced total electricity consumption by 10% in early 2000s. In China energy efficiency improvement has had two distinct phases. In the first phase, China pursued conventional methods including price reform and retrofitting of energy intensive industries to reduce energy intensity by about 66% from 1980 to 2000. In the second phase China has embarked on an aggressive program of energy efficiency improvement that embodies all consumers and all central as well as local authorities. It has been able to improve the efficiency of major energy-intensive industries by a range of 20-60% between 2000 and 2008. China aims at reducing its energy intensity by another 20% between 2010 and 2020.

Energy efficiency programs of developed as well as developing countries have been reviewed by the World Bank, which has tried to distill the most important success factors in these programs. The best practice cases are thought to have benefited from:

(a) Long-term political commitment at a high government level;
(b) Creation of a proper (and specialized) institutional set up;
(c) Creation of incentives including appropriate energy pricing schemes;
(d) Mobilization of sustained financial resources;
(e) Monitoring and measurement of the results; and
(f) Effective communication with the public.

The above features are normally addressed through four distinct tasks: (i) preparation of an energy efficiency framework; (ii) preparation of rules and regulations; and (iii) preparation of the implementation arrangements; and (iv) identification of financing arrangements. In order to announce a long-term political commitment to energy efficiency, most countries have passed an energy efficiency law (or decree) that addresses the overall energy efficiency framework by:

- A clear statement of the government's intent;
- Specific goals or targets of energy efficiency;
- Specific intervention strategies;
- Provisions for implementing the legislative intent;
- Requirements for monitoring, oversight, and reporting
- Provision of resources (funding and physical) for implementation.

Another comprehensive review by the International Energy Agency (IEA 2010) indicates that the success of energy efficiency programs depends on the clarity of rules and regulations that should:

- Have a statutory basis;
- Be economical for producers and consumers;

- Focus on larger consuming subsectors;
- Be established in cooperation with industry and manufacturers;
- Be enforceable, with penalties applied in the case of violation;
- Include coordinated voluntary measures (standards and labels) and regulations with performance floors and ceilings;
- Be phased in over time to accommodate technology improvements;
- Be strengthened (to be more stringent) at regular intervals (every 3–5 years), in consultation with industry and manufacturers;
- Minimize the regressive effect of regulation on the poor through safety nets.

The World Bank and the IEA studies also point out the importance of implementation capacity, particularly in the areas of compiling energy information, pursuing the requirements of the law and regulations, and monitoring and evaluating the results. It is often suggested that these should be carried out by a specialized agency. According to a recent survey (Taylor, et al, 2008) of 29 energy efficiency agencies in the OECD and developing countries, the organizational affiliation of the specialized agency could range from a specialized office within a ministry, to independent state-owned entities focused on overseeing energy efficiency interventions. Agencies established in the 1980s and early 1990s were housed within the ministries of energy. More recently, energy efficiency agencies have been established within a public agency focused on "clean energy".

The above range of possibilities normally leads to a substantial debate about the proper place for the specialized energy efficiency agency. There is a trade off in having it closely associated with the government or placing it in a location that is rather independent of the government. An independent entity may be able to make faster decisions and also attract more skilled staff with a flexible salary scale. A government affiliation, on the other hand would enable the agency to act in a more authoritative manner which is often necessary when enforcing efficiency codes and standards. It is suggested (ESMAP 2008) that the organizational model of the energy efficiency agency should be selected based on: (a) the identification of the most important targeted sectors and the type of organization that can be effective in intervening in these sectors; (b) the skills and technical capacity needed to implement the intervention strategy (for example, regulation, market transformation, technology and industrial development, financial intermediation); and (c) the trade-offs between placing the agency close to the centre of government, which allows it access to political decision makers, and giving it more autonomy.

Aside from the location of the specialized agency, the institutional set up should also utilize the private sector capacity in implementing energy efficiency activities. ESCOs, in particular, are a good model for sustainable implementation of energy efficiency investments that do not require extensive government intervention—assuming that the barriers to energy efficiency, especially any energy price subsidies, have been removed. Besides providing private sector participation and financing, ESCOs transfer technical risks away from the end users and financiers. They can also package smaller projects, bundle the procurement of goods and services, and take on project risks. But creating strong and credible ESCOs has proved very challenging in many countries. Emerging and developing economies often lack the legal and financial infrastructure to adapt and support such business models. Equity markets are limited, and few investors have the funds required to create new companies to test such business types. In addition, new ESCOs often lack the range of skills (corporate management, financial management and credit assessment, risk mitigation, management, and sales) required to bring credibility to customers and financiers. Therefore, creation of an ESCO market would need a clear supportive strategy at its initial stage. For example many countries have tried to ensure a stable business for ESCOs by requiring public sector facilities to undergo energy audits and to improve energy efficiency. These guaranteed early markets provide ESCOs with an opportunity to build capacity and develop skills.

Finally, a great deal of the discussion of the international experience focuses on the challenges of financing energy efficiency projects. Financing arrangements of energy efficiency projects and activities are addressed in various manners depending on the stage of financial market development in the corresponding countries. The funding may come from the private sector (financial markets, commercial banks, private investors, etc.) or the public sector (public budgets, dedicated funds, bilateral and international development assistance). In some countries, the financial markets and companies engaged in energy efficiency are sufficiently developed to raise the needed financing without public support. But in most cases public resources are needed either to support a specialized agency or to provide some sort of fiscal incentive to the private sector.

Two main categories of activities require financing: (a) pre-investment activities (that is, the marketing, project development, and technical design needed to efficiently package good projects), and (b) investment projects. A common source of program failure is the inadequate balance of these two categories, which leads either to insufficient project pipeline development, or to an inability to arrange and deliver financing for a series of well-developed projects. Energy efficiency projects can be costly, risky, and complex to administer. The mix of financing instruments should fit the project characteristics. The common financing instruments include targeted subsidies (to producers or consumers) that bring down the up-front investment cost, concessional loans (with low interest and/or long maturity), partial loan guarantees to mitigate the risks perceived by commercial lenders, loan-loss reserve funds, rebates on energy audits, and investment grants.

The choice of the right financial arrangement depends on many factors, including the nature of the intervention, the capacity of financial institutions, the financial resources of the government, and the capacity and interest of the private sector. In countries where financial markets are not well developed energy efficiency projects are supported by a special revolving fund. These funds function as one-stop shops that combine financial intermediation with project preparation and can finance projects; lend money to the end-users and to the private sector (including ESCOs).

3.3 Proposed Strategy and Institutional Framework for Egypt

As in most developing countries, the fast rise in Egypt's energy demand has been driven by three factors: (i) increasing household use of modern energy, especially electricity; (ii) increasing industrialization; and (iii) the expansion of motorized transport. By examining each of these demand components one can identify the possibilities of more effective use of energy resources. The latest available statistics show that the industrial sector accounts for 39% of the final energy consumption in Egypt. Transport and residential/services sectors account for 34% and 27% respectively. Although the industrial sectoraccounts for the largest share of the total energy use, the residential sector is by far the largest electricity consumer. Energy efficiency measures aimed at conserving electricity use should then focus on residential/services and the industrial sector. Energy efficiency measures aimed at conserving oil and gas should concentrate on the transport and industrial sector.

Table 3.1: Composition of Energy Consumption in 2009

Energy Use \ Sector	Residential and Services	Industrial	Transport
Energy Mix (%):			
• Coal	0	2	0
• Oil	36	32	97
• Gas	8	44	3
• Electricity	49	18	0
• Other	7	5	0
Final Energy Consumption (MTOE)	12	17	15

Source: IEA (2010), EIA (2010) and authors estimates

A World Bank review of energy efficiency in Egypt has estimated a potential gain of about 20% through better incentives and technologies. More specifically, it is estimated that:

- In the industrial sector, most industries have 10% to 40% of energy saving potential;
- Building and appliance energy efficiency can be improved between 20% to 80% through better insulation and better standards;
- The transport sector represents an energy saving potential of about 15% even relying on existing transportation modes and technologies.

Although energy efficiency had not taken a prominent role in Egypt's past energy strategy, it has now become a high priority. Due to the inadequate supply of domestic oil and gas and a rather tight government budget the government has now arrived at the conclusion that energy efficiency should be pursued as an important avenue to reduce the demand-supply gap as well as the financial burden on fiscal resources. As a result, Egypt is now trying to address energy efficiency on both the demand and the supply sides. At the same time, the country is facing significant constraints that need to be addressed in order to move forward the energy efficiency agenda. The most important constraints include:

- Energy prices are well below costs and do not encourage energy savings;
- There is no law, regulation or effective policy to promote energy efficiency;
- Development of dedicated institutions in charge of energy efficiency is at only a discussion stage;
- There is little reliable data and information on energy use by subsectors, key industries, equipment and appliances;
- There are no dedicated funds or other financial mechanisms and incentives to support energy efficiency activities;
- There are no mandatory fuel efficiency standards in transport, no mandatory energy efficiency building codes, no benchmarking for industries, and only few energy efficiency standards for appliances;
- There is an insufficient capacity to develop and undertake energy efficiency programs and projects.

In order to overcome the above barriers Egypt needs to develop and implement a set of administrative and regulatory measures along with a variety of market-based programs to encourage energy efficiency and to induce behavior change.

The first question to address is whether Egypt should prepare and pass an Energy Efficiency Law. There are various trade-offs to consider including the time and resources that would need to go into such an effort. It is also important to note that the draft Electricity Law includes several clauses designed to improve energy efficiency. The draft law requires that (i) electricity distributors and transmitters purchase energy generated by co-generation using feed-in tariffs; (ii) electricity consumers with high capacity use (above 500KW) hire an energy management professional and maintain energy records; and (iii) a framework is prepared for the expansion in the application of energy labels for different appliances and equipment.

Although the draft electricity law does not provide comprehensive energy efficiency framework there may not be a need for the preparation of a separate energy efficiency law. Experience in some countries, such as China and South Africa, indicates that energy efficiency can be pursued based on the preparation of a national strategy provided that the regulatory and institutional arrangements are well designed and implemented. Our assessment indicates that Egypt's main shortcomings can be effectively addressed within the context of a national energy efficiency strategy. Such an strategy should: (a) identify clearly sector priorities; (b) present a design of the institutional set up; (c) elaborate the responsibilities for the development of rules and regulations; (d) present the viable financing mechanisms; and (e) identify clearly the sources of financial support to the public and private projects as

well as upstream work in management audits and project preparation. Associated with the strategy but albeit of broader scope is the plan for energy price reform.

Sector Priorities: The strategy should include quantitative objectives for the targeted sectors. Egypt has set such a target (20% improvement by 2020) in the context of the overall energy strategy though the avenues for achieving such a gain have not been deliberated or even identified. There is a need to prepare a sectoral plan in support of the announced target. In the residential and commercial sector the following efficiency improvements would provide substantial opportunity: (a) building codes regulating the overall energy use per unit of residential or office floor space;(b) energy audits to identify available energy saving potential; (c) financial incentives for construction of energy efficient buildings and purchase of energy efficient equipment and materials; and (d) information on best practices in building design and construction.

In the industrial sector energy efficiency improvements should include: (a) development and introduction of energy efficiency standards for industrial equipment; (b) implementation of energy audits to identify potential areas for energy efficincy improvement; (c) creation of financial incentives to produce or install energy efficient equipment and processes; (d) introduction of voluntary agreements (VA) for improving EE in particular industries; and (e) implementation of demand-side management (DSM) programs (in cooperation with energy suppliers) to reduce energy demand and peak load.

Institutional Arrangements: The institutional set up should enable all stakeholders to work together to provide and implement the specific plan of energy efficiency improvement. The missing links at this stage are a high level decision making body and a specialized agency. Though the eventual decision maker regarding all aspects of the energy sector is the Supreme Energy Council, there is a need for a specialized committee to give direction to the stakeholders in energy efficiency. The second missing link is the lack of a specialized agency. The specialized agency should function as the country's hub for promoting energy efficiency. It should have the capability to compile energy information, pursue the requirements of the law and regulations, and to monitor and evaluate the results. It should have the overall strategic responsibility for implementation of energy audits and surveys; enforcing energy efficiency standards and labeling programs; promoting R&D and dissemination of advanced energy technologies; facilitating market penetration and commercialization of high-efficiency equipment; and mobilizing financial support for energy efficiency projects. As mentioned earlier the Supreme Energy Council established in June 2009 an Energy Efficiency Unit at the Cabinet of Ministers. The Unit has no executive or implementation authority and has not yet taken a leading role. There is a need to review the current status of the unit in light of the institutional requirements for clean energy development.

Financial Support: Although energy efficiency projects are often economically and financially viable they have difficulty attracting debt and equity finance from conventional sources. Like in many other developing countries, there is general perception in Egypt that energy efficiency projects are riskier than other investments because the benefits are not clearly tangible, implementation is rather complex, and the project preparation time and expense is too high relative to the often small size of the project. Contrary to other energy investments, energy efficiency cannot be directly measured in terms of its incremental physical output. Rather, it is measured as a savings or decrement against a baseline of consumption or expense. Installation of energy efficiency devices require the use of new technologies that are often less known to the consumers and bring about a perception of risk. Financing instruments, as well as other policies, should focus on reducing these perceived risks.

The risk aspect deters identification and implementation of energy efficiency projects by public and private sectors. To attract public and private capital to the energy efficiency market, specific financing strategies and mechanisms are needed for the various sectors and stages of energy efficiency development. As mentioned earlier the financing instruments should fit two categories: pre-investment activities and investment

projects. In the Egypt's context one can consider a more specific breakdown of these activities to include: (i) project preparation consisting of audits, surveys and technical assistance in project formulation; (ii) energy efficiency projects; (iii) energy efficiency ventures; and (iv) R&D and promotion of new technologies. The preparation work is often a serious bottleneck. Energy audits can be financed by the consumer if the audit results in sufficient energy savings. However, the cost has to be absorbed in the event that savings are insufficient. Even if the audit yields high energy savings the end user initiating the efficiency measures lack the capital to cover the upfront audit and assessment costs. This results in an initial gap and bottleneck in the energy efficiency project identification. Financing the actual energy efficiency projects usually entail energy efficient building retrofits and standard equipment and process replacement. Costs can be recovered from the energy savings and by the end user (residential, commercial, institutional and industrial). However, in a transitional market there will be a need for financial support or at least bridge financing of such projects. Energy efficiency ventures are businesses that produce, market, distribute and sell energy efficiency products and services. These can include the developers and manufacturers of energy efficiency technologies (from energy efficiency light bulbs or heating systems to controls, energy metering, etc.), and the associated vendors, retailers and service companies that sell, install and service the technologies. ESCOs could serve as an important market actor that would assume the costs of the equipment, process replacement and building retrofit through an Energy Performance Contract (EPC). Payback is ensured by a percentage of energy savings as stipulated in the EPC. However, ESCOs require financing both for themselves as ventures and for the projects they undertake. Finally, R&D and technology innovation are important components of the energy efficiency business and would not survive at the initial stages of energy efficiency markets without a clear and specific financial support mechanism.

Financing Instruments: Financial instruments should be selected to fit the identified activity. Grants are often needed for project preparation and R&D. Loans and guarantees can support energy efficiency projects. Contingent loans and equity contribution are often suitable to supporting energy efficiency ventures. Financial support should be targeted to the creation of financial incentives and should include also other instruments like tax exemptions and financial penalties for failure to install energy efficient industrial equipment.

Although the specialized agency should have the capacity and the obligation to consider an entire host of financial instruments, it would need a specific fund to use and allocate to various energy efficiency activities. Considering Egypt's potential energyefficiency program, we recommend establishment of an Energy Efficiency Fund. Creation of this specialized fund will provide the strongest political signal and the most important facility for the formulation and implementation of the energy efficiency program in Egypt. In proposing the above suggestion we have also considered the option of including this fund in the Renewable Energy Fund that is currently proposed in the draft Electricity Law. The experience of other countries indicates that combining the energy efficiency and renewable energy funds, as well as combining the specialized agencies, is suitable to countries where the renewable energy development is of rather modest magnitude. On the other hand, in countries where renewable energy is of large scale it should have a separate agency and separate fund from that of energy efficiency. Egypt falls in the latter category.

The creation of the Energy Efficiency Fund will also enable Egypt to mobilize the rather abundant international financial and technica) resources currently available for improving energy efficiency in the country. International financial resources can be mobilized from a number of bilateral and multilateral channels. Most of these resources are provided in conjunction with the climate change agenda. Almost all these sources of finance attach the highest priority to energy efficiency projects. These sources are broadly categorized into: carbon trading; and the international funding pools. Carbon trading, or carbon market, is a general term referring to various possibilities of exchanging carbon reduction credits. Under the Kyoto Protocol each developed country is obligated to limit its carbon emissions to a certain ceiling. The Protocol also provides for three market mechanisms – emissions trading, the Clean Development Mechanism (CDM) and

the Joint Implementation Mechanism. These mechanisms enable a developed country exceed its emissions reduction commitment, provided that it compensates the excess emission by buying surplus allowances (credits) from other (developed or developing) countries. This provides a financial mechanism for a developed country to support carbon emission reduction investments in a developing country[10].

International funding pools are formed with the financial contribution from the industrial countries to fund qualified projects in developing countries. The Global Environmental Facility (GEF), which is by now a well established source of grant funding, provides funding for piloting and innovating new approaches and technologies. A more recent and larger funding mechanism which was created in 2008 is the Climate Investment Funds (CIF). These Funds are hosted and managed by the World Bank. However, their underlying investment programs and projects are prepared jointly by the World Bank and the corresponding regional development banks. CIF consists of two main components: a large $6 billion Clean Technology Fund (CTF) and a number of smaller funds referred as Strategic Climate Funds (SCF). CTF supports large-scale carbon reduction projects. It provides scaled-up financing for demonstration, deployment and transfer of low-carbon technologies with significant reduction in greenhouse gas (GHG) emissions.

Preparation of the energy efficiency strategy and its associated program components would require extensive consultation among the stakeholders. Table 3.2 contains a set of recommendations for the strategy/program components that can be used to initiate the consultation process.

[10] The carbon market has reached a large volume (5 GT or $120 billion in 2008). However, the major part (63%) of this volume is related to the EU Emissions Trading System. The remaining volume is mostly the trade related to the certified emissions reductions (CERs) achieved by the CDM projects. This latter category is of direct interest to our discussion. The CDM is a mechanism for a developed country to contribute to the funding projects in developing countries. There were some 17000 CDM projects under implementation in 2009 (Fenham et al, 2009). Renewable energy projects accounted for 45 percent and energy efficiency accounted for 15% of the total. There are a number of proposals to substantially scale up the CDM by (i) bundling a number of activities in a single transaction or program, (ii) taking a sector (rather than a project) approach; and (iii) formulating policy-based CDMs. Implementation of these wholesale approaches can be facilitated by establishment of country-wide energy efficiency funds such as the one proposed here for Egypt.

Table 3.2: Recommended Features of Energy Efficiency Strategy for Egypt

Strategy Item	Recommendations
Sector Priorities	Buildings and appliances represent the low-hanging fruits in energy efficiency in Egypt. The industrial sector is likely to be responsive to energy audits and efficiency incentives. The transport sector offers significant but long-term potentials for energy efficiency improvement.
Institutional Set-up	There are two missing links: a high level decision making body and a specialized agency. The Supreme Energy Council established in June 2009 an Energy Efficiency Unit at the Cabinet of Ministers. The Unit is intended to be a coordinating arm but has no executive or implementation authority. There is a need to review the current status of the Unit in light of the institutional requirements of the clean energy development. The option of creating a Clean Energy Committee and a specialized energy entity should be considered.
Rules and Regulations	While the Supreme Council for Energy is the ultimate authority for approving the rules and regulations, the preparation of rules and regulations should be based on a wide range of consultation within the public and private sector. It is recommended that the Supreme Council for Energy mandates the Clean Energy Committee to prepare draft rules and regulations.
Categories of Financial Support	To attract public and private capital to the energy efficiency market, specific financing strategies and mechanisms are needed for the various sectors and stages of energy efficiency development. In the Egypt's context financial support is required for: (i) project preparation consisting of audits, surveys and technical assistance in project formulation; (ii) energy efficiency projects; (iii) energy efficiency ventures; and (iv) R&D and promotion of new technologies.
Financing Instruments	Although the specialized agency should have the capacity and the obligation to consider an entire host of financial instruments, it would need a specific fund to use and allocate to various energy efficiency activities. Considering Egypt's potential energy efficiency program, we recommend establishment of an Energy Efficiency Fund. The creation of this specialized will provide the loudest political signal and the most important facility for the formulation and implementation of the energy efficiency program in Egypt. The creation of the Fund will also enable Egypt to mobilize the rather abundant international (financial and technical) resources currently available for improving energy efficiency in Egypt. International financial resources can be mobilized from a number of bilateral and multilateral channels. Most of these resources are provided in conjunction with the climate change agenda. Almost all these sources of finance attach the highest priority to energy efficiency projects. The Energy Efficiency Fund would also require a well designed allocation and disbursement procedure to support EE in public as well as private sector through direct financing or through financial intermediaries, e.g., commercial banks, and service companies, e.g. ESCOs.
Capacity Building	Capacity building is an essential pre-requisite for a successful energy efficiency program. It covers a wide range of skills and capabilities needed by the government agencies, equipment suppliers, financial intermediaries, energy consumers and energy efficiency service providers. In each of these areas capacity building should draw upon the international experience, resources and funding in a practical manner.
Information Systems, Monitoring and Evaluation, and Communication (Awareness Campaigns	The role of information systems is crucial in improving energy efficiency particularly considering the complexity of measuring the output of energy efficiency projects. The specialized agency should develop a comprehensive and reliable energy data and information system including: (i) a reliable energy consumption and efficiency data system; (ii) a clear set of energy efficiency indicators for key sectors, processes and appliances; and (iii) a monitoring and evaluation framework for energy efficiency programs and activities. It should also prepare the material to support the promotion and implementation of the energy efficacy policy.

4. Development of Renewable Energy

4.1 Egypt's Current Program and Accomplishments

Egypt has been rather ambitious about the development of renewable energy resources. In 2010, renewable energy, mainly hydropower and wind, accounted for 12 percent of Egypt's electricity generation. Government policy has consistently emphasized hydropower, but there is a view that most potential hydro resources have already been developed. Egypt's hydropower potential is about 3,664 MW with an estimated energy of 15,300 GWh per annum. There are currently five main dams in operation which are all located on the River Nile. Almost all the electricity generation comes from the Aswan High Dam and the Aswan Reservoir Dams. The Aswan High Dam power project has a theoretical generating capacity of 2.1GW, although low water levels often prevent it from operating anywhere near design capacity. An ongoing refurbishment program is expected to extend the operational life of the turbines by about 40 years and increase generating capacity at the dam to 2.4GW.

Among other renewable energy resources wind and solar offer significant opportiunities. Egypt is endowed with an abundance of wind energy resources especially in the Suez Gulf area which is considered one of the best sites in the world due to high and stable wind speeds. The West of Suez Gulf Zone offers the most promising sites to construct large wind farms due to high wind speeds which range between 8-10 meter/second on average and also due to the availability of large uninhabitant desert area. There are also other promising sites having wind speed of 7-8 meters/second in the east and west of Nile River near Beni Sweif and Menia Governorates and El-Kharga 0asis in New Valley Governorate. Solar energy is also rather abundant. Due to its geographic location, Egypt enjoys sunshine all year, with direct solar radiation varying between 1,970 KWh/m2/year and 2,600 KWh/m2/year.

4.2 Wind Energy Development

Egypt's attempt to develop wind and solar energy was initiated in 1986 when the New & Renewable Energy

Table 4.1: The Commissiong Date and Source of Support for Major Wind Projects

Commissioning Date	Capacity (MW)	Source of Financial/Technical Support	Type of Turbine
2001	30	Danida 1	Ijara
2001	33	KfW1	Ijara
2003	30.36	Danida 2	Ijara
2004	46.86	KfW 2& 3	Murabaha
2006	85	Spain	
2007	79.9	KfW 4	
2008/09	120.7	Japan	
2010	120.7	Danida 3	Murabaha
Total	**546.52**		**100 Turbines**

Authority (NREA) was set up with the objective of assessing the country's renewable energy resource and investigating the technology options through studies and demonstration projects. The main accomplishments have occurred in the last decade and have been mostly focused on wind energy. A series of large-scale grid connected wind energy projects have been implemented in Egypt with a total installed capacity of about 550 MW in 2010. Table 4.1 contains the commissioning date of the major wind projects along with information about the source of international assistance that has enabled project construction.

Egypt's progress in implementing wind power projects is rather impressive in the sense that the installed capacity is the largest in Africa and in the Middle East. However, the more impressive matter is Egypt's target and associated program for future implementation. The government has set a goal of building about 7200 MW of wind power capacity by 2020. The identified wind resources are considered sufficient to support such a target. The government has gone through extensive deliberations to determine the manner in which public and private investments should be mobilized to undertake the corresponding projects. In particular the government has tried to minimize certain risks to facilitate the private sector participation. For example, it has earmarked more than 7600 square kilometers of desert lands for future projects. Land Use Agreement for the area assigned to each project will be signed with the investor for free (only actual expenditures will be paid after the project operation through installment form 3 to 5 years). Other incentives for private investors include:

- EIA, including a bird migration study will be prepared by NREA;
- The financial risk for investors is reduced by signing a long-term PPA .The Government guarantees the financial obligations of the public sector. The electricity purchased price is denominated in foreign currency with a small portion relating to the local currency to cover local costs;
- RE equipment imports are exempted from customs duties;
- The project can benefit from carbon credits.

Worldwide, renewable energy has attracted a lot of attention and resources in the recent years. Similar to the

Table 4.2: The Commissiong Date and Source of Support for Major Wind Projects

Country	2004	2005	2006	2007	2008	2009	2010
China	764	1266	2599	5912	12210	25104	41800
USA	6725	9149	11603	16819	25170	35159	40200
Germany	18428	18500	20622	22247	23903	25777	27214
Spain	8263	10028	11630	15145	16740	19149	20676
India	3000	4430	6270	7850	9587	10926	13065
Italia	1265	1718	2123	2726	3736	4850	5797
France	386	757	1567	2455	3404	4492	5660
United-Kingdom	888	1353	1963	2389	3288	4051	5204
Canada	444	683	1460	1846	2369	3319	4008
Denmark	3124	3128	3136	3125	3160	3465	3752
World Total	**49.963**	**59173**	**74,178**	**93,952**	**121,328**	**158,008**	**194,154**
Egypt	145	145	230	310	390	430	550
Africa (total)	242	252	337	478	584	757	926

Source: thewindpower.net

case of Egypt, the worldwide expansion of (non-hydro) renewable energy thus far has been focused on wind power. The total installed wind power capacity grew by a factor of 10 from about 20 GW to about 200 GW over the last decade. The installed capacity in 2010 was 194 GW of which 42 GW was in China; 40 GW in the US; 27 GW in Germany; 20 GW in Spain and 13 GW in India.

Wind power technology is considered a prominent example of renewable energy where R&D has successfully improved technology, lowered the cost, and has been disseminated around the world in a rather short period of time. The cost of wind power varies depending on the site characteristics, but the average cost of wind electricity has declined from more than 20 cents/ kwh in early 1990s to 6 to 7 cents/kwh today. Advances in wind power technology were initiated in Denmark for most of the early stages and then taken up by Germany, Spain, and United States. The most impressive progress has been made in China where wind power capacity grew from less than 1 GW in 2004 to 42 GW in 2010 when China became the largest wind energy provider worldwide. The development of wind energy in China, in terms of scale and rhythm, is considered absolutely unparalleled when taking account of the advances that China has made in establishing its own manufacturing capacity and the leadership role in building the larger size wind turbines.

India is the only other developing country in the list of top 10 wind power producers worldwide. India has been preoccupied with the wind technology for a longer time than China but the progress and in particular the transfer of technology has gone up and down depending on market conditions. The success of technology transfer has not been due to a clear and strong government leadership but by the private sector's incentive to take advantage of cheap labor and resources in India. This constitutes the prominent distinction between the wind power promotion programs of China and India. While both countries rely on the private sector for the bulk of investments, the Chinese government has taken a strong leadership role by announcing a clear strategy and incentive system. India seems now convinced of a need for such government leadership and is incorporating the idea in the promotion of solar power. There are rather clear prospects for further cost reduction with the larger scale of wind turbine production, and advancements in technology. The present R&D efforts focus on building large size (10 MW) wind turbines, reducing the material weight of turbine blades, and designing more intelligent rotors to improve reliability. There are also various initiatives to improve the availability of wind power through storage facilities, or combination with other energy resources, e.g., hybrid systems which may use wind and gas, or wind and solar.

4.3 Solar Energy Development

Egypt's progress in implementing solar projects has been limited though it has very attractive sites for solar energy that could be used to produce heat through solar collectors, or generate electricity directly through photo-voltaic (PV) technology,[11] or in a Concentrated Solar Power (CSP)[12] system.

Egypt's only major solar power project was commissioned in 2010 in Kuraymat. It is a 140 MW solar thermal-combined cycle power plant of which 20 MW is from solar thermal. The project was constructed with financial support from the Global Environment Facility and Japan Bank for International Development. The solar generation of 34 GWh represents only 3.6% of the total energy generated by the plant. Nevertheless, it is considered a learning experience for Egypt and other countries in the region.

Egypt is struggling with planning future solar power plants. On the one hand the country is recognized by the international community as a major source of solar energy that could be tapped for domestic use as well as possible export to Europe. On the other hand, the investment cost of solar power plants is presently very

[11] A PV cell is basically a semiconductor that absorbs solar energy (sunlight) and converts it directly into electric energy.
[12] Mirror systems to reflect and focus incident solar radiation onto a receiver) which is mainly tubing system filled with a heat transfer fluid (HTF) usually thermal mineral oil, or water.

high in comparison with the oil and gas plants. The higher cost of solar as well as the tight cash flow of the power sector deter an ambitious plan for development of solar electricity. The only clear proposal at this stage relates to the construction of the Kom Ombo plant (located about 40 km North of Aswan and 150 km South of Luxor). The Kom Ombo site has an available land of approximately 750 hectares for the solar plant. The meteorological data shows an annual sum for direct normal irradiation (DNI) of 2516 kWh/m2 for the site. The land availability and the DNI support a proposal for construction of a 100 MW CSP plant.

Worldwide experience with solar technologies indicates that solar energy development is at an early stage of development. Presently solar energy accounts for only 1% of world's total energy consumption. Most solar energy produced today is based on photovoltaic technology, and more than 90 per cent of photovoltaic modules use wafer-base crystalline silicon. This is a well established and reliable technology, but it uses large amounts of silicon as primary feedstock material. Numerous efforts are under way to improve the resource effectiveness and cost efficiency of this technology. Nonetheless, it is expected that by 2020 most photovoltaic applications would shift to thin-film technology, which is based on a different manufacturing approach. The main advantages of thin films are the relatively low cost of raw materials, the high degree of automation, the resource effectiveness of the production process, the suitability for integration with buildings and better appearance. Photovoltaic technology is expected to go through another transition after 2020, when a third generation of photovoltaic systems is expected to further reduce cost and increase efficiency. As a result of these developments the electricity generation cost of solar photovoltaic systems is expected to decline to around 5–7 cents a kilowatt hour by 2050.

Grid-connected solar PV has grown fast in recent years though the concentrated Solar Power (CSP)[13] is considered to be a more promising technology for large scale grid-connected electricity. Solar PV has grown fast, albeit from a small base, in the recent years. Between 2004 and 2009, grid-connected PV capacity increased at an annual average rate of 60 percent reaching about 21 GW in early 2010. The industry expects even higher growth in the next four to five years. Germany is the eading country with a capacity of 9.8 GW accounting for some 47 percent of existing global solar PV capacity. Spain, Italy, Japan and the US are the other countries with substantial capacity.

CSP received some attention in 1990s but did not result in noticeable capacity construction. It has taken a high profile since 2005. Global capacity in 2010 was less than 1 GW (about 660 MW) all in the US and Spain. The Spanish market has driven most of the growth over the past few years but some significant growth is now expected in the US where an additional capacity of more than 8 GW is planned to be commissioned by 2014. Worldwide, significant developments are taking place in CSP technology. Small plants and research projects are currently under way in France, Germany, and elsewhere in Europe. A 100 MW commercial plant is planned in Abu Dhabi, and new plants are under consideration/construction in Algeria, Egypt, and Morocco in connection with the Mediterranean Solar Plan. Morocco has announced a plan to build 2 GW of CSP by 2020. China has stated an intention to build 2 GW of solar power by 2020. Although a bit early to assess but the most impressive plan for development of solar power appears to be that of India that aims at developing 20 GW of capacity by 2022.

Finally, it is useful to note that solar hot water technologies are becoming widespread and contribute significantly to hot water production in several countries. China, Germany, Turkey, Brazil and India lead the market for the existing installed capacity. Although these technologies do not directly generate electricity, they often help to

[13] CSP usess direct sunlight, concentrating it several times to reach higher energy densities and thus higher temperatures. The heat is then used to operate a conventional power cycle through a steam turbine that drives a generator. CSP development involves a higher level of cost and risk compared with the conventional energy sources. It is nevertheless expected that these costs and risks can be reduced by a large scale deployment of the technology.

conserve electricity consumption. In most applications solar water heaters are commercially viable and do not need to be subsidized. However, there is a need to promote the technology by training, capacity building and awareness.

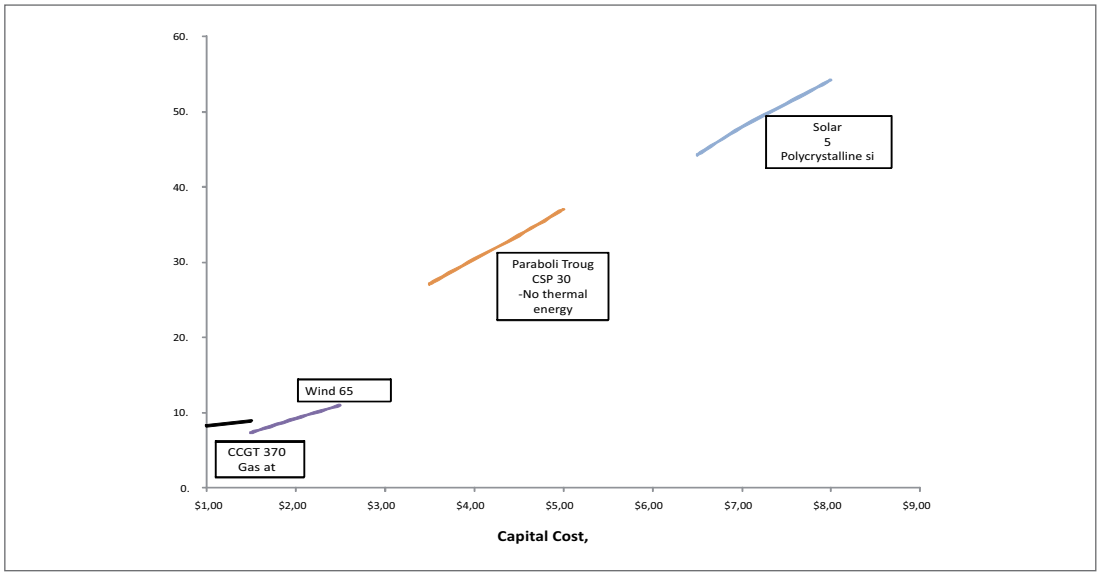
4.4 Incentives for Developing Renewable Energies

Despite the increasing attention given to the development of renewable energy, there are still significant barriers including the need for subsidy, the weakness of the regulatory and institutional capacity, and the riskiness of renewable energy projects. Although costs have declined, the average cost still is in most cases higher than that of the conventional electricity generation. This is particularly true in the case of solar power where the capital cost of CSP and PV are still much higher than those for conventional power. Figure 4.1 shows an approximate comparison though the actual cost of each option would vary from country to country.

Consequently, most existing wind power projects and all existing solar energy power plants, whether done by the public utility or private power providers, have been built with subsidies from governments and/or international donor agencies. This is likely to be the case for the near to medium terms. The size of the subsidies provided to private participants is essentially that which enable them to obtain acceptable returns on their equity investments. Depending on the country, subsidies to the private sector have been normally provided through two main mechanisms: the Renewable Portfolio Standards (RPS) and Feed-in-Tariffs (FIT). In some cases, these mechanisms are combined with financial incentives (e.g., investment grants, tax breaks, etc). The RPS is a quota mechanism that mandates the quantity of wind or solar electricity to be purchased by utilities over a time period. A tradable instrument (e.g., the Renewable Energy Certificate in the US) is established that sets the price per MWh for each type of power. The FIT mechanism, on the other hand, sets a standard price (with a premium over the market price) for all qualifying resources to be paid over the life of the project or a set time period, providing developers with a predictable revenue stream.

Each mechanism has its own advantages and disadvantages. The RPS has been used successfully in some US states but has been less effective in other

Figure 4.1: Relative Comparison of Economic Generation Costs and Capital Costs



Assumptions: Capacity factors-PV 20%; CSP 20%; Wind 40%; CCGT 90%.; 25 years project life; 10% discount rate.

countries. The FIT mechanism is now used in 23 out of 27 European Union states and a number of developing countries, and is generally credited with the rapid deployment in the last decade of renewable energy generation globally.

Developing a FIT mechanism essentially involves the following tasks. For each technology the government should:

- Estimate financial generation costs;
- Set terms of long-term PPA;
- Set limits to plant capacity anddifferentiate tariffs by plant capacity;
- Consider setting a degression rate: a schedule of FIT rate decline over time based on each technology's projected experience curve. Periodic review (e.g. every 4 years) to determine if tariffs need revision;
- Set grid interconnection procedures.

Aside from the manner in which the government should subsidize the development of renewable energy, there are some other important requirements for a successful program. The international experience indicates that the key features are as follows:

- Effective institutional arrangements for program implementation;
- Well articulated goals for the short, medium and long terms, with targets, activities and budgets defined in some detail for the short term;
- Clear priorities set for R&D, demonstration and commercial investments;
- Well designed incentive system and transparent process for participation of the private sector.

As mentioned earlier China is the most prominent example of a country that often announces very clear strategy with the relevant features when embarking on new technologies. More recently India, learning from the experience of wind development, has decided that it needs to have a clear strategy for solar energy. This strategy is prepared according to the state of the art and provides very useful insights for Egypt. The Indian strategy announces a National Solar Mission the objective of which is to establish India as a global leader in solar energy, by creating the policy conditions for its diffusion across the country as quickly as possible. A target has been set for the deployment of 20,000 MW of solar power by 2022. The timeline for achieving the target has been specified further: to ramp up capacity of grid-connected solar power generation to 1000 MW by 2013; an additional 3000 MW by 2017 through the mandatory use of the renewable purchase obligation by utilities backed with a preferential tariff. This capacity can be more than doubled – reaching 10,000MW installed power by 2017 based on the enhanced and enabled international finance and technology transfer. The key driver for promoting solar power would be through a Renewable Purchase Obligation (RPO) mandated for power utilities, with a specific solar component. This will drive utility scale power generation, whether solar PV or solar thermal. The Solar Purchase Obligation will be gradually increased while the tariff set for solar power purchase will decline over time. A Solar Research Council will be set up to oversee the strategy, taking into account ongoing projects, availability of research capabilities and resources and possibilities of international collaboration. Although in the long run, the Mission would seek to establish a sector-specific legal and regulatory framework for the development of solar power, in the shorter time frame, it would be necessary to embed the activities of the Mission within the existing framework of the Electricity Act 2003. A solar energy fund is established that would disburse subsidies through the Indian Renewable Energy Development Agency.

4.5 Proposed Strategy and Institutional Framework for Egypt

Egypt's present energy strategy (the resolutions adopted by Supreme Council of Energy in February 2008 and February 2010) aim at increasing the share of renewable energy to 20 percent of the energy mix by 2020. This target is expected to be met largely by scaling-up wind power as

solar is still very costly and the hydro potential is largely utilized. The share of wind power in total electricity generation is expected to reach 12 percent, while the remaining 8 percent would come from hydro and solar. This translates into a wind power capacity of about 7200 MW by 2020. The solar component is limited to 100MW of CSP and 1 MW of PV power. As mentioned in the previous section a draft Electricity Law was also prepared in 2008 that, among other things, aims at facilitating the construction of wind and solar plants through market liberalization, private sector participation and financial support. In particular, the new law provides for the establishment of a "Fund for Development of Power Generation from Renewable Energies (RE Fund)". Although the Law has not yet been approved the Supreme Energy Council endorsed in May 2011 the establishment of the RE Fund. This Fund is expected to provide the resources that the transmission company would need to purchase renewable energy through feed-in tariffs which are expected to be higher than the cost of conventional electricity generation.

Progress regarding wind power has been rather impressive not only with the construction of the existing plants but also the processes that have been put in place to bring in public and private investments into the sector. Substantial deliberations have gone into devising the procurement process to purchase wind power from private producers. The concept of the feed-in tariff has been accepted but scheduled for adoption at a later stage. In the meantime the procurement process envisages that in the short to medium-term Egypt would use an international competitive bidding approach requesting bids from the private sector to supply energy from wind. The financial risk for investors is reduced through guaranteed long-term power purchase agreements. The bidding process would consist of a pre-qualifications phase that would take about a year to assess the experience and financial status of the bidders as well as to complete the studies of wind measurements, bird migrations, environmental impact assessments, and soil testing. Then the short-listed bidders would be asked to submit proposals to construct, own, and operate the wind plant. The target is to have the private sector contribute 2500 MW by 2020. The intention is to target highly qualified international developers with strong financial status and high capacity for technology transfer. Also, local manufacturing will be promoted by giving an advantage to proposals having higher shares of locally manufactured components.

The first tender has been already initiated and promises to provide further lessons to be incorporated in future bids. In May 2009, the government floated an international tender for a wind farm at the Gulf of El Zayt. In cooperation with the World Bank, it invited private international and local developers to submit their prequalification documents for the first competitive bid to build a 250 MW wind farm. The sale of the rights for this wind farm will be for a build-operate-own (BOO) operation, which means that the developer will be responsible for the planning, construction and operation of the wind farm. The power produced will be sold to the Egyptian Electricity Transmission Company (EETC) under a 20-25 year Power Purchase Agreement (PPA). Egypt's Central Bank will guarantee all financial obligations of the EETC under the PPA. All renewable energy equipment will be exempt from customs duties, and the projects will benefit from carbon credits through the Clean Development Mechanism.

Following the tender, 34 offers were received and a short list of 10 qualified developers was announced at the beginning of November 2009. The bidders are now compiling their final bids to be submitted in the second half of 2011. The wind farm is scheduled to be operational in 2014. An environmental impact assessment, which will also include a bird migration study, will be prepared by NREA in cooperation with international consultants, and financed by the German Kreditanstalt für Wiederaufbau (KfW).

The next challenge is to secure finance for the projects by the public and private sector. Financing of large scale wind and solar development faces a variety of challenges due to the size of the required investment and the need for some type of subsidy. Egypt has been successful in tapping international support for renewable energy projects. AfDB is playing an important role in financing both wind and solar programs. Other MDBs including the World Bank and the International Finance Corporation are equally involved in supporting the required investments. The Clean Technology Fund (CTF) provides support through the AfDB and the World Bank to the development of wind and solar plants and the associated transmission projects. The wind

program has been supported by Germany, Denmark, Spain and Japan. Plants under construction and preparation are also being financed by Germany, Japan and Spain, as well as the European Investment Bank.

The future program for the development of renewable energy is substantially scaled up with an investment cost of approximately $ 7 billion during the next 10 years. The need for the huge investment finance comes at a point in time when government resources will be tight. Therefore, a well designed, systematic and well coordinated approach is needed to tap international financial (as well as technical) resources. Although Egypt has a good track record in this area, it should take a higher profile in attracting public and private financial institutions. In particular, it should emphasize more on the use of European resources which seem to be available rather abundantly for renewable energy projects in North Africa.

The European Council has set as an objective an 80-95 per cent reduction in greenhouse gas emissions by 2050 compared to 1990 levels. As some 80 percent of these emissions come from energy production and consumption, the pathway towards achieving the decarburization target will depend on improved energy efficiency and the use of low-carbon energy resources. To this end the EU has set a target of 20-20-20 aiming at improving energy efficiency by 20 percent, and increasing the share of renewable energy to 20 percent, by the year 2020. To achieve these targets the EU is expected to invest €80 billion in technology development. This amount can increase to 1 trillion Euros in the next 20 years in order to keep energy flowing while making the switch to low carbon energy. Along with this generous expenditure, the EU will remain conscious to ensure that available funds are invested in the types of projects that yield the highest impact. And this is obviously where the partnership between the EU and Egypt could provide a win-win solution. This is particularly important and possibly fruitful for development of solar energy in Egypt.[14] This is also an area in need of further analysis and clarification.

The current EU plans (see EC 2009) indicate substantial (20 GW) import of renewable energy including solar power from North African countries by 2020 while all these countries are presently in need of developing power generation capacity for domestic use. However, the availability of financial resources from the EU is worth serious consideration by Egypt.

Associated with the EU, the European Investment Bank (EIB) is expected to play a significant role in financing the energy integration projects.EIB is the EU's long-term lending bank and serves to support the EU's objectives inside and outside of the EU. Its main focus is within the EU but has in the recent years become an important player in developing countries in particular in relation to the underlying investments in the Mediterranean Partner Countries (FEMIP) including most of the countries in North Africa. It also provides grants for project preparation and technical assistance through Neighborhood Investment Facility (NIF) which is funded by the EU budget. EIB also mobilizes finance from bilateral entities such as KfW and AFD. Also the EU and its members contribute to the FEMIP Trust Fund which is a significant source of support for solar energy deployment in North Africa. EIB has the overall coordination responsibility on behalf of the EU for financing the investment requirements of the MSP. EIB can participate in the direct finance of the projects alone or in association with private banking institutions. It is also planning to create and manage the European Green Energy Fund (EGEF) to provide the private and public investors with EU backed guarantees. Another idea at the development stage is creation of an entity called E-SECURE in support of renewable energy investments. Mainly acting as a trader E-SECURE will buy the electricity from the companies owning the plants and sell it on the

[14] Cooperation between the EU and North African countries was first initiated under "The Euro-Mediterranean partnership" in November 1995. The partnership was endorsed by 12 partner countries around the Mediterranean including Morocco, Tunisia, Algeria, Libya and Egypt (among others). The partnership was re-launched in 2008 as the "Union for the Mediterranean" and now includes all 27 EU Member States along with 16 partners across the Southern Mediterranean and the Middle East. The Union for the Mediterranean has identified six priority projects one of which is the Mediterranean Solar Plan (MSP).

local and European markets. This is considered as a vehicle that could facilitate investments in MSP.

Mobilization of the European and more broadly the international and technical assistance would require a strategic approach by the Egyptian government. Although there are presently numerous sources of financial support and technical cooperation, they are scattered and rather small scale. There is a need for a rather large-scale approach where a macro package of financial and technological cooperation is designed in a coherent and comprehensive manner, and negotiated with the donor community.

In addition to the procurement and financing constraints Egypt would need to attend to certain technical issues which often deter investment in renewable energy. The two outstanding issues are system stability and assessment of wind and solar intensities.

Interconnection of renewable energy, particularly wind, to the power grid raises specific concerns about system stability. The complexity of the interconnection of wind farms to the power grid stems from the fact that wind energy is rather unstable and available only during certain hours of the day. By its nature the wind power generation may drop suddenly. To keep the grid operation stable, there is a need to ensure that other power generation sources are available to compensate for the drop. The associated technical issues include: back-up system, and power quality (voltage, frequency, etc). Another common characteristic of the wind farms is that they are located somewhat remote from the power grid. Therefore, the utility has to ensure the sufficiency of power transmission capacity. A rather unique feature of wind power in Egypt is that most of the wind resources are concentrated in the Gulf of Suez and Gulf El-Zayt areas. This raises the additional issue of the impact on the system when large volumes of wind power are interconnected at certain points of the network. EEHC has studied the issues of back up capacity and transmission network requirements in various previous and ongoing works but needs to make an assessment of the operating impact of integrating up to 7,200 MW of wind power into the transmission system. It also needs to develop the grid code that would prescribe the technical requirements for wind turbine manufacturers and developers.

The second technical issue relates to the measurement of wind and solar resources. While there is some degree of comfort about the available measurements of wind resources, there is a need for implementing a broad measurement of Direct Normal Insolation (DNI) data which constitutes a critical data input into the design of solar power plants. The plant and the associated solar field need to be designed based on DNI measured by well-maintained and calibrated ground-based instruments. Egypt has DNI data modeled from sunshine hours routinely collected by meteorological stations but this is not considered accurate. Data from satellite radiation maps, even if available for the area, are often not sufficient to use by itself because of very low spatial resolution (as low as 100 x 100 km) and inherent inaccuracies.

To summarize, the development of renewable energy resources in Egypt is on the right track but would need substantial strengthening in several areas. The wind development program has the right ingredients including a vision, target, a specialized agency with some accumulated skills, and reasonable incentive system. The solar development program lacks most of these ingredients. Also both wind and solar development suffer from the lack of a high level decision making body and a clear financing mechanism.

To strengthen the renewable energy development program, the government should take actions in regard to the institutional arrangements, financing mechanisms, and solar energy strategy. In regard to the institutional relationships, it is noted that the presence of a specialized energy agency – NREA – has provided an important vehicle for research and development, technical capacity building, and preparation and implementation of renewable energy projects. However, there is a need for a strategic body with higher political clout and wider reach among the stakeholders. It is recommended that government should form a high level committee for this purpose. Since the same body is missing in the case of energy efficiency we recommend that a Clean Energy Committee be formed to provide strategic directions to the energy efficiency and renewable energy programs.

The Clean Energy Committee should take responsibility for addressing the major barriers to the development of renewable energy. The Committee should utilize its political power to declare a clear vision, to bring the major stakeholders together, to announce the government policy and to mobilize financial resources. In particular the Committee should address two immediate issues: the parameters of the "Fund for Development of Power Generation from Renewable Energies (RE Fund)"; and the country's strategy and plan for solar energy development.

The draft Electricity Law introduces the idea of establishing the RE Fund. Although the Law has not yet been approved the Supreme Energy Council endorsed in May 2011 the establishment of the RE Fund. This is clearly a helpful first step but there is still a lot of uncertainty about the sources of finance and the process of disbursement. It is recommended that the proposed Clean Energy Committee takes charge of designing a coherent financing scheme which would (i) clarify the parameters of the RE Fund; and (ii) lead the communication with the international financiers with the objective of making the RE Fund an umbrella instrument for channeling resources from various donors to the high priority renewable energy projects.

There is also a serious need for innovative analytical work to maximize mobilization of donor funds at the minimum cost. A detailed understanding of donor resource availability should be developed. Also a tactical method should be adopted regarding the way that government can approach the donors to provide them with the comfort that they need to provide financial and technical assistance. The Clean Energy Committee should consider the matter as potentially most important aspect of its function and lead the communication with the international financiers with the objective of making the RE Fund an umbrella instrument for channeling resources from various donors to the high priority renewable energy projects.

Solar energy development in Egypt would need substantial deliberations. The Clean Energy Committee should bring together the relevant stakeholders and develop a clear strategy. Egypt's current plans for solar energy are rather unclear and of modest size. The un-ambitious approach is understandable while solar energy is expected to cost substantially higher than the available alternatives. However, there are three advantages that Egypt needs to incorporate into its deliberation of a solar energy strategy. First, most other developing countries which are pushing in this direction are focusing on the acquisition of a market niche and technology. Second, there is substantial financial support that Egypt could tap into through a calculated and sometimes innovative approach to financing solar projects. Third, the solar energy industry expects a rapid cost reduction the next 10 years. A decision to be to be aggressive or passive in the development of solar energy should emerge from a well designed strategy rather than by default.

5. Development of Local Manufacturing and Services

5.1 Egypt's Current Program and Accomplishments

Private sector in Egypt has shown a lot of interest in the energy related manufacturing and services. The government has also been supportive of such developments. The recent opportunity pursued by both sides is the wind power industry. Egypt has been pursuing wind technology since 1970s when it founded its first wind test station with the assistance from DANIDA. However, much of the progress has been achieved in recent years. NREA has substantial in-house expertise from developing some 500 MW of wind power in Egypt in areas ranging from initial resource assessment to wind farm operation and maintenance. The government has also encouraged local production of wind turbine components. Electrical components (cables, transformers) and wind turbine towers have been mostly produced by local companies. Egypt has the capability to manufacture towers and the majority of the "balance of system" items. Together, these account for around 75 per cent of the investment costs of wind. It is estimated that using locally-manufactured components to the full extent possible could reduce system costs by 10–15 per cent in the short term; possibly increasing to 25 per cent in the longer term as the local supply chain is better integrated (El Sobki, 2009). This program will help build local capacity and generate new jobs. It will require a staff of several hundred persons for regular maintenance and additional workforce for repairs and major overhauls. Increased local production and employment will directly contribute to local economic development.

The development of the wind sub-sector in Egypt would also further strengthen Egypt's role as a leader in renewable energy development in the region and could help it become regional supplier for the wind industry. Skill development would require a large scale program and Egypt is on track for moving forward with a considerable sized program. This large scale program should also enable Egypt to adopt more customized facilities for achieving optimum performance under Egyptian conditions.

Presently there is only one well known company – the El Sewedy for Wind Energy Generation (SWEG) that has been established by the Sewedy Group which is an industrial conglomerate. SWEG is focused on wind energy equipment and facilities. It is acquiring technologies and building capacity via alliances with international (mainly European) suppliers. SWEG has already ventured into wind-turbine and tower manufacturing through its subsidiaries. It is also planning to enter into turbine-blade manufacturing in the near future. In addition to its manufacturing activities, SWEG plans into the wind-related service areas such operation and maintenance of wind power plants. In addition to SWEG, a number of other local investors have stated their interest in the wind and solar industries but no specific plans have been announced. Aside from the specialized manufacturing facilities, Egypt has local capacity in some other power equipment areas such as cable and transformer manufacturing that could serve the needs of the wind and solar plants.

A typical wind energy project has four distinct components: (i) wind towers that account for about 15% of the project cost; (ii) nacelle and enclosed turbine that represents about 40% of the cost; (iii) blades and rotors that account for 20%; and (iv) the balance of the plant accounting for 25%. In Egypt there is some existing capacity in each of these areas. But more importantly, the energy industry provides substantial potential to expand into the wind industry when convinced of its profitability. In manufacturing towers a number of manufacturers have the capacity to produce a high volume if the market size expands. SWEG and the

German tower manufacturer SIAG have established a joint venture that is supplying the market with a vision of expanding to a capacity of 400 towers/year. There required still sheets are currently imported because there is no domestic manufacturer at this stage.

To manufacture the nacelle and enclosed turbine SWEG has bought a stake in Spanish company M. Torres that would provide an avenue for technology transfer. In the area of blades and rotors SWEG is reported to have negotiations with various international manufacturers. Finally, in regard to the balance of the system there is substantial potential to increase the local content. There is a large network of qualified contractors, local manufacturers of cable, and transformers that work in the power sector and could serve the needs of the wind industry.

Egypt has little local capacity in the solar sector. It has a number of small companies that are involved in supplying solar water heaters. This is indeed an area that should be promoted because solar water heaters are often commercially viable provided that market information is transparent. Aside from this small sector, Egypt does not have much capacity to locally produce the components of solar power plants. Conceptually a solar power plant can be divided into two parts: the solar field and the traditional power block with each component representing almost equal share in the project cost. The key components of solar field are the metal support structure for the mounting, the mirrors and the receivers. The structure has to meet certain requirements for the structural stability against wind loads in order to ensure the precise alignment of the mirrors over the entire length of the collector row which can reach up to 150 meters. Mirrors have to be highly precise. Receivers have to absorb as much light as possible while reflecting as little thermal energy as possible. Since the CSP market worldwide is still at a very young stage, only few companies exist which can supply these components. The power block used for CSP is very similar to that used for combined cycle power plants. Its main component is the steam turbine. Normally turbines are manufactured by big industrial companies with long-term experience in the field. Egypt has the industrial base for manufacturing most of CSP components but would require a comprehensive plan for transfer of specialized technologies.

5.2 Lessons from International Experience

The geography of renewable energy is changing dramatically. For example, wind power plants existed in just a handful of countries in the 1990s but now are being operated or built in over 82 countries. Many developing countries are building renewable energy plants. Some 20 countries in the Middle East, North Africa, and sub-Saharan Africa[15] have now active renewable energy markets. One of the forces propelling renewable energy development is the potential to create new industries and generate new jobs. Jobs from renewables now number in the hundreds of thousands in several countries. Development of renewable energy and associated manufacturing and services have been encouraged/facilitated by the availability of dedicated financial resources from the international community. Development banks have increased the size of their assistance in this area. Europeans particularly the European Investment Bank (EIB) and Germany's KfW have provide growing amounts of loans, grants, and technical assistance for renewables.

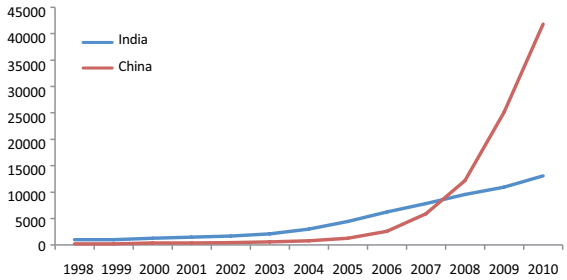
CSP manufacturers and developers are focused predominantly on opportunities in the United States and Spain. An increasing number of projects are expected to obtain utility power purchase agreements (PPAs) at

[15] In sub-Saharan Africa, there have been some installations of solar water heaters, solar PV and small wind turbines for pumping water. By contrast there is very limited development of large scale solar or wind technology mostly due to the lack of investment resources and technical skills. At the same time there is a strong interest and prospects for the development of renewable energy due to the prevailing high oil prices, and the international financial and technical support (Karekezi and Kithyoma 2003).

competitive prices as CSP is increasingly valued as a hedge against carbon pricing and as a source of peaking, intermediate, or baseload generating capacity (when paired with thermal storage or natural gas generation). In the U.S. market in particular, renewable portfolio standard (RPS) requirements for utilities have spurred new project development opportunities for industry firms and utilities, first capitalized on by Acciona's 64 MW Nevada Solar One in 2007.Leading firms in CSP include Brightsource, eSolar, Siemens, Schott, SolarMillenium, Abengoa Solar, Nextera Energy, Infinity, Tessera, and Acciona, with dozens of other manufacturers and developers active in the market. The manufacturing capability in the developing world has remained limited. India seems to be determined to take advantage of the present circumstances to embark an ambitious effort in developing solar manufacturing capacity. Technology transfer in renewable energy manufacturing is working in an unprecedented manner. The benefits of technology transfer go beyond the energy sector as they result in the development of local manufacturing and service capacities. Therefore, the governments have supported the technology transfer through political and financial support. Transfer of technology takes place through several methods including: (a) a licensing agreement that gives the licensing firm access to the concerned technology with some restrictions on where it can be sold; (b) establishing joint-venture partnerships between two companies for sharing a licensed technology or collaborative R&D; and (c) transfer of technology by multinational corporations that carry out their technology development and deployment within a global network. Global and regional networks could lead to changing directions of flow of technology. For example, China and India were beneficiaries of transfer of wind technology but are now becoming potential bases of technology transfer to other developing (as well as industrial) countries.

Comparing the experiences of China and India in transfer of wind technologies results in three interesting observations. First, what is common in both experiences is that transfer of technology starts with a simple licensing agreement but moves on to joint-venture partnerships and merger and acquisitions as the technology transfer becomes more intense and sophisticated. This enables the local manufacturers to move in the forefront of technology

Figure 5.1: Growth of Wind Power Capacity in India and China (MW)



Source: thewindpower.net

and become effective leaders in the international and regional networks. Second, what is different in the experience of China and India is the role of the government. While in both cases investments and innovations are undertaken by the private sector, technology development in China is guided by the government under what appears to be a clear and deliberate vision. Third, transfer of technology starts with a North-South direction and then takes a multi-directional flow.

Although China and India are often bunched together in their success in the wind industry, the two countries have had substantially different track records. Both countries have been exceptionally successful in this regard. However, the transfer of technology in China is driven by a public-private partnership while private sector has made the bulk of investments and the government has provided a very clear strategy and incentive system. The incentive systems include well publicized feed-in tariffs and specific (70%) local-content requirement for suppliers of wind turbines. China has used these instruments to dictate the type of technology transfer that it prefers to obtain. Over the course of a few years it adjusted the incentive system to target more advanced wind turbine technology, normally deployed in connection with larger units. However, the market has remained open to competition among the Chinese and global firms which are both currently manufacturing wind turbines in China. The largest market share is held by the Chinese firm Sinovel which obtained its initial technology through a licensing firm with the German firm Fuhrlander but later partnered

with American Superconductor Inc to jointly develop new technologies for larger turbines. This is typical of China's process of transfer of technology – starting with a licensing agreement, and moving to a joint venture partnership for developing more advanced versions of the corresponding technology.

India has depended on the market forces for the development of its wind industry. As a result the industry has gone up and down with market conditions. The relative success of the industry is not due to a clear and strong government leadership but rather to the private sector's incentive to take advantage of cheap labor and resources in India. Although the Indian and foreign wind turbine manufacturers supply the domestic requirements, they also aim to manufacture for export purposes. Indeed some foreign companies now source more than 80 percent of the components for their turbines in India and export them around the world including the US, Europe, and Australia (Lewis 2009). Even the very successful Indian firm Suzlon is now exploiting international opportunities by supplying turbines to various countries in North and South America and Europe.

India has studied the track record of China where the country has in a span of less than 10 years become a leading manufacturer of solar PV panels and wind turbines. In both areas China is capable of competing with advanced manufacturers. In each area, China has effectively transferred the technology from advanced manufacturers and has adapted to domestic manufacturing through well designed public-private machinery. India is now taking a similar approach to the development of solar industry. Indeed, India's solar development vision is now most ambitious worldwide as India has set a target of 20 GW for 2022. The vision has a clear objective in making India take a global leadership role in solar manufacturing (across the value chain) of leading edge solar technologies. It depends on a high-level specialized Solar Energy Council to lead the implementation of the strategy. It establishes quantitative targets with a plan to set up dedicated manufacturing capacities in each sub-industry. India already has PV module manufacturing capacity which intends to expand in the next few years. But currently, there is no indigenous capacity/capability for solar thermal power projects; therefore new facilities will be required to manufacture concentrator collectors, receivers and other components to meet the demand for solar thermal power plants. The present indigenous capacity to manufacture silicon material is also very low.

India's strategy to create local manufacturing in the solar industry is a good example of its leading deliberations. It sets out a clear vision with detailed quantitative targets. The targets for solar development capacity give a view of the size of the potential market that local manufacturers could aim to serve. In the absence of such targets, the market risk (along with a host of other risks) would deter private investments in the sector. The strategy also takes a conscious approach to help the private sector get the best technology and benefit from the most up-to-date R&D advancements in the international industry. As mentioned earlier, India's new approach to the development of solar energy industry is similar to China's approach to the development of wind power industry, and provides a good practice to be considered in the development of Egypt's strategy in the area of renewable energy industry.

5.3 Proposed Strategy and Institutional Framework for Egypt

Development of local manufacturing capacity in the renewable energy industry has been supported by the government of Egypt. However, the support has been of an ad hoc nature. Going forward, the local industry would need a clearly announced support mechanism from the government. The mechanism should enable local manufacturers to assess the size of the market, decision making process and the available incentives. The international experience indicates that development of the local manufacturing has been successful in countries where the government presented a specific vision and target. Manufacturing of wind energy equipment originally took off in Denmark when this country decided to develop an economic niche that could become an export industry. More recently, China achieved a very impressive success in this area when it identified the wind industry as a key growth component of the country's economy. And presently

India has made the same declaration about the solar manufacturing industry.

Egypt is well positioned to embark on developing local manufacturing of wind and solar equipment and services. It has a good basis for developing the required technical and managerial skills. It has the support of the international community. And it can count on export potentials to other countries in Africa and the Middle East[16]. However, it needs to develop a vision as well as clear designs for: (a) the institutional arrangements; (b) the incentive systems; (c) the R&D facility; (d) human resource development and (e) the international cooperation.

Institutional Arrangements: The Ministry of Electricity and Energy as well as NREA have often stated their support for the increased local contents of renewable energy facilities. However, there is no specialized decision making body that could develop a comprehensive view of the challenges and solutions to encourage new manufacturing and service ventures. It is recommended that the proposed Clean Energy Committee takes a leadership role and work with the private sector as well as other stakeholders to develop a vision and strategy for the development of local manufacturing and services. The Committee may form various working groups to investigate each outstanding issue.

Incentive System: The government has exempted all renewable energy equipment, spare parts and materials from all custom duties. The incentive system should be further strengthened by: (i) local demand creation that is normally declared through setting a target for the renewable energy industry; (ii) financing through low interest rate loans, and priority sector lending; (iii) ease of doing business often in the form of creating a single window clearance mechanism for all related permissions; and (iv) infrastructure enablers such as promoting technology parks consisting of manufacturing units (across the value chain), housing, offices, and research institutes. The financial support aspect would require its own mechanism and instruments. These issues are intertwined with those discussed in conjunction with the establishment of the RE Fund. However, an additional consideration is the manner in which the government may support the start-up companies. It is recommended that the RE Fund is provided with a window to give (equity/debt) support to start-ups, entrepreneurs and innovators for R&D and pilot projects.

R&D Program: R&D in Egypt should follow a clear strategy to combine technology transfer with local adaptation in order to provide advice to local manufacturers on: (i) innovative and new materials, processes and applications, (ii) new and potential improvement to the existing processes, materials and the technology for enhanced performance, durability and cost competitiveness of the systems/ devices, (iii) technology validation and demonstration projects aimed at field evaluation of different configurations in order to obtain feedback on the performance, operability and costs, and (iv) support for incubation and start ups. The Supreme Council for Research Centers[17] and the Clean Energy Committee should develop and declare a clear strategy for R&D in the area of renewable energy.

Human Resource Development: The key to development of wind and solar manufacturing industries is the ability to acquire technically qualified manpower of international standard. Some capacity already exists in Egypt in wind

[16] Egypt has developed a considerable local technical capacity in energy technologies and engineering/consultancy services. Its local manufacturing capacity has come to the forefront by the recent progress in producing wind equipment. Knowledge sharing and export of energy technologies from Egypt to the rest of Africa particularly sub-Saharan countries can cover broad areas in thermal generation, transmission, distribution, etc. However, a clear and immediate start can be initiated on the renewable energy, because almost every country in Sub-Saharan Africa is now eager to jump start a program in this area. These countries have also the option of accessing generous funding from bilateral and multilateral donors (including climate change funds) but have difficulty in formulating and implementing such projects. Egypt's assistance could prove effective and timely in moving such projects forward. At the same time a closer technical cooperation with sub-Saharan countries would enable Egypt to build new dynamism in its economy to create jobs and enhance its economic growth prospects.

[17] An organization co-chaired by the Minister of Higher Education and Scientific Research and the Secretary of State for Scientific Research.

manufacturing. However, there is substantial further skill requirement in both wind and solar manufacturing and services. A coherent strategy is needed to develop human resources while drawing upon the country's educational and vocational facilities, as well as utilizing the abundant international assistance. The strategy should consider: (i) designing and offering by engineering colleges courses in solar and wind technologies with financial assistance from the government; (ii) technical training courses for technicians aimed at providing skilled manpower for field installations and after sales service network; and (iii) introducing a government fellowship program to train selected engineers and scientists in wind and solar energy in world class institutions abroad; this could be supported under programs of bilateral cooperation, or institution to institution arrangements.

Egypt has developed niches of excellence that are apt to orienting themselves towards clean technologies. The country has a small but solid base of high quality universities with strong R&D capacity in the core sciences of relevance for clean technologies such as anotechnology, engineering and material sciences. The government has supported R&D and education in cleaner technologies. The Higher Council of Science and Technology declared in August 2009 renewable energy as one of Egypt's five National Research priorities. In line with this strategic orientation, the Science and Technology Development Fund (STDF) launched targeted R&D calls targeting Renewable Energy. The Nile University, one of Egypt's most successful research universities, has finalized plans to establish a renewable energy center, drawing on its expertise in related areas.

The vision announced by the Ministries of Higher Education, and Science and Technology provide a framework within which one should develop a comprehensive program for human resource development in renewable energy.

International Collaboration: Egypt has a good track record in international cooperation in the energy sector in general and in the wind energy development in particular. However, international cooperation in local manufacturing has been limited to SWEG's efforts to develop various segments of the wind manufacturing industry. There is a lot that the government can do to help in strategizing and optimizing cooperation with the international community particularly in regard to technology development. A well coordinated public-private partnership on the Egyptian side would enable the country to take advantage of both private and government facilities in other countries particularly Europe. Cooperation should be implemented at the level of research organizations as well as industry partners.

6. Conclusions and Recommendations

The government of Egypt has recognized that the availability of sustainable power supply is essential for economic and social prosperity and human development as well as for attracting private sector investments in the country. The government has therefore a clear policy of securing a reliable supply of power to all sectors of the economy. To meet the rapidly growing electricity demand the government has successfully expanded the power supply capacity from 17000 MW in 2003 to about 25000 MW in 2010. Despite this rapid expansion, the installed capacity is viewed rather insufficient to meet the prevailing peak demand as indicated by some wide-spread electricity shortages experienced in the summer of 2010. The complexity of the electricity and gas supply situation became publicly evident in August 2010 when the government had to review at the highest level the prevailing power shortages. The review brought out the fact that the availability of natural gas for power generation has turned into a real constraint and that the power sector is forced to use increasing amounts of oil for electricity generation. The issue is exasperated by the projection that there is a need to expand the power supply capacity by a rather large magnitude in the next 10 years.

The increasing use of fossil fuels in the power sector has triggered a strong interest in the diversification of the energy mix particularly the development of renewable energy resources. Also the government has arrived at the conclusion that energy efficiency should be pursued as an important avenue to reduce the energy demand-supply gap as well as the financial burden on fiscal resources. The benefits of energy diversification and energy efficiency for Egypt go beyond the energy sector as they result in cleaner environment, transfer of advanced technologies, and possible new areas of manufacturing and services. At the same time Egypt faces numerous challenges in pursuing renewable energy development and energy efficiency.

International experience indicates that energy efficiency is indeed the low hanging fruit that would yield faster benefits if properly addressed. However, energy efficiency improvement in Egypt is challenging due to a number of constraints:

- Energy prices are well below costs and do not encourage energy savings.
- There is no law, regulation or effective policy to promote energy efficiency.
- There is no clear and comprehensive strategy and/or program for improving energy efficiency.
- There is no dedicated institution(s) that have clear responsibility for pursuing energy efficiency objectives.
- There is little reliable data and information on energy use by subsectors, key industries, equipment and appliances.
- There are no dedicated funds or other financial mechanisms and incentives to support energy efficiency activities.
- There are no mandatory fuel efficiency standards in transport, no mandatory energy efficiency building codes, no benchmarking for industries, and only few energy efficiency standards for appliances.
- There is an insufficient capacity to develop and undertake energy efficiency programs and projects.

Our assessment indicates that Egypt's main constraints can be effectively addressed within the context of a national energy efficiency strategy. Such an strategy should: (a) identify clearly sector priorities; (b) present a design of the institutional set up; (c) elaborate

the responsibilities for the development of rules and regulations; (d) present the viable financing mechanisms; and (e) identify clearly the sources of financial support to the public and private projects as well as upstream work in management audits and project preparation. Associated with the strategy but albeit of broader scope is the plan for energy price reform.

Sector priorities should be as specific as possible. In the residential and commercial sector the following efficiency improvements would provide substantial opportunity: (a) building codes regulating the overall energy use per unit of residential or office floor space;(b) energy audits to identify available energy saving potential; (c) financial incentives for construction of energy efficient buildings and purchase of energy efficient equipment and materials; and (d) information on best practices in building design and construction. In the industrial sector energy efficiency improvements should include: (a) development and introduction of energy efficiency standards for industrial equipment; (b) implementation of energy audits to identify potential areas for energy efficiency improvement; (c) creation of financial incentives to produce or install energy efficient equipment and processes; (d) introduction of voluntary agreements (VA) for improving EE in particular industries; and (e) implementation of demand-side management (DSM) programs (in cooperation with energy suppliers) to reduce energy demand and peak load.

The institutional set up should enable all stakeholders to work together to provide and implement the specific plan of energy efficiency improvement. The missing links at this stage are a high level decision making body and a specialized agency. Though the eventual decision maker regarding all aspects of the energy sector is the Supreme Energy Council, there is a need for a specialized committee to give direction to the stakeholders in energy efficiency. The second missing link is the lack of a specialized agency. The specialized agency should function as the country's hub for promoting energy efficiency. It should have the capability to compile energy information, pursue the requirements of the law and regulations, and to monitor and evaluate the results. It should have the overall strategic responsibility for implementation of energy audits and surveys; enforcing energy efficiency standards and labeling programs; promoting R&D and dissemination of advanced energy technologies; facilitating market penetration and commercialization of high-efficiency equipment; and mobilizing financial support for energy efficiency projects. In an attempt to coordinate various aspects of energy efficiency the Supreme Energy Council established through a decree in June 2009 an Energy Efficiency Unit at the Cabinet of Ministers to coordinate, guide, support and monitor all energy efficiency activities in the country. The unit includes members of eight ministries representing the end user sectors such as Transport, Housing, Tourism and Trade & Industry, and the supply sectors such as Electricity and Petroleum. The Ministries of Environment and Finance are also represented on the Energy Efficiency Unit. The Unit is intended to be a coordinating arm for the Cabinet and its Supreme Energy Council but has no executive or implementation authority. The Energy Efficiency Unit has not yet become a leading body in developing strategy or monitoring implementation. There is a need to review the current status of the Unit in light of the institutional requirements of the clean energy development.

Financing instruments should be designed to support: (i) project preparation consisting of audits, surveys and technical assistance in project formulation; (ii) energy efficiency projects; (iii) energy efficiency ventures; and (iv) R&D and promotion of new technologies. Considering Egypt's potential energy efficiency program, we recommend establishment of an Energy Efficiency Fund. Creation of this specialized fund will provide the loudest political signal and the most important facility for the formulation and implementation of the energy efficiency program in Egypt. Creation of the Energy Efficiency Fund will also enable Egypt to mobilize the rather abundant international (financial and technical) resources currently available for improving energy efficiency in Egypt.

The development of renewable energy resources in Egypt is on the right track but would need substantial strengthening in several areas. The wind development program has the right ingredients including a vision, target, a specialized agency with some accumulated

skills, and reasonable incentive system. The solar development program lacks most of these ingredients. Also both wind and solar development suffer from the lack of a high level decision making body and a clear financing mechanism.

To strengthen the renewable energy development program, the government should take actions in regard to the institutional arrangements, financing mechanisms, and solar energy strategy. In regard to the institutional relationships, there is a need for a strategic body with a high political clout and an ability to reach a wide set of stakeholders. It is recommended that the government form a high level committee for this purpose. Since the same body is missing in the case of energy efficiency we recommend that a Clean Energy Committee be formed to provide strategic directions to the energy efficiency and renewable energy programs. The Committee should utilize its political power to declare a clear vision, to bring the major stakeholders together, to announce the government policy and to mobilize financial resources. In particular the Committee should address two immediate issues: the parameters of the "Fund for Development of Power Generation from Renewable Energies (RE Fund)"; and the country's strategy and plan for solar energy development.

Development of local manufacturing capacity in the renewable energy industry has been supported by the government of Egypt. However, the support has been of an ad hoc nature. Going forward, the local industry would need a clearly announced support mechanism from the government. The mechanism should enable local manufacturers to assess the size of the market, decision making process and the available incentives.

Egypt is well positioned to embark on developing local manufacturing of wind and solar equipment and services. It has a good basis for developing the required technical and managerial skills. It has the support of the international community. And it can count on export potentials to other countries in Africa and the Middle East. However, it needs to develop a vision as well as clear designs for: (a) the institutional arrangements; (b) the incentive systems; (c) the R&D facility; (d) human resource development;; and (e) the international cooperation.

In regard to the institutional arrangements, it is recommended that the proposed Clean Energy Committee take a leadership role and work with the private sector as well as other stakeholders to develop a vision and strategy for the development of local manufacturing and services. The Committee should also lead the development of an incentive system that would include: (i) local demand creation that is normally declared through setting a target for the renewable energy industry; (ii) financing facilities that provide low interest rate loans, priority sector lending; (iii) ease of doing business often in the form of creating a single window clearance mechanism for all related permissions; and (iv) infrastructure enablers such as promoting technology parks consisting of manufacturing units (across the value chain), housing, offices, and research institutes. The financial support aspect would require its own mechanism and instruments.

R&D in Egypt should follow a clear strategy to combine technology transfer with local adaptation in order to provide advice to local manufacturers on: (i) innovative and new materials, processes and applications, (ii) new and potential improvement to the existing processes, materials and the technology for enhanced performance, durability and cost competitiveness of the systems/ devices, (iii) technology validation and demonstration projects aimed at field evaluation of different configurations in order to obtain feedback on the performance, operability and costs, and (iv) support for incubation and start ups.

The key to the development of wind and solar manufacturing industries is the ability to acquire technically qualified manpower of international standard. Some capacity already exists in Egypt in wind manufacturing. However, there is a substantial need to further skills in both wind and solar manufacturing and services. A coherent strategy is needed to develop human resources while drawing upon the country's educational and vocational facilities, as well as utilizing the abundant international assistance. The strategy should consider: (i) designing and offering by engineering colleges courses in solar and wind technologies with financial assistance from the government; (ii) technical training courses for technicians aimed at providing skilled manpower for field installations and after sales service network; and (iii) introducing a government fellowship program to train selected engineers and scientists in wind

and solar energy in world class institutions abroad; this could be supported under programs of bilateral cooperation, or institution to institution arrangements.

Finally, there is a lot that the government can do to help in strategizing and optimizing cooperation with the international community particularly in regard to technology development. A well coordinated public-private partnership on the Egyptian side would enable the country to take advantage of both private and government facilities in other countries particularly Europe. Cooperation should be implemented at the level of research organizations as well as industry partners.

Need for Technical Assistance

Egypt would need substantial technical assistance (TA) in order to establish a clean energy industry. The TA requirements are quite extensive but focusing on the short to medium term needs we recommend assistance from the international donors in the following areas:

Time-Frame for the Action Plan and the TA Activities

The above TA activities are all considered essential in the short to medium terms. However, the most urgent activities include: (i) TA for operationalizing the RE Fund; and (ii) the TA for supporting Institutional Arrangements for Clean Energy Development. Other TA activities are also listed in the above table according to the order of priority.

More generally, a reasonable time-frame for implementing the action plan and the TA activities would aim at:

(a) Addressing the institutional and financing arrangements immediately. The institutional arrangement can and should be deliberated for all three aspects (energy efficiency, renewable energy and local manufacturing). Also of immediate attention are jump starting the energy efficiency program with the items considered "low hanging fruits." The time-table for these activities should not exceed two years. The associated TAs should be launched to support these activities.

(b) Pursuing other items within the next five years. This includes (i) formulating a strategy for solar power development; (ii) reducing technical risks associated with renewable energy; (iii) establishing a well designed incentive system for local manufacturing and services; (iv) taking a strategic approach to international collaboration.

Area of Technical Assistance	Brief Description of the TA Activity
Operationalizing the RE Fund	This TA is immediately necessary to move forward the activation of the recently established RE Fund. The TA should develop the disbursement mechanisms, and the sources of replenishment. It will set up a transparent system of accountability, and a proposed approach to international financiers.
InstitutionalArrangement for Clean Energy Development	This TA is immediately necessary to review the present institutions and provide support in designing and setting up a high level and specialized decision making body that would give strategic directions to all the major players in energy efficiency, renewable energy development and local manufacturing and services. It will review the mandate of the Energy Efficiency Unit and other relevant entities in order to decide how to approach the establishment of a Clean Energy Committee and an Energy Efficiency Entity. The TA would design the scope of responsibilities, the operational procedures and the mandate in regard to the private sector and the international financiers. The TA will also assess the resource requirements and help in operationalizing the Committee and the Entity.
Design and Establishment of the Energy Efficiency Fund.	This TA activity would design the structure of the Energy Efficiency Fund, the disbursement mechanisms, and the sources of replenishment. It will set up a transparent system of accountability, and a proposed approach to international financiers.
Capacity Development for Enforcing Building Codes and Appliance Standards.	This TA activity will support the relevant government agencies to develop the required capacity to enforce the building codes and appliance standards. The institutional and technical capacity is a pre-requisite to making these codes and standards mandatory. The TA would support a review of the Codes and Standards to ensure that they are up to date and launch a number of training programs as well as the design of the enforcement processes.
Efficiency Improvement of Public Buildings.	This TA activity would support the selection of pilot buildings, and prepare a program for energy audit, and efficiency improvement of the public buildings.
Formulating the Solar Energy Development Strategy	This TA activity would help Egypt to assess its comparative advantage in solar energy development based on the international best practice. The strategy should include specific targets and practical steps for achieving the targets, with a clear plan to utilize international finance particularly from various European facilities. The need for this TA should be assessed after the completion of the ongoing study on Combined Renewable Energy Master Plan.
Installation of Direct Normal Insolation (DNI) measurement equipment.	This TA activity would fund installation of the DNI measurement/monitoring equipment in a number of pre-identified locations in order to arrive at a broad measurement and reliable accumulated DNI data.
Designing the Incentive System for Local Manufacturers	This TA activity would help in designing an incentive system that spans from financial facilities to infrastructure enablers and to various aspects of supporting innovation, technology transfer and start-up ventures.
R&D and Human Development	This TA activity would help in designing a clear strategy to combine technology transfer with local adaptation in order to provide advice to local manufacturers. The TA will also help in designing a coherent strategy to develop human resources while drawing upon the country's educational and vocational facilities, as well as utilizing the abundant international assistance.

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