The Arab Republic of Egypt

Power Sector in Brief - 2010

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Foreword

Continuous and reliable supply of electricity is required for Egypt's socio-economic development. With a highly urbanized population and a high growth electricity demand, a systematic expansion of the electricity generation facilities and other infrastructure developments are imperative to cope with household demand. At the same time, economic growth will hinge on the provision of adequate and reliable power to vital sectors like industry, agriculture, tourism and transport sectors, to which the government gives high priority. Against this background, the Egyptian government has made the expansion of electricity infrastructure, including generation, one of its priorities under its Sixth (2007-2012) National Development Plan, which outlines the country's development agenda over coming years.

Cognizant of the importance of the power sector for Egypt's development, the Bank Group has since 1974, financed 18 operations in the energy sector, 14 of which are fully completed. The completed projects include the development of five power stations (Shoubrah El Khiema, Dameitta, Cairo West, El Arish and El Kureimat Steam Power Station), one transmission project (El Kheima Transmission Network) and two rural electrification projects (Rural Electrification I and II).

The AfDB, as essential partners in the government's economic development programme, continues to provide financial and technical assistance to ensure that Egypt achieves its goal of expanding electricity supply by at least than 7% annually to nurture and sustain the envisioned economic growth. The Bank has recently invested in three ongoing projects: the El Kureimat Combined Cycle Power Plant Project (Module III); the Abu Qir 1300 MW Steam Power Plant Project; and the Ain Sokhna 1300 MW Steam Power Plant Project. These projects represent a cumulative lending amount of UA 665.4 million, accounting for more than 50% of the active portfolio's net commitment value. In addition, the Bank has invested in the Egyptian Refinery Company project, a UA 153 million private sector operation aiming at converting low grade fuel oil purchased from General Petroleum Corporation into refined products for domestic market consumption, including high end diesel fuel.

The AfDB is also supporting the Government of Egypt in realizing its ambitious plan to achieve 20% of the generated electricity from renewable energy resources, including 12% from wind energy, by the year 2020. In this regard, the Bank looks forward to supporting Wind farms in the Gulf of Suez and in Kom Ombo using Clean Technology Fund (CTF) and ADB financing for a total of USD 310 million.

To better understand the fast evolving context under which the power development partnership between the Bank and Egypt is evolving, we believe it is important to take stock of the key challenges facing the sector. We also feel that it is critical to set out the proactive approach adopted by Egypt to international cooperation, transfer of technology, and regional energy integration. This brief overview should, we hope, shed light on some of the key challenges and issues confronting Egypt In the field of power supply and demand.

Jacob Kolster
Director, Regional Department North – I (ORNA)

Hela Cheikhrouhou
Director, Energy, Environment and Climate Change Department (ONEC)

This Brief was prepared by Hossein Rasazi (Consultant, ORNA) under the supervision of Vincent Castel (Principal Program Coordinator, ORNA) and Emmanuel Nzabanita (Chief Power Engineer and Manager in Charge, ONEC.2). Overall guidance was received from Jacob Kolster (Director, ORNA) and Hela Cheikhrouhou (Director, ONEC). The authors would like to thank Khaled El-Askari (Infrastructure Expert, EGFO), Tanja Faller (Energy Economist, ONEC.0) and Daniel Lekoetje (Public Utilities Economist, ONEC.2) for their contribution.

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I - Context

Harnessing the sources and uses of power has been at the core of Egypt's political economy since the days of the pharaohs. Whether from water, wind and human muscle as in ancient times or from oil, gas and hydro in modern Egypt, the availability and distribution of energy and power have always been a critical component in the social compact between governments and the population. Energy, hydrocarbons in particular, thus play a significant role in today's Egyptian economy--both from oil and natural gas production and also in terms of revenues from the Suez Canal, an important transit point for oil shipments out of the Persian Gulf.

Decreases in oil production over the decade have been offset by the rapid development of the natural gas sector for both domestic consumption and export. Over the past decade, Egypt has become a significant natural gas producer and a strategic source for European natural gas. Egypt currently has a pipeline network for exports to southern Europe and Eastern Mediterranean countries in addition to liquefied natural gas exports to Europe, Asia and the Americas.

More than 90 percent of Egypt's energy consumption today is met by oil and natural gas. Oil's share of the energy mix is mostly in the transportation sector but with the development of compressed natural gas infrastructure and vehicles, the share of natural gas in the transportation sector is expected to grow. In terms of electricity generation, natural gas represents over 80 percent of the total mix, the remainder being met mostly by hydroelectricity.

Economic and sector-specific reforms undertaken over the past 5-10 years have impacted the demand and supply for power in several ways.

Sustained economic growth has thus triggered a rapid increase in electricity demand. Peak load increased by an average of 7 percent in 2005-2008 and reached as high as 8.1 percent in 2008/09. The availability of reliable power supply is not only considered a pre-requisite for economic growth but also for economic and social prosperity and human development. It is also essential for attracting private sector investments in the country.

The government has therefore a clear policy of securing sustainable and reliable supply of power to the population at large and all sectors of the economy.

To implement this policy, an ambitious power sector investment program has been under implementation aiming at additions of 7,000 MW and 11,850 MW during the first (2002-07) and the second phases (2007-12), respectively. As a result the country's power system presently has an installed capacity of about 24,000 MW which is viewed rather insufficient to meet the prevailing peak demand because the reserve margin has declined to very low levels since 2009, and some wide-spread electricity shortages were experienced in the summers of 2009 and 2010.

Reform of the electricity sector, begun in mid 1990s, has been accelerated in the recent years with a clear vision to establish 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 is expected to be submitted to the Parliament in 2011. All power companies still remain state-owned although the new law envisages divesture of up-to 49 percent of each company to the private sector. The new electricity law enables 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. A more competitive electricity market is expected to encourage private sector participation in power generation and distribution. The new law also stipulates further facility 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.

Presently the average electricity tariff is estimated at US cents 3.5/kWh compared with US cents 2.2/kWh in 2004. Industrial consumers have been subject to sharper tariff adjustments, especially energy intensive industries, and now pay up to cents 6.3/ kWh for medium voltage.

Looking into the future, there is a need to expand the power supply capacity by a rather large magnitude. Such an expansion raises certain issues 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. This background note describes the outstanding issues and the manner in which the government and the sector entities attempt to overcome the corresponding challenges. It also points out Egypt's proactive approach to international cooperation, transfer of technology, and regional energy integration.

II - Structure of the Power Sector

Egypt's energy sector falls under the responsibilities of two ministries – 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.

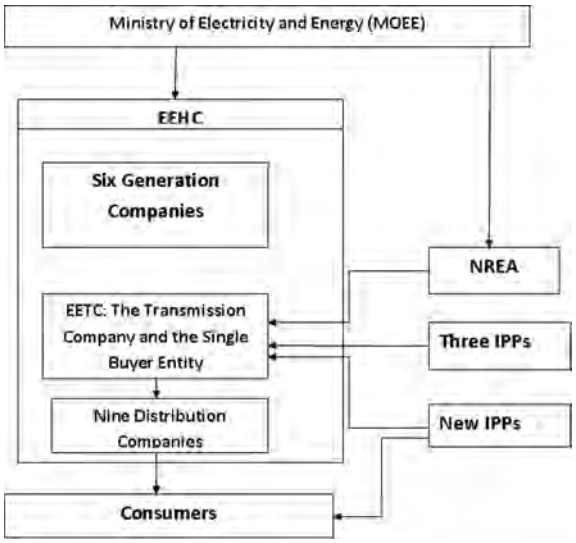
The Ministry of Electricity and Energy (MOEE) acts as the owner of the state entities in the power sector. The electricity industry, which was vertically integrated under Egyptian Electricity Authority (EEA) until 2000, has been structurally unbundled, both "vertically" (along the functional lines of 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 coordinates 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, planning and execution of projects in their domains. In case of new hydropower projects, once they 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.[1]

Finally, the Egyptian Electric Utility and Consumer Protection Agency (EEUCPRA) has been operational 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 nine distribution companies. This single-buyer market does not allow for direct transactions between the generators and major consumers. However, this is considered as an intermediate step towards the establishment of a liberalized 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.

Figure 1- Structure of the Power Sector



[1] 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 Dairout power plant. EEHC 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.

III - 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 21,330 MW in 2009. The residential sector accounts for almost half of the total electricity consumption and the industrial sector for a fifth. There are potentials and plans to improve energy efficiency and to moderate the demand growth which is forecast 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 2009 from 12,230 MW to 23,502 MW. The installed capacity comprised 21,030 MW of EEHC owned power plants (2,800 MW hydropower and 18,230 MW thermal); 2,048 MW in three private power plants; and 425 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. Although EEHC has added some capacity since 2008, the reserve margin will remain too low for the next several years, generally below ten percent instead of a standard 12-15 percent which is needed to ensure adequate level of reliability.

Figure 2: Electricity consumption

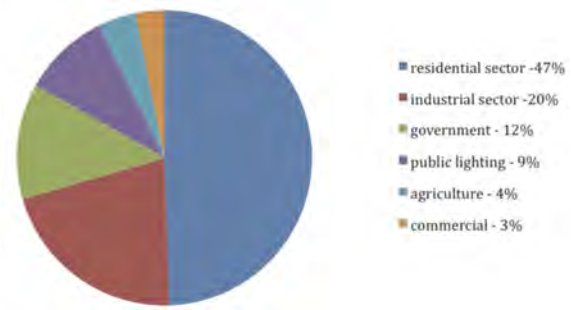
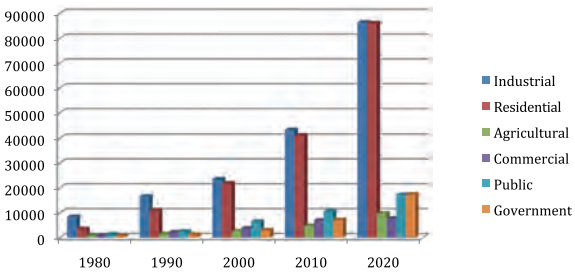


Figure 3: Annual Electricity Consumption by Major Sectors (in GWh)



Electricity in Egypt is generated mainly from thermal and hydropower stations. However, the percentage of hydro power energy generated is gradually reducing due to the fact that all major hydropower sites have already been developed and new generation plants being built are mainly gas fired. Thermal generation is based on combined cycle and steam plant technologies. In its generation investment plan, EEHC allocates 38% of its new base load generation capacity to steam plants and 36% to combined cycle.

The electricity transmission and distribution network has developed into a complex interconnected system commonly referred to as the UPS, serving all major load centers countrywide. In 2008, the transmission system had a network of 39,552 km of overhead lines and 77,000 MVA of transformer capacities. The distribution system consisted of 134,005 km of medium voltage lines, 218,408 km of low voltage lines and 131,201 transformers with aggregate capacity of 46,107 MVA supporting almost 21.5 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.

IV - Energy Diversification Strategy

Egypt's total primary energy demand has grown at an average annual rate of 4.6% during the last two decades. This rather high growth is linked to the 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 is estimated at about 60 million tons of oil equivalent (mtoe) composing of 51 percent oil, 47 percent gas, and 2 percent coal.

Egypt ranks among the 11 countries in the world showing fastest growing GHG emission. At the same time the Government of Egypt incorporates in its energy policy actions that are aimed at curbing the growth in GHG emissions. More specifically the Ministry of Electricity and Energy pursues a power development strategy that aims at: (i) increased use of efficient fossil-fuel generation technologies (CCGT and supercritical steam boilers); (ii) large scale development of Egypt's renewable resources with the goal of having 20% of its energy generated from renewables by 2020; and (iii) stepping up efforts for more efficient consumption of electricity. Nevertheless, Egypt is facing an unprecedented challenge in the energy sector where it has to respond to the rapidly increasing energy demand, limited and declining production of crude oil, and an increasing awareness regarding the impact of energy consumption on the local and global environments.

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 685,000 bbl/d. On the other hand, oil consumption has increased steadily and has absorbed almost all of domestic oil production since 2006.

Although not an important oil exporter, Egypt has still a strategic importance in international oil trade because of its operation of the Suez Canal[2] and Sumed (Suez-Mediterranean) oil pipeline[3], and its significant oil refining capacity (comprising ten refineries with a combined capacity of more than 900 thousand barrels per day)[4].

[2] 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. There are some of the changing dynamics of crude oil markets driving a drop of this volume 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.

[3] The Sumed pipeline runs 200-miles from Ain Sukhna on the Gulf of Suez to Sidi Kerir on the Mediterranean. The Sumed's capacity is 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.

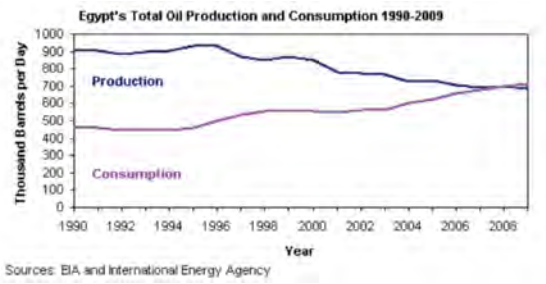
[4] Egypt has the largest refining sector on the African continent with ten refineries. The largest refinery is the 146,300-bbl/d El-Nasr refinery at Suez. The government has plans to increase production of lighter products, petrochemicals, and higher octane gasoline by expanding and upgrading existing 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.

Natural Gas.[5] Natural gas has substituted for oil both in domestic use and in export of energy. Gas accounted for about 50 percent of primary energy demand in 2009 while the share of oil stood at 43 percent. Production of gas has nearly tripled between 1998 and 2008. In 2009, Egypt produced roughly 60 billion cubic meters (bcm) and consumed 42 bcm. The electricity sector is the dominant gas consumer, accounting for 56 percent of the total gas demand. The Government has aggressively pursued use of gas since the early 1990s, not only in power stations but also in industry through fuel switching programs.. 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 own use and re-injection and accounts 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. 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 58.5 Tcf in 2009, making the country the third highest in Africa after Nigeria (185 Tcf) and Algeria (159 Tcf). Egypt exported 18.3 bcm of natural gas in 2009, around 70 percent of which was exported in the form of LNG and the remaining 30 percent via pipelines.

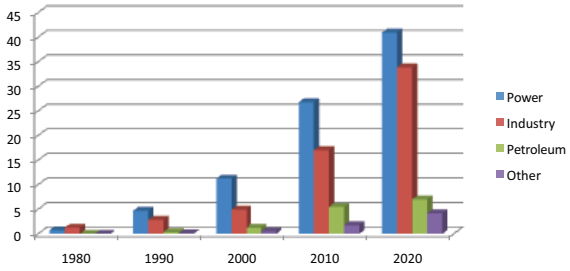
The rapid growth in internal and external demand for Egyptian gas has triggered a technical need to revisit the gas allocation policy. In particular, there is a concern about long-term availability of gas for Egypt's own future use. This concern has led the Ministry of Petroleum to announce

Figure 4: Egypt's Oil Production and Consumption



Sources: EIA and International Energy Agency

Figure 5: Annual Gas Consumption by Major Users (in billion cubic meters)



a policy of ⅓ gas for export, ⅓ gas for domestic consumption, and ⅓ gas reserved for future generations. This has introduced a constraint in expanding the export volume unless gas reserves are upgraded substantially. Export plans are supposed to be reevaluated shortly. There is a high likelihood that additional reserves will be discovered. But still decisions about new gas export projects would have to be based on the full conviction that

[5] 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.

the country is maintaining sufficient gas for domestic consumption[6].

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 already raised aggressively the price of gas to certain customer groups. The present price is $3/mmbtu for energy intensive industries and $1.7/mmbtu for other industries. In the residential sector the price remains between $0.5/mmbtu and $1.5/mmbtu. The price of gas to the power sector is $1.00 to $1.25/mmbtu. It is also useful to note that the financial yield from gas export has changed substantially in the recent years. There was previously a perception in the industry that Egypt earns a much higher return from the sale of LNG than the sale of piped gas. However, the recent reports by the Ministry of Petroleum indicate that in 2010 Egypt gets up to $4.2/mmbtu for piped gas. At the same time the average price of LNG at the US port is just over US$ 4/mmbtu. After deducting the cost of re-gasification, sea transport and liquefaction, Egypt gets less than $2/mmbtu from selling LNG to the US market. The net gain of LNG export to Europe and Asia is somewhat higher but not by a significant amount.[7]

Renewable Energy. Renewable energy represents an important option for the change in energy mix. In 2009, renewable energy, mainly hydropower, accounted for 12 per cent of Egypt's electricity generation. Government policy has consistently emphasized hydropower, but there is a view that most potential hydro resources have been already 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 hydropower generation locations, all of which 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. The remaining hydropower sites are considered very modest when compared to the Aswan sites.

Among other renewable resources wind and solar energy offer significant potentials. Egypt is endowed with an abundance of wind energy resources especially in Suez Gulf area which considered one of the best sites in the world due to high and stable wind speeds. The West of Suez Gulf Zone is the most promising sites to construct large wind farms due to high wind speeds which ranges between 8-10 meter/second in average, proximity to load centers and transmission infrastructure, and availability of large uninhabited 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 Suef and Menia Governorates and El-Kharga Oasis in the New Valley Governorate. Nonetheless, the geographic concentration of large wind farms is expected to be one of the main challenges that need to be adequately studied and addressed before large scale development takes place.

[6] Presently exploration and production of natural gas continue to grow. While there have been noticeable decreases in the production of natural gas associated with oil extraction, new finds of non-associated gas fields combined with domestic demand and an export infrastructure, are increasing interest in the Egyptian natural gas sector. Most industry analysts place Egypt's natural gas production on an upward trend in the short- and medium-term. To promote exploration in the more expensive deepwater offshore, the Egyptian government revised pricing policies by agreeing to pay more for natural gas produced in these areas, assuring continued international interest in developing these potential resources. This is an important decision because over 80 percent of Egypt's natural gas reserves and 70 percent of production is in the Mediterranean area but exploration and production continue in all major hydrocarbon rich areas including the Nile Delta and the Western Desert.

[7] According to the IEA (IEA, 2008), the cost of additional LNG export from Egypt to Europe is estimated at about $6.00/MMBTU, including cost of production and pipeline of $2.75, and the cost of liquefaction, shipping and re-gasification of $3.25. Therefore the economics of increased LNG export is subject to significant uncertainty.

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.

The present energy strategy (the resolution adopted by supreme council on energy in 2007) 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 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 at this stage considered to start with 100MW of CSP and 1 MW of PV power.

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. Worldwide, investments in renewable energy are made through various subsidy mechanisms including feed-in tariffs, soft loans, tax credits, etc. Following the new energy draft law, Egypt will be using a combination of these instruments in order to utilize donors support during the investment phase while also providing incentive to the private sector for participation in public-private ventures.

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 DFIs including KfW, EIB, 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.

As mentioned earlier, the new Electricity Law will provide for the establishment of a “Fund for Development of Power Generation from Renewable Energies (RE Fund)”. This Fund is expected to provide a 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. The establishment of the Fund is also expected to receive a $50 million support from CTF though its longer-term sustainability of the fund is expected to be based on the utilization of financial savings related to lower consumption of gas in the power sector (assuming that such gas is exported and brings in additional revenue).

The establishment of the above Fund could help the Government to pursue a commercialization program that would enable EETC to purchase wind power through a competitive bidding process. Similar to the experience in other countries the process is considered to follow a two-phase approach. In the first phase the power grid company issues tenders requesting supply of power from renewable energy resources. In phase two, a feed-in tariff will be announced to facilitate private sector participation in wind energy development.

Egypt has tried to minimize certain risks to facilitate the private sector participation in development of renewable energy. The Government has earmarked more than 7600 square kilometers of desert lands for future projects. NREA has all permits for land allocation. 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 facilities include:

- EIA, including 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.

Energy Efficiency. Egypt is trying to address energy efficiency on both the demand and the supply sides. Energy efficiency is a powerful tool in that it brings a range

of economic and environmental benefits. Economic competitiveness, energy security, fiscal expenditure savings, and local and global environmental benefits are among the demonstrated benefits of energy efficiency.

Recognizing the importance of energy efficiency, the Government of Egypt has prepared a National Energy Conservation plan that deals with the demand-side issues. The efficiency measures include pricing schemes as well as technological programs such as efficient lighting scale-up that is being carried out in association with the electricity distribution companies. Among other activities, there is also an energy efficiency program for small and medium enterprises which is under implementation by the Credit Guarantee Company.

The Government's commitment to the supply-side efficiency is demonstrated by programs to reduce transmission losses as well as utilizing more advanced technologies. A prominent example of such efforts is the implementation of the 600-MW Ain-Sokhna thermal power plant, which represents the first power plant based on super critical boiler in the MENA region.

Finally, there may be significant potentials for efficiency improvement in the older existing power plants. In order to assess such potentials, EEHC has requested assistance from AfDB to launch a review of some of the older plants. The purpose of the review is to identify the areas in which EEHC's plant operational practices can be improved by adopting best practices and by establishing clear and documented processes. The review will also cover the technical records of the designated plants in order to assess the need for rehabilitation and renovation.

Nuclear Energy. The government has established an institutional framework consisting of the Nuclear Power Plan Authority (NPPA), Atomic Power Authority (APA) and Nuclear Material Authority (NMA) to develop a nuclear energy program. Egypt has a 22MW nuclear research reactor at Inshas in the Nile Delta, built by INVAP of Argentina, which began operation in 1997. The country's interest in nuclear technology has been now revived in line with its energy diversification strategy and intentions to move to low carbon energy technologies. The present power development program includes 4000 MW of nuclear capacity to be commissioned in the next 15 years. The first nuclear plant of 1000 MW with an estimated cost of $1.5 billion is planned to be built at Dabba, on the Mediterranean coast, 160km west of Alexandria. The project is scheduled for commissioning in 2020 with international participation and financing. Subsequent nuclear plants of 1000 MW each are scheduled for commissioning between 2020 and 2025. China and Russia are among the potential participants in Egypt's potential nuclear energy development. Also, Australian engineering firm WorleyParsons in June 2009 signed a 10-year nuclear power plant consulting contract worth $160 million with the Egyptian government to assist in selecting the technology and the site as well as supervising the design, construction and early test-runs of the proposed nuclear plants.

V - Emerging Challenges and Opportunities

In line with the overall economic reform agenda, the power sector has gone through some significant changes while expanding the supply capacity to respond to the rapid growth in electricity demand. However, further expansion of power supply faces a number of strategic questions and opportunities in regard to: (a) availability of natural gas; (b) investment and finance; (c) the role of the private sector; (d) local manufacturing and services; and (e) the country's prospects for becoming an energy industry hub.

Availability of Natural Gas. Overall, Egypt's gas program has been very successful. Since the early 1990s, gas reserves and production have approximately quadrupled while domestic consumption has been developed rapidly. In 2009, Egypt's gas production was about 61 bcm, of which 18 bcm, or 30 percent, was exported.

The non-power use of gas is growing fast while replacing high value fuels; there is therefore a potential trade-off between power and non-power use of gas.

Investment and Finance. In order to meet the electricity demand the Government has been implementing an ambitious power supply program. The ongoing investment projects are part of the 2007-2014 plan which aimed at an addition of 7,750 MW to the generating capacity. This includes installation of 3,750 MW of combined cycle power plants and 4,000 MW of steam power plants. The investment requirement for this time-slice is expected to reach EGP 46.5 billion ($8.4 billion). The 2010-2020 plan which consists of 11,150MW steam generation plant using Egyptian natural gas, 10,750MW of CCGTs capacity using Egyptian natural gas, 6,475MW of wind power capacity and 270 MW of solar power capacity. This program would add about 30,000 MW to the installed capacity almost doubling the electricity generation in energy (GWh) terms. This program also indicates an annual investment of more than $3 billion for generation, transmission and distribution.

The Government is the sole owner of EEHC, NREA, and it is the largest equity investor in the domestic power sector. EEHC holds the majority of power sector assets with an official book value equity investment of over EGP 9.8 billion (US$ 1.8 billion) as of June 2008[8]. This is about 10 percent of the consolidated assets of EEHC. NREA is currently implementing a number of sizable wind and solar power projects, and its assets are estimated to increase from about EGP 2.2 billion (US$ 0.4 billion) in FY06 to EGP 7.8 billion (US$ 1.4 billion) in FY10. Private equity, totaling about US$ 350 million entered the sector through the three private power projects (BOOTs) in the late 1990s and early 2000s.

[8] Source: EEHC financial data is based on Staff estimates.

EEHC investments were largely financed through borrowings which caused long-term debt to increase by nearly 100%, from EGP 28.5 billion to EGP 51.68 billion over the period. The Company's gearing, as measured by the debt-equity ratio has therefore increased from 3.9 in FY 2003/04 to 4.8 by FY2008/09. To contain this increase in the gearing ratio, the company's management and shareholder have decided to strengthen equity through immediate implementation of a zero dividend policy and the advanced negotiations with major debt holders, particularly the National Investment Bank (NIB), to convert a portion of its longstanding debt obligation to equity shares in the company.

About 70% of the current liabilities of the company are comprised of past due loans and interest payments owed to government and local banks and about 20% are due to other parastatals mainly for the supply of oil. All together, the current liabilities increased from 40.54 billion in 2007/2008 to 45.64 billion in 2008/2009 against current assets of EGP 28.94 billion, resulting in a current ratio of 0.63, slightly hedging upward.

Cognizant of the consequences of EEHC's weak liquidity position and high debt equity ratio, the finance department of EEHC has taken steps to eliminate distribution of dividends as long as the current ratio is below the medium term target of 1.5 and the debt-equity ratio above 3:1. Energy efficiency measures are also scaled up to curb the growth in demand which drives up the generation investment program of EEHC.

The government has been successful in mobilizing donor resources. The key donors supporting the power sector in Egypt have been the AfDB, the World Bank, Arab Fund for Economic and Social Development (AFESD), the Kuwait Fund for Arab Economic Development (KFAED), the European Investment Bank (EIB), the OPEC Fund and USAID. In addition, significant donor support is also provided by the Islamic Development Bank (IDB), the Japanese Bank for International Cooperation (JBIC) and KfW. The recent major power projects supported by those donors are summarized in Table 1.

The Ministry of International Cooperation and the MEE coordinate all donor interventions in the energy sector. There is a strong partnership among donors under the umbrella of the Development Partners Group (DPG), which has a number of focus groups, including that for Environment and Energy. There is active sharing of information and harmonization of donors' position on key sector issues with a view to promoting long-term sector viability. The presence of the EGFO has enhanced coordination with other donors through participation in the DAG.

Upcoming planned public projects include eight thermal projects to be developed by EEHC. These projects are estimated to cost EGP 67.5 billion (US$ 12.3 billion) in total. EEHC has included the AfDB, Arab Fund, Kuwait Fund and World Bank in the financing plan for the 1,300 MW Helwan South (ii) and 1,300 MW Qena projects. Financing plans for the 750 MW Banha, 1500 MW Qassasen and 650 MW Suez projects are also being finalized.

Table 1: Donor Support in Power Generation

Project	Power to be Generated (MW)	Financier(s)	Total cost*(USD million)	Year to be commissioned
El Kureimat III (CC)	750	AfDB/NBE	448.3	2009/2010
Nubaria III (CC)	750	AFESD/EIB/AHLY United Bank	509.8	2009/2010
Tebbin (ST)	700	WB/NBE/OPEC	737.4	2010
El Kureimat (Solar thermal)	140	JBIC/GEF		2010
Sidi Krir (CC)	750	EIB/NBE/CIB	710.00	2009/2010
El Atf (CC)	750	AFESD/KFAED/EIB/NBE/CIB	583.60	2009/2010
Cairo West (ST)	700	AFESD/KFAED/OPEC/NBE	735.80	2010
Abu Qir (ST)	1300	AfDB/IDB/KFAED/AFESD/OPEC	1,702.10	2012
Ain Sokhna (ST)	1300	AfDB/WB/AFESD/KFAED	2189.70	2013/2014
Giza North (CC)	1500	WB/EIB/OPEC	1366.00	2013/2014
Banha (CC)	750	AFESD/KFAED/IDB/OPEC/Abu Dhabi Fund/Saudi Fund	793.00	2013/2014

* All project costs include customs and taxes
CC = combined cycle gas turbines / ST = steam cycle

In the near term, NREA is expected to carry out three wind power projects, about 440 MW in total, and at least one concentrated solar power project. These projects are estimated to cost EGP 7 billion (US$ 1.3 billion) in total. NREA has obtained grants and soft loans for the financing of its wind projects. A regional concentrated solar power (CSP) investment plan has been approved by the Clean Technology Fund (CTF). The CTF intends to provide up to US$ 750 million of soft financing for CSP investment in the MENA region, of which US$ 95 million is the indicated amount available for Egypt. Egypt, through NREA, has planned to request CTF financing support for its CSP projects. Other donors, development financial institutions and AfDB are expected to be approached to help finance these projects.

There is a general agreement that there would be need for both public as well as private sector based financing for the development of renewable energy. The main components of these investments would include generation plant construction, and transmission reinforcement. While the latter component is considered in the domain of the public sector, the plant construction could be financed by either the public or private sectors, or through PPPs.

A good example of structuring case-specific financing is the recently announced joint venture wind project between Abu Dhabi Future Energy Company (MASDAR) and NREA to develop a 200-MW wind farm in the Gulf of Suez. This project could serve as a model for future Public-Private Investments in wind and set the course for large scale development of wind resource in the Gulf of Suez region. The preliminary estimate of the project cost is $440 million. The estimated equity contribution from NREA and MASDAR is US$ 70 million each. CTF is expected to provide $50 million. The Government contribution is expected at $30 million while AfDB (ADB window) is considering a loan of $140 million, and the remainder is expected to be financed by other debt sources.

The Role of the Private Sector. The government is seeking private sector's participation in power generation and distribution. This 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. The government is now encouraging the re-entry of the private sector with the provision that the government does not take undue market risks.

In retrospect, 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 tendering 250 MW wind BOO based on a similar risk allocation framework as those of the three IPPs.

Private sector participation in electricity supply is often viewed as an instrument to foster competition, provided that there is a conducive market structure. 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.

The government is preparing the ground for advancing the sector reform further. The new Electricity Law introduces a number of changes toward strengthening sector's commercial orientation and its opening to private investment

and competition. 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.

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.

Local Manufacturing and Services. Egypt has seen a keen interest from private sector to develop energy related manufacturing and services capacity. 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 the 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 maintenance 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.

Egypt's prospects for Becoming an Energy Industry Hub. Egypt has some rather distinct comparative advantages for becoming an energy industry hub in the Africa region. First, Egypt is at the cross-road of several energy corridors and rather uniquely positioned to play a central role in the region's energy sector. Second, Egypt has a strong educated labor force and skills-base that can be directed to various areas of energy industry particularly the new energy technologies. It has become the largest producer of fabricated steel in the Middle East and North Africa region. Third, Egypt is regarded in the international community as a reliable and high potential partner that is provided with financial and technological support. Fourth, the Egyptian authorities are keen to pursue the opportunities to create a wider market for Egyptian services in the Arab and African countries through the establishment of joint consulting companies or marketing the Egyptian experience in the field of electricity. Finally, the economic reforms implemented since 2004 have substantially improved the investment framework for international cooperation. Foreign direct

investments have increased from less than a billion dollar to close to $13 billion in 2009.

A particular area of Egypt's comparative advantage for becoming an industry hub is wind power. Egypt is in the forefront in Africa with considerable success in:

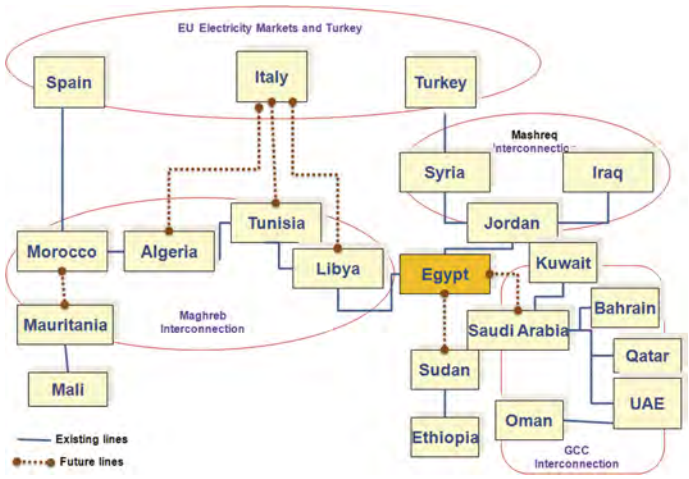
- Launching an accelerated program of wind power development
- Enabling both public and private sectors to invest jointly or separately
- Establishing the associated manufacturing and services

Egypt's tangible experience and proximity to the rest of the Africa region could provide important lessons and considerations for other countries that are trying to initiate renewable energy programs. Egypt could also be considered as an effective partner in manufacturing the various components and in providing services related to renewable energy particularly wind power.

Egypt's central position in region's energy sector is indicted by the significant role it plays in various regional energy networks. Despite the existing interconnection capacity, electricity trade between Egypt and its neighbors has been limited to rather small amounts. Within the existing interconnection capacity Egypt could sell more electricity if financially motivated. The government has been also discussing the possibility of constructing a high capacity (3,000 MW) interconnection with Saudi Arabia. Further, Egypt has participated in the Nile Basin initiative and the study of energy trade among Egypt, Ethiopia and Sudan.[9] Finally, Egypt has participated in the Observatoire Mediterranean de l'Energie (OME) and the Study of the electrical interconnection of the Mediterranean countries which aims at interconnection with the European network through Turkey from East and Spain from West.

Egypt is also a major player in the regional gas trade. The only cross-border gas pipeline system in the Mashreq region is the Arab Gas Pipeline (AGP). It was conceived as an international gas infrastructure from Egypt to Turkey, via Jordan and Syria, with the ultimate objective of enabling Egyptian gas to reach the European markets. To date, the sections in Egypt, the crossing of the Gulf of Aqaba and through Jordan have been constructed, as the section in Syria from Jordanian border to Al Rayan (the hub of the Syrian gas network). The link to Tripoli in Lebanon was also completed in 2004 though it remained idle due to the lack of gas supply until 2009 when a rather small amount of gas started to flow. The final phase of the pipeline included two segments within Syria (186 km from Furglus to Aleppo, and 60 km from Aleppo to Kilis at the Turkish border) and a short segment (45 km) within Turkey from Kilis to Gaziantep to connect to the Turkish gas network. The plans for construction of these segments have kept postponing due to uncertainty in the availability of additional gas from Egypt.

Figure 5: Egypt's Position for Becoming a Regional Energy Hub



Technology Transfer. Technology transfer has always been an embedded characteristic of energy sector development. However, the present

[9] A Bank financed study (ENTRO Power Trade Study) which was completed recently examined the possibility of connecting the three countries of the Eastern Nile Region (Egypt, Sudan and Ethiopia).

circumstances are different in a sense that technology is being developed on a fast track and needs to be transferred in the same manner. New energy technologies are underway for almost all aspects of the energy sector particularly the renewable energy and the transmission grids both of which are very relevant to Egypt.

In the recent years Egypt has succeeded in transferring certain wind technologies. To put the wind power development in perspective it is noted that worldwide wind power capacity has grown at a rate of 30 percent p.a. in the last decade reaching 125 GW in 2009. Wind power technology is an example of energy technologies which has been successfully improved, and widely spread around the world. The cost of wind power depends on site characteristics, but the average cost has declined from more than 20 cents a kilowatt hour in the early 1990s to 7-9 cents a kilowatt hour today. There are clear prospects for further cost reductions with larger-scale wind turbine production and advances in technology. R&D efforts are focussing on building larger wind turbines, reducing the material weight of turbine blades and designing more intelligent rotors to improve reliability. There are also initiatives to improve the availability of wind power through storage facilities or through combinations with other energy resources, such as hybrid systems that use wind and gas, or wind and solar.

Advances in wind power technology were initiated in Denmark at an early stage but are now emerging from Germany, Spain, the United States and other countries. Egypt has benefited from the wind technology development. However, it could perhaps enhance these benefits by studying some of the best practice experiences in China, India and South Korea. Local firms in these countries have progressed in a span of less than 10 years from no wind turbine manufacturing to the state-of-the-art wind systems.

Solar technology is at a much earlier stage with several new technologies under development. Egypt has applied solar photovoltaic (PV) technology to projects such as water pumping, desalination, refrigeration for vaccines, navigation aids, wireless stations etc. It has also initiated a solar power program by building a 140 MW integrated solar combined cycle power plant at Al Kureimat. The solar share of the capacity is 20 MW and was brought to successful operation in mid 2010. It is now moving to a larger scale deployment of solar energy by building 100 MW of concentrated solar power (CSP) and 20 MW of photovoltaic projects during the next seven years. Furthermore, Egypt is now in the process of developing a national CSP plan based on which it will proceed to identify the most appropriate potential sites, strengthen its R&D capacity, and develop the required incentive system for promotion of solar power. Finally Egypt is interested in exploring the potentials for exporting solar power to Europe and participating in emissions trading.

Egypt sees the high potential in solar power and also for the country's ability to serve as the hub for the export of clean energy. However, it notes that solar power costs

substantially more than wind power at the present time. Clearly, a large scale deployment of solar power would require extensive support from the international community.

To implement the large-scale solar energy capacity, Egypt would need access to new technologies as they become available. Solar technology is in transition, with several new technologies under development.

VI - Conclusions

Rapid economic growth imparts a variety of benefits but tests the limits of the institutional and infrastructure capacities of the country. The case of Egypt's power sector is a typical example of such trade-offs. While economic growth has triggered an increasing demand for electricity the power sector faces a number of serious challenges and interesting opportunities that have been described in this background note.

Egypt's power development strategy has been adapting to various international and domestic trends. The government has shown clear intentions to cooperate with the international community in combating climate change and to stay in the forefront of emerging technologies. The country has made a significant push towards development of renewable energy and potentially nuclear power. While each of these new directions adds further dimensions to the power development strategy, there are considerable uncertainties about the timing and cost of these options. The base-line option of building gas-fueled power plants is still the overarching theme of the country's capacity expansion plan. The dual-firing gas/heavy fuel oil fired plants is also considered when gas availability may be uncertain. The non-conventional (renewable and nuclear) options are aggressively pursued and fit in the expansion plan when such facilities have a clear path to the construction stage.

No matter which energy mix the country decides to pursue the investment requirements are rather large. In practice the power supply capacity should expand by about 2000 MW/year, which in turn implies an investment of approximately $3 billion to $4 billion/year (including generation, transmission and distribution). The government has recognized the power sector's cash flow constraint and is taking significant steps to alleviate the situation. First, in June 2008, the government implemented a plan to remove gas and electricity subsidies for energy intensive industries including steel, cement, aluminum and fertilizer companies. There was at the same time a price increase for other industrial companies. Second, the government has decided to use PPPs and private sector schemes to mobilize resources to meet the future investment needs of the power sector. Third, the government is increasingly mobilizing resources from clean energy funds such as the CTF.

The feasibility of installing IPPs dedicated to industrial use is now being investigated by the Government. It appears that these dedicated plants may not be able to secure financing because of the uncertainty in the demand profile. This has triggered suggestions that EEHC enters into such transactions to support the financing aspect of these projects. The proposed Dairut IPP is being structured accordingly. The ongoing attempts to formulate this project is expected to provide very valuable lessons regarding the market appetite for IPPs and the arrangements that could be put in place to encourage future IPPs while preserving the government interest in

a balanced sharing of the risks between the private and public sectors.

Private sector has also shown a keen interest in providing manufacturing and services capacities related to wind and solar facilities. As a result the country has witnessed growing technical skills in both private and public sectors while capitalizing on international technical cooperation in the corresponding energy technologies. This raises several important prospects for Egypt. Local manufacturing and services impart benefits which go beyond the energy sector. They help in building new manufacturing capabilities, generating new jobs, increasing local production and employment that will also contribute to local economic development. This is also an area in which AfDB can assist the public and private entities in Egypt to establish a wider dialogue and cooperation with other African countries.

Annex: List of Useful Background Material

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