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Faculty of Environmental and Civil Engineering

POLO TERRITORIALE DI COMO

Master of Science in Environmental and Geomatic Engineering

Green Innovation for Sustainable Community Development

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Abstract

The world's natural resources are limited and the world's development has been leading to an increase of the natural resources demand. There is an emerging need to have a balance between the limitation of the availability of the natural resources in the world and the world development.

This research defines the green innovation as innovative regulations, policies or management decisions respecting the environmental and social dimensions, using the management, technical theories and practices to establish a development. The presence of the concept of sustainability ensures that the development will continue its effect and it will remain on the long run. This explains the idea behind the title of the research Green Innovation for Sustainable Community Development.

The developing process methods which respects the economic, social and environmental dimensions, is needed to be promoted in all the community levels and to be educated in schools and universities; cooperation between all the stakeholders in the community is needed in order to have in the long term enough natural resources for the next generations and clean environment.

Egypt is the biggest country in the Middle East in term of population and has a strategic position between Africa, Asia and Europe; it is facing challenging problems which need to be solved in innovative ways and sustainable solutions. This research will analyze this case study, aiming at providing some recommendations for an innovative and sustainable approach to the issue of development.

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1. Introduction

Sustainable development has been defined in many ways, but the most frequently quoted definition is from Our Common Future, also known as the Brundtland Report:
"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- The concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and
- The idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs."

The development process happened in the communities considering the social dimension or the environmental dimension is suffering now from the harmful effects on their environment and social society. Therefor to ensure a better future, and sustainability in the development process became an essential concept.

The concept of sustainability development is not only related to the planner or the decision maker. To achieve the goals of the sustainable development, the cooperation between all the stake holders in the community is necessary. Therefor the awareness in the community is very important in all of its levels.

An innovative approach represents a necessary method to solve community development problems and satisfy community needs. There are many definitions for the green innovation. When it comes to existing literature on green innovation there seems to be a biased and limited focus on reducing negative environmental externalities. This generally leads to the assumption that governmental intervention is required for successful green innovation (Bernauer et al., 2006).

This research highlights Egypt as case study and the green innovation and sustainable development in the country's development. Some of the Egyptians challenges in the energy sector, water sector and environmental pollution will be analyzed. Egypt is very rich by its natural resources, it has oil but it used to export it till 2008, when country started to consume all of it is national production and became an oil importer country. It has The Nile River as the main source of freshwater in the country but it became a water scarce country. Furthermore the industrial and economic development has deeply affected the environment. A green innovation strategy for a sustainable development is needed for the country for its future developing plans: this concept is not only to be adapted by the decision maker level but it is an approach that needs to be promoted in the county education system, disseminated in schools and universities.

2. Case Study: Egypt

2.1 Energy Sector

Egypt has an important strategic role in international Energy trade because of its operation of Suez Canal, Arab Peace and Sumed Pipeline (Suez-Mediterranean) oil pipeline and its significant oil refining capacity.[1] The petroleum industry plays a key role in the Egyptian economy (Figure 1). It is one the main sources of foreign exchange. The energy sector in Egypt concerns the oil, natural gas and electricity.

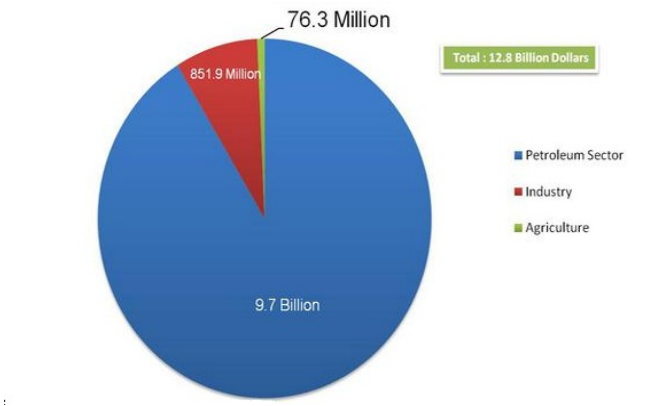

Figure 1 The petroleum sectors' share of total foreign direct investments in 2009
Source: Egyptian Central Auditing Organization

[1] "Egypt - US Energy Information Administration (EIA)." 2011.

2.1.2 Total Primary Energy

In 2009, Egypt's Total Primary Energy supply amounted to 72 mtoe. Natural gas and oil account for the bulk of primary energy supply since the oil accounted for 32.6 mtoe or 45.3% of the TPES, the natural gas accounted for 35.8 mtoe or 49.7% of the TPES while coal accounted for 0.83 mtoe or 1.2% of the TPES. Hydro and Renewables accounted for 1.1 mtoe and 1.6 mtoe respectively (Table 1) (Figure 2).

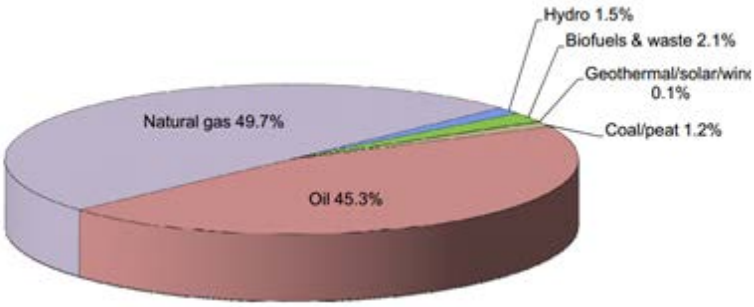

Figure 2 Share of total primary energy supply 2009
Source: International Energy Agency

Supply and Consumption	Coal	Crude Oil	Oil Products	Natural Gas	Hydro	Geothermal and solar	Electricity
TPES	831	32078	603	35831	1108	97	-80
TFC	401	0	24888	11982	0	0	10228
Industry	392	0	2619	8028	0	0	3347
Transport	0	0	13345	359	0	0	0
Residential	8	0	5042	805	0	0	4079
Non-Energy Use	0	0	0	2765	0	0	0

Table 1 Energy Balance for Egypt 2009 (ktoe)
Source: International Energy Agency

From the Consumption side, the Industry sector is considered as an important sector and the largest share of the energy consumption occurs in this sector, but it is not as dominant over transport and residential consumption as in other middle and low middle income countries. In industries, the percent of natural gas use is higher than the percentage of the oil use which are 8 mtoe and 2.6 mtoe respectively, since 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. Coal use is limited to coke input in the iron and steel industries. Oil's share of the energy consumption mix is mostly in the transportation sector, but with the development of compressed natural gas (CNG) infrastructure and vehicles, the share of natural gas in the transportation sector is likely to continue to grow. The absence of electricity and solar power in transport is remarkable. Trains still run on diesel, except those of the Cairo Metro. The residential sector is considered as 49% of the total electricity consumption. The absence of traditional fuel is a significant achievement in a country with little wood fuel resource. However, the absence of the solar power in the residential sector is very clear and need more development.[2]

2.1.3 Oil

Egypt is ranked as the 29th oil producer in the world and the 5th largest oil producer Africa. However, Egypt achieved the largest number of Oil discoveries among the OAPEC members (Organization of Arab Petroleum Exporting Countries) during the Period from 2005 to 2009 (OAPEC secretary general's annual report). Egypt turned from an oil exporter country to a net oil importer country since 2008.

[2] "Egypt - Power Sector in Brief - African Development Bank." 2010.

2.1.3.1 Supply

Oil production in Egypt was 0.61 mb/d in 1980, peaked at 0.93 mb/d in 1996, has since declined 0.723 mb/d or 0.9% of world's total in 2011 (IEA database, 2012). And since 2008 the oil production in Egypt is less than the demand. The Egyptian oil production comes from four main areas: the Gulf of Suez (26%), the Western Desert (43%), the Eastern Desert (10%), and the Sinai Peninsula (11%) then 10% of the production comes from the Delta (2%) and the Mediterranean Sea (8%) (Figure 3) and new finds started to show up in the Mediterranean deep water offshore.[3] As for the oil reserves Egypt has 0.6 billion tonnes of petroleum reserves, which accounts for approximately 0.25% of world reserves (BP, 2012).

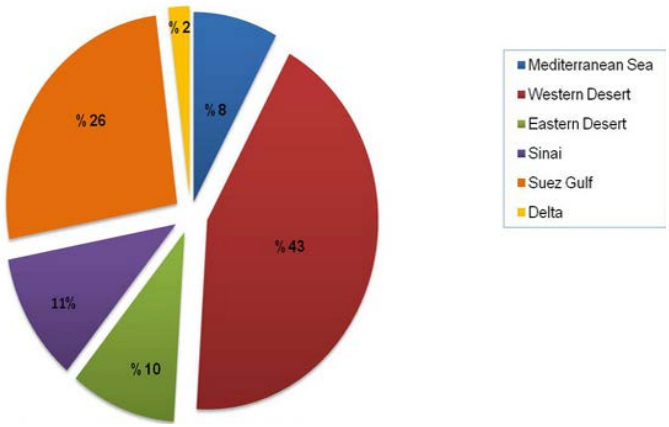

Figure 3 The annual production of crude oil by the region in Egypt 2009
Source: Ministry of Petroleum in Egypt – Production Sector

[3] "Egypt Energy Data, Statistics and Analysis - Oil, Gas ... - EIA." 2011.

2.1.3.2 Exports

The main trade off in exporting oil in Egypt mainly depends on the government's ability to satisfy the domestic demand of oil and exporting the oil. If the local demand kept increasing with no progress in the oil exploration then Egypt will convert to be a net oil importer. Egypt has exported 114,000 bbl/d in 2011; half of the oil exports were sent to India (60,000 bbl/d), followed by Italy (25,000 bbl/d). India and Italy are traditionally top destinations for Egypt's crude oil exports. The remainder of Egypt's crude exports went to other European and Asian countries. U.S. imports small volumes of crude oil and petroleum products from Egypt.[4]

2.1.3.3 Refining

Egypt has one of the strongest and largest refining industries in Africa with 10 refineries mostly concentrated in the north east of Egypt based in the Port Suez refinery complex, Cairo and Alexandria, operated mostly by state-owned agencies, with a combined crude oil processing capacity of 726,250 bbl/d. The refining capacity exceeds domestic demand, which prompts Egypt to import crude oil, process it, and export it. The largest refinery is El-Nasr refinery with a capacity of 146,300-bbl/d located on the Suez Canal, which is owned by the Egyptian government and the rest of the refineries as follow:[5]

- Alexandria Ameriya Refinery.
- Alexandria El Mex Refinery.
- Alexandria MIDOR Refinery.
- Asyut Refinery.
- Cairo Mostorod Refinery.

[4] "Egypt Energy Data, Statistics and Analysis - Oil, Gas, Electricity, Coal." 2011.
[5] "Print - Egypt Energy Data, Statistics and Analysis - Oil, Gas ... - EIA." 2011.

- El Suez Refinery.
- Tanta Refinery.
- Wadi Feran Refinery.

There are current plans for expanding refining capacity by over 600,000 bbl/d by 2016, and even further expansions into the next decade; which would require large amounts of foreign investment.[6]

2.1.3.4 Demand

Demand for oil has been in steady increase from 0.26 Mb/d in 1980 to 0.65 Mb/d in 2007 and the gap between production and consumption has shown up. The domestic consumption has absorbed almost all of the domestic oil production and since 2008 Egypt's imports of both crude oil and refined petroleum products increased to fill the gap between its domestic oil consumption and production. The graph below shows that domestic demand outpaced supply in 2008, turning Egypt to an importer of oil. In 2011, the total oil production was 0.723 Mb/d and the oil consumption was 0.787 Mb/d (Figure 4). The government has been pushing to reduce domestic petroleum consumption by attempting to reduce subsidies and promote the use of natural gas. However, subsidy reduction is a politically sensitive issue that has proven difficult to be fully implemented.

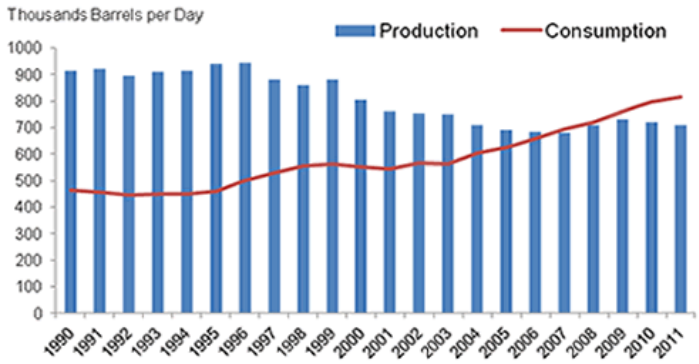

Figure 4 Total oil production and consumption in Egypt 1990 – 2011

Source: U.S. Energy Information Administration, International Energy Statistics

[6] "Egypt - Analysis - U.S. Energy Information Administration (EIA)." 2011

2.1.3.5 Sector Organization

The Egyptian General Petroleum Corporation (EGPG) is the state authority charged with the upstream activities such as infrastructure, licensing and production. It also owns and operates the major part of the refining capacity. It accounts for 20% of the oil production. The international oil companies have a significant part in the upstream sector on a production sharing basis with EGPG.

The petroleum sector is managed by three holding companies:

1. The Egyptian Petrochemicals Holding Company (ECHEM).
2. The Egyptian Natural Gas Holding Company (EGAS).
3. Ganoub El Wadi Petroleum Holding Company (GANOPE).

The major international companies in Egypt are British Petroleum and Eni.

2.1.4 Natural Gas Sector

Egypt is ranked as the 12^{th} gas producer in the world and the 2^{th} largest gas producer in Africa. Egypt is relying more on the natural gas in domestic use and in export of energy.

2.1.4.1 Supply

Egypt's natural gas sector has been expanding rapidly, as production has more than tripled from 646 Billion cubic feet (Bcf) in 2000 to 2.2 (Tcf) in 2010. Over 70% of the production is located in the Mediterranean and Nile Delta. Due to major recent discoveries, natural gas is likely to be the primary growth engine of Egypt's energy sector and it has substituted for oil in export of energy. Egypt's proven gas reserves registered at 77 (Tcf) to be the third highest in Africa, after Nigeria and Algeria. New discoveries offshore the Nile Delta and some finds in the Western Desert have led the

increase in proven reserves. Over 80 percent of Egypt's natural gas reserves are located in the Mediterranean and Nile Delta.[7]

2.1.4.2 Demand

The government is encouraging households, businesses the transportation sector and the industrial sector to consider natural gas as a substitute for petroleum and coal. The electricity sector is the dominant gas consumer, accounted for 56% of the total gas demand, followed by the industry sector, accounted for 29% of the total gas demand. The petroleum sector accounts for 12% of the total gas demand since it uses a substantial amount of gas for own use and re-injection (Figure 5). The government is encouraging households, the transportation sector and the industrial sector to consider natural gas as a substitute for petroleum and coal. The residential sector and the transportation sector, combined they are accounted for 4%. In the residential sector the gas is delivered through low pressure pipeline distribution systems (Figure 6) and in LPG cylinder by retailers. The use in the transportation sector is represented by the use of compressed natural gas (CNG) in vehicles (Figure 7).

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 a policy of 1/3 gas for export, 1/3 gas for domestic consumption, and 1/3 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. According to the Ministry of Petroleum in Egypt, the quantity of natural gas vehicles sold in Egypt between the fiscal years 2004/2005 and 2009/2010 more than doubled.[8]

[7] "Egypt Energy Data, Statistics and Analysis - Oil, Gas, Electricity, Coal." 2011.
[8] "Egypt - Power Sector in Brief - African Development Bank." 2010.

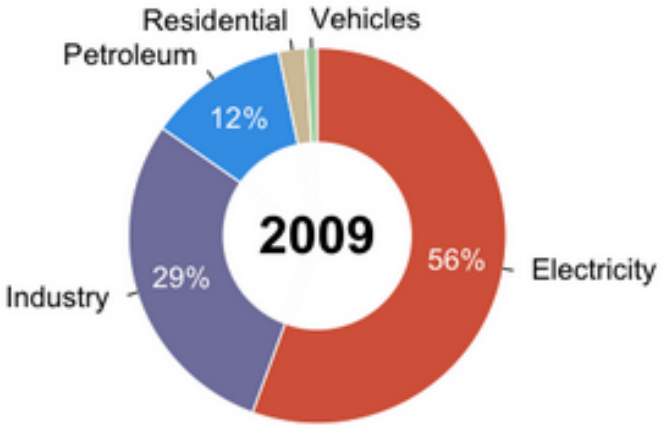

Figure 5 Natural Gas Consumption by sector

Source: The Egyptian Natural Gas Holding Company (EGAS)

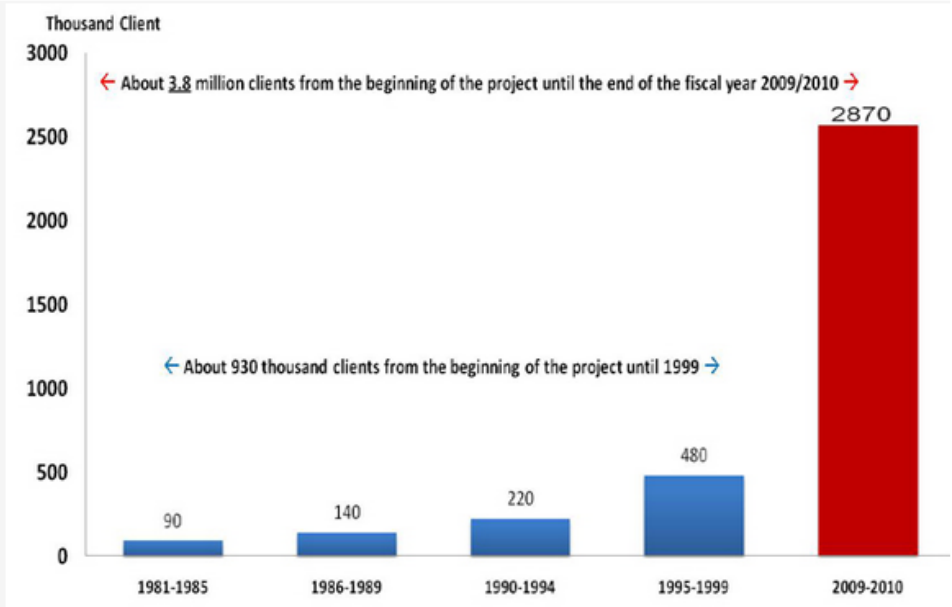

Figure 6 Increase of natural gas delivery to houses,

Source: Ministry of Petroleum in Egypt - Gas Sector

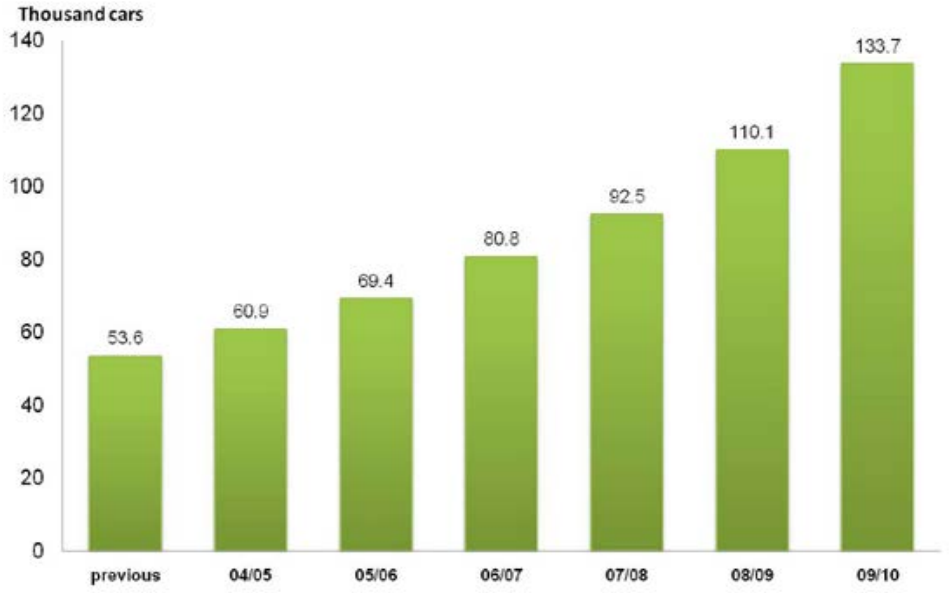

Figure 7 Increase of natural gas vehicles until 2010
Source: Ministry of Petroleum in Egypt - Gas Sector

2.1.4.3 Exports

The significant growing domestic demand, supported by government subsidies, is the main constraint for government to regulate the amount of gas exports. Egypt exports the natural gas overseas both by international pipeline and as Liquefied Natural Gas (LNG). The (AGP) Arab Gas Pipeline which provides gas to Jordan, Syria, and Lebanon, with recent additions extending the pipeline to Turkey and European markets. The top four destinations of Egyptian gas exports in 2010 were Spain, Jordan, Israel, and USA, which received 17.3%, 16.6%, 13.8%, and 13.6%, respectively, and they all together accounted for 61.4% of total Egyptian gas export volume in 2010 (BP, 2011) (Figures 8,9).

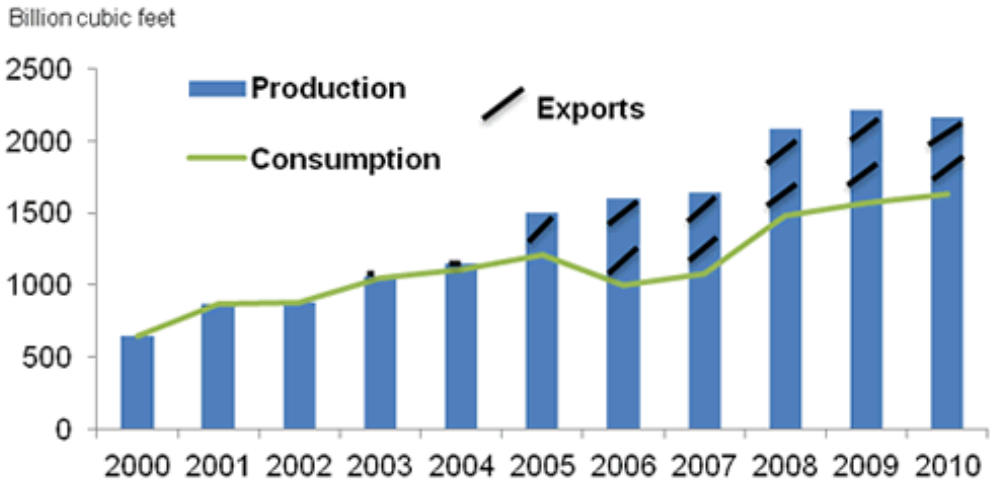

Figure 8 Natural gas production, consumption and exports in Egypt (2000-2010)
Source: U.S. Energy Information Administration, International Energy Statistics

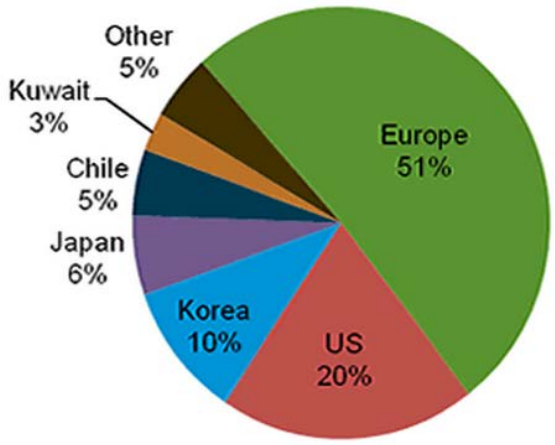

Figure 9 Egyptian liquefied natural gas (LNG) exports 2010
Source: FACTS Global Energy

2.1.5 Electricity

Egypt is the second larger producer of electricity in Africa after South Africa, but it is facing so many challenges in the electricity sector.[9]

In Egypt, the access to electricity is 99.6% according to the World Bank data base and this rate is among the highest in Africa with 100% urban access to electricity and 99.3% in rural areas, approximately 800,000 people is still lack access to electricity in 2009 according to the International Energy Agency (IEA).

The power sector has been at the center of the Egypt's energy policy. Concerning the development of the power sector as a result of Egypt's domestic energy demand, the government plans to increase the amount of power generated from renewable sources, particularly wind and solar and to satisfy 20% of the electric energy demand from renewable energy resources by the year 2020. Egypt's total net electricity generation was 136.6 billion kWh in 2010 and ranked as 26 in the world and the highest consumer of electricity in Africa, having a population of 80 million and consuming 12 percent of the continents annual demand. Total electricity consumption and generation have both grown by an average of 7 percent annually from 2000 to 2009. Most of Egypt's power demand growth comes from the growing industrial sector but the major use of the electricity is from the housing sector.

[9] "Egypt - Analysis - U.S. Energy Information Administration (EIA)." 2011.

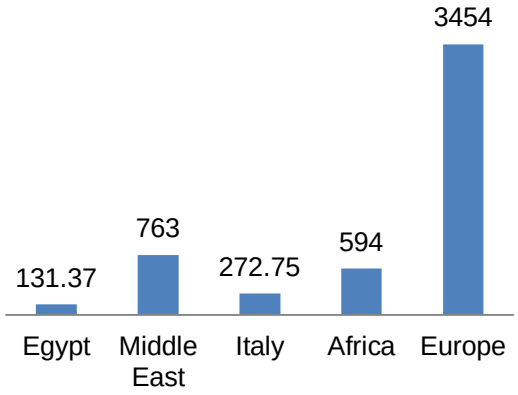

Figure 10 Electricity Net Generation 2009 (billion kWh)

Source: U.S. Energy Information Administration, International Energy Statistics

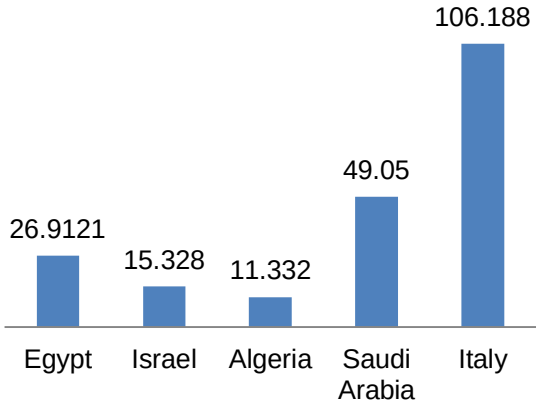

Figure 11 Installed capacity 2009 (GW)

Source: U.S. Energy Information Administration, International Energy Statistics

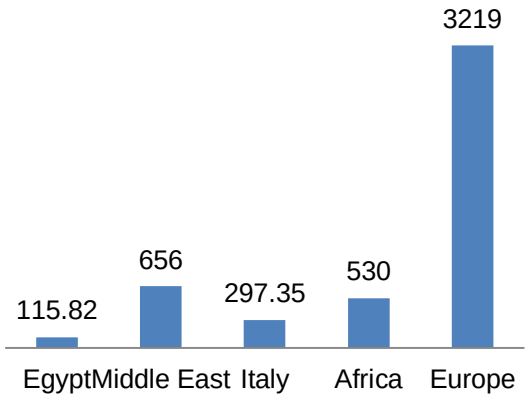

Figure 12 Electricity net consumption 2009 (billion kWh)

Source: U.S. Energy Information Administration, International Energy Statistics

2.1.5.1 Prices

The prices of electricity in Egypt range among the lowest in the world, but not affordable by the major part of the population. The prices are fixed by the Egyptian government and apply in equal manner to all regions. Electricity is highly subsidized. Since October 2004, several electricity tariffs were raised, by an average of 8.6 %, for the first time since 1992 and further 5 % increases were set for all electricity customers for each of the following five years. In 2008, the rise summed up to 7.5 %, including an additional 2.5 %-increase caused by high oil prices. While the increase in some segments exceeded 18 %, prices of the first segment of domestic consumption – less than 50 kWh per month, mainly composed of low income families.

The governmental plan was intended to gradually accommodate the electricity prices to the actual cost of the electricity system: a new plan has been approved for the electricity tariffs starting from January 2013 where the prices would raise again, closer to the cost price and where subsidies would be cancelled for energy-intensive factories, such as cement and ceramic factories. Indeed Egypt had already asked for a loan from International Monetary Fund (IMF) and one of the conditions to get the loan was to reform the energy subsidies strategies.

However the application is difficult and new tariffs decision has been delayed. This is due to the movements in opposition to the current government and the government, which doesn’t want to increase the anger level in the society.

2.1.5.1 Sector Organization

Egypt's Electricity sector is organized under the Egyptian Electricity Holding Company (EEHC) which comprises sixteen affiliated companies (six for productions, nine for distributions, and the Egyptian Electricity Transmission Company). Growing electricity demand in the late 1990s spurred industry restructuring and limited privatization of the

sector. However, the country now has several privately-owned power plants that are either independent power projects (IPPs) or financed under Build, Own, Operate and Transfer (BOOT) schemes. BOOT projects allow for the financing and development of the large-scale energy projects without affecting the country's debt profile. Therefore The Electric Utility in Egypt is divided into State-owned companies generating over 90% of Egypt's generating capacity. Transmission remains a monopoly under the EEHC umbrella, and private sector companies can only sell their electricity to the government-owned transmission network.[10]

-Government Owned:

Generation	Transmission	Distribution
1. Cairo Generation Company 2. West Delta Generation Company. 3. East Delta Generation Company 4. Upper Egypt Generation Company. 5. Hydro Plants Generation Company. 6. Developing and Utilizing The New and Renewable Energy Authority.	1. The Egyptian Electricity Transmission Company.	1. North Cairo Distribution Company. 2. South Cairo Distribution Company. 3. Alexandria Distribution Company. 4. North Delta Distribution Company. 5. South Delta Distribution Company. 6. Behaira Distribution Company. 7. Middle Egypt Distribution Company. 8. Upper Egypt Distribution Company.

Table 2 Government owned electrical companies

[10] "Egypt - Analysis - U.S. Energy Information Administration (EIA)." 2011.

-The Private Sector:

Generation	Transmission	Distribution
1. Suez Gulf Power Company (BOOT Project). 2. Port Said East Power Company (BOOT Project). 3. Sidi Krir Generation Company (BOOT Project). 4. International Bensmark Power. 5.MIDOR for Electricity (Medalak)	1. The Egyptian Chinese Joint Venture Company for Investment. 2. Delta Company for Construction and Reconstruction. 3. Engineering Group for Electric Energy. 4. Madinety Electrochemical Energy. 5. New Giza Eternal Luxury City Services.	1. Global Energy Company. 2. Alexandria Carbon Black Company. 3.Om El Gorefat. 4. National Electricity Technology Company. 5. Mirage. 6. Sendian Company. 7. Consukorra Company. 8. Power House Company. 9.ElGouna Electric 10. Generget Company for Renewable Energy. 11.Emak for Utilities and Services

Table 3 The private sector's electrical companies

Key Role of Ministry of Electricity and Energy:[11]

- Set and Implement general policies in the fields of electricity generation, transmission and distribution to use the most technical and scientific proven developments and technologies.
- Follow up and monitor different activities to provide electrical power for the social and economic development to support the government's framework and plans.
- Suggest tariff of electrical power to the cabinet.
- Supervise study and implementation of important electrical projects.
- Set data structure and technical statistics of electric activities.

[11] "Ministry Strategies - New Page 3." 2006.

- Organize and provide the technical support, consultancy and experience to Arab countries in the electrical field.

2.1.5.3 Supply

In 2010, total installed capacity was 26.91 GW with an increase of 9.4 percent compared to the previous year, and the generated electricity was 138.73 billion kilowatt-hours which is equivalent to 0.66% of the world total (according to the 2012 BP). Around 90% of Egypt's electric generation capacity is thermal (using the Egyptian natural gas), with the remaining coming from hydroelectric, mostly from the Aswan High Dam and very small percent from wind and solar sources. The capacity exceeded the peak demand by about 10 percent; the available capacity was less than the summer peak demand.[12] 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.

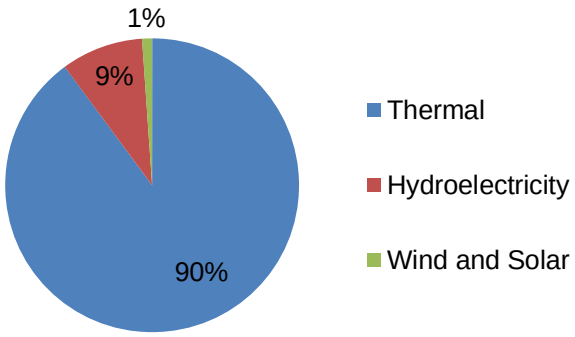

Figure 13 Generated electricity by type 2011
Source: Egyptian Electricity Holding Company Report 2010-2011

[12] "African development bank group report." 2010.

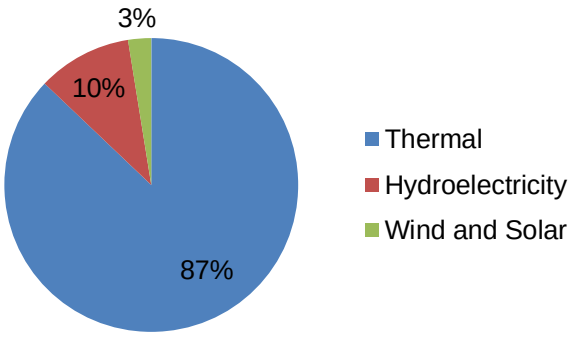

Figure 14 Installed capacity by Type (2010/2011)

Source: Egyptian Electricity Holding Company Report 2010/2011

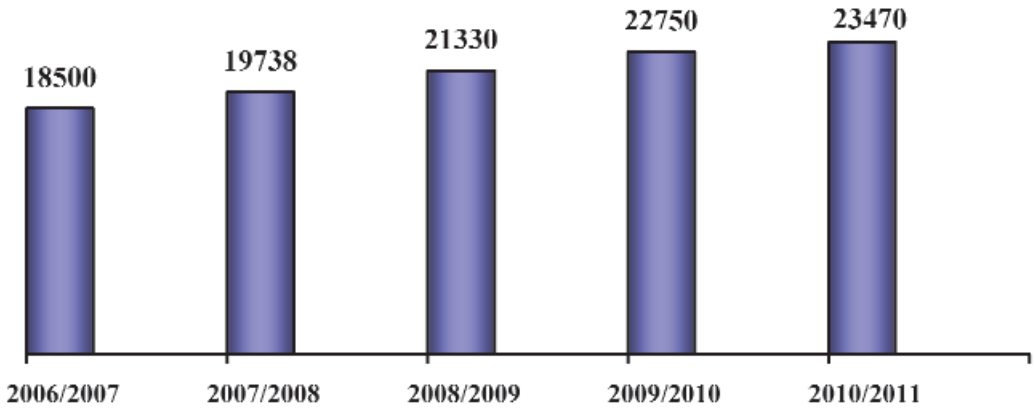

Figure 15 Yearly peak load development (MW)

Source: Egyptian Electricity Holding Company Report 2010/2011

Regional distribution of capacity

There is a high degree of regional concentration of power generation capacity in Egypt. Most of the installed capacity is located in the northern part of Egypt, more than 70% of

the total capacity. Cairo region (Greater Cairo, metropolitan area and the suburbs) representing 21.9 percent of total capacity. The Greater Cairo Metropolitan area is the major urban, industrial, and financial agglomeration in Egypt and represents 19.5% of the Egyptian population. It is followed by The Middle Delta which represents 17.6 percent of total capacity and the West Delta which represents 13.7 percent of total capacity. On the other side Sinai and Upper Egypt represent the regions with lower capacity.

Transmission

The electricity transmission and distribution network has developed into a complex interconnected system. The total transmission lines and cable length in 2010 were 42223 km and the transformers capacities were 87400 MVA. The transmission is only managed by Egyptian Electricity Transmission Company.

Egypt has international electrical interconnection between several countries (Integrated Arab Electrical Interconnection connecting Lebanon, Syria, Jordan, Egypt and Libya). The operational arrangements are under preparation to assure the success of the commissioning of the interconnection line Libya – Tunisia to connect The Mashrequ (East Arabian Countries) with Arab Maghreb (Libya, Tunisia, Algeria and Morocco), and in the framework of achieving the Integrated Arab Electrical Interconnection. It is also planned the interconnection between The Kingdom of Saudi Arabia and Egypt and estimated to be completed by 2015; this will allow the sharing of 3000 MW between the two countries. This project will indirectly expand each country's electricity capacity by pulling from each other's supplies at different peak hours. Longer-term plans call for broader interconnections will include North Africa, the Middle East (Maghreb Arab Countries, Mashrequ Arab Countries and The Countries of Gulf Cooperation Council) and Europe (Figure 17).

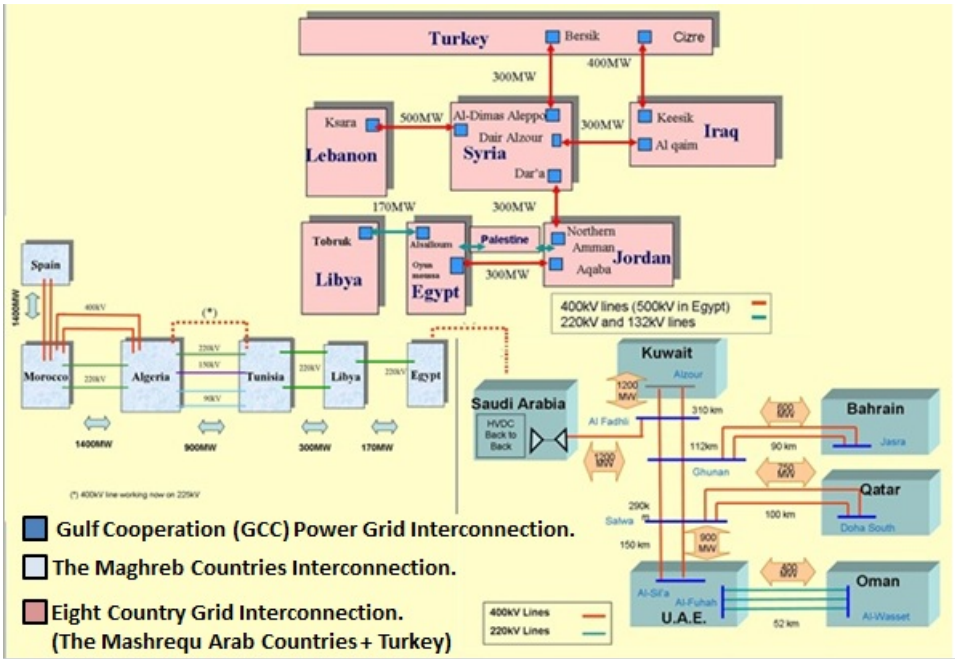

Figure 16 Egypt's international electrical interconnection

2.1.5.5 Egypt's Electricity mix

Conventional Thermal

In 2010, Conventional thermal energy sources accounted for almost 90 percent of the total electricity generated in Egypt Nearly all of this was met by domestically produced natural gas. Existing natural gas subsidies combined with plans to expand gas-fired generation capacity indicate that the fuel will continue to play an important role in Egypt's electricity mix.[13]

[13] "Egypt - Analysis - U.S. Energy Information Administration (EIA)." 2011.

Renewable Energy

The 1st move in Egypt toward renewable energy was in 1988 when the 1st wind farm at Ras Ghareb on the Red Sea coast was established with a total capacity 400 kW. The 2nd wind farm started operating in 1996 at Hurghada on the Red Sea coast with a total capacity 4.5 MW. The government has founded The New and Renewable Energy Authority (NREA) in 1986 under the authority of The Ministry for Electricity and Energy. The mission of (NREA) aims at identifying and evaluating new and renewable energy sources and at planning for their development. NREA also carries out technical, economic and environmental studies needed for the development of the renewable energy, implementing new and renewable energy projects through its own means or in cooperation with others and implementing demonstration and field testing projects for renewable energy technologies. NREA has the right to certify and provide guarantee for renewable energy products and to implement projects, either alone or in cooperation with others, including overseas governments and authorities.

Hydroelectricity

Since 1926, the year of operating the first hydro-power plant, Egypt had constructed a total of 2800 MW hydro-power capacities and only the Aswan High Dam represents 2100 MW. In 2010, Egypt generated around 13046 GWh from hydroelectric resources, almost all of which came from the Aswan High Dam. All the existing hydro-power schemes are located in Upper Egypt, south of Cairo. Hydro-power played a significant role in satisfying Egypt's energy needs in the seventies by providing more than two thirds of electricity demand. Since late eighties, the situation has been completely reserved with oil and gas providing about 85% of electricity demand now. The potential hydro-power in Egypt is limited to the run-of river plants. Most of hydro-power available in Egypt has been utilized for electric energy production. Small power plants planned to be constructed will not affect satisfying electric energy needs. It is

remarkable the decrease in electricity generation from hydro power plants from 2007/08 to 2009/10 from 15510 GWh to 12863 GWh (Figure 17).

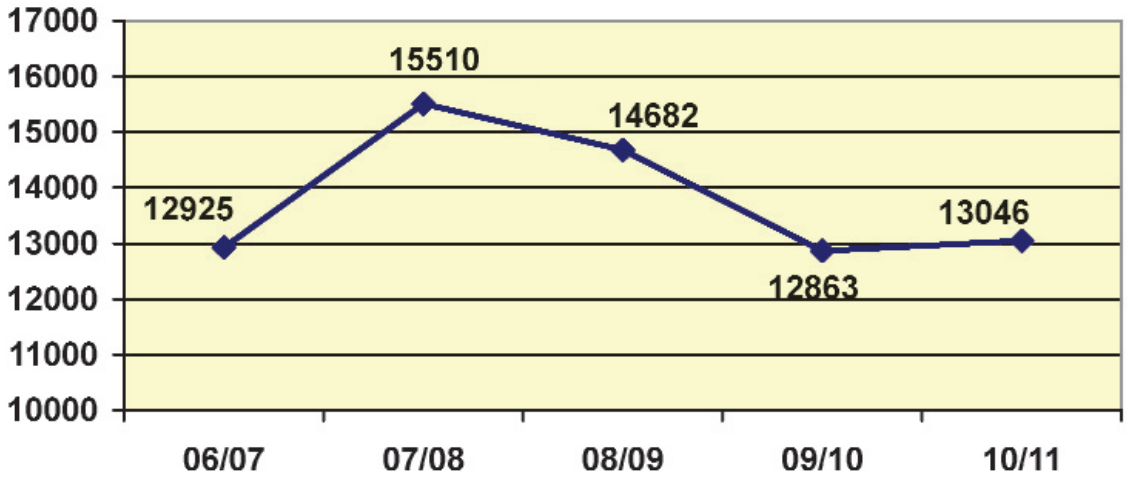

Figure 17 Development of hydro energy generated (GWh)
Source: Egyptian electricity holding company report 2010/2011

Wind Energy

Egypt developed the wind energy as an electricity source in its electricity mix from 5 MW in 2000 to 550 MW in 2010 (Figure 18). At the end of 2011, over 98% of Africa's total wind installations of just over 993 MW were to be found across four countries - Egypt (550 MW), Morocco (291 MW), Tunisia (114 MW) and Cape verde (24 MW) (Figure 19).

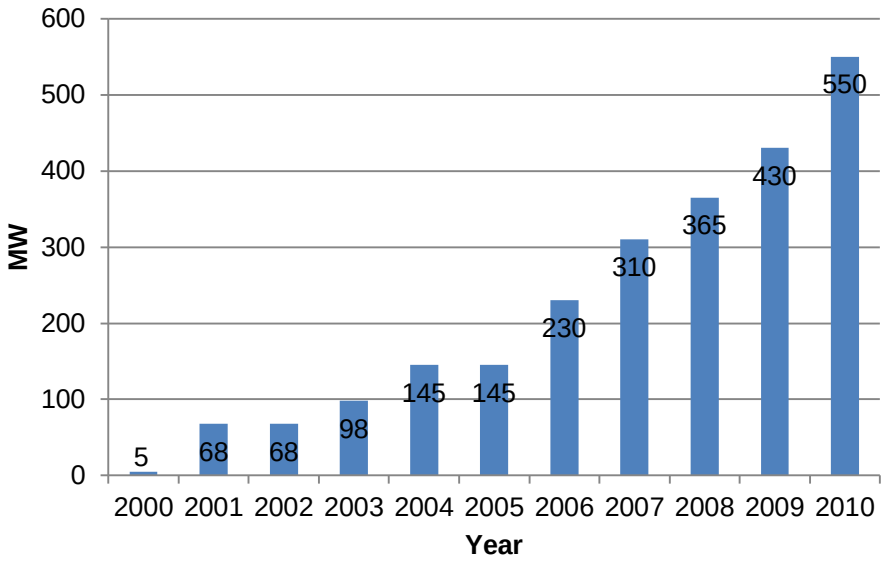

Figure 18 Installed wind capacity in Egypt 2000-2010

Source: Egyptian New and Renewable Energy Authority (NREA)

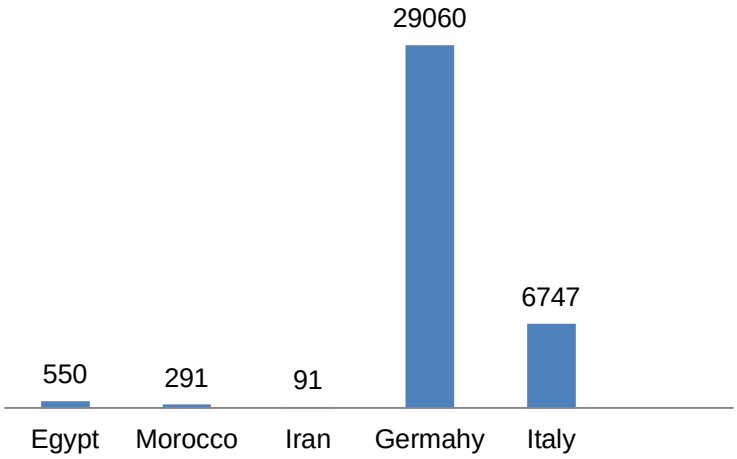

Figure 19 Installed wind capacity 2009 (GW)

Source: Egyptian New and Renewable Energy Authority (NREA)

According to The Egyptian New and Renewable Energy Authority (NREA), Some of the world's best wind power resources are located in Egypt. A comprehensive

eight-year wind-resource assessment in Egypt called Wind Atlas has been done. The purpose of the Wind Atlas was to establish a meteorological basis for assessing Egypt's wind energy resources in six designated regions: the northwest coast, the northeast coast, the Gulf of Aqaba, the Gulf of Suez, the Red Sea, and the western desert. The Wind Atlas for Egypt is one of the first – and certainly the most comprehensive – numerical wind atlases ever established resource over an area of more than one million square kilometers. The Wind Atlas for Egypt confirms the existence of a widespread and particularly high wind resource in the country. According to the Wind Atlas, the western part of the Gulf of Suez is home to some of Egypt's best wind resources. Average yearly wind speeds surpass 7 meters per second, and there is potential for some 20,000 MW of wind capacity. The Gulf of Suez is the region where both short- and medium-term plans for Egypt's wind energy development are focused. (Figure 20) illustrates the distribution of wind-generation potential in Egypt at a height of 50 meters. Pink, red, and purple areas indicate areas with economic potential for wind energy generation, while yellow areas represent marginal ones.

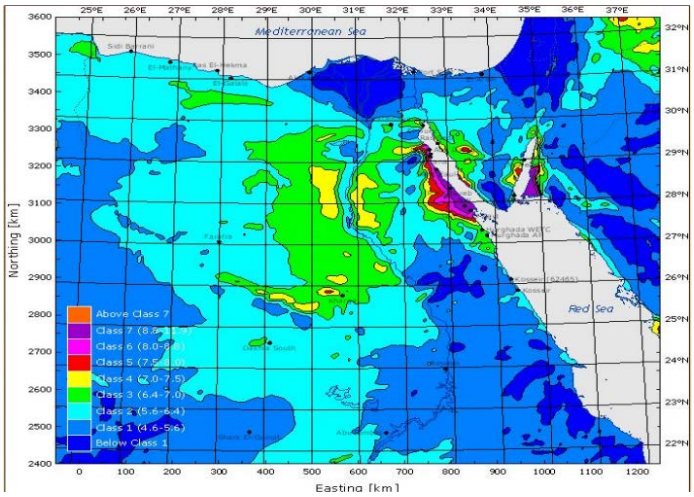

Figure 20 Wind map of Egypt

Source: Egyptian New and Renewable Energy Authority (NREA)

And based on the Wind Atlas Egypt's the wind energy potential sites are: (figure 21)

1. Gulf of Suez area-Class 1 at the height of 50 m above ground level is between 400 and 800 W/m²- wind speed (> 9 m/s).
2. Western Egypt Domain at the west bank of the Nile-Class 1 at the height of 50 m above ground level is between 300 and 400 W/m² - wind speed (7-8 m/s).
3. Areas close to Kharga -Class 1 at the height of 50 m above ground level is between 300 and 400 W/m² -with wind speed (7-8 m/s).

4. Eastern Egypt domain at the east bank of the Nile-Class 1 at the height of 50 m above ground level is approx. 300 W/m² -wind speed (6-7 m/s).
5. Gulf of Aqaba area Class 1 at the height of 50 m above ground level is between 400 and 600 W/m² (national reserve so restricted site).

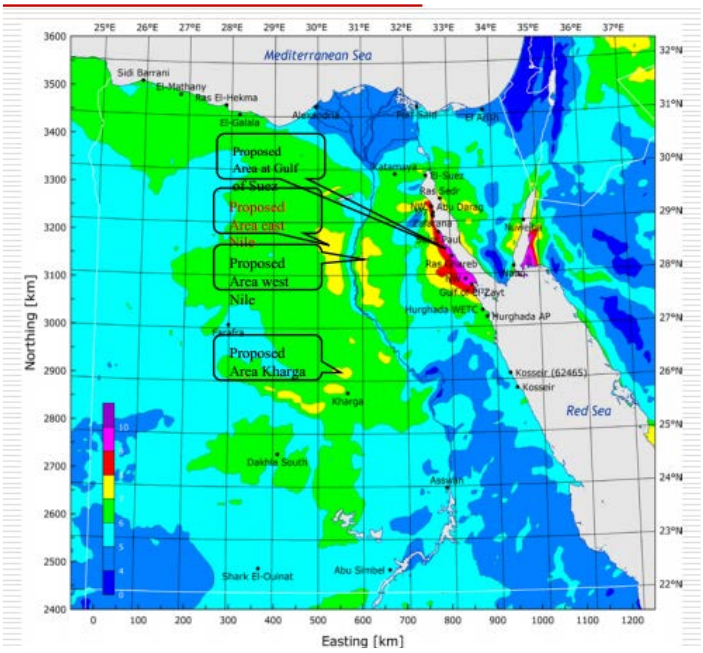

Figure 21 Wind Atlas Egypt's the wind energy potential

Source: Egyptian New and Renewable Energy Authority (NREA)

Egypt has a running wind farms in the Zafarana region along the Red Sea, considered the largest farm in Africa; it has been constructed in stages since 2001 with a total installed capacity of 430 MW. The farm houses several wind projects that were developed in several stages and financed in cooperation with development banks from Germany, Denmark, Spain, and Japan. In 2010, 120 MW of wind capacity were added to Zafarana in cooperation with the Danish International Development Agency (DANIDA), taking the total installed capacity to 545 MW out of 550 MW as total installed wind capacity. The total generated electricity from the wind farm is about 1,147 GWh. The other wind farm is in Hurgada with a total installed capacity 5 MW. The plan is to increase wind's share of electricity generation to 12 percent from the total generation capacity. There are several wind projects currently under preparation that combined could greatly increase Egypt's installed wind capacity. The projects will be implemented through governmental cooperation agreements with Germany, Japan,

Spain, France, and the European Union. Wind projects are being prepared in cooperation with private international companies as well.

Solar

Egypt has an excellent potential of solar energy which will be suitable for a lot of solar technologies projects even Concentrating Solar Power (CSP) or Photo Voltaic (PV). According to the 1991 Egyptian Solar Radiation Atlas, the country averages between 5.4 and more than 7.1 kilowatt-hours per square meter (kWh/m^2) of annual daily direct solar radiation, from north to south. (Figure 22) The annual direct normal solar irradiance ranges from 2,000 kWh/m^2 to 3,200 kWh/m^2, rising from north to south, with a relatively steady daily profile and only small variations in resource. Such conditions are supported by 9–11 hours of sunlight per day, with few cloudy days throughout the year.

The construction of the first solar thermal power plant was at Kuraymat City just over 90 km south of Cairo. The plant was completed and connected with the national grid at the end of June 2011 with total installed capacity of 140 MW. The plant uses concentrated solar power (CSP) with back up natural gas fired generators. The initial operation of this power plant started at the 1st of July 2011 with estimated total energy generated of 852GWh/year**.**

According NREA, solar power accounts for 20 MW of the plant's total generation. The solar-thermal plant is part of a general plan to export North African generated electricity to Europe.

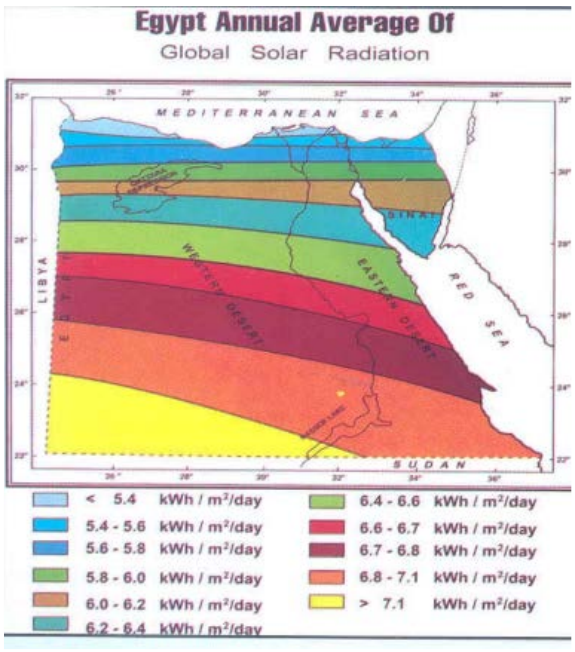

Figure 22 Global annual average of global solar radiation

Source: Egyptian New and Renewable Energy Authority (NREA)

Nuclear Energy

There are three authorities in Egypt to develop the country's nuclear energy program. They are Atomic Power Authority (APA), The Nuclear Power Plan (NPPA) and Nuclear Material Authority (NMA). Egypt is operating a research nuclear reactor with a capacity of 22 MW since 1997.

2.1.5.6 Transmission and Capacity targets and projections

Since the country plan has been delayed due to the revolution, it was targeting to increase the electricity generation in 2012-2013 by 5.6% from 156.4 TWH to 165.1 TWH (Figure 24)

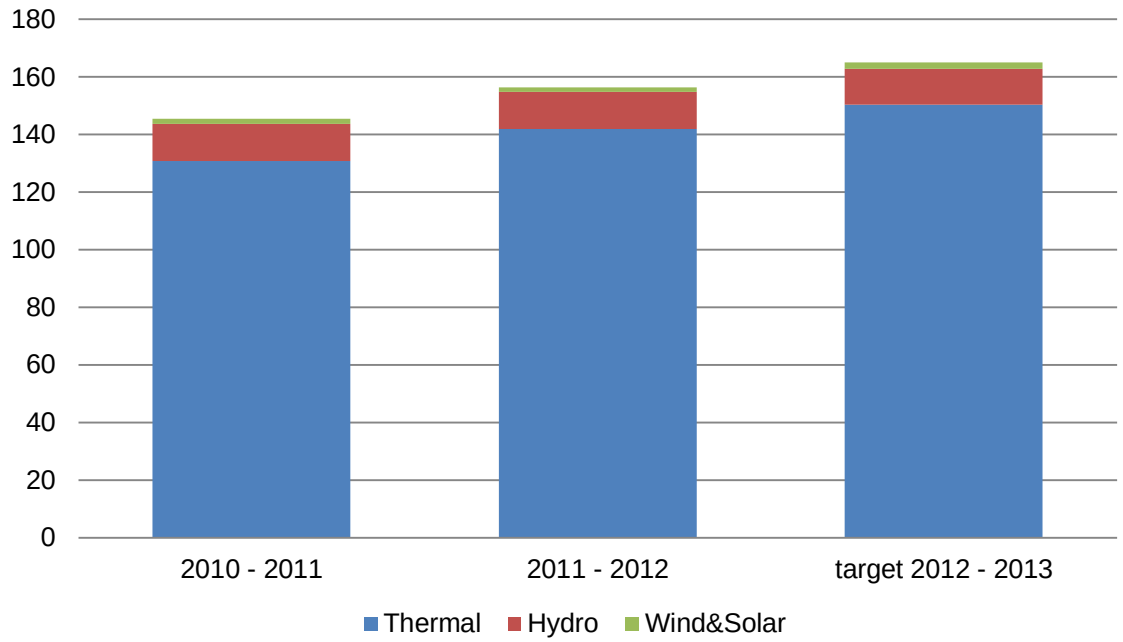

Figure 23 Electricity generation target (billion kWh)

Source: Egyptian Electricity Holding Company Report 2010 - 2011

The seventh five year plan 2012 – 2017 includes implementation of 12400 MW thermal power projects and 32MW hydro power plant owned and operated by EEHC. Three giant conventional power plants with total installed capacity 5500 MW are planned to be built and to be operated by the private sector.

In nuclear power, the present power development program includes 4000 MW of nuclear capacity to be commissioned in the next 15 years. The Ministry of Electricity and Energy in 2010 approved a 1000 MW power station at El Dabaa, on the Mediterranean coast, which is open to international participation and to become operational by 2019 as the country's first nuclear power plant. Subsequent nuclear plants of 1000 MW each are scheduled for commissioning between 2020 and 2025.

The plan is also considering the renewable energy development: on April 2007 the Supreme Energy Council in Egypt adopted a resolution on an ambitious plan aiming to increase the contribution of renewable energy to reach 20% of total energy generated in 2020, where hydro power represents 5.8%, wind 12% and solar 2.2%. The target will be met by scaling up wind energy capacity to reach 7200 MW in year 2020, two

concentrated solar power plants, with total capacity of 100 MW and four photovoltaic plants with total capacity 20 MW.

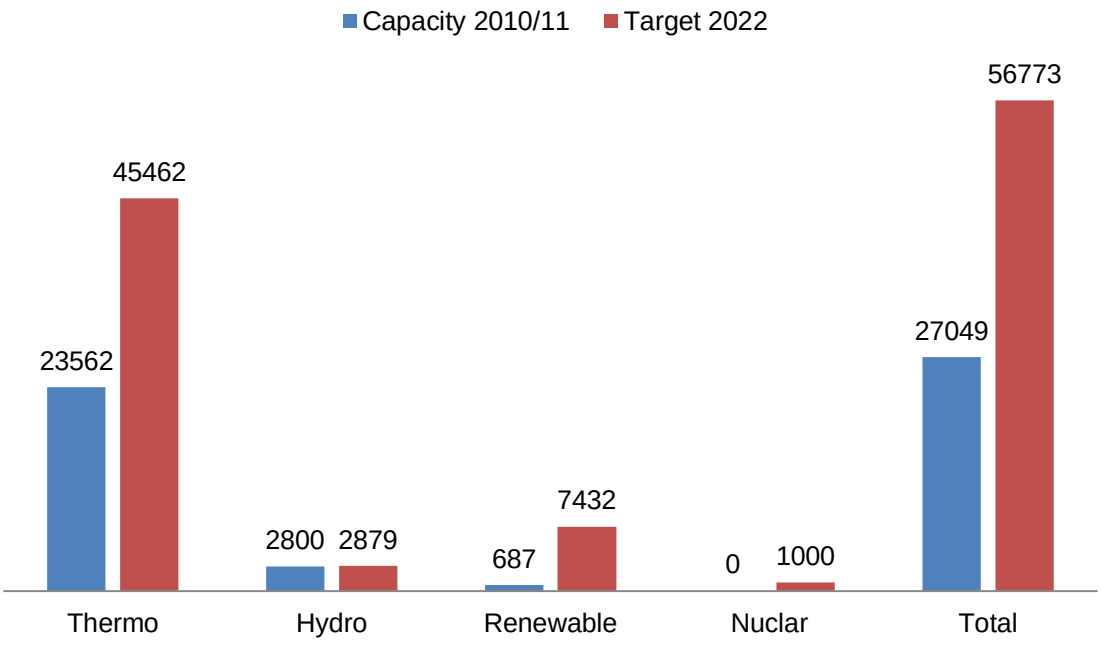

Figure 24 Generation expansion plan (2010-2022) by power planet type (MW)

Source: The Ministry of Power and Energy Report 2010 - 2011

By 2022, Egypt is expecting large expansions in the thermal power plants to reach 45462 MW thermal installed capacity using Egyptian natural gas. The hydro power will not see much expansion since around 85 percent of the Nile's hydropower potential has already been exploited. In the other hand the renewable energy will have a significant increase up but the current published projects will not satisfy the 20% share of the total capacity.

Future Plans for electricity transmission:

1. The interconnection between Egypt and eastern Nile Basin countries (Ethiopia and Sudan).

2. The interconnection between Egypt and Democratic Republic of Congo passing through Central Africa and Sudan to transmit 40GW of hydro power generated from Congo to North Africa and Europe.
3. The interconnection between Egypt and Europe; through Egypt's participation in the Observatorie Mediterranean de l'Energie (OMG) and the study committee for the electrical interconnection of the Southern and Eastern Mediterranean Countries as an introduction to the interconnection with European network and exporting renewable energy (solar and wind) from Egypt to Europe.

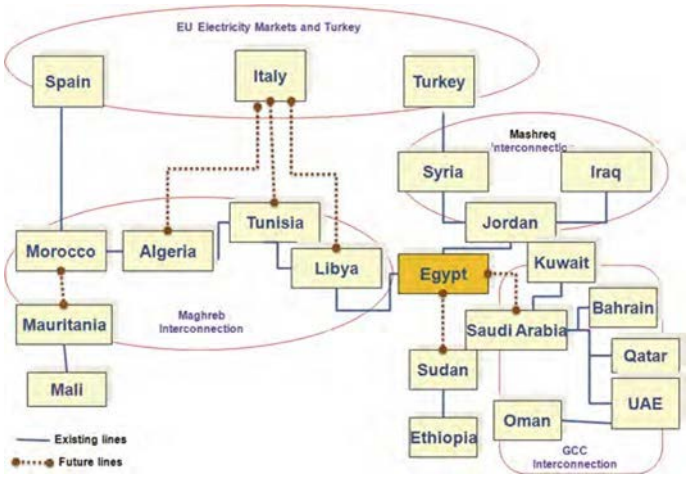

Figure 25 Future plans for Egypt's international electricity interconnection.

2.1.5.7 Residential Consumption

Residential sector consumption represents around 50% of the total electricity consumption and the industrial sector represents only 20% of the total electricity consumption. The electricity share per capita from the house use in 2010- 2011 was 679 kWh and 1638 kWh (Table 2).

Electricity share per capita	2010-2011 (Kwh)	2011-2012 (Kwh)
From Total Electricity usage	1591	1638
From Electricity use in houses	645	679

Table 4 Electricity share per capita
Source: The Ministry of Power and Energy Report 2010 - 2011

2.1.6 Energy Policy

The energy policy is mainly prepared by The Supreme Council of Energy. The main structure of it consists of the ministers of electricity and petroleum, with consultations in the parliamentary committee for industry and energy. Egypt's policy aims to increase the use of renewables in part by environmental considerations, in part by an interest in diversification of energy supply. Moreover, in Sept. 2006, the direction for using nuclear technology to generate electricity by building a nuclear plant and also increase dependence on renewable energy has been announced but still up to now the real construction of the power plan has been postponed.

The energy policy in Egypt focuses on the following issues:

- Enhancement of natural gas utilization,
- Adjustment of energy price and removal of subsidies,
- Energy conservation and efficient energy use,
- Promotion of renewable energy utilization.

The recent and current policy which is adapted in the new country's 10 years plan from 2012 to 2022 and the major features of the future energy policy in Egypt can be summarized as follow:

(1) Increase the energy generating production by 5% to 7% to meet the demand in different sectors.

(2) Use different types for thermal electricity production between (combined and vapor) and having a reasonable reserve to give the possibility to maintain the old units and expansion works for the other units.

(3) Use different sources to generate energy (thermal, hydro, solar, wind, biomass and nuclear power) to decrease the dependency on the thermal methods, since the thermal planets produce around 90% of the total generation and to reach a capacity of electricity generation from renewable energy sources to produce about 20% of the total generation by the year 2020.

2.2 Water in Egypt

Egypt has made significant progress in terms of direct access to safe drinking water at household level (92.4%) and basic sanitation services (92.9%) in the last decades. Yet, access is uneven and stark geographical and socio-economic disparities persist affecting the living conditions and health of millions of Egyptian children and their families (UNICEF).[14]

Water supply in Egypt between 1990 and 2010 increased from 89% to 100% in urban areas and from 39% to 93% in rural areas. Since 2005, Egypt is classified as water scarce country as it has less than 1000 m^3 of fresh water per year per capita.[15]

[14] "Water, Sanitation and Hygiene - Unicef." 2012.
[15] "World Health Organization.

2.2.2 Water Resources

The main water resources in Egypt are Nile water, Groundwater, rainfalls and potential desalination of sea. The Nile River is called in Egypt “the source of life”, since it is the main source of fresh water in the country representing 79.3% of the Egypt’s water resources and covering more than 95% of the current needs of freshwater. Egypt is getting a fixed amount of Nile water each year based on the agreement made in 1959 with Sudan which is determined to be 55 BCM per year. 7.75 BCM per year extracted from groundwater and around 1.05 BCM per year comes from rain falls, which are very scarce and mainly occur near the Mediterranean coast in winter. The reuse of Agriculture drainage water has increased from 2.7 BCM per year in 2009 to 9.7 BCM per year in 2011. The reuse of the treated wastewater has increased from 1.4 BCM per year in 2009 to 2.9 BCM per year in 2011. Desalination of seawater as accounting for 0.1 BCM per year is having due to its high cost comparing to the other resources (Figure 26).[16]

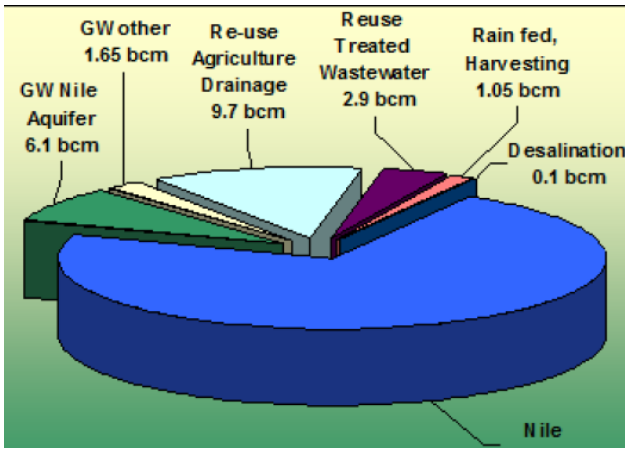

Figure 26 Sources for water supply in Egypt

Source: CEDARE,2011

[16] "Case Study - UNW-AIS." 2012.

2.2.3 Demand

Agriculture is the main consumer of water in Egypt: it withdraws around 85% of total water supplied. Municipal and industries consume 15% of the total water consumption. (The hydropower and the navigation they are both considered as non consumption sectors).

The developing of the agriculture sector will have a great influence on the water share for other sectors. Moreover the increase of population and the economic growth are being the main factors in the increase of water demand in the municipality and the industrial sector. [17]

2.2.4 Sanitation

Sanitation services in Egypt are less developed than water supply services. At present, there are more than 323 wastewater treatment plants in the country. The capacity of wastewater treatment plants has increased by 10 times in the last two decades. The existing capacity of 12 million m^3/day. Length of wastewater collection networks / sanitation pipelines increased from 28,000 km in 2005 to 34,000 km in 2010.[18] The main problem of the sanitation services is mainly in the rural areas where there is a lack of appropriate sanitation systems. Only 20 percent of rural villages are served by sewerage networks with treatment plants: this leads to the discharge of significant amounts of untreated wastewater into agricultural drains and canals.[19] The rest of the rural villages have some type of sanitary facility and mostly depend on the on-site disposal of wastewater “septic tank”.

[17] Hamza, W. "Water availability and food security challenges in Egypt." 2007.
[18] "Holding Company For Water and Waste Water-Arab Republic of Egypt.”
[19] "World Bank Supports Improved Sanitation Services in Rural Egypt." 2013.

In the new water policy implemented in 2005 the government is committed to develop the sanitary services in rural villages since the number of the rural wastewater treatment plants in operation is around 500 while the total number of rural villages is more than 5500 villages. The development for the sanitary services for the rural villages facing so many difficulties that were mentioned in the Egyptian National Rural Sanitation Strategy Report made by Holding Company for Water and Wastewater in 2008 as follow[20]:

Financing:

The need for investment in rural wastewater treatment facilities and improved conveyance systems (sewers or trucks) is massive. Although villages can be ranked in terms of their pollution exposure, in the final analysis all quantities and types must be treated and safely disposed. Ultimately, every rural Egyptian household's sludge, septage, and sullage has to be transported to treatment facilities, treated, and then disposed. Solid waste should also be safely managed and the role of local administration should also be activated, otherwise it contributes to surface water and groundwater pollution and absence of obvious results (outputs) of the implementation of the national program for rural sanitation in Egypt

Land availability:

In wastewater treatment, there is a generally inverse relationship between land area requirements and construction cost. This is because lower-cost technologies rely on exposure to sunlight for biological treatment, consequently this requires larger areas for treatment basins and more stay time in these basins. Vacant land is scarce in the Delta and its cost is high.

[20] "Egypt National Rural Sanitation Strategy - Final Document." 2009.

Disciplinary and professional labor:

For the most part, the three disciplines of on-site sanitation, wastewater pollution control, and water resources management have been professionally, organizationally, and financially bounded from one another. Solid waste management and trucked wastewater conveyance are also bounded from one another and from the other three disciplines. A sustainable institutional framework requires engineers, local officials, technicians, professional laborers, and community participation specialists; each to apply his/her knowledge and skills within an integrated water resources management framework that ensures stopping the causes of current deterioration and transition into new situation after implementing the National Program for Rural Sanitation.

Village-centered bias in project planning:

Until recently, investments in rural wastewater treatment were directed to single villages, although it is technically feasible and cost-effective to implement treatment facilities which serve clusters of villages. Focus on single-village service areas is probably an effect of the structure of the State budget and the five-year planning system, in which local councils are both political constituents and budget entities.

Weak environmental health enforcement:

Law 48/1982 regulations which forbid the discharge of untreated wastewater to surface waters are rarely applied and can hardly be applied, given the shortage of wastewater treatment facilities.

The Government of Egypt, increasingly aware of the rural sanitation problem, is committed to implement the National Program for Rural Sanitation in Egypt through the Ministry of Housing, Utilities, and Urban Development (MHUUD).

2.2.5 Sector Organization

The water management is shared between several ministries and authorities:

1. Ministry of Water Resources and Irrigation.

The ministry is in charge of the management of water resources, distribution, developing, monitoring and assessment of the water quality of the different water sources. It is also in charge of collecting and disposal the drainage water from agriculture and protects the coastal lakes and shorelines.

2. The Ministry of Agriculture and Land Reclamation:

The ministry is in charge of the water management at the farm level. It is also in charge of land reclamation and improving agriculture sector.

3. The Ministry of Housing, Public Utilities and New Urban Societies:

The ministry is in charge to provide water supply and sanitation services.

4. The Holding Company:

The company established in 2004 and it is in charge to purify, desalinate, transfer and sell drinking water, and collect, treat and safely dispose wastewater. Its strategic role is to improve the water quality and keep financial stability by modifying the account system in the company and its subsidiaries for water and wastewater sector.

5. The Ministry of Water and Sanitation:

Initiated in 2012 by the new government of Egypt. It was a part of The Ministry of Housing, Public Utilities and New Urban Societies.

Other ministries are involved in different levels in the water management and operation such as:

6. The Ministry of State and Environmental Affair:

The Ministry is collaborating with the national and international development partners, on defining environmental policies, setting priorities and implementing initiatives within a context of sustainable development.

7. The Ministry of Health and Population.

8. The Ministry of Local Development.

9. The River Transportation Authority.

10. The General Organization for Industrialization.

11. The Ministry of Electricity.

There are many actors in the water sector with different interests and different way to use the water. The integration between the different ministries and authorities in the water policy is one of the main key of success to apply the sustainable development.

2.2.6 Water Policy

The water policy in Egypt passed by many phases during the last 50 years:

- 1st in 1975: The water policy was based on matching between supply and demand.
- 2nd in 1981: The Water Master Plan had an objective to provide the water requirements for agriculture growth.
- 3rd in 1993: Water security projects
- 4th in 1994: New water policies
- 5th in 2004: National Water Resources Plan Development using the integrated water resources and demand management for sustainable development.

The National Water resources Plan (NWRP) has been developed by cooperation between the Ministry of Water Resources and Irrigation (MWRI) and the Government of the Netherlands. The plan was completed in 2003 and launched in 2005 with a time horizon until 2017. The plan aims to be towered the integrated water resources management that aim to use the available resources such as fresh surface water, groundwater, precipitation and drainage water in the most efficient way to satisfy all the stakeholders that need to use water such as agriculture, industries, municipalities, pump stations, hydropower plants, fishers, navigation and in stream flow. An extensive effort is required to coordinate in planning and management between the different concerned government institutions and each stakeholder that use the water. The policy has 4 pillars as follow:[21]

[21] "National Water Resources Plan. 2017."

1) Increasing water use efficiency.

2) Water quality protection.

3) Pollution control and water supply augmentation.

4) Institutional restructuring.

The Plan includes 39 actions in the fields of institutional reform and strengthening, policies and legislation, physical interventions, capacity building, technological and information systems, water quality, economic and financial framework, research, raising awareness, monitoring and evaluation and trans boundary cooperation. The physical interventions mentioned include irrigation improvement and rural sanitation (CEDARE 2011).

2.3 Environmental Pollution

2.3.1 Air Quality

In 2007 the World Bank ranked Cairo's air worst in the world for pollution by particulates.

The air in Egypt is polluted due to different factors. A temporary pollution with a limited impact due to natural factors like dust emissions is due to the different storms such as El-Khamaseen which usually arrives in April carrying big amount of sands and dust from the desert. The air restores its original nature when the temporary natural factor ends. The other factors of pollution are related to the different human activities divided in two categories stationary sources such as factories and mobile sources such as transportations. The ministry of the state for environmental affairs (MSEA) and its agency which called Egyptian Environmental Affairs Agency (EEAA) have established in 1998 a monitoring integrated national network for the air pollution represented in 87 stations in 2009 (Figure 27).

Figure 27 Distribution of air quality monitoring stations located in Greater Cairo and Delta
Source: Egypt State of Environment

Some indicators have been developed for the environmental assessment and evaluating the environmental problems and to provide a simple picture for the state of the environment. To clarify the air pollution and its quality, the following elements need to be measured: Sulfur Dioxide, Nitrogen Oxides, Particulate Matter, Lead, Ozone, and Carbon Monoxide.

Sulfur Dioxide (SO_2)

Sulfur dioxide is generated as emission from stationery sources or mobile sources such different factories, power planet, refineries, burning of fossil fuels and diesel fuel vehicles in particular. The average concentration of SO_2 has been decreased significantly from 2004 till 2009 to reach 31 ($\mu g/m^3$) (Figure 28). Overall the average concentration of SO_2 is below the limits set by the Environmental Law No.4/1994, to be 60 ($\mu g/m^3$), except in some cities where the concentration exceeded this value. By regions in Egypt, the annual average concentration of SO_2 has been decreased from 1999 till 2009 specially in Greater Cairo which was over the limits in 1999 and in Delta cities but in the Upper Egypt cities the concentration has been significantly increased in 2009 to reach 46 ($\mu g/m^3$) while it was 16 ($\mu g/m^3$) in 2008 (Figure 29) because of the new construction process in this region for new cities and new factories and the increase of the diesel consumption vehicles used in these projects.

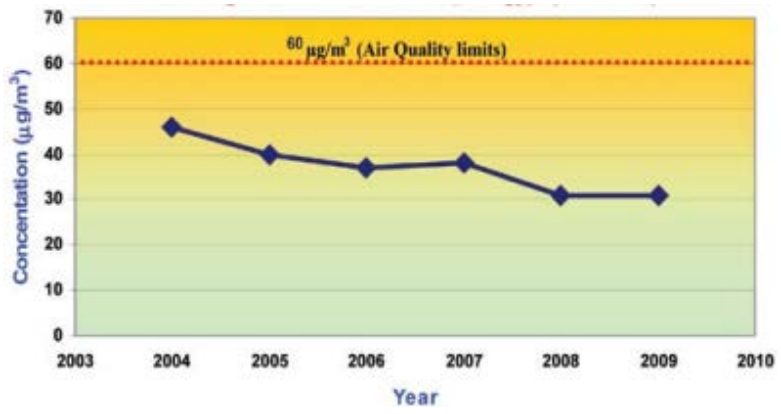

Figure 28 Annual average concentration of sulfur dioxide 2004-2009

Source: Egypt State of Environment

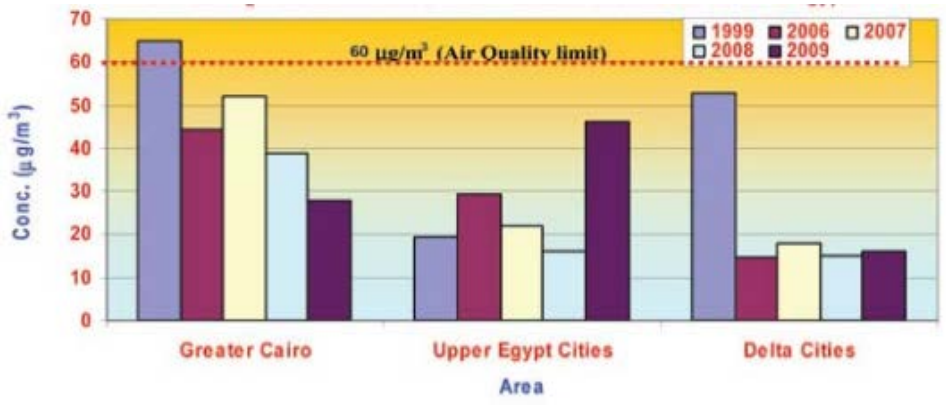

Figure 29 Annual average concentration of sulfur dioxide in different regions

Source: Egypt State of Environment

Nitrogen dioxide (NO_2)

Nitrogen dioxide is generated as emission due to the fuel combustion at high temperature. The average concentration of NO_2 stated always over the limits in the period 2004 – 2009 and showed a significantly increase in 2008 followed by significantly decrease in 2009 (Figure 30). The environmental law in Egypt did no define a limit for the average annual concentration of NO_2. The limit defined by the World Health Organization (WHO) is 40 ($\mu g/m^3$). The main reason for the high concentration of NO_2 in the air is the high traffic density specially in Greater Cairo. The concentration start increasing also in other regions due to the same reason specially in Upper Egypt where the annual average concentration of NO_2 was over the limits in 2009 (Figure 31).

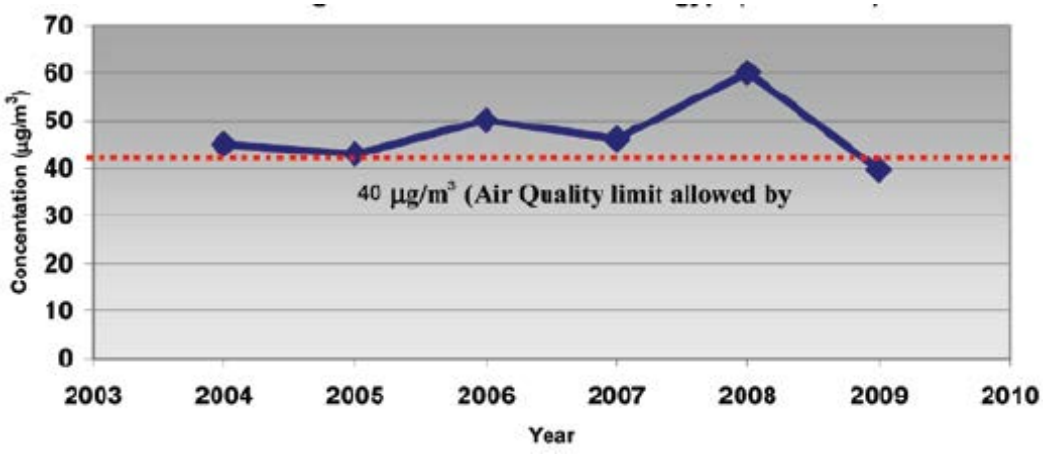

Figure 30 Annual average concentration of nitrogen dioxide 2004-2009

Source: Egypt State of Environment

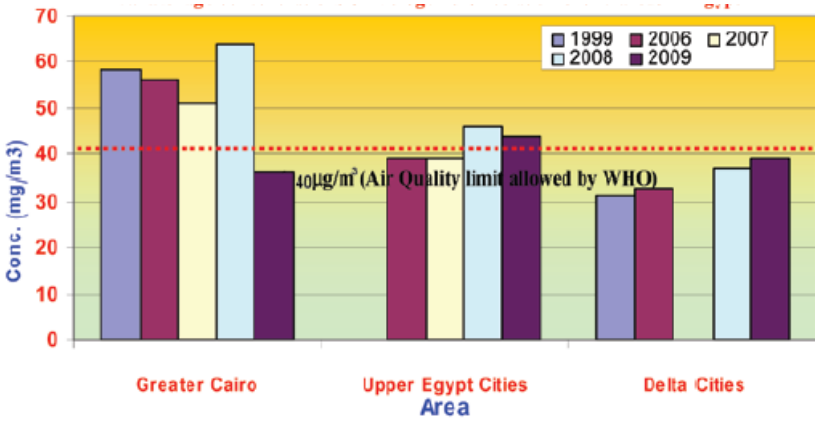

Figure 31 Annual average concentration of nitrogen dioxide in different regions

Source: Egypt State of Environment

Particulate Matters (PM_{10})

In the Report issued by The Ministry of State and Environment in Egypt in 2009, inhaled particles are considered one of the main problems causing the increase in pollution levels in Egypt, especially in Greater Cairo and neighboring areas. The particulate matters (PM_{10}) are generated from stationary and mobile sources. Particulate matter can be directly emitted or can be formed in the atmosphere when gaseous pollutants such as SO_2 and NOx react to form fine particles (United state environmental protection agency). The average annual of PM_{10} in the period 2004 – 2009 is always exceeding the limits (Figure 32) due to the increase of the traffic density, the industrial development; open burning of solid waste and natural factors such as the wind carrying the dust. The high level of the average concentration of PM_{10} is shows in the three main Egyptian regions especially in the Delta cities (Figure 33).

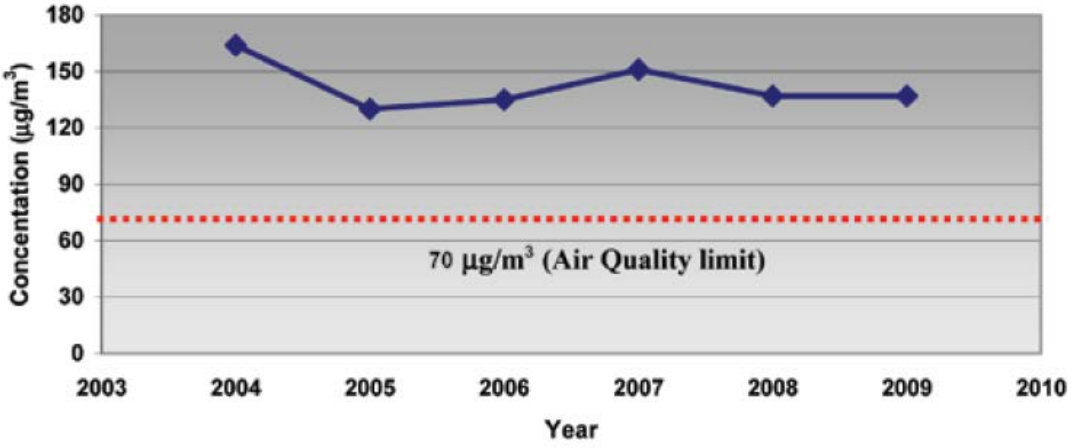

Figure 32 Annual average concentration of PM_{10} 2004-2009

Source: Egypt State of Environment

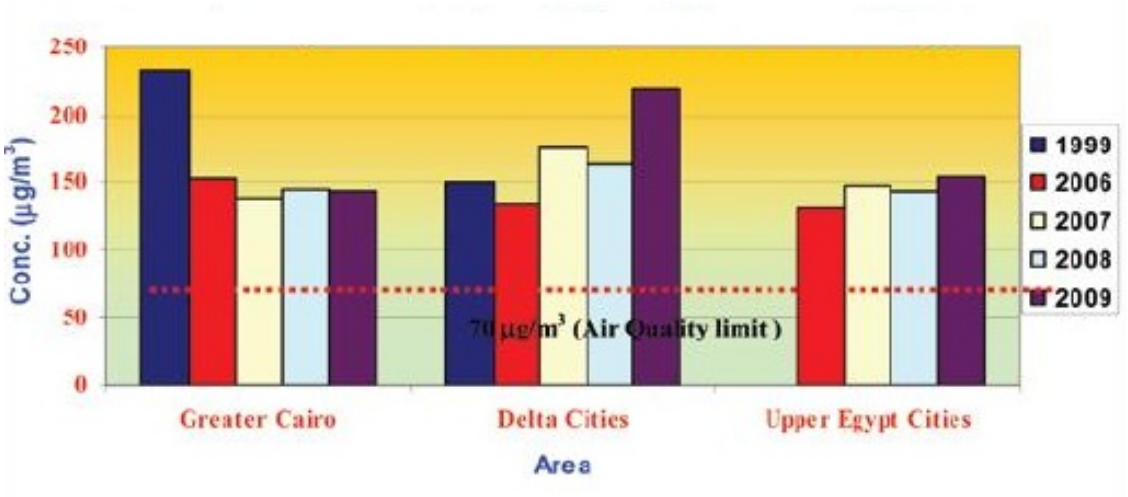

Figure 33 Annual average concentration of PM_{10} in different regions

Source: Egypt State of Environment

Lead

Lead is highly toxic and harmful for the human health. The main sources of the lead in the air are from fuel in vehicles, oil, coal and the industrial emissions. The available data of the average annual lead concentration is for Great Cairo which shows a significant decrease from 1999 till 2009 (Figure 34) due the 10 years program implement by The Ministry of the State and Environment in 1998 to 2008 for lead pollution reduction. However, the average annual concentration is still exceeding the limits. The limits are 0.5 (µg/m^3) in residential areas and 1.5 (µg/m^3) in industrial areas.

Figure 34 Annual average concentration of Lead 2004-2009

Source: Egypt State of Environment

Carbon Monoxide (CO)

Carbon monoxide is a colorless gas forms when the carbon in fuels doesn't burn completely. It is generated as emission from vehicles and combustion of wood and coal. The environmental law set its limits to be 30 (mg/m^3) for one hour and 10 (mg/m^3) for 8 hours. The available data in three areas in Greater Cairo; Fum ElKhalig, Heliopolis and Giza shows the average readings less than the limits (Figure 35).

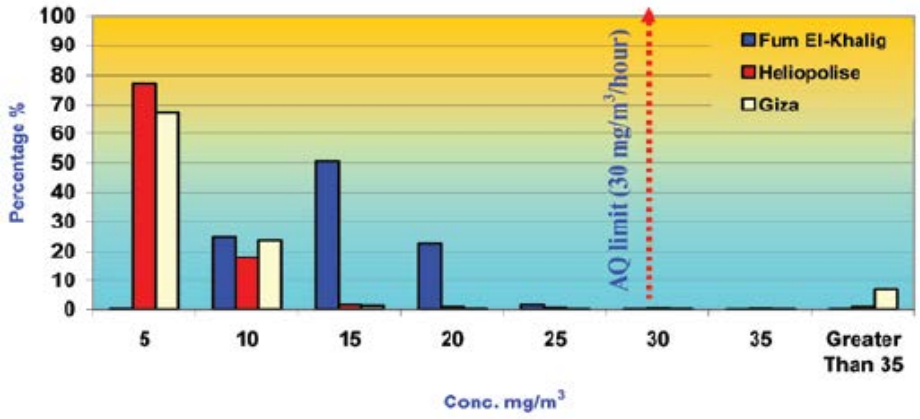

Figure 35 Hourly average frequent distribution of Carbon monoxide at different monitoring station 2009

Source: Egypt State of Environment

Ozone (O_3)

The ozone is a gas in the air and its impact depends on where it occurs. The harmful ozone which forms near the earth's ground at lower layers of the atmosphere is a result when the pollutant emissions from different sources react chemically in sunlight. Therefore the concentration of the ground ozone in Egypt is higher in the summer time than the winter time due to the increase of the sunlight hours. The environmental law set the limits for the concentration of ozone at 200 ($\mu g/m^3$) in one hour and 120 ($\mu g/m^3$) during 8 hours. The trend of the average annual concentration of O_3 in between 1999 and 2009 shows its peak in 2007 and started to decrease in 2008 and 2009 (Figure 36).

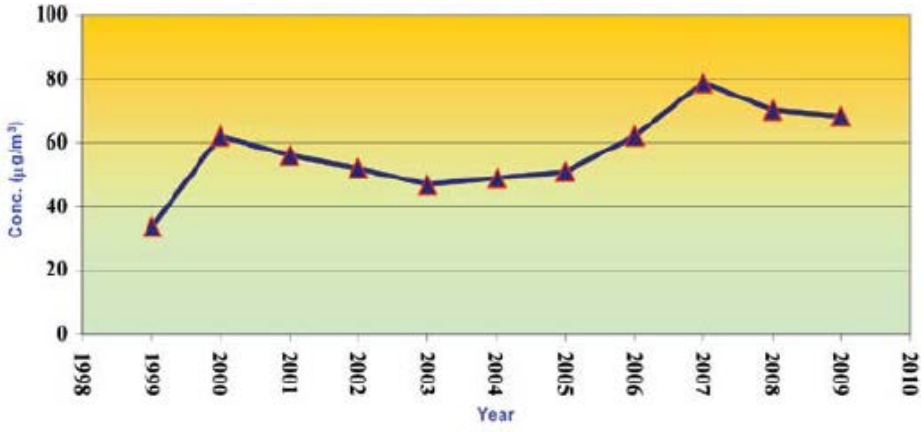

Figure 36 Annual average concentration of O_3 in different regions

Source: Egypt State of Environment

Black Cloud in Egypt

Black cloud in Egypt is a name for an old and chronic phenomenon in Egypt represented in a mass of pollutant air in some areas specially in Greater Cairo that darkening the sky. The black cloud brings pollution levels up to ten times the limits set by the World Health Organization. One of its main reasons is the burn of rice straw in huge quantities by the farmers followed by the increase of vehicles number and the industrial emissions[22].

[22] "A black cloud over Cairo | EOSDIS - Earth Data Website." 2011.

2.3.2 Noise Pollution

Noise pollution is an obvious problem in Egypt and a part of the problem is just related to the citizen's behavior to follow some rules to reduce the noise pollution. A noise monitoring network has been implemented in the Greater Cairo by The Ministry of State and Environment to measure the noise pollution in different areas and still developing to cover more areas, the areas are covered till now are the main squares in Cairo, industrial areas, commercial and administrative areas, areas located on main roads and residential areas. Most and almost all of the annual average levels in all these area in the day time and the night time are over the limits in 2009. The increase of the traffic density is a common source of noise pollution in most of the areas.

Noise Level in Main Squares

The average annual noise level exceeds the international limits at 80 dB in some of the main squares and this is due to the increase of the traffic density in these areas (Figure 37).

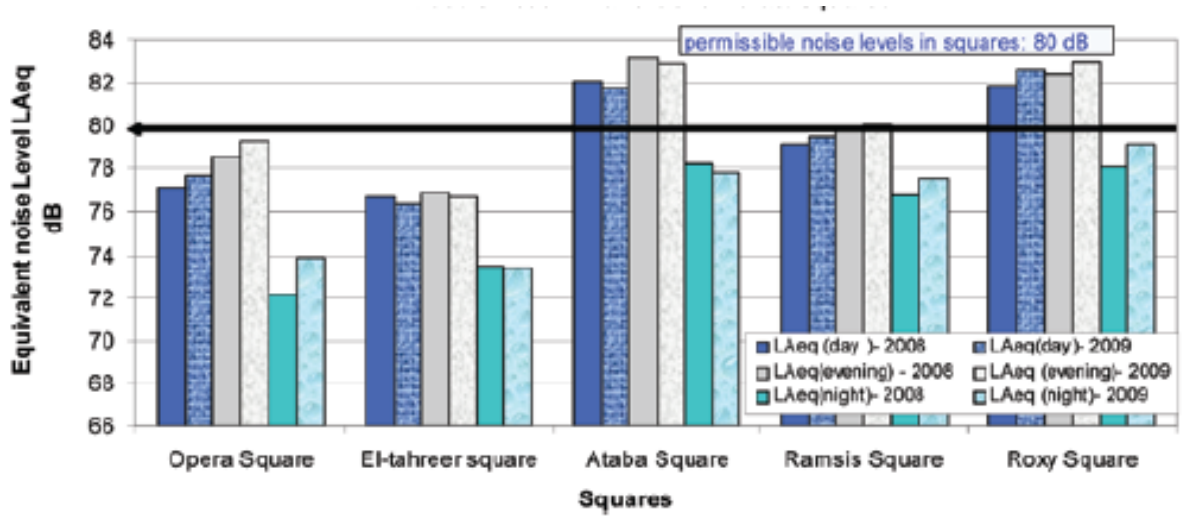

Figure 37 Equivalent noise levels for the three-day periods in main squares of Cairo 2009

Source: Egypt State of Environment

Noise Level in Industrial Areas

The measures shown below are taken for three different industrial areas and they all show exceed for the limits of the annual average sound levels (day time and night time) (figure 38).

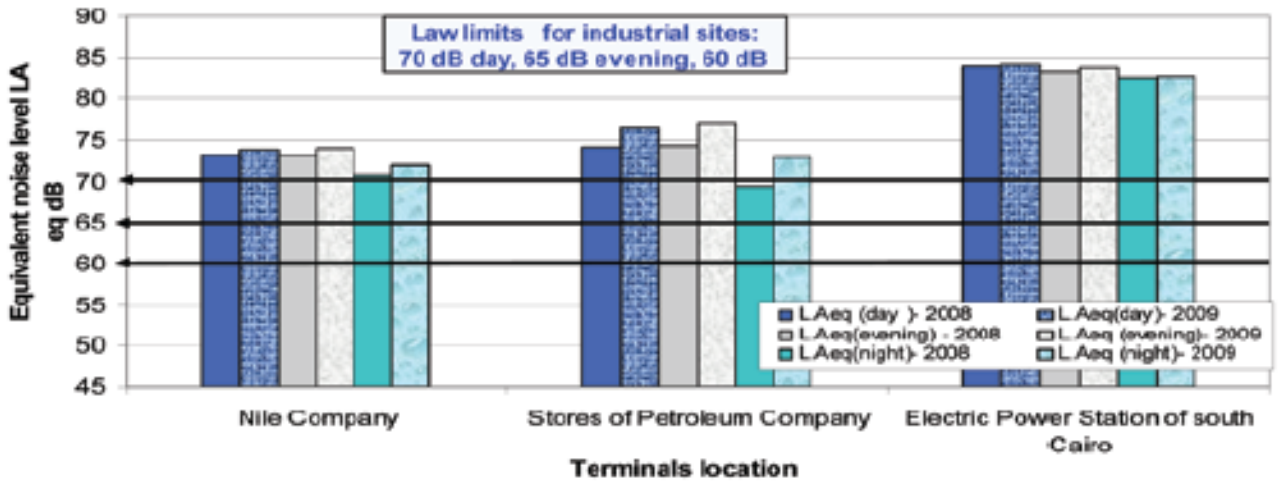

Figure 38 Equivalent noise levels for the three-day periods in Industrial areas in Cairo 2009
Source: Egypt State of Environment

Noise Level in Commercial and Administrative Areas

The annual average level of noise in the commercial and administrative areas located in the northern, eastern and western region exceeds the limits. Figures 39, 40 and 41 represent the equivalent noise levels for the three-day periods in commercial and administrative areas in the northern, eastern and western regions of Cairo in 2009.

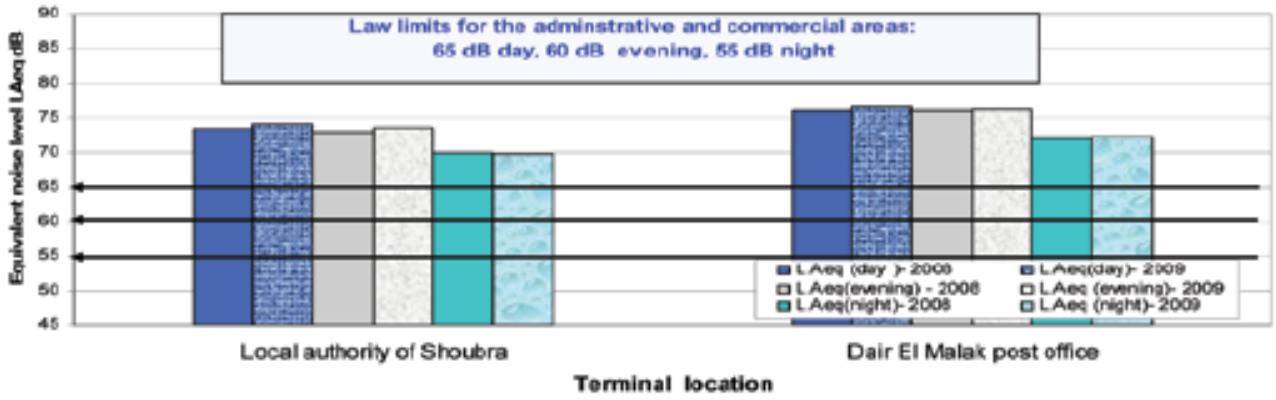

Figure 39 Equivalent noise levels in commercial and administrative areas in the northern region

Source: Egypt State of Environment

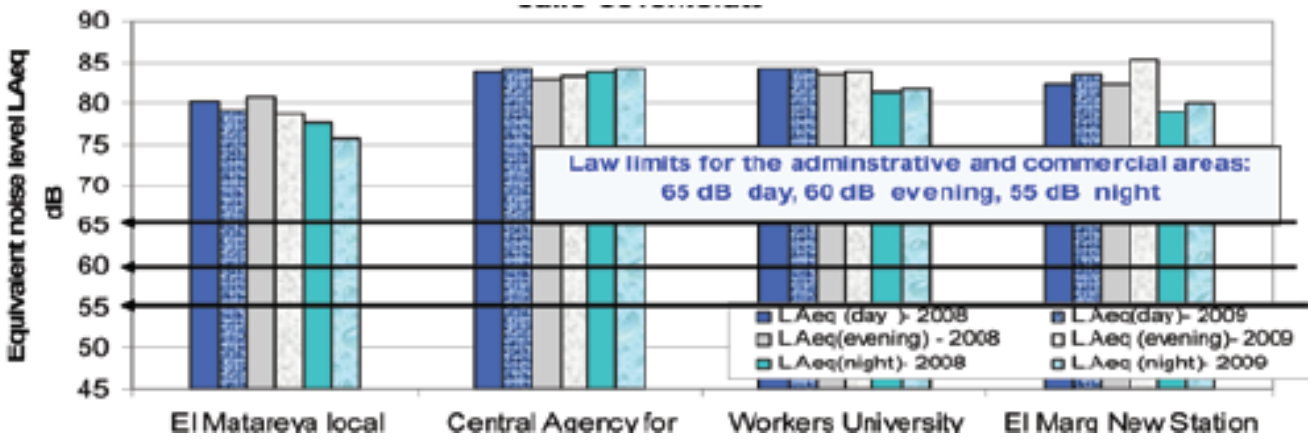

Figure 40 Equivalent noise levels in commercial and administrative areas in the eastern region

Source: Egypt State of Environment

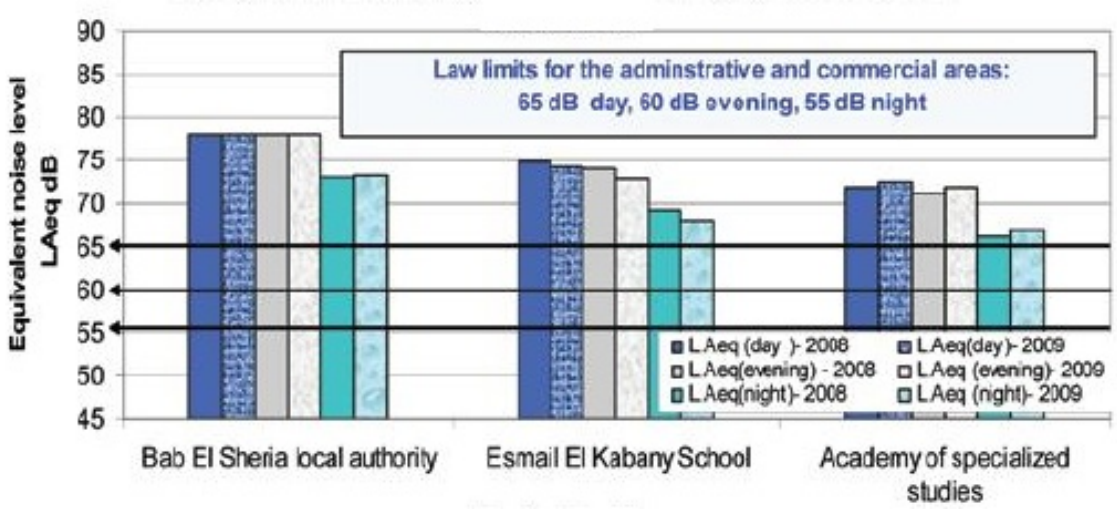

Figure 41 Equivalent noise levels in commercial and administrative areas in the western region

Source: Egypt State of Environment

Noise Levels in Areas Located on Main Roads

The annual average level of noise in areas located on main roads located in the northern, eastern and western region shows an increase from 2008 to 2009 and it exceeds the limits. Figures 42, 43 and 44 represent the equivalent noise levels for the three-day periods at the sites of commercial activities, workshops or located on public road in the northern, eastern and western regions of Cairo in 2009.

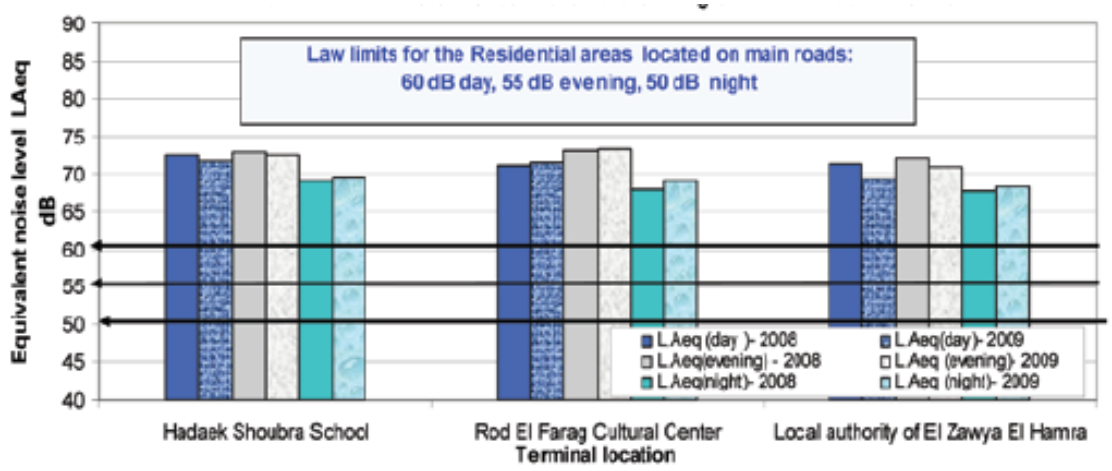

Figure 42 Equivalent noise levels in the areas located on main roads in the northern region

Source: Egypt State of Environment

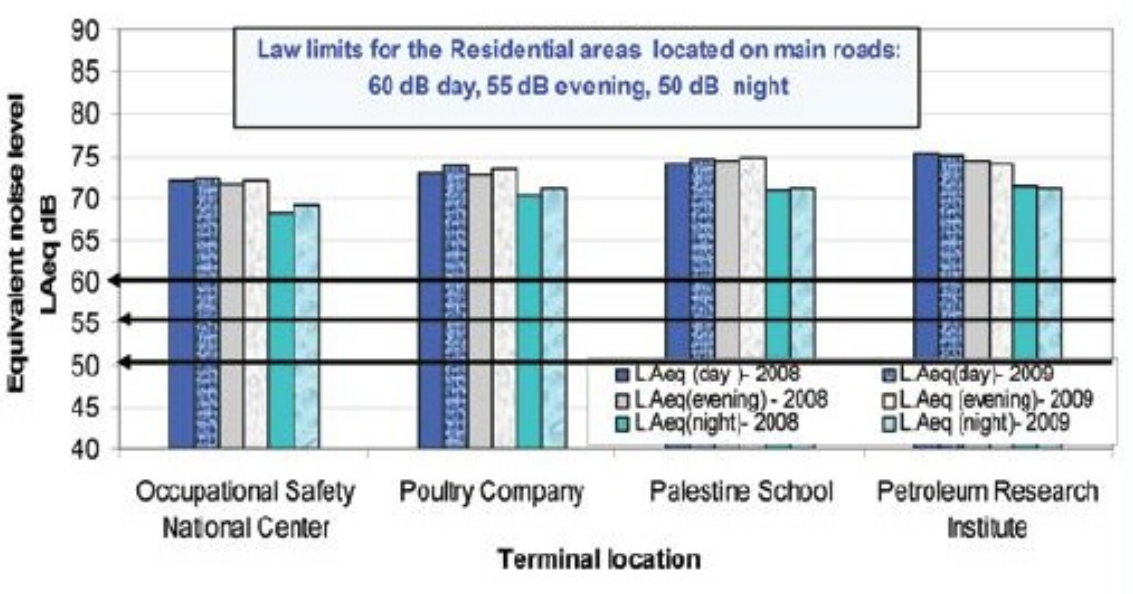

Figure 43 Equivalent noise levels in the areas located on main roads in the eastern region

Source: Egypt State of Environment

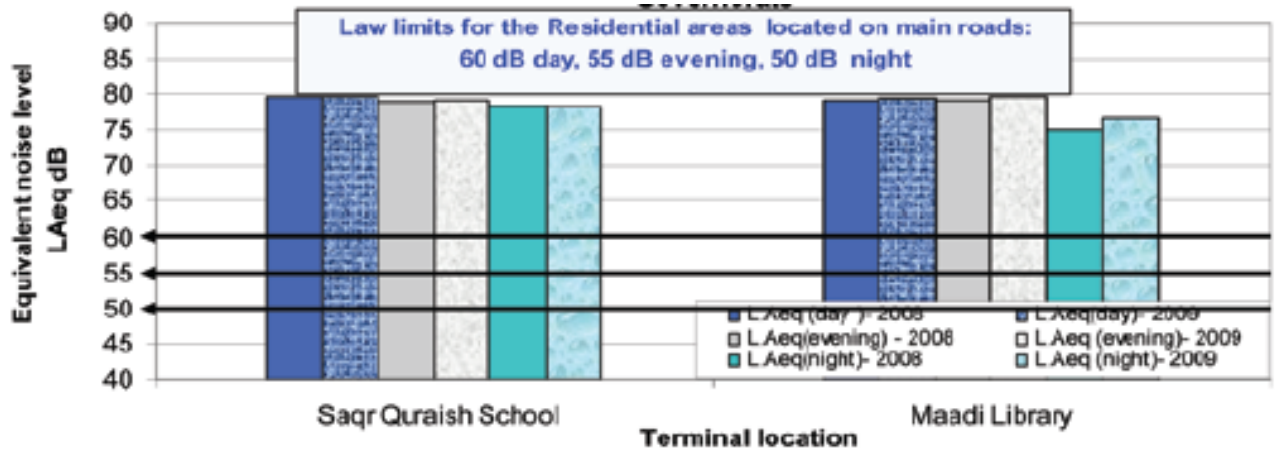

Figure 44 Equivalent noise levels in the areas located on main roads in the western region

Source: Egypt State of Environment

Noise Level in Residential Areas

The annual average level of noise in residential areas exceeds the limits (Figure 45). One of the main reasons of this increase in the average level of noise is the increase of the traffic density in these areas.

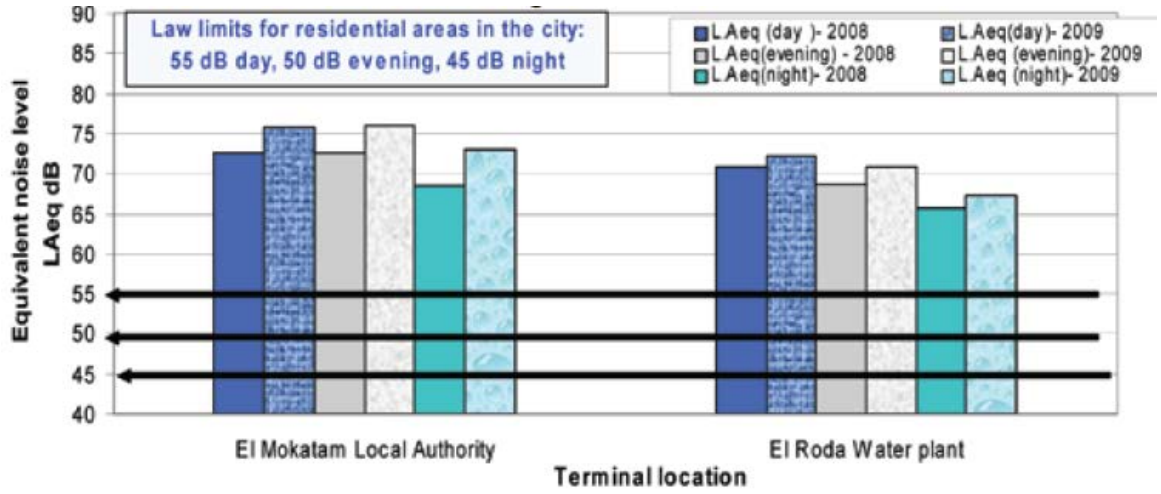

Figure 45 Equivalent noise levels for the three-day periods in residential areas in Cairo 2009
Source: Egypt State of Environment

2.3.3 Water Pollution

The water pollution in Egypt is a serious problem that comes from domestic, industrial and agriculture sources due to many reasons including the organic and inorganic pollutants and quantity of oxygen dissolved in the water. Other reasons are: the run off of excessive use of chemical fertilizers, the chemical waste, industrial waste (such as food, textile, cement and fertilizer factories), domestic wastewater that discharge directly in the Nile River, the lack of wastewater treatment facilities. All of that harm is leading to environmental, health problems and bad impact on the land use. Since the Nile River in passing across all Egypt and the population is concentrated around, it became an easy path for many harmful activities of waste disposal.

Pollution in the Nile Rive

Many monitoring stations for the water quality have been installed in the Nile River and its branches. The following measures have been taken:

Biological oxygen demand (BOD)

The average values in all the regions were below the limits in 2009, except in two regions where the values were very close to the limits (Figure 46). The period between 1997 and 2009 shows a significant decrease of the average value due to the efforts to reduce the discharge of wastewater into the Nile River (Figure 47).

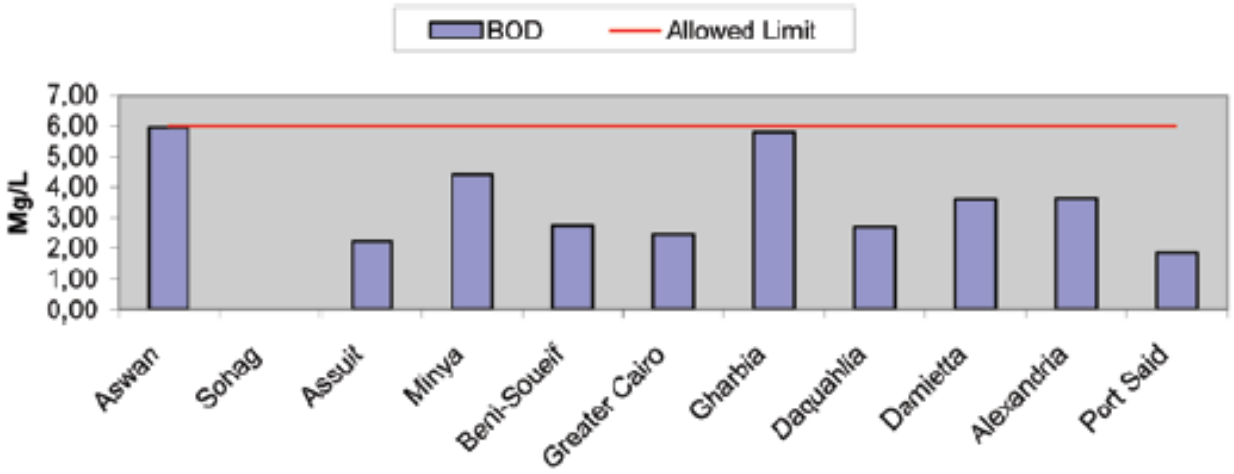

Figure 46 The average values of BOD among different regions in Egypt 2009

Source: Egypt State of Environment

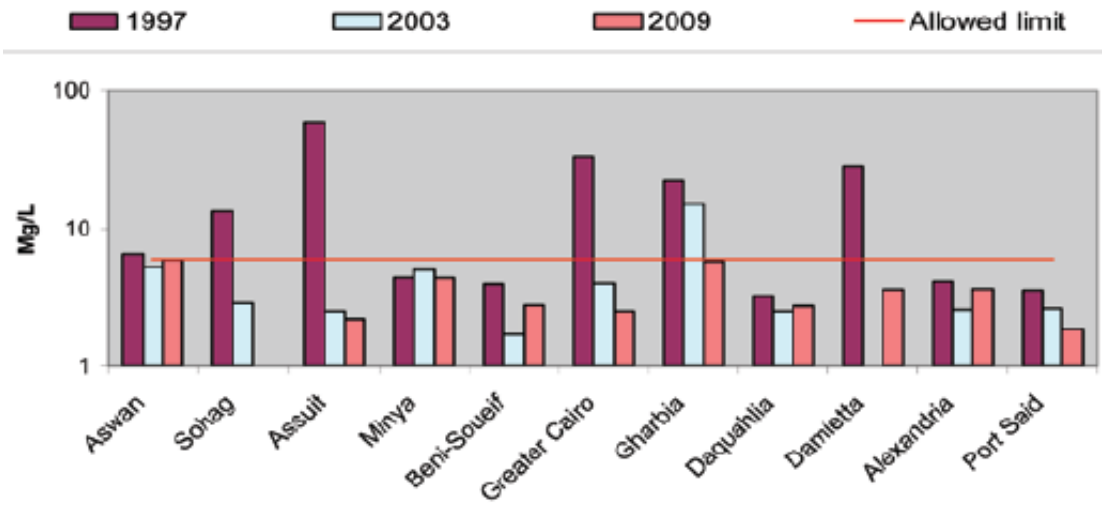

Figure 47 The average values of BOD among different regions in Egypt 1997 – 2009

Source: Egypt State of Environment

Chemical Oxygen Demand (COD)

The average of chemical oxygen demand (COD) is exceeding the limits in most of the Egyptians regions specially in Alexandria, Damietta, Beni Souef and Greater Cairo (Figure 48). The average values of COD in the period between 1997 and 2009, shows a significant decrease in the Greater Cairo and successful decrease to be below the limits in Assiut (Figure 49).

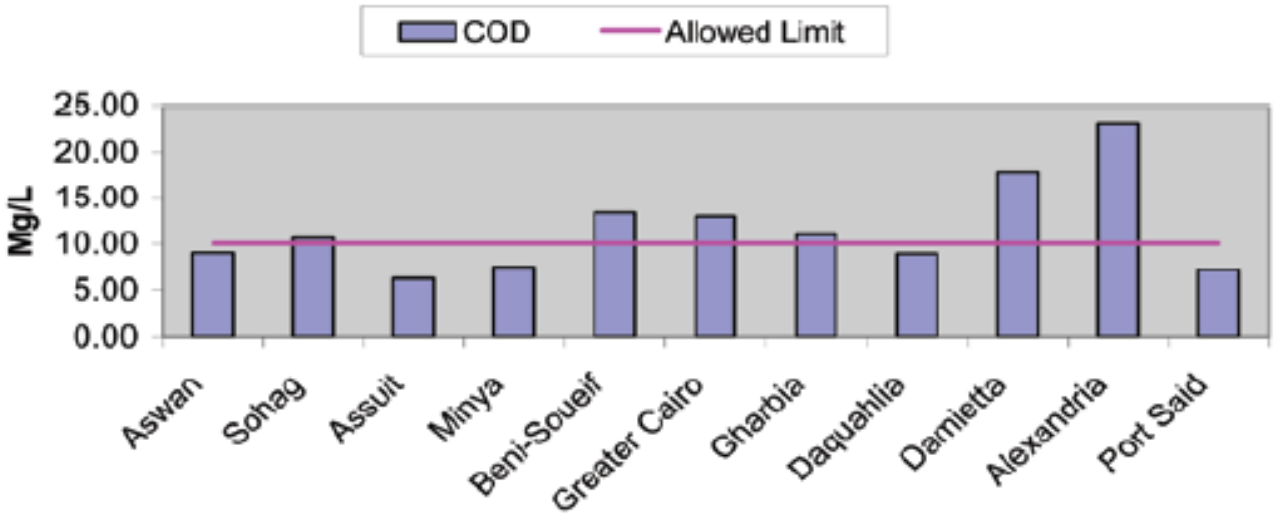

Figure 48 The average values of COD among different regions in Egypt 2009

Source: Egypt State of Environment

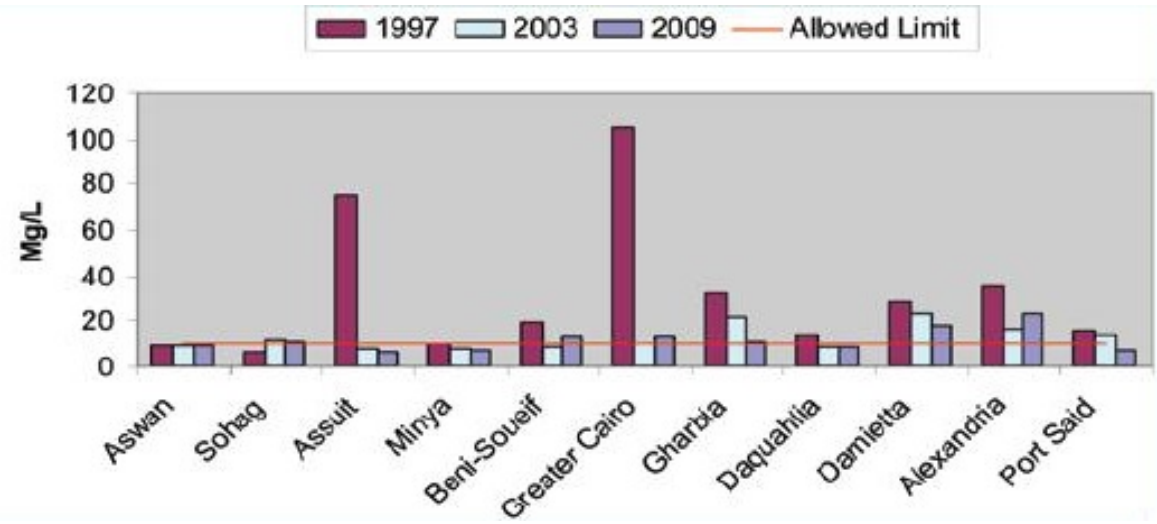

Figure 49 The average values of BOD among different regions in Egypt 1997-2009

Source: Egypt State of Environment

Dissolved Oxygen (DO)

The average values of the dissolved Oxygen in all the Egyptian regions are over the limits (Figure 50). The average values in the period between 1997 and 2009, shows a significant decrease in the Sohag region, but still exceeding the limits in 2009 (Figure 51).

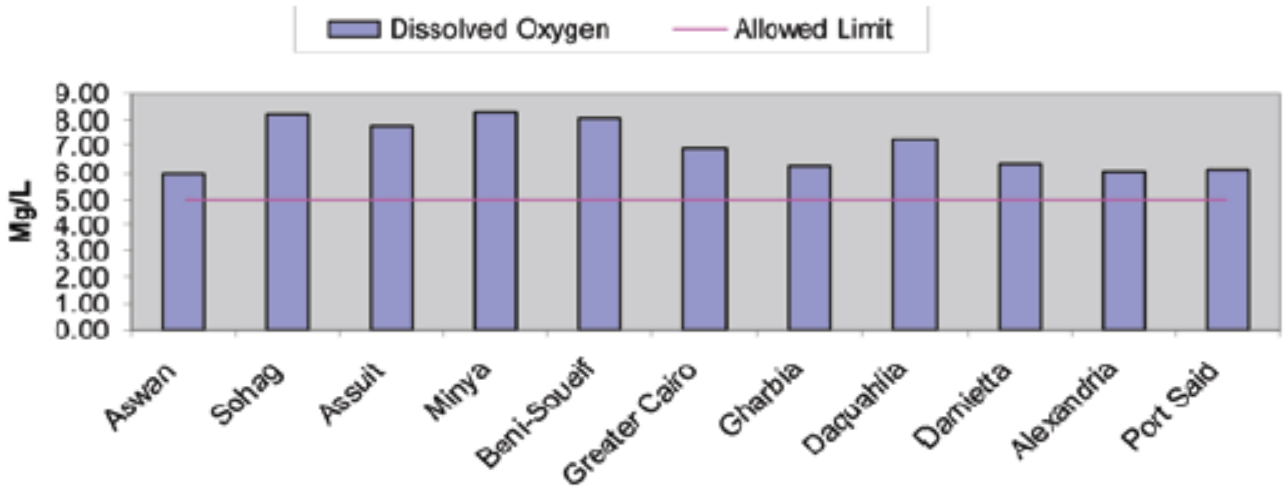

Figure 50 The average values of DO among different regions in Egypt 2009

Source: Egypt State of Environment

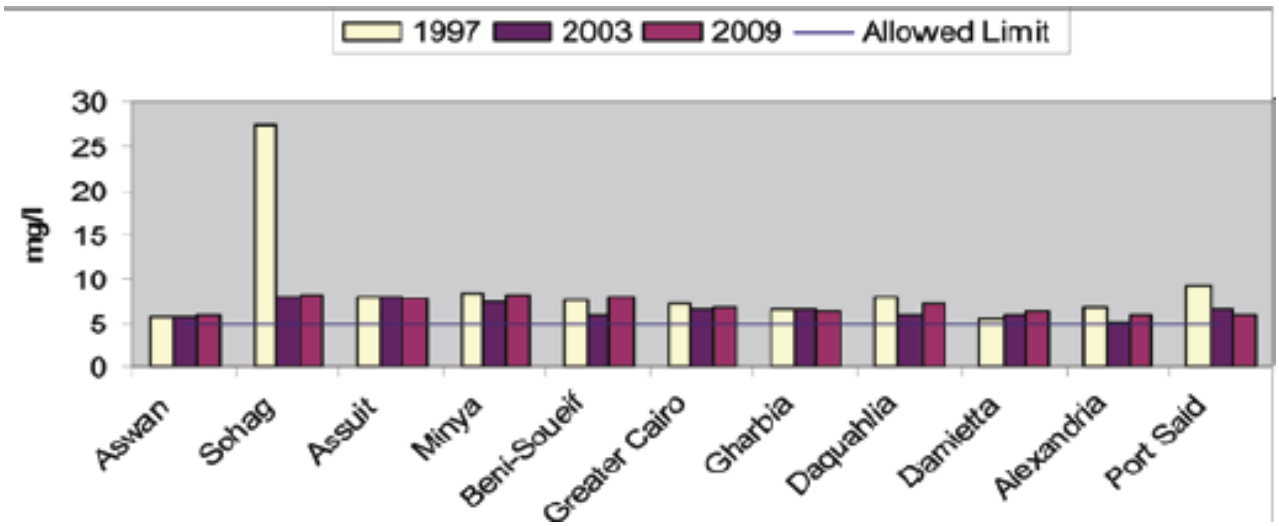

Figure 51 The average values of DO among different regions in Egypt 1997 – 2009

Source: Egypt State of Environment

Nutrients concentration (ammonia, nitrate and phosphate)

According to the data from 2009, the ammonia concentration was less than the limits (0.5 Mg/L) in all the regions except in Alexandria (0.57 Mg/L). The nitrate concentration was less than the limits (45 Mg/L) in all the regions. The phosphate concentration was less than the limits (1 Mg/L) in all the regions (figure 52).

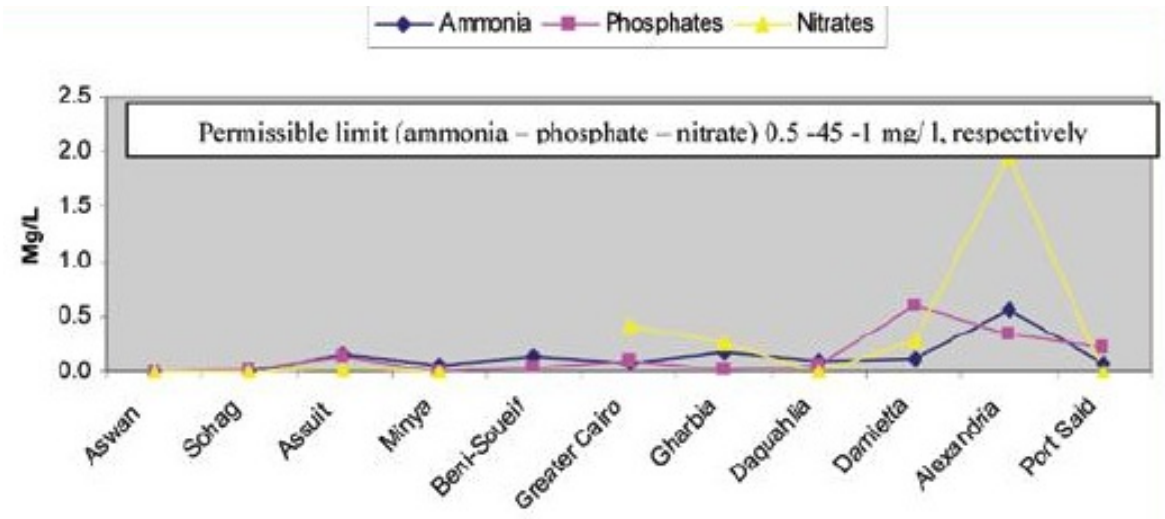

Figure 52 The average values of Nutrients among different regions in Egypt 2009

Source: Egypt State of Environment

The Total Dissolved Solids (TDS)

The average concentration total dissolved solid was less than the limits (500 Mg/L) in all the regions (figure 53).

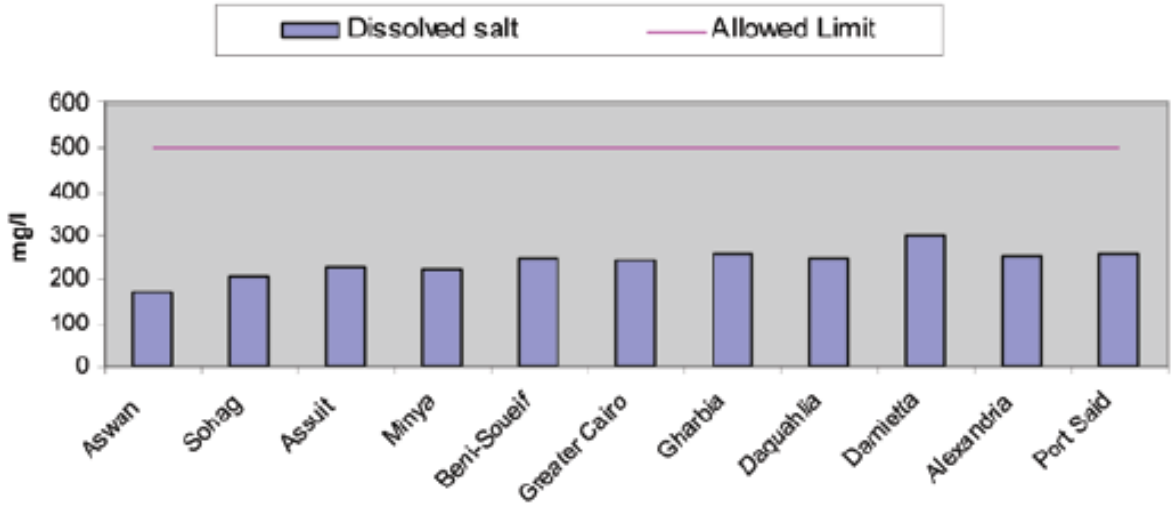

Figure 53 The average values of TDS among different regions in Egypt 2009

Source: Egypt State of Environment

3. Issues and Challenges

3.1 The Gap between Demand and Supply

Egypt is rich by its natural resources but recently there is a relevant gap between demand and supply in the water sector and energy sector. The expectation for demand in rising in electricity sector is 7% for the next years. Many are the reasons that created that gap. Some of them are explained in the following paragraphs.

Rapid Increase of The Population

Currently Egypt is ranked as the 15th most populous country in the world. The Central Agency for Public Mobilization and Statistics in Egypt estimated the population to be around 83,661,000 in January 2013. The population grow is around 1.7 percent and it is expected to be over 100 million by 2020 (Figure 54). The increase of the population is proportional to the increase of the demand for the energy and water. Figure 55 shows the decrease of water share per capita as a reflection to the increase of the population.

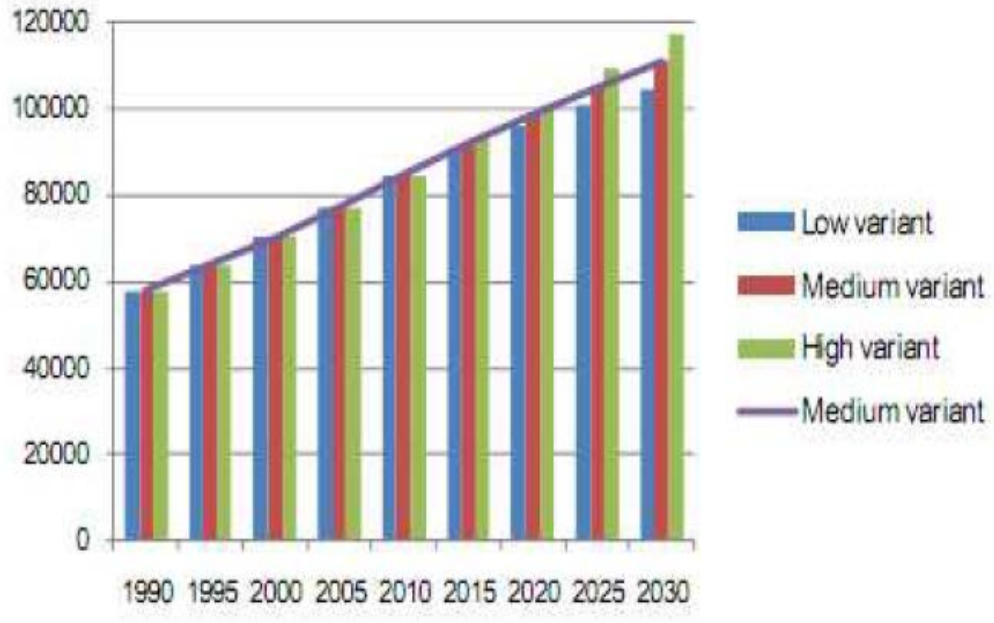

Figure 54 Historic and Future Population Trends in Egypt 1990–2030
Source: Francisco Figueroa de

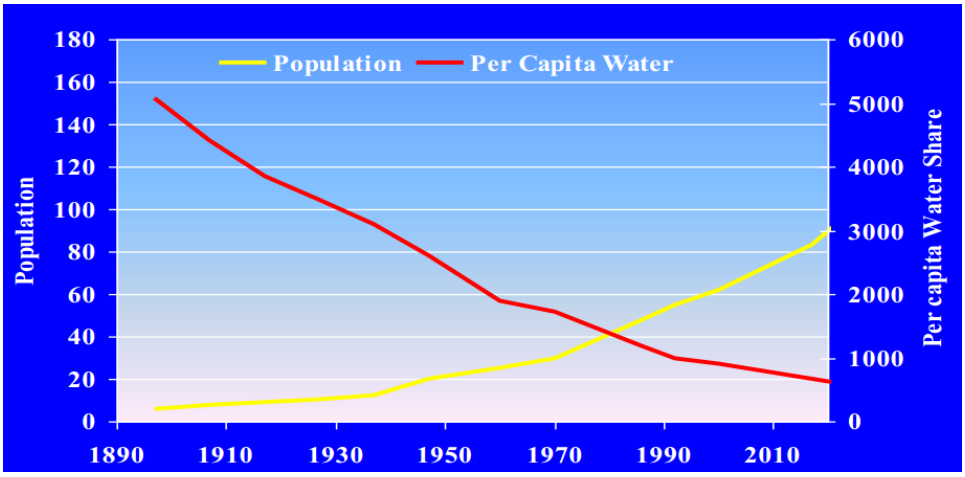

Figure 55 Water availability per capita

Source: Ministry of Water and Irrigation-Egypt

Economic and Industrial Development

Egypt's GDP witnessed a real increase of 5.0 % annually during 1993–99, which was similar to the average growth rate of 5.2 % annually during 2000–07, and reached to be 5.1% in 2010. But after the Egyptian revolution the GDP growth rate decreased to 1.8% in 2011 and closer to the lowest point in had in the last 10 years which was 1.7% in 2002.

The new government is planning to attract more investors to establish industrial projects in the country, when the political situation of the country becomes more stable. In that case the increased energy demand will need to be met.

Financing and Investments

Egyptian electricity consumption is increasing much faster than capacity expansions and new financed projects are needed. The development of the water and waste water system require also huge budgets.

Financing energy projects is a real challenge for the Egyptian economy: the government is planning to invest in the power sector over the next decade (plans on papers till it can find the money), while also seeking financing from external sources. The private sector, international organizations, and renewable energy funds such as the World Bank's Clean Technology Fund have all provided investment in the sector. The country moved towards private investments. The private investment in Egypt has steadily increased since the government noticed the importance of the private sector in the energy sector and the positive change that private investment brought to Egypt's energy sector without affecting the country's debit profile. Moreover the renewable energy sector needs private participation stays close. However prospects for private investment in Egypt are flagging. One of the main reasons is the unstable political situation. In the other hand the recent political changes have not affected Egypt's long term commitment to renewable energies and in terms of the general investment environment, the doing business index (DBI) by the world bank ranked Egypt at 109th out of 183 countries in the world and 11th in the Middle east and North Africa out of 19 (World Bank, 2012). The areas in which Egypt performed particularly poorly were "Enforcing Contracts" (ranking at 145)," Dealing with Construction Permits" (ranking at 165th) and "paying taxes" (ranking at 152th), which are critical for infrastructure energy investment.

The rapid increase for traffic density

The number of licensed vehicles is increasing by 15% annually in Egypt and the number of old car which is not maintained is significantly high in the streets. This causes a high consumption for the oil and gas and damages to the air and the noise pollution.

Subsidy Problem

One of the problems in the energy subsidy strategies in Egypt is that energy subsidies are often intended to support the poor but in practice they benefit the rich, since the higher income part of the population consume more of the energy products that are (directly or indirectly) subsidized by the government.

The second problem is their impact on the economy since the energy subsidies represent a continuous drain on Egypt's budget which is considered as low middle income economy country. The Energy subsidies amount to about 73% of all subsidies. The subsidies estimated in 2010, US$20.28bn, is more than the equivalent of the country's entire budgeted fiscal deficit of $19.2bn for 2010/2011, or 9.3 per cent of nominal GDP. More than half of energy subsidies are attributable to petroleum products, while one-third is accounted for by electricity and about 15% by natural gas. In addition to the high budgetary cost associated with the energy subsidies, artificially low energy prices result in an excessive energy consumption that has resulted in Egypt's switch from oil exporting to an oil importing country while also limiting the country's ability to export natural gas.

The third problem is the reform of the energy black market where the subsidized energy products like diesel, gasoline and LNG cylinders are offered for much higher price for the final customer due to some shortage in the market or even to be exported in illegal ways to be sold outside Egypt which cost to the government a big lost.

The water subsidy is also considered as a main reason of wasting a lot of water by the community in different level and also to maintain and enhance the services level by the government. The subsidy on water is about 80% in Egypt.

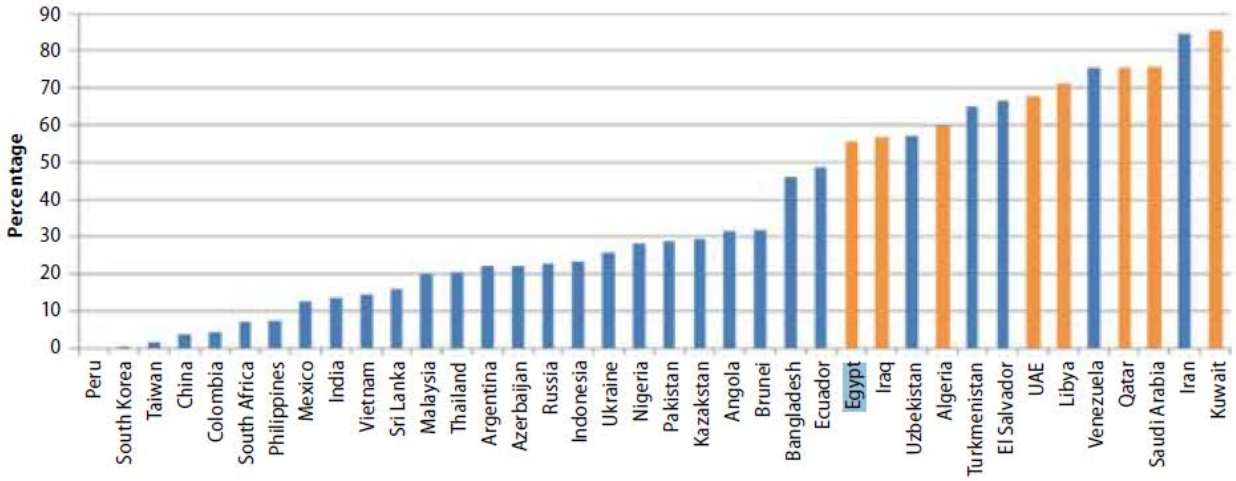

Figure 56 Average subsidization rates for domestic fuels in selected countries 2010

Source: IEA

Being dependent on the gas to produce electricity

As mentioned before about being depended on the gas for electricity generation, this lack of diversity of energy sources in Egypt is not only of concern from an environmental point of view, but it is also a source of concern from a national energy security point of view. For the future plans until 2017 the situation will not change much and the electricity will be still mainly depended on gas with just an increase of 5% of the total production from renewable resources but in the other hand a decrease by 2% for the hydro power. A more diversified energy base may hence make sense from more than one perspective in the long run (Figure 57).

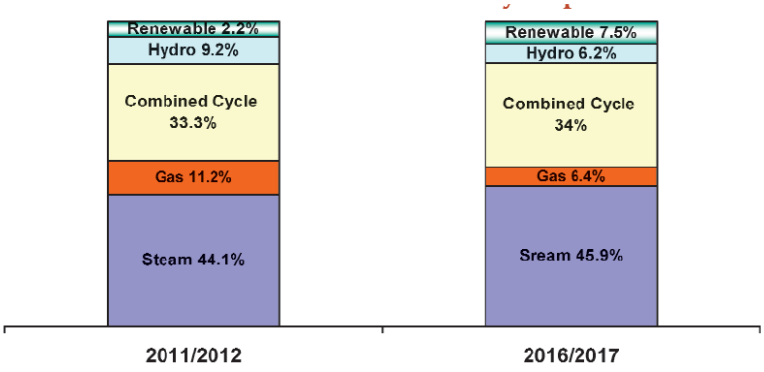

Figure 57 Installed capacity by type

Source: Egyptian electricity holding company report 2010/2011

Gas Export Commitments and Increasing Local Demand

The natural gas is playing an important role in the energy sector in Egypt, transportation and for the economic growth as exports. Egypt depends on natural gas to power its electricity plants; unfortunately, post-revolution complications with international contracts for exploration have led Egypt to export more gas which has affected the availability of the gas for the domestic usage for electricity production. Furthermore the increase of the demand in electricity consumption during the hot summer from one side and the aging of infrastructure from the other, all of that have led to intermittent blackouts. The summer of 2010 highlighted these problems, as the country experienced rolling nationwide blackouts which led to a number of protests in front of power plants.

The Unexpected Increase of Electricity Consumption

The unexpected increase of electricity consumption in the summer is new challenge for the electricity sector. The current overall peak summer demand is more than can be easily provided by the national grid. And one of the key factors of increasing the electricity demand in the summer is due to the hot weather and the significant increase of the air conditioners users.

The number of air conditioner units in Egypt was under 200,000 in 1999, rising to three million in 2009, and doubling to six million by 2012 due to the introduction of cheaper units to the market, accounting alone for 20 percent of energy consumption, which represented an unexpected increase[23].

The Lack of Awareness

The sustainability concept has to be implemented in the plans by the decision maker but also it has to be adapted by the community. The public communication is a very important and strategic task for applying the new policies in different sectors to raise the community awareness towards the importance of the sustainability, environment, rational usage and health issues, in order to have a positive feedback and result to the welfare of the country and for next generations.

[23] "Egyptian Electrical Holding Company."

4. Sustainability in Egypt

The concept of sustainability entered in some of the plan set by the Ministries in the last 10 years. National Water Resources Plan 2005 was launched by The Ministry of Water and Irrigation with support of the Government of Netherland; the Ministry of State for Environmental Affairs made a plan called The National Strategy for Sustainable Development and also has in its report 'Egypt State of Environment Report' started to introduce a chapter about green concepts. The issue of 2008 has part5: Global Environmental Trends, chapter16 called Green Cities, Green Building and Green Chemistry. And in the issue of 2009 has chapter 15 called Green Economy. In the National Strategy for Sustainable Development introduced in 2002, the government realized that the development plans without considering the three dimension of sustainability together (Economic, Social and Environment) leaded to increase the pollution rate, with a consequent unbalance between the supply and consumption and a need for more awareness towered the community. In the chapter of green economy in the Egypt State of Environment Report 2009 a summary about the moving towards sustainability in different sectors are highlighted below:

Energy Sector:

1- Ministry of Electricity plans to increase Egypt's consumption from renewable energy to reach 20% by 2020, distributed to 12% from wind energy and 8% from water and solar energy.
2- Ministry of Electricity aims to rationalize 20% of energy consumption by 2022 based on a plan to be implemented as of this year by offering 6.1 million energy-saving bulbs, Moreover, Ministry of Industry developed a plan to rationalize energy consumed in industry sector as of 2015.
3- Adjust pricing structure of oil products and restructure energy sector to ensure delivery of subsidy to those who really deserve it.

In the energy sector, the country is planning to reduce air pollution and introduce more solutions to protect the environment but it still needs raise the community awareness towards these projects and the benefits will come back to the society by implementing these projects and policies.

Transportation:

1- Replacing old taxi cars in Greater Cairo to reduce emissions of 264,000 tons of carbon dioxide annually, along with the socio-economic return of the project.
2- A program to convert public vehicles into gas-operated instead of benzene.
3- A law that prohibit the production and importation of 2-stroke motor bikes to reduce emission of air pollution.
4- Ministry of State for Environmental Affairs is about to initiate implementing pilot project for sustainable transportation systems.
5- The state supports public transportation systems by start implementing third line of the underground.

In the transportation sector, the country has to enhance the public transportation more to attract the people to use them and reduce using the private cars since the public transportation is not well maintained, not comfortable, buses do not have a timetable and all public transportation is totally crowded. The public transportation is still working on diesel and benzene and some of them have been converted to gas. It is recommended to introduce alternative green fuel options for the public transportation and to maintain them in a way that makes them more preferable to the people to use them to reduce the air pollution, noise pollution and the street traffic jam.

Industry:

1- Ministry of State for Environmental Affairs implements two programs for industrial pollution control (EPAP) and Environment Protection for both the private and public sector (PPSI). These two programs cover 120 projects to abate industrial pollution.
2- Encouraging shifting towards industries that rationally consume natural resources.
3- Redistribute industrial map of Egypt and settle industries in new cities.
4- Expand in providing subsidies for small and medium-size industries implemented in environmental field.
5- Reuse of water and control of industrial discharge.

In the Industry sectors, it is still cheaper for the factories not to respect the environment therefor with the each program the country is providing; the country has to develop the proper monitoring policy to have a complete environment management system. The

implementation of an environmental management system effectively is working on the reduction of environmental pollution in factories also it works to increase the volume of production as a result of lower volume of air and solid waste, liquid, and recycling the parts that don't get rid of it by reduction methods. This policy will lead to a reduction of the use of the resources that produce harmful pollutants, or to replace certain types of materials and other types of energy, and the use of materials and energy and raw materials in the manufacture of products most closely linked to the objectives of sustainable development.

Agriculture:

1- Achieve sustainable use of natural agriculture resources.
2- Concentrate on methods of integrated agriculture management.
3- Optimize water use in agriculture; improve irrigation less-consuming and adjust crops composition in favor of crops less-consuming water.
4- Recycle swage and agriculture wastewater.

In the Agriculture sector, the different awareness campaigns to the farmers about rational usage will support the goals of the ministry plan toward the sustainable development.

In the report of the Ministry of Planning 2011/2012 for the 2012/2013 plans, the country is looking to give the research priority to be oriented on the following topics:

1- Non-traditional Agricultural Techniques.
2- Renewable Energy and Nuclear Energy.
3- Water Usage Technologies.
4- Medicine Technology.
5- Nanotechnology.
6- Biotechnology and Genetic Engineering.
7- New Martials Technology.
8- Climate Change.

These areas of research are very important for the sustainable development for the country.

4.1 Sustainability in Education in Egypt

The Egyptian education system is the largest in system in The Middle East and North Africa.

The education in the national legislation in the Egyptian Constitution:

Article (18): Education is a right guaranteed by the state, which is compulsory in primary school, and the state is working to extend the obligation to other stages, and supervise the whole education, ensure exploitation universities and scientific research centers, in order to achieve linkage between the education and the needs of society and national production.

Article (20): Education is Free in the state educational institutions in various stages.

Egyptian Education law:

Law No. 139 of 1981 which is issuing and organizing the education laws in Egypt.

Article (1): aimed at pre-university education to educate the students culturally and scientifically from the mental, social, health and behavioral aspects, to prepare the student to be a believer of the God, his homeland, values of goodness, from the aspects of emotional and nationalism, mental, social, health, behavioral and Sports, with a view to the preparation of human Egyptian believer with his Lord and his homeland and the values of goodness, truth and humanity and provide him the appropriate values, theoretical and applied studies that achieve his humanity, dignity and ability to achieve the same and to contribute efficiently in the society activities, production, services or to continue his higher education and university education for the development of society and achieve prosperity and progress.

To achieve the sustainable development in the education system in Egypt, the education law needs to be reformed by adding the sustainable development goals to its aspects for preparing the students in all levels in the education system.

The Education System in Egypt:

Egyptian educational system is a centralized system under the control of the central government in Cairo, and is divided into several levels:

- Nine years of compulsory basic education consists of six-year “primary level" and, and three years "intermediate level".
- Three years of high school education level (general or technical).
- University Level or five years for advanced technical education.

The education as mentioned before is free in Egypt in the governmental educational institutes and the private educational institutes are also presented in all educational levels such as schools and universities where the students have to pay studying fees. The number of private educational institutions is increasing due to the lack of facilities and the very large number of students in the governmental educational institutions therefore the private educational institutions are providing higher facilities for reasonable a number of students plus the flexibility for students to join the department they like while the governmental institutions the students enter the university based on a high merit competition. The majority of the students are linked to the governmental education system which has less facility.

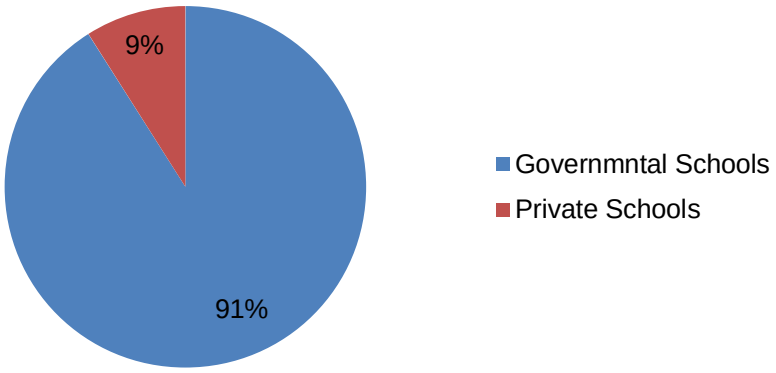

Figure 58 Percentage of students enrolled in governmental and private schools in Egypt Source: Central Agency for Public Mobilization and Statistics 2009

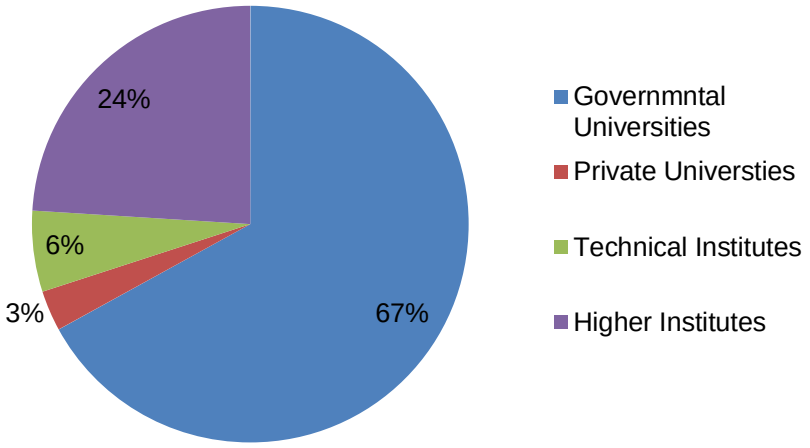

Figure 59 Percentage of students enrolled in governmental, private universities and institutes in Egypt
Source: Central Agency for Public Mobilization and Statistics 2009

In the different levels of governmental school, the concept of sustainability and green innovation is not represented in the courses and there is no such a course called sustainability. Followed by the governmental universities in the underground level where there is no presence in the sustainability development concept in the courses while it started to introduce in few universities one or two courses about sustainability. In the post graduate level there are many researches about sustainability in the technical and science universities.

4.3 New approach for the education (Recommended Actions):

The educational institutes buildings and facilities:

The rapid increase of population and the limited budget for the education leaded to a lack of the facilities in the educational institutions and to a non reasonable number of

students per classroom. The sustainable development courses considered to be practical courses where it needs to be teach in a proper environment where each student can fully understand the message and to have the ability to discuss but with the very large amount of students per class room and one teacher it is not possible to deliver the message in a proper way.

The Teachers and courses:

The lack of training and courses related to sustainable development in the preparing phase for teachers. To be able to ensure the sustainable development in educational institutes then it is important to prepare the teachers in the way that they will be to provide the proper and needed knowledge to the students. Therefor it is necessary to introduce the sustainable development concept in the teachers preparing phases for the new teachers and to make workshops, seminars and training for the current teachers.

The non-presence of the sustainable development courses or its concept inside the current courses is the second part of the challenge since the prepared teachers without the proper materials making an incomplete picture. It is important to start preparing the sustainable development courses from the school levels. It is important to prepare these courses with the cooperation between the ministry of the education experts, teachers from the schools, research centers and presenters from the society, from different ministries such as water ministry, energy and electricity ministry, environmental ministry, agriculture ministry and transportation ministry to be able to prepare a course that serve the Egyptian community and its real needs.

The courses need to be different than traditional teaching way which based on memorizing the contents and not to be only concentrating on the theories. The courses have to be covering latest topics in the sustainable development and to be always updated.

In schools level, it is important to cover the skills about how to live in a sustainable way regarding the usage of the resources and to go further by introducing the skills how to find innovative solutions to solve the society current problems. The courses have to match the country’s policies in the different sector and that’s why the ministries need to

be involved in preparing the courses to ensure that the courses goals will build the students skills in the way that will serve the society for the sustainable development.

In the university level, it is important to build the design, analysis and solving problems skills with respect to the sustainable development goals. The sustainability concept is more introduced in the post graduate studies and less promoted in the undergraduate level in universities. It is time to move from traditional way of considering only the economic and engineering aspects and to be more aware by the social and environmental aspects. The students have to be aware by the social science and the environmental laws. The natural resources management and the integration between all the stake holders concept has to be introduced.

The education in the governmental institutes in Egypt is neglecting the practical part by involving the students in real problem cases outside the institute due the large amount of students enrolled and since the sustainable development is connected with the environment and the society, it is important to focus more on the practical real cases outside the institutes to give the students the ability to apply what they have been studied in a way that can serve their society.

The coordination between universities researches and different ministries, institutes and the community is one of the barriers in the sustainable development future in Egypt and the research in all active Egyptian institutes itself is organized according to yearly plans, which are developed for budgetary purposes and typically reflect a compilation of individual initiatives. The lack of a wider national research plan negatively affects their orientation to local needs. Therefore it is important to have a long term sustainable development plan, to make the different sectors work together to achieve the sustainable development goals.

6. Conclusion

The opportunity to move toward sustainable development in Egypt has many benefits for the country. In the energy sector, the move toward renewable energy to meet the domestic demand will show positive impacts on the economic, social and environmental dimensions in the country. It will not only help to fill up the gap between the demand and supply for electricity but it will also help Egypt's strategic position and its international interconnections electricity grid, as an important key factor to make Egypt a main exporter for the clean energy.

Shifting to the renewable energy resources has also many environmental benefits. The pollution analysis shows the very low level of air quality in Egypt. The burning fuel in electricity production is one of the main reasons cause air pollution by emitting in the air sulfur dioxides, nitrogen dioxides and carbon oxide. The cause of indirect thermal pollution to the water can be related to its use as a coolant. The indirect impacts come from air emissions settling out on water and land. Renewable energy resources can provide immediate environmental benefits by avoiding these impacts and risks which will be better for the human health, ozone layer, black cloud and greenhouse effect issues.

Introducing the renewable energy in a big scale to the Egyptian energy mix will not only reduce pollution but they will provide also economic development, energy security and social benefits. It will make Egypt less dependent on the natural gas for electricity production: Egypt will be able to conserve the fuel resources for the future generation and allow the country to export the surplus. The renewable energy sources do not depend on the oil and natural gas market therefore their price are not related to price fluctuations in that market based on the demand and supply. This represents an important issue and can be a part of the solution for the subsidy problem in the electricity sector in Egypt and the subsidy for the fuel used to generate electricity. The renewable energy projects will also create many job positions in its sector, involving competences in the operations, maintenance and construction.

There is a balance need between the development required and the environmental and social requirement which can be expressed by the term sustainability. The sustainability usage concept for the natural resources should be adapted by the planner and the community. The sustainability is an approach helping the community to better use the resources, safeguarding the environment and considering the need for the future generation: decisions made today are affecting the future and if the natural resources are depleted faster than it can be generated, the world will suffer from their scarcity.

The public awareness of the sustainability concepts needs to be promoted by the government departments, institutes, NGO's and to be introduced in the education courses in schools and universities. A part of the public awareness is to make the people participate in different activities related to the sustainability and rational usage concepts because they are not only theoretical concepts. To apply the sustainability and rational usage concepts by the community, they need to adapt new life style, new skills change their current behavior and have a new vision. Therefore the public awareness is an important factor to ensure the success of the sustainable development.

The introduction for the green innovation concepts and the sustainability development are very important aspects to be launched in the Egyptian schools and universities: educated minds are not only needed in the research centers but instead spread in the country to all the stakeholders.

Educating the community regarding the requirements of the green and sustainable future will have an impact on the economy, the natural resources and the environment within the country and, in the long term, globally. By introducing more technical courses and improving the research within the green innovation and sustainability development, students will be helped to solve their country's problems with the best solutions that respect the community culture, their environment and represent the best solution for the economy.

This type of education which provides new concepts to the community is aiming to increase the awareness of the community. It is also preparing the students to transform their community in the future and contributing in the global goal of the sustainable development.

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